

Instructor:	Lawrence Yee
Office/phone:	S 226/755-6887
Office hours:	MW 12:30-1 pm, M 5:50-6:05 in S205
Prerequisites:	Chem 12A with grade of C or better
Course materials:	TEXT " Organic Chemistry ", D. Klein, 1 st or 2nd edition Chem 12B web site: http://ccchemteach.com Chem 12B Lab Experiments (FREE – go to Chem 12B site) Safety goggles or safety glasses Calculator Alchemie Mechanisms app (iOS and Android), \$9.99 Gradescope.com to take online Quizzes and Exams - FREE
Recommended Materials:	Molecular Model kit Marvin Sketch chemical drawing software – FREE Alchemie ModelAR app (iOS and Android) - FREE

COURSE DESCRIPTION

- Organic Chemistry II covers the structure, reactions, and synthesis of alcohols and ethers, dienes and aromatics, aldehydes and ketones, acids and derivatives, and amines. Nomenclature of organic compounds, stereochemistry, reaction mechanisms, and structure determination/characterization will be discussed.
- This course consists of lecture and lab. Hands-on work and group work will be used to help you learn and understand organic chemistry. Your learning depends on you; you are responsible for your learning. This course is fast-paced and covers a lot of material. Each successive topic builds upon previous topics. To maximize your learning of organic chemistry, focus on the topics covered in lecture, relate these topics to the content in the textbook, try working questions/problems at the end of each chapter, and review frequently. Focus on important points that are covered in lecture and ask questions over material you don't understand. After each class, review your notes and the assigned chapter and try working more questions/problems. When questions arise, please ask! I am available during office hours or by appointment. In addition, ACCESS Program study sessions and tutoring will be held available for related problem-solving practice.
- Chem 12B is a 5 unit course. You are expected to work/study/practice 15 hours per week (9 hours for lecture, 6 hours for lab) in this class.

COURSE OBJECTIVES

1. Review CHM 12A substitution, elimination, addition, and acid-base reactions.
2. Identify and understand an organic oxidation and reduction reactions.
3. Apply substitution and elimination concepts to ethers and epoxides.
4. Determine (characterize) the structure of a compound using IR, NMR, MS.
5. Identify a conjugated diene and understand electrophilic addition reactions of dienes.
6. Identify an aromatic compound and apply substitution, elimination, and oxidation-reduction principles to aromatic side chain reactions.
7. Apply addition and elimination concepts to predict electrophilic aromatic substitution reactions (EAS) of benzene and monosubstituted benzenes.
8. Understand electrophilic aromatic substitution reactions (EAS) of di and polysubstituted aromatics.
9. Understand nucleophilic addition reactions of O and C nucleophiles to C=O compounds
10. Understand nucleophilic addition reactions of N nucleophiles to C=O compounds.
11. Apply acid-base principles to organic acids.
12. Apply nucleophilic addition and elimination concepts to nucleophilic acyl substitution reactions of acids and derivatives.
13. Apply nucleophilic addition and elimination concepts to enols and enolates reactions.
14. Apply acid-base, substitution, and elimination principles to amines.
15. Develop synthesis strategies for organic synthesis.
16. Apply organic chemistry lab skills, which include the proper use and operation of organic lab chemicals, equipment, instruments, lab techniques, and safety procedures, to experiments.

STUDENT LEARNING OUTCOMES

By the end of the course, you should be able to apply the course objectives to:

- (i) Given the name of an organic compound, relate the physical properties, chemical properties, and uses to the compound's major functional groups and structure.
- (ii) Given reactants, predict products and propose mechanisms for organic reactions.
- (iii) Given an organic compound, design a synthesis.
- (iv) Given IR, NMR, and mass spectrums, deduce the formula and structure of organic compounds.

(v) Demonstrate proficiency in basic laboratory skills used in organic chemistry.

ASSIGNMENTS AND GRADING

Your CHM 12B Course Grade (lecture and lab) will be based on your mastery of the 16 Course Objectives.

A = demonstrate knowledge, comprehension, application, analysis, synthesis, and evaluation of concepts and principles

B = demonstrate knowledge, comprehension, application, and analysis of concepts and principles

C = demonstrate knowledge and comprehension of concepts and principles

Your mastery of each Course Objective will be evaluated with these Graded Assignments you will do each week:

- Quiz (15-20 minutes) or Multi-Objective Test (30-45 minutes).
- Lab Activity.
- Alchemie Mechanisms Homework (most weeks).
- You are expected to work/study/practice 15 hours per week in this class.

Your Chem 12B grade consists of 11 Quizzes, 4 Multi-Objective Questions, Biology/Industrial Reactions Application, 12 Alchemie Mechanisms homework, and 15 Lab assignments. Every student will have an Incomplete Grade in this course until every assignment has been completed. Your Course Grade will be determined at the end of the semester when you have completed all course assignments based on the following criteria:

Grade	Quizzes	4 Multi-Objective Questions	Bio/Ind Rxn	Homework	Lab
A	Pass (Master) 10 of 11	Pass (Master) 3 of 4 Questions	B (>80%) or higher	≥ 87.5%	≥ 87.5%
B	Pass (Master) 9 of 11	Pass (Master) 2 of 4 Questions	B- (>75%) or higher	≥ 75%	≥ 75%
C	Pass (Master) 7 of 11		Complete		≥ 60%
D or F	Pass (Master) less than 7				

A ≥ 87.5%, B range (75-87.5%), B- = 75-79.9%, B = 80-84.9%, B+ = 85-87.4%, C = 60-74.9%

Example: A CHM 12B student passes 9 Quizzes, passes 1 Multi-Objective Question, 65% on Bio/Ind Rxn, 75% on Homework, and 80% on Lab earns an overall C grade.

11 Quizzes (weekly)

Each Quiz will evaluate ONE Course Objective and will be given every Wednesday. You will have 30 minutes to complete the quiz. *Make sure you are available to take the Quiz on Wednesday between 6 pm and midnight.* You will be allowed to use your book and notes. Each Quiz will consist of 4 or 5 questions and will be graded **Pass (Master)/Not Pass (Master)**. *A Pass (Master) Grade (80% or higher) means you have mastered that Course Objective. If you do NOT Pass (Master) a quiz, i.e., do not master a Course Objective, you can retake Quizzes 1-3 on 2/15/23, Quizzes 4-6 on 3/15/23, Quizzes 7-8 on 4/12/23, and Quizzes 9-11 on 5/10/23.*

Four (4) Multi-Objective Questions

Each Multi-Objective Question will evaluate several Course Objectives and will be given on Wednesday, 2/15/23, 3/15/23, 4/12/23, and 5/10/23 between 6 pm and midnight. You will have 30 minutes to complete the Question, like a quiz. Each Question consists of one question with up to five parts; the question will be **Pass (Master)/Not Pass (Master)**. *A Pass (Master) Grade is 80% or higher. Make sure you are available to take the Questions on these days and times.* You will be allowed to use your book and notes.

We will use Gradescope for online Quizzes and Exams this semester. Go to [gradescope.com](https://www.gradescope.com) (<https://www.gradescope.com/>). See <https://help.gradescope.com/article/qj7gm49peg-student-add-course> for more information.

Biology Reaction or Industrial Reaction Application

You will work in a group of 2 to 4 to apply 2 or more Course Objectives (except Objective 16) to a biology reaction or industrial reaction. The number of group members = number of Course Objectives in your biology reaction or industrial reaction. Each person is responsible for one reaction. Your group should check each reaction.

Your Biology or Industrial Reaction must be reaction types we have covered in Chem 12B this semester.

For each reaction, identify the reaction type, structural features, and reactive sites, e.g., alpha carbon, describe the mechanism using curved arrows, and other concepts that are important in the reaction. Other concepts may include resonance structures and stability, formal charge, configuration of reactants and products.

Submit your group names, biology reaction or industrial reaction, and Course Objectives covered by 5/1/23.

Submit (by e-mail or share via Google Drive) your Bio or Industrial Reactions Application presentation slides to me by Wednesday, 5/17/23 at noon. I will post your slides on the Chem 12B web page.

Each group will evaluate 2 presentations by Friday, 5/19/23 at noon. You will submit your review of each group's presentation on a Google form.

Extra Credit added to Bio/Ind Reaction grade: BACON (Biology And Chemistry Online Notes). These tutorials are biology reactions that are explained with organic chemistry. We will review some of these bio reactions in lecture. THESE BIO REACTIONS ARE POSSIBLE REACTIONS YOU AND YOUR GROUP CAN DO FOR YOUR BIOLOGY OR INDUSTRIAL REACTION FINAL EXAM PROJECT.

11 BACON tutorials @ maximum 10% of **Bio/Ind Reaction** Extra Credit. The cost is \$6 to do these BACON tutorials (funds go to the developer at UCLA). Go to LearnBacon.com, click "Sign Up" to create an account. Follow the instructions and then register for Hartnell College - CHM 12B. When prompted, enter this PIN: HC12B\$. Each tutorial has specific start and end dates during the semester. Take the Quiz at the end of each Tutorial. Your Quiz Score determines your Extra Credit.

Do NOT miss Multi-Objective Questions, Quizzes, or the Bio/Industrial Reaction Application. If you know you cannot take a Question or Quiz on the scheduled date and time, inform me as soon as possible before the Question or Quiz in **writing** and reschedule the exam. Missing a Question or Quiz without valid reasons will result in a not pass grade.

Homework

You have to put in the study time (2 hours of deliberate, active practice for every lecture hour) to do well in this class. A Homework assignment will be posted on the Chem 12B Homework page after each lecture. Homework consists of textbook readings, videos, online practice problems (ungraded b/c answers are given), and GRADED assignments using the **Alchemie Mechanisms** app (you used this app in Chem 12A or \$9.99 for full access). There will be 12 Alchemie Mechanisms homework assignments this semester. Each Mechanisms Homework is due Thursday at noon. Late Alchemie Mechanisms Homework will NOT be accepted.

After you download the app (<https://www.alchemie.ie/mechanisms>) onto your tablet or phone, click on "sign in" (upper right corner) to create an account. After you verify your e-mail, click on the gear icon (upper left corner) and use this course code: 4mstks

NOTE: 1. You have to register to earn credit for doing each Mechanisms homework assignment.

2. You will earn a homework grade for the Mechanisms exercises you do this semester.

Other **Homework** includes **Retrieval and Deliberate Practice of course material**. While reviewing course material, practice retrieving the information and develop your problem solving skills by doing the Quiz Practice Problems (with solutions) on the Chem 12B website, textbook problems, or both spaced over time. This will help your long term retention of these concepts.

Laboratory

In science, observations are made to discover, learn, and understand what's going on in nature. In science courses, hands-on activities are the best way to make observations and learn science. As such, the laboratory is a very important part of this course. You may be asked questions related to these labs on lecture quizzes. In Chem 12B lab, experiments demonstrate and elucidate concepts discussed in lecture. You will synthesize, separate, isolate and characterize organic compounds using organic chemistry microscale lab techniques. You will also gain an awareness of organic substances. Although many organic substances pose safety concerns, e.g., flammability, toxicity, mutagenicity, carcinogenicity, the Organic Chemistry lab is a safe environment as long as you are aware of the nature of these substances and their proper use and handling. Guidelines for lab procedures and lab safety are described in the Chem 12B Lab web page. Part of your lab grade will be based on a "lab safety factor".

Science is a collaborative endeavor. Employers value employees who know how to work as a team. You will work in a group of 2 in lab. Make sure each team member contributes equally to each experiment. However, each student is responsible for doing each lab assignment individually. **Expect to spend the entire lab period in lab.**

Your **Lab Grade** consists of:

15 Lab Activities (weekly)

Lab Activities are designed for you to apply and practice the objectives discussed in lecture to lab and to develop skills in collecting data, analyzing data to obtain results, and interpret your results to draw conclusions. I encourage you to work with your lab partner or other Chem 12B students on these Lab Activities but **you must submit each Lab Activity individually** due at the end of each Wednesday's lab.

There are 15 Lab Activities. Each Chem 12B student will do Lab Activity C. You will work on Lab Activity C with another group. On the week you do Lab Activity C, you do not have to do the scheduled Lab Activity.

Lab Safety Factor

The Lab Safety Factor will be determined by your lab instructor at the end of the semester. It will be based on your attendance (including *being on time*), your timely submission of lab assignments, your observation of lab safety rules and regulations, your lab technique, and your initiative and cooperation (ability to do your own work and an equal share of group work, ability and willingness to work, collaborate, and cooperate with other students). If you arrive late; hand assignments in late; do not observe lab safety, e.g., don't use eye protection, endanger the safety of your peers and

instructor; have poor lab technique, or no one likes working with you, you will receive a low lab safety factor grade and a lower lab grade.

Lab Policies

1. Safety glasses or goggles and other appropriate personal protective equipment (PPE) are required in lab. For students who wear contact lenses, you will need to wear safety glasses/goggles over your contact lenses. Try to be aware of your safety as well as the safety of others in lab.

2. **ALL LABS MUST BE PERFORMED TO PASS THIS COURSE.**

3. Late lab assignments will be penalized 5% per calendar day.

4. FAILURE TO CHECK-IN YOUR LOCKER, whether you drop the course or complete it, results in a \$25 LAB FEE plus a charge for any broken or missing equipment.

5. The chemistry lab has 14 computers.

a. You **cannot** store your lab data and results on the hard drive of a computer you are using. Please bring a flash/thumb drive to store lab files.

b. Each computer is connected to a network printer. You will need to supply your own printer paper.

c. These computers are connected to the internet so you can look up scientific information. Please do not download images, files, or software onto these computers.

College Policies

Incomplete grades will only be given to students who are Pass (Master)ing the course, have completed at least 70% of the course requirements, and have special circumstances that prevent completion of the course.

The **Attendance Policy** states that "a college student is expected to attend all of his/her class sessions". Students who do not attend the first class meeting will be dropped and will be replaced by other students unless the student notifies the instructor in advance. **Non-attendance does not automatically drop you from the course.** You must submit the appropriate forms to the Admissions Office to drop or withdraw from any course at this College. Failure to submit the proper forms will result in a failing grade (F) for the course.

The Department of Supportive Programs and Services (DSPS) coordinates academic accommodations for students with documented disabilities at Hartnell College. If you have, or suspect you may have, a disability that impacts your education, please contact the DSPS Office to determine your eligibility for accommodations. DSPS is located in the Student Services Building B, Room 107 (831) 755-6760. I encourage you to meet with a DSPS Counselor to discuss your specific accommodations and to have test proctoring forms signed 5 days in advance.

Spring 2023 CHM 12B TENTATIVE SCHEDULE

Week	Objective	Monday Lab	Wednesday Lab
Week 1 1/23 Quiz 1	1. Review CHM 12A reactions. Alcohol reactions	Locker check-out. Lab safety. Lab 0 Organic lab techniques	Lab 0 Organic lab techniques
Week 2 1/30 Quiz 2	2. Organic redox 2/3 Last day to drop with No Grade 2/4 Last day to add	Lab 1 Ethanol by fermentation	Start Lab 2 Tylenol --> phenacetin
Week 3 2/6 Quiz 3	3. Apply sub/elim to Ethers and Epoxides	Lab 1 Separate EtOH from solid. Distill EtOH	Finish Lab 2
Week 4 2/13 MOQ 1, Q1-3r	4. Structure characterization: IR, MS, NMR. 2/17 President's Day	Structure Characterization – use IR, NMR	Structure Characterization – use IR, NMR
Week 5 2/20 Quiz 4	2/20 President's Day 5. ID conjugated dienes and Dienes addn rxns	No Lab	Lab 3 Dye Sensitized Solar Cell
Week 6 2/27 Quiz 5	6. ID aromatics and apply sub/elim/redox to side chain rxn	Lab 4a Test for unsaturation with Br ₂	Lab 4a Lab C GC/LC
Week 7 3/6 Quiz 6	7. Electrophilic Aromatic Substitution Reactions	Lab 4b EAS rates	Lab 4c Acetanilide bromination
Week 8 3/13 MOQ 2, Q4-6r	8. EAS of substituted arenes	Lab 4d Salicylic acid nitration	Finish Lab 4c and 4d
Week 9 3/20 Quiz 7	9. Nu addn rxn of O and C Nu ⁻ to C=O cpds	Lab 5a Grignard-like reaction	Finish Lab 5a
Week 10 3/27 Quiz 8	10. Nu addn rxn of N Nu ⁻ to C=O cpds 3/31 Cesar Chavez Day	Lab 5b Maillard rxn	Finish Lab 5b Lab C GC/LC
4/3	Spring Break		
Week 11 4/10 MOQ 3, Q7-8r	11. Apply acid-base to organic acids	Lab 6 Part A MSG	Lab 6 Part B Wintergreen/aspirin
Week 12 4/17 Quiz 9	12. Nu ⁻ Acyl Substitution of Acids and Acid Derivatives 4/21 Last day to drop with W	Lab 6 Part B Wintergreen/aspirin, Part C Biodiesel	Lab 6 Part C Biodiesel
Week 13 4/24 Quiz 10	13. Enols and Enolates Condensation Reactions	Lab 7 Aldol condensation	Finish Lab 7
Week 14 5/1 Quiz 11	14. Amines Reactions	Lab 8 Multistep Synthesis of PABA	Lab 8
Week 15 5/8 MOQ 3, Q9-11r	15. Organic Synthesis Strategies	Lab 8	Finish Lab 8
Week 16 5/15	5/20 Last Day of Term	Locker check-in	5/17 Bio/Industrial Application project due 5/19 Bio/Industrial evaluation due

EMERGENCY NOTIFICATION

In the event of a life-threatening emergency call 911.

To report a non-life threatening incident, safety hazard, or a suspicious activity please contact campus security at 755-6888

To obtain campus status information, call the campus safety and facilities emergency status bulletin telephone number: 831-796-6222.

From a campus line, simply dial 6222

Please visit Hartnell's emergency reporting link here: <http://www.hartnell.edu/reporting-emergencies>

Non-emergency police business.831-758-7321	Non-life threatening incidents, injuries or illness <ul style="list-style-type: none"> during school hours call Campus Safety 831-755-6888 after school hours call 831-755-6888 	Utility Failure <ul style="list-style-type: none"> during school hours call the Facilities Office at x6950 or 831-755-6950 after school hours call 831-755-6888 	Any incident with potential for adverse publicity to the college <ul style="list-style-type: none"> call President's Office, x6900 or 831-755-6900 after school hours call 831-755-6888
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Emergency Text Notifications

In the event of an emergency, Hartnell College can contact you by email, text, and voice. [Hartnell College has partnered with the Everbridge Mass Notification](#) system to provide emergency notifications. The system is used to send emergency notifications to Hartnell faculty, staff, and students in the event of a campus emergency such as a campus closure or hazardous situation. The system will send notifications through email, voice calls, and text messaging.

Students: If you receive an emergency notification, please tell your instructor immediately.

During a campus emergency, you will generally be told to do one of two options, SHELTER IN PLACE or EVACUATE.

When either of these are given, vehicle traffic coming onto campus will likely be turned away. Students are required to obey the directions of staff in a timely fashion.

EVACUATION:

Please note the exit(s) in the room. In the event of an alarm or safety threat, uniformed Hartnell personnel equipped with two-way radios--including security, and maintenance staff--have up-to-date information; they also have the authority to order either shelter-in-place or immediate building evacuation. For evacuation, immediately heed their directions by proceeding calmly and quickly to an exterior assembly area as indicated by trained staff. Please stay back at least 200 feet from any building until the "all clear" command is issued.

SHELTER IN PLACE:

In the event of a safety threat, instructors and staff will lock classroom doors and direct occupants to stay clear of windows. Occupants are requested to remain quiet. During this time, DO NOT access any exits unless directed by first responders or staff. A shelter in place order is also used for severe environmental threats like a thunderstorm.

In the event of an Active Shooter Event, there are three things you need to know in order to survive: [Run, Hide, Fight](#)

[Ready.gov Active Shooter Website](#)

RUN Have an escape route and plan in mind Leave your belongings behind Keep your hands visible	HIDE Hide in an area out of the shooter's view Block entry to your hiding place and lock the doors Silence your cell phone and/or pager	FIGHT As a last resort and only when your life is in imminent danger Attempt to incapacitate the shooter Act with physical aggression and throw items at the active shooter
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EMERGENCY PREPAREDNESS: The first 72 hours of a disaster are often the most difficult, but this period can be less stressful if everyone has extra supplies on hand. The college has a limited amount of emergency supplies, so students and staff should have on campus their own portable emergency kit including snacks, water, and prescription medication; this is especially important for those who may need to shelter on campus. For more information go to <http://72hours.org/>

Students: If you have knowledge of an emergency on campus, share it immediately. If you see something suspicious or potentially hazardous, let someone know.

Reporting suspicious Behavior

If you see suspicious behavior on campus, please contact [Campus Safety](#)

Anonymous reporting of incidents or concerns

Hartnell's Behavioral Intervention Team (BIT) accepts and processes anonymous reports from anyone about incidents or concerns on our campus. Please visit the [Behavioral Intervention Team website](#) for more information.

Reporting Forms

Public Incident Report Form Use the Public Incident Report form for: Student Conduct Violations Academic Integrity Issues Student Complaints or Grievances	CARE Form Use the CARE form for: Concerns about Well-being Mental Health Concerns Unusual or Disruptive Behavior	Useful Links Campus Maps and directions Emergency online resources Campus Safety Policies Hartnell's Emergency Alert System Hartnell College Behavioral Intervention Team
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Reactivity Principles and Trends

Does an organic reaction occur? Which atoms are involved in a reaction? What are the products of an organic reaction? An understanding of these concepts will help you predict how organic reactions occur. (Reference: P. Scudder, J. Chem. Educ. 1997, **74**, 777)

1. Check: Lewis structure rules of reactants, products, and intermediates; formal charge, charge balance, etc.
2. Coulomb's law - a positive charge/ion (cation) is attracted to a negative charge/ion (anion). Like charges do not attract, attack, or react with each other. Dications or dianions are not common (see formal charge).
3. Structural features (functional groups) give you information about how organic compounds react.
 - a. Identify the most reactive nucleophile (electron source) and electrophile (electron sink) to predict the most probable reaction partners. Rank the relative reactivity of the common electron sources and sinks (best to worst) by type and within each type.

Table 1. Nucleophile (Electron Sources) and Electrophile (Electron Sinks) Classification

Nucleophile Type	Example		Electrophile Type	Example
Organometallics (see carbanions)	alkyl lithium (CH ₃ ⁻)	Best	Electron deficient species	carbocations, CH ₃ ⁺ , BF ₃
Group I hydrides (H ⁻)	NaH		Acids	HCl
Complex metal hydrides	NaBH ₄		Single bonds between heteroatoms	C-O (C is the E ⁺)
Active metals	Li metal		Leaving groups on sp ³ carbons	CH ₃ I (I is the leaving group)
Lone pair nucleophiles, bases (see pK _a table)	ROH, RNH ₂ , OH ⁻		Carboxyl derivatives (sp ² -bound L)	acyl halides, anhydrides, esters
Allylic sources	enolates, enamines		Heteroatom-carbon multiple bonds	aldehydes, ketones, nitriles, CO ₂
Simple pi bonds	alkenes, alkynes, dienes		Conjugate acceptors	enones, acrylates
Aromatic rings	benzene	Worst	redox-active metals	CrO ₃

- b. Draw a "curved arrow" from the nucleophile to the electrophile using a **known** bond breaking/making process.

Table 2. Bond Breaking and Making Processes

Bond Breaking/Making Process	Example
Polar: most organic reactions are polar reactions	
1. Proton transfer	acid-base reaction alkene + HBr
2. Ionization of a leaving group	1 st step of S _N 1 or E1
3. Nucleophilic attack on:	
a. electron deficient species	Cl ⁻ + carbocation
b. C bonded to leaving group	S _N 2 substitution of alkyl halide
c. H bonded to βC (C adjacent to C bonded to leaving group) to form a π bond	Elimination reaction of alkyl halide
d. a polarized multiple bond, e.g., C=O	Grignard reagent + aldehyde
4. 1,2 rearrangement of a carbocation	2° C ⁺ to 3° C ⁺
Radical:	Alkene polymerization
5. Initiation - non-radical forming radicals. Usually light is required for this step to occur.	
6. Propagation - a radical reacts with a non-radical to produce a new radical and new non-radical.	
7. Termination - two radicals react to form a non-radical.	
8. Pericyclic: Concerted 6 electron pericyclic	Diels-Alder reaction

A reaction mechanism shows the sequence of elementary steps by which reactants form products. In other words, a reaction mechanism shows the order in which bonds break and form in a reaction. Organic chemists and o-chem students like using curved arrows to show bonds breaking and forming to describe a mechanism. **Beginning organic chemistry**

students often get carried away using curved arrows. If you can describe an elementary step with one of the bond breaking/making processes in Table 2, you'll be able to describe a mechanism and predict or explain an organic reaction.

c. **FOUR** types of polar organic reactions: acid-base, addition, substitution, elimination.

4. Chemical reaction concepts: A reaction occurs when reactants collide with sufficient energy for bonds to break and form. Most reactions are exothermic.

a. The "right" atoms in each reactant have to collide together. Alignment and access (steric effect of size and crowdedness) of reactant atoms can limit some reaction paths, such as S_N2 .

b. Thermodynamics: High energy species, such as free radicals, are unstable and reactive; low energy species, such as alkanes, are stable and unreactive.

c. Thermodynamics: Strong bonds don't react (see Teflon with strong C-F bonds); weak bonds do react (see weak N-O bonds in TNT). Bond dissociation energies can be used to estimate ΔH_{rxn} ("bonds broken minus bonds made") and give relative stabilities of reactants and products.

d. Thermodynamics: The stability of intermediates, such as 1° , 2° , 3° carbocation, anions, radicals, can be used to choose between reasonable alternatives, e.g., Markovnikov's rule.

e. Kinetics - rate - which process occurs fastest? The fastest reactions produce the major product. E.g., proton transfer is very fast - often the first step in a reaction mechanism. But with weak organic acids and bases, proton transfer is slow enough to allow nucleophilic attack. Refer to Table 2 Bond Breaking and Making Processes.

f. Many organic reactions are equilibrium (reversible) reactions. E.g., organic acid-base (proton transfer) reactions are equilibrium reactions and tend to form the weaker acid/base. See pK_a tables.

5. Medium (solvent) pH - acidic media contain powerful electrophiles and weak nucleophiles; basic media contain powerful nucleophiles and weak electrophiles.

Adapted from P. Scudder, J. Chem. Educ. 1997, **74**, 777.

Chemistry Study Strategies

“It is not how smart a person is but how efficiently does a person work?”

-- Dr. Lawrence Doyle, Executive Director, UCLA Medical School Prime Program and Expert on improving study skills, 3/11/11 presentation. Parts of these strategies are adapted from his talk.

You have other classes, a job, a family, and a life. You have academic and professional goals that you want to achieve. You want to learn what you need to learn from every class to prepare you for your next classes and to learn and develop a set of well rounded skills that employers value.

Review, review, review: You will forget 25-30% of what you learned within 1-2 hours (to 12 hours) if you don't review. You'll forget another 25-30% after 24-48 hours if no review.

“**Spacing Effect**” – *deliberate* practice, e.g., learning and reviewing, that is spread out over time enhances long term retention. Cramming does not help you remember.

“**Retrieval Effect**” – repeated practice of active retrieval of information, not studying, promotes and enhances long term retention. Repeated retrieval practice through testing was shown to enhance long term retention, whereas repeated studying produced essentially no benefit.

Practice retrieval by **Quizzing yourself** – self-testing is an extremely effective way to learn faster and retain more.

Need to sleep 6 to 8 hours per night. A rested brain and body learns, retains, recalls, and processes information better than a tired one. Put in the time so you don't feel compelled to pull an all-nighter. Cramming does not help you remember.

Study Skills:

1. **Time management.** It does not matter how smart you are if you don't or can't put in the time to study.

Study two hours for every class hour.

It is better to take fewer units and get better grades than to take too many units and get poor grades. *Protect your GPA.*

2. **Memory.** See “Spacing Effect” and “Retrieval Effect”.

Chunking information. Learn better in groups of 4 or less. E.g., phone number: xxx-xxx-xxxx

Use mnemonics, e.g., place mnemonics – relate what you are trying to remember to a place.

Lists – usually items at the beginning and end are learned first and remembered, middle not so well. If items on a list are on flash cards, need to shuffle the cards.

3. **Reading.** Relate what you already know to what you are reading.

Reading a science textbook is **NOT** the same as reading a newspaper or novel.

Scan a chapter before reading it helps you identify main ideas and main points and determine what you are reading.

For example, look over the headings first. Next, read the end of chapter summary. Then, read the chapter. You'll have an idea of what you are reading and know what to look for and focus on. **Quiz yourself when you are done.**

4. **Note taking.** Process information as you get it - class lecture and textbook reading.

Predict an answer or what the teacher is about to say improves learning. You'll get immediate feedback.

Write one idea per line in your notes. Is it a main idea, lesser point, or digression?

Write a summary of the lecture ASAP (ideally at end of lecture). Then, share it with or teach someone else. **(Those who TEACH learn faster and retain more.)**

Compare your notes with other students if you feel you have missed something in a lecture.

Quiz yourself when you are done.

5. **Test taking.** Improve your exam performance by taking a **PRETEST** or **PRACTICE TEST** (with immediate feedback) to prepare.

Common mistakes include: **not setting plans** for every test, **premature closure** (get an answer and move on to next question), **change answer** (most people should not change answer. Intuition is usually right. Test taker often tricks self into believing teacher is trying to trick them), and **not reviewing every test** to identify mistakes. **Have a Growth Mindset.** Use visualization to visualize self doing well on test or other goal like athletes do.

Several books have been written on how people get good at something (see “Talent Is Overrated: What Really Separates World-Class Performers from Everybody Else”, Geoffrey Colvin and “The Talent Code: Greatness Isn't Born. It's Grown. Here's How.”, Daniel Coyle). Here are three important factors:

1. **Deliberate practice** is deep, focused practice that makes you get better each time. More than just reading and reviewing, work on practice questions/problems that push you to a deeper learning and understanding. Try to teach someone what you are studying. This is a good reason to study with other students.

2. **Insightful coaching** for help, feedback, and guidance. See your instructor or SI Leader for help.

3. **Motivation** so you feel you are investing your time to accomplish something worthwhile. A positive attitude helps.