

# Chemistry for Life Science Students

A three semester course sequence, with a total of 13 course credit hours including both lecture and laboratory, was designed to provide a strong chemistry foundation for students planning to pursue degrees and/or careers in areas related to the life sciences. This sequence is an *alternative to*, and not a replacement for the four semester sequence (CHEM 1061/2/5/6, CHEM 2301/2/4, CHEM 2311). The directive is to prepare students for future study in the life sciences, and includes satisfying the prerequisite requirements of the biochemistry course for non-majors, currently BIOC 3021.

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## Who is this course sequence designed to serve?

UMN students with interests in life science related subjects and majors, and/or planning for futures working in life science related careers. The first and second semesters may also be appropriate for many programs requiring less than the full chemistry complement.

## Who is this course sequence NOT specifically designed to serve?

UMN students with interest in chemistry intensive majors, those planning to pursue chemistry related careers, or students that simply want to take more chemistry. Examples include, but are not limited to, chemistry, chemical engineering, and biochemistry majors. **These students will continue to be served by the current four semester chemistry sequence.**

## Motivation and Background

The initial idea for this proposed course sequence originated when Chemistry was approached by the College of Biological Sciences (CBS). They expressed a need for their students, with the exception of Biochemistry majors, to reduce the time and number of course credits required to complete the foundational chemistry content through the biochemistry for non-majors course, BIOC 3021. They had determined that the majority of their students did not require all of the content in our current four semester CHEM sequence, and they were in somewhat desperate need of additional advanced course work in their specific areas of study that would be facilitated by reducing the chemistry commitment. The faculty in these programs reached the conclusion that their students would be better served by the addition of advanced area-specific coursework at the expense of some of the current chemistry coursework (*University limits on credits for degree programs and focus on time to degree make this effectively a zero-sum game*).

Another important driver behind development of this course sequence is that many programs have already de facto reduced the chemistry requirements by a semester. Due to prerequisites, they only had one way to accomplish this in the current system, and they eliminated the last semester lecture of organic chemistry, CHEM 2302/4. In addition, reduction in chemistry laboratory credits meant removal of CHEM 2311, ie all of organic laboratory since our current structure places all 4 credits in a single one-semester course. They did this even while recognizing that a large part of the CHEM 2302/4 content was more relevant to life science studies than other parts of the four semester chemistry curriculum and there was a noticeable lack of knowledge and preparation pertinent to understanding biological molecules and mechanisms. However, the pedagogical pressure to find space in their own degree programs dictated an overall result that was judged better for their students. It became clear that designing a three semester sequence tailored to students in the life sciences, rather than simply truncating a sequence that currently attempts to serve all students at the University of Minnesota simultaneously, provided the opportunity for significantly improved service.

Once initial discussions began, it became apparent that the same motivations underlying the original request from CBS apply to many programs and students outside of CBS that are pursuing majors directly related to the life sciences, or that choose to expand their individual preparation for a future career in the life sciences. This was confirmed through conversation and consultation with CLA and CFANS, with both colleges indicating strong enthusiasm for the new sequence (see letters

of support for details). This motivated the intention to design the course sequence for service to life science students across the University.

Beyond the identified need of many programs to make room for additional advanced program specific content, the proposal to develop an alternative chemistry sequence provides an opportunity to improve service to all students taking chemistry. The large number of degree programs represented by students in the freshman and sophomore level courses (138 majors have representation) presents an extreme challenge when trying to address the enormous breadth of chemistry skills and topics with a single course sequence. Focusing on one of the largest group of subscribers, life science related students, allows for more targeted and relevant course design. At the same time, concomitant reduction of the breadth served in the current four semester sequence may allow for future course refinements.

## University of Minnesota Student Learning Outcomes Addressed

- Can identify, define, and solve problems
- Can locate and critically evaluate information
- Have mastered a body of knowledge and a mode of inquiry
- Can communicate effectively
- Have acquired skills for effective citizenship and life-long learning

## Course Sequence Structure

<b>semester 1</b>	<b>semester 2</b>	<b>semester 3</b>	<b>total</b>
lecture (3 cr.)	lecture (3 cr.)	lecture (3 cr.)	9 credits
laboratory <sup>†</sup> (1 cr.)	laboratory (1 cr.)	laboratory (2 cr.)	4 credits

<sup>†</sup>The first semester laboratory will be CHEM 1065, shared with the current general chemistry sequence.

## Implementation Timeline

The proposal is to offer the first semester of the sequence for the first time in the Fall of 2016. A single lecture section of 300 will be offered, and CBS has agreed to fill that section with their incoming freshman class. Angela Perkins will be the course instructor the first time the sequence is offered. Numbers of sections in future semesters will be determined by a combination of demand and appropriate continuing course development.

**Sept 8, 2015** Present the new course sequence proposal to the Chemistry faculty for discussion and eventual vote.

**Sept 22, 2015** Present the 5 new courses to the CSE Curriculum Committee for approval

**Dec 8, 2015** Second meeting of the CSE Curriculum Committee if needed

**Jan 2016** Submit course sequence to the Campus Curriculum Committee

Feb 2016 Course approval and into the ECAS system

March 2016 Rooms and times determined and on the final course schedule

April 2016 Registration opens for Fall 2016

## Prerequisite Knowledge and Assessment

An individualized placement exam, covering prerequisite topics, will be centrally administered to all students registering for the first course in this sequence, as well as CHEM 1061. The system used to administer the exam (ALEKS) is an artificially intelligent product that determines a student's knowledge state at a given point in time. Any student who does not initially perform at a high enough level will be given a deadline of one month prior to the start of classes to continue work in the tutoring system and improve their score to attain placement in the desired course. A more detailed description of required prerequisite knowledge is provided in the syllabus for the first semester lecture course.

## Moving Between the Two Chemistry Tracks and Transfers

The flexibility to move between the two chemistry tracks after the first semester was considered to be very important given that students are often undecided on their major and future career plans upon arrival at the University. To allow for this option, the first semester lecture course was designed to have sufficient overlap with CHEM 1061 to allow students to be successful if they choose to change tracks following the first semester. Although these students will not be in the same position as students continuing in the same track, their circumstances will be analogous to transfer students that have completed courses at other institutions. Flexibility is also facilitated by the use of a common laboratory course for both sequences in the first semester.

Beyond the first semester, transfer between the two sequences becomes more difficult. We expect that all programs planning to accept the proposed three semester sequence will also accept the current four semester sequence. Therefore, students completing CHEM 1062/66 will be advised to continue with the current series. Students that complete the second or third semester of the proposed three semester sequence, and then choose to pursue a major requiring the current sequence (such as chemistry or biochemistry), will be evaluated on an individual basis. The number of such students is expected to be small.

Although sequences such as the one proposed here are becoming more common, the majority of transfer students will be coming from more traditional sequences with a linear structure of two semesters of general chemistry and two semesters of organic chemistry. In these cases, the students will be advised to continue in our current sequence, entering at the appropriate point. Transfer students are evaluated on an individual basis to determine the appropriate point of entry. Transfer students do arrive with an array of backgrounds and preparation, and the new sequence may be appropriate in some cases. This will be determined during advising on a case-by-case basis.

## Balance Between Lecture and Laboratory Credits

The original joint CHEM/BMBB committee suggested that the 13 total chemistry credits should be distributed as 10 for lecture and 3 for laboratory. This was based largely on the committee's focus on content in the current lecture series and subsequent consolidation for the life science series. That committee did not reach the point of discussing content in the laboratory sections in detail. The 10:3 lecture to laboratory credit ratio was also present in one of the two proposals initially debated by the Chemistry committee as described below. However, as series development proceeded, the majority of the committee began to see pedagogical value in adding an additional credit of laboratory (see proposed course sequence structure in previous section). Support was based on the added value from enhanced learning opportunities offered in laboratory courses for students to develop problem-solving, effective communication, and critical-thinking skills in a hands-on setting. Recent research also indicates that, "more inquiry and less coverage increase student learning." (for example Luckie et al. *Advan in Pysiol Edu* 36:325–335, 2012, which is the origin of the quote) Chemistry remains a laboratory based science, and the laboratory offers a premier environment for inquiry driven learning. The conclusion was that the skills gained by students through an additional one credit of laboratory outweighed the one credit of lecture material exchanged.

## Preparation for Professional Schools

While it is recognized that the course sequence should be sufficient for admission to most life science related graduate and professional programs, satisfying admissions requirements for 100% of professional programs was not considered to be a primary goal in the development. We do expect that the course sequence will satisfy most, if not all admissions requirements for relevant professional programs. Admission to medical school, a profession program that tends to attract much of the attention, is discussed as an example in the next section. Ongoing diligence and working with advising across campus will be required to continually identify any potential programs that may not accept the sequence and communicate that to the students. This is an issue faced by all course sequences and programs given that admission requirements for professional programs are not static. In any case where the three semester program is identified as insufficient for the students' future plans, the four semester sequence will remain as an appropriate alternative.

## Medical School Admission Requirements

Although there are many possible professional programs related to the life sciences, medical school often receives special attention. At the national level, medical education is changing, as are school admission requirements. Our medical school, for example, recently dropped the number of required chemistry courses from 11 to 4. More medical schools are expected to follow suit. The course sequence will not jeopardize any University of Minnesota student's chance for admission to medical school. It is fairly common for medical schools to receive applicants' transcripts that do not fully comply with the school's posted prerequisites. This is because colleges' curricula, and course naming policies, vary around the country. In such cases, the college can send a letter to the medical school admissions offices explaining their curriculum and course titles (our medical school maintains a file of such letters from colleges across the country). If the new chemistry series is adopted, CBS will send such a letter to all 141 medical schools in the US, ensuring that U of M students will not be disadvantaged.

Below is a list of the top 10 medical school destinations for U of M students out of CBS accounting for 88.25% of the students admitted to medical school. All either have specific stated requirements for admission that are met by the new course sequence, or have been contacted directly and provided assurance that they will accept the new series as fulfillment of their chemistry prerequisite.

<b>medical school</b>	<b>% CBS students</b>	<b>series meets requirements?</b>
U Minnesota, Twin Cities	39.43	yes
U Minnesota, Duluth	7.31	yes
U Minnesota, TC/Duluth	6.79	yes
U Wisconsin	3.39	yes
Medical College of Wisconsin	3.39	yes
Mayo Medical School	2.87	yes
Sanford – U of South Dakota	2.35	yes
U of Iowa	2.35	yes
Creighton	1.57	yes
New York Medical College	1.31	yes
Penn State U	1.31	yes

## Professional School Entrance Exams

The course sequence is designed to provide an excellent foundation for students that eventually choose to take life science related professional school placement exams. However, exhaustive coverage of all specific topics that could be encountered on future placement exams was not one of the primary design principles adopted for the course sequence. The wide number of topics covered by the broad distribution of such exams makes complete coverage impractical and beyond the purpose of the course sequence. An additional consideration when evaluating the importance of covering specific topics addressed on placement exams was retention of such facts. The three semester sequence will present content 1–3 years prior to students taking such exams. Retention of individual facts, particularly when those facts are not utilized in subsequent courses, is not in concurrence with this time frame. Figure 1 shows the memory retention for chemistry skills in general chemistry. The curve follows the well established “forgetting curve” commonly associated with the original work of Ebbinghaus in 1885 (and often associated with his name).

When considering the MCAT in particular, recent changes in the exam have reduced emphasis on individual facts and increased emphasis on problem solving and interpretation. Consultation with the counselors in the U of M Health Careers Center produced unanimous support for more emphasis on problem solving and critical thinking with less emphasis on coverage of specific topics. For this reason they were also strongly supportive of increasing the laboratory credits at the expense of lecture credits, indicating that, in their opinion, problem solving skills developed in the laboratory courses would be more valuable to the students than additional topic coverage in the lecture courses when taking the MCAT and other placement exams. For example, the current MCAT now includes questions where all possible answers are correct and the students are asked to identify the best option, and questions where none of the answers are completely correct but the better solution must be identified. Research does not support the idea that inclusion of more content in a course translates into more retention or learning.

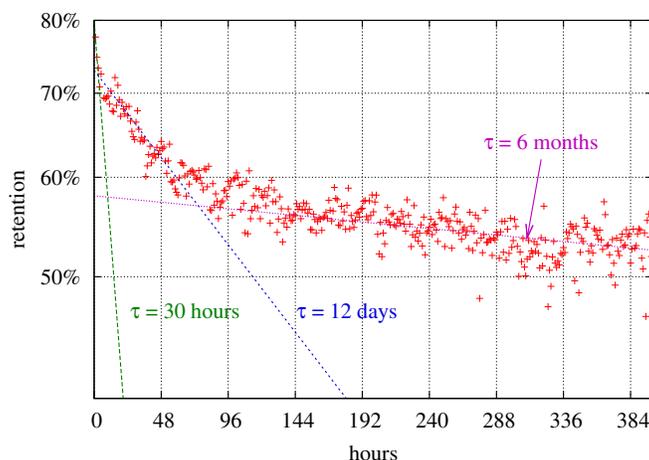


Figure 11: Student mastery retention as a function of time since initial mastery. The vertical axis is logarithmic. The three lines represent simple exponential decays with the indicated time constants.

Figure 1: Figure and caption copied from “Knowledge Spaces”, chapter by Christopher J. Grayce, edited by Falmagne, J. C., Albert, D., Doble, C., Eppstein, D., Hu, X., Springer, 2013, ISBN 978-3-642-35329-1.

## Development History

**Jan 2012** CBS, represented primarily by Paul Siliciano and David Bernlohr, approached Chemistry and explained the need for a course sequence in chemistry that was more targeted towards students in the life sciences, and that would reduce the time and number of credits compared with the current four semester sequence (five semesters when including biochemistry).

**March 2012** The Head/Chair of the Departments of Chemistry and Biochemistry, Molecular Biology and Biophysics (BMBB) formed a joint committee consisting of members from both departments to investigate development of the sequence:

<b>Chemistry</b>	<b>BMBB</b>
David Blank (co-Chair)	Paul Siliciano (co-Chair)
Michelle Driessen	John Lipscomb
Andrew Taton	Alex Lange
Jane Wissinger	Gary Nelsestuen

The charge to the committee was:

*The Department of Chemistry (CHEM) and the Department of Biochemistry, Molecular Biology and Biophysics (BMBB) have decided to embark on an exciting and dynamic program to restructure their lower division courses in general, organic, bio-organic and biochemistry targeted towards students with broad career aspirations in the life sciences. National initiatives in both education and research are driving the need for coursework that focuses on substantive foundational information while providing flexibility for students with diverse career paths. It is anticipated that the majority, if not all the undergraduates in the College of Biological Sciences, would eventually utilize this course series. In addition, we expect that students from other colleges may utilize such a series as a chemical foundation for their program of study. Our charge to the joint committee is to outline the chemistry/biochemistry content that would best serve these students and develop a two-year course sequence to deliver that information.*

**April '12 – June '13** The joint committee met once or twice every month while working on development of a two-year course sequence. These discussions focused largely on walking through all of the content in the current course sequence and evaluating priority for individual topics, ranking each as critical, important, or not necessary. In addition, the committee considered a number of alternative plans for integration and ordering of content based on the chemical education literature and current examples at other institutions. For example, approaches that present organic first, approaches that eliminated the formal year of general chemistry, and the idea of integrating biochemistry earlier, and throughout the sequence.

**June 2013** The joint committee produced a progress update for the department Heads/Chairs that included an initial priority list of topics to retain from the current curriculum, a recommendation for a total of 13 hours of lecture and 3 hours of laboratory credit (including biochemistry), and a recommended structure that largely left the biochemistry as a 3 credit course at the end of the two year sequence. An estimate of the percentage of students that would be served by such a course sequence broken down by college was also provided. The estimate was roughly 30% from CBS, 30% from CLA, 15% from CFANS, 15% from CCE, and <10% from CSE.

**June 2013** The committee update was discussed in a meeting with Bill Tolman and David Bernlohr. The magnitude of the undertaking, required resources, and fact that the lion's share of the work would fall to Chemistry was acknowledged and discussed. The joint committee was thanked for their work, and instructed to hold and wait for further instructions while the significant logistical and administrative issues were given consideration.

**Aug '13 – Aug '14** While the need to proceed remained for the life science students, significant logistical challenges coupled with personnel changes in the CBS Dean's office resulted in the project falling temporarily dormant.

**Sept 2014** CBS contacted CSE and Chemistry in order to restart the project.

**Oct 2014** In a meeting convened by the recently appointed interim Dean of CBS, Tom Hayes, that included CSE Associate Dean Paul Strykowski, Paul Siliciano, and David Blank,

CBS restated the need and enthusiasm for the new course sequence, and requested that development resume in earnest. This was followed by an effort to try and reconstruct where the committee had left matters over a year prior.

- Nov 2014** In a meeting that included Tom Hayes, David Bernlohr, Paul Siliciano, Bill Tolman, David Blank, and Nikki Letawsky Shultz (CBS head of advising) Chemistry presented and discussed the significant challenges associated with their large undergraduate service commitment and the subsequent development of an alternative sequence. Resources and options were discussed, and a plan to continue with development was tentatively accepted. The plan acknowledged the fact that development of the first three (of four) semesters of the sequence would reside almost entirely in the Chemistry Department.
- Jan 2015** In a presentation to the Chemistry faculty, David Blank briefly went over some of the background above and proposed a plan to proceed with a new three semester chemistry sequence for the life sciences. The presentation incorrectly represented parts of the plan, which produced misunderstanding and concern about the structure of the sequence. At the same time a majority of the chemistry faculty indicated that they had too little information before them, and that the current level of course development was insufficient to make a decision concerning such a large curricular addition.
- Feb 2015** David Blank made a second presentation to the chemistry faculty, clarifying errors in the initial presentation, providing additional details, and proposing that, rather than committing to the new course sequence, the department would, "... proceed with the development, design, and assembling of implementation details associated with a new chemistry course sequence for the life sciences ... ." The chemistry faculty agreed to this proposal with the idea that a proposal with mature course descriptions and syllabi would be brought before the faculty for consideration at a later time.
- Feb 2015** Bill Tolman appointed a committee within Chemistry to proceed with development of the three semester course sequence and assembling of implementation details. The members of the committee were David Blank, Michelle Driessen, Steve Kass, Doreen Leopold, Angela Perkins, and Jane Wissinger.
- Feb '15 – June '15** Meeting every two weeks, the development committee considered possible combinations of content, order, and course series structure. Two proposals emerged within the committee. One was based on a common first semester for all chemistry students, an equal number of lectures for general chemistry and organic chemistry, followed the current ordering of topics in the four semester sequence, and included 10 credit hours of lecture (leaving 3 credit hours for laboratory instruction). The second included integration of select general and organic chemistry topics and a change in order for some topics relative to the current sequence. The second proposal included a reduction in the depth of coverage for selected topics, did not require equal time be given to content traditionally in gen chem and organic respectively, and

resulted in 9 credit hours of lecture and 4 credit hours of laboratory. After many lengthy discussions of the strengths and weaknesses of both proposals, the majority of the committee indicated a general preference for the second proposal, while acknowledging aspects of the first that should continue to receive serious consideration as development proceeded. Strong support was expressed by the majority of the committee for the additional credit of laboratory in the second proposal as an important learning opportunity for students to develop problem-solving, effective communication, and critical-thinking skills aligned with learning outcomes.

**June 2015** Doreen Leopold resigned from the committee.

**June '15 – Aug '15** The remaining five members of the committee proceeded with the development largely along the lines of the second proposal, and worked to incorporate important issues that were addressed in the first proposal, such as the ability to change tracks at then end of the first semester. In addition to the lecture sequence, the focus also turned to development of the laboratory sequence that had received much less attention up to this point.

**Aug 5, 2015** The committee presents the current form of the proposal to, and requested feedback from representatives of the university office of education (Leslie Schiff), CBS (Jane Glazebrooke, Paul Siliciano, Nikki Letawsky Shultz, a number of their DUGS), CFANS (Anthony Seykora), and CLA (Nanette Hanks).

**Aug 2015** Course proposal sent to the Chemistry Faculty.

**Sept 8, 2015** Course proposal presented and discussed at the Chemistry Faculty Meeting.

**Sept 11, 2015** Suggested changes from the Faculty were due the committee in writing (via email). One set of proposed changes was received that was co-signed by six of the faculty members.

**Sept 15, 2015** The committee considered suggested changes, all of which were relatively minor. The committee accepted most of the changes, and the revised proposal was distributed to the faculty for a vote.

**Sept 18, 2015** The Chemistry faculty votes on the statement, “The chemistry department should proceed with implementation of the three semester sequence for students interested in the life sciences as outlined in the proposal emailed to the faculty on September 15, 2015. (YES, NO, ABSTENTION)”

**Proposed Textbooks:****General Chemistry Material**

Zumdahl *“Chemistry, An Atoms First Approach”* Cengage Publishing

or

Burdge & Overby *“Chemistry, Atoms First”* McGraw-Hill Publishing

**Organic Chemistry Material**

Karty *“Organic Chemistry, Principles and Mechanisms”*, Norton Publishing

**Lecture Days:**

3 Credit Class – 42 class days

-2 first/last days

-3 exam days

37 Instructional Days (per semester)

**Prerequisite Knowledge:** The following topics list is considered prerequisite knowledge (tested in placement exam or learned in CHEM 1015). The expectation is that the students will know this material already and it will not be covered in class.

**1. Measurement, Units, & Significant Figures****2. Atoms**

- subatomic particles and atomic structure
- atomic number, mass number, isotopes
- periodic table
- mole and molar mass

**3. Period Table & Trends**

- classification of elements (metals, nonmetals, halogens, etc...)
- effective nuclear charge
- periodic trends (radius, IE, EA)
- ionic radius

**4. Basics of Chemical Reactions**

- balancing
- stoichiometry
- limiting reactants
- weak vs. strong electrolytes
- precipitation reactions
- acid-base reactions
- simple redox – activity series and identifying loss/gain of electrons

## **Semester 1: Fall 2016 (3 credits)**

### **Schedule of Lectures:**

#### **Topic (# of lectures)**

#### **Quantum Theory and Electronic Structure of Atoms (3-5)**

*Zumdahl – Chapter 2 or Burdge – Chapter 3 & 4.4-4.5*

Intro to light (Brief)  
Quantization of Energy (Brief)  
Bohr Atom (Brief)  
Quantum Mechanical Model (wave properties)  
Quantum Numbers  
Orbital Shapes and Energies  
Electron Configurations of Atoms and Ions  
Pauli Exclusion Principle, Aufbau Principle, Hund's Rule  
Periodic Trends

#### **Atoms to Molecules – Bonding (6-7)**

*Zumdahl – Chapters 3 & 4 or Burdge – Chapters 5 & 6*

Lewis Dot Symbols  
Ionic Compounds and Bonding (lattice energy)  
Naming Ions and Ionic Compounds  
Covalent Bonding and Molecules  
Molecular and Empirical Formulas  
Naming Molecular Compounds  
Includes basics of naming organic alkanes  
Covalent Bonding in Ionic Species  
Molecular and Formula Masses  
Percent Composition  
Molar Mass  
Octet Rule  
Electronegativity and Bond Polarity  
Drawing Lewis Structures  
Formal Charge  
Resonance  
Exceptions to the Octet Rule

#### **Structure of Organic Molecules (2-3)**

*(Organic Handout)*

Introduction to Hydrocarbons  
Lewis Structure of Alkanes, Alkenes, Alkynes  
Single, Double, Triple bonds  
Representing Organic Molecules  
Condensed formulas to Line Structures  
Classification of Carbons ( $1^\circ$ ,  $2^\circ$ ,  $3^\circ$ )  
Simple Resonance of Hydrocarbons (cation/anion)  
Concept of Molecules having 3D Shape  
Introduction of functional groups beyond hydrocarbons  
Introduction of Biomolecules (phospholipids, steroids, DNA, proteins etc.)

#### **Molecular Structure and Orbitals (1-2)**

*(Zumdahl – Chapter 5, Burdge – Chapter 7)*

VSEPR (Molecular Geometry)  
Hybridization ( $sp^3$ ,  $sp^2$ ,  $sp$ ,  $dsp^3$ ,  $d^2sp^3$ )  
Molecular Polarity

## **Energy Changes in Chemical Reactions (2-3)**

*(Zumdahl – Chapter 6, Burdge – Chapter 10)*

Energy and Energy Changes  
Thermodynamics Intro  
First Law of Thermodynamics  
Enthalpy and Enthalpy Changes  
Hess's Law  
Standard Enthalpies of Formation  
Bond Enthalpy and Stability of Covalent Molecules

## **Gases (2-3)**

*(Zumdahl – Chapter 7, Burdge – Chapter 11)*

Pressure  
Gas Laws (Brief)  
Boyle, Charles and Avogadro  
Kinetic Molecular Theory  
Gas Mixtures (Partial Pressures)

## **Intermolecular Forces - Liquids and Solids (3-4)**

*(Zumdahl – Chapter 8, Burdge – Chapter 12)*

Intermolecular Forces  
Vander Waals, Dipole-Dipole, H-Bonding  
Intro States of Matter  
Properties of Liquids  
Surface Tension, Viscosity, Vapor Pressure  
Phase Changes  
Melting, Freezing, Sublimation, etc  
Phase Diagrams  
Application of IMF to Organic and Biomolecules  
Effects on solubility, mpt, bpt, secondary structure  
Fats vs Oils

## **Properties of Solutions (2-3)**

*(Zumdahl – Chapter 11, Burdge – Chapter 13)*

Solution Composition – Molarity/Molality (Brief Review)  
Factors Affecting Solution (Temp/Pressure Effects)  
Colligative Properties  
BP Elevation – FP Depression  
Osmotic Pressure

## **Entropy and Free Energy (2-3)**

*(Zumdahl – Chapter 17, Burdge – Chapter 14)*

Spontaneous Processes  
Entropy  
Entropy Changes in a System  
Entropy Changes in Universe  
Predicting Spontaneity  
Thermodynamics in Living Systems

## **Chemical Equilibrium (4-5)**

*(Zumdahl – Chapter 13, Burdge – Chapter 15)*

Concept of Equilibrium  
Equilibrium Constant  
Equilibrium Expressions  
Heterogeneous Equilibria, Gaseous Equilibria  
Chemical Equilibrium and Free Energy  
Calculating Equilibrium Concentrations  
Le Châtelier's Principle

### **3-Dimensional Shape of Molecules (3-4)**

*(Organic Textbook or Handout)*

3D Shape (not planar) – wedge/dash notation

Conformations of simple alkanes (Newman Projections)

Energy Changes in Conformational Analysis

Conformations of Cyclic Compounds

Cyclohexane Conformations (ax vs eq)

$\Delta G$  differences to relate to Equilibrium for chair conformers

Disubstituted Cyclohexane (cis vs trans)

Isomers – Structural vs Stereo-

Chiral vs Achiral Molecules

Discussion of Enantiomers/Diastereomers

Application to the 3D Nature of Biomolecules (Steroids, Sugar, Amino Acid)

## **Semester 2: Spring 2017 (3 credits)**

### **Schedule of Lectures:**

#### **Topic (# of lectures)**

#### **Acids and Bases (3-4)**

*(Zumdahl – Ch 14, Burdge – Chapter 16)*

Bronsted Acids and Bases  
Molecular Structure and Acid Strength  
pH Scale  
Strong Acids and Bases (calculating pH)  
Weak Acids and Bases (calculating pH)  
Conjugate Acid/Base Pairs  
Polyprotic Acids  
Acid-Base Properties of Salt Solutions  
Acid-Base Properties of Oxides and Hydroxides  
Lewis Acids and Lewis Bases

#### **Expansion of Acids/Bases (2-3)**

*(Organic Textbook – Karty – Chapter 6)*

Introduction of Curved Arrow Notation  
Organic Functional Groups and Acidity  
Predicting Outcomes with pKa  
Trends for Acidity (periodic, hybridization, resonance, etc)  
Introduction of Amino Acid Structure  
Application with Electrophoresis

#### **Acid-Base Equilibria and Solubility Equilibrium (3-4)**

*(Zumdahl – Chapter 15 & 16, Burdge – Chapter 17)*

Common Ion Effect  
Buffered Solutions  
Buffering Capacity  
Titrations and pH Curves  
Acid/Base Indicators  
Henderson-Hasselbalch Equation  
Solubility Equilibrium ( $K_{sp}$ )

#### **Chemical Kinetics (6-8)**

*(Zumdahl – Chapter 12, Burdge – Chapter 19, Karty Chapter 7 & 8)*

Reaction Rates  
Collision Theory  
Measuring Reaction Progress and Expressing Reaction Rates  
Dependence of Rate on Reactant Concentration  
Dependence of Rate on Temperature  
Integrated Rate Law  
Determining Rate Laws and Rate Constants  
Organic Reaction Mechanisms (arrow pushing)  
Kinetics of Bimolecular Reactions ( $E2/Sn2$ )  
Kinetics of Unimolecular Reactions ( $Sn1/E1$ )  
Energy Barriers and Rate Constants – Transition State Theory (Large DG, fast rate)  
Kinetics of Proton transfers and Carbocation rearrangements  
Catalysis (specific acid/base catalyst – reactions)  
Biological Catalysts

## Competition Among $S_N2$ , $S_N1$ , E2, & E1 (2-4)

*(Karty – Chapter 9)*

Factors Affecting Reactions

Nucleophilicity/Basicity

Leaving Group

Good leaving groups

Conversion of Bad LGs into Good – Acid Catalyzed Dehydration Reaction

Substrates

Solvent (Protic vs Aprotic)

Temperature

Regiochemistry of Elimination (Zaitsev)

Stereochemistry of Substitution

Kinetic vs Thermodynamic Control (Hammond's Postulate)

## Nomenclature and Structure (2-3)

R/S Designation Nomenclature

Basic Nomenclature of Alkenes & Alkynes

Cis/Trans & E/Z Geometric Isomers

Alcohols, thiols, sulfide structures and properties

Fisher Projections – Carbohydrate Structure and Stereochemistry

## Nucleophilic Substitution and Elimination – Reactions that are Useful ( $S_N2$ & E2) (4-5)

*(Karty – Chapter 10)*

Substitution Reactions ( $S_N2$ )

Alcohols to Alkyl Halides ( $\text{SOCl}_2$ ,  $\text{PBr}_3$ )

Alkylation of Amines

Formation of Ethers and Epoxides (Williamson Ether Synthesis)

Stability of Ethers

Formation of Thiols and Sulfides

Synthesis of Nitriles

Ring Opening of Epoxides (Acid/Basic Conditions)

Epoxides in Biological Systems

Squalene Epoxide  $\rightarrow$  Lanosterol (carbocation cascade)

Enolates –  $\alpha$ -halogenation and  $\alpha$ -alkylation

Glycoside Formation – Intro to Carbohydrates

Enzyme Catalyzed  $S_N2$  Reaction (Lysozyme catalyzed reaction)

Elimination Reactions (E2)

Dehydration of Alcohols ( $\text{POCl}_3$ )

Alkyne Synthesis

Hoffman Elimination (converting an amine to a good leaving group)

## Free Radicals and Electrochemistry (4-5)

*(Zumdahl – Chapter 18, Burdge – Chapter 18 & Karty – Chapter 25)*

Balancing Redox Reactions

Standard Reduction Potential

Cell Potential

Dependence of Cell Potential on Concentration

Homolysis – Bond Dissociation Energies

Structure and Stability of Alkyl Radicals

Radical Reactions

Hydrogen Atom Abstraction

Halogenation

Radical Addition to an Alkene

Chain Mechanism

Kinetics and Thermodynamics of Radical Halogenation

Niacin – Crucial vitamin in redox

Redox in the Cell

NADH –  $\text{NAD}^+$  ( $\text{NADPH}$  –  $\text{NADP}^+$ )

Antioxidants

### **Electrophilic Addition to Nonpolar $\pi$ -Bonds (Carbocation Intermediates) (3-4)**

*(Karty – Chapter 11)*

Electrophilic Addition Mechanism – Strong Brønsted Acid to an Alkene

Regiochemistry – Production of More Stable Carbocation

Stereochemistry of Addition

Addition of a Weak Acid to an Alkene (acid catalyst) –  $\text{H}_2\text{O}/\text{H}_2\text{SO}_4$

Electrophilic Addition of a Strong Brønsted Acid to an Alkyne

Acid Catalyzed Addition of  $\text{H}_2\text{O}$  to an Alkyne

Electrophilic Addition of a Brønsted Acid to a Conjugated Diene

Kinetic vs Thermodynamic Control in Electrophilic Addition

Terpene Biosynthesis

### **Electrophilic Addition to Nonpolar $\pi$ -Bonds (Cyclic Transition States) (1-2)**

*(Karty – Chapter 12)*

Addition of Dihalides to Alkenes - Halogenation ( $\text{X}_2$ ) and Halohydrins ( $\text{X}_2, \text{H}_2\text{O}$ )

Epoxide Formation using Peroxyacids

Hydroboration/Oxidation of Alkenes and Alkynes

**Semester 3: Fall 2017 (3 credits)**

**Schedule of Lectures:**

**Topic (# of lectures)**

**Structure Determination (5-6)**

*(Karty – Chapter 15 & 16)*

Survey of Techniques

UV, IR, NMR, MS

**Conjugation and Aromaticity (3-4)**

*(Karty – Chapter 14)*

Aromaticity and Hückel's Rules

MO Picture of Aromaticity

Heterocyclic Aromatic Compounds

Aromatic Ions

Aromaticity and DNA

**Structure and Properties of Carbonyl Containing Molecules (3-4)**

*(Handout)*

Aldehydes, Ketones

Carboxylic Acids

Acidity

Carboxylic Acid Derivatives

Fatty Acids

Acyl Phosphates

Thioesters

Biomolecules – Lipids, Triacylglycerol

**Nucleophilic Addition to Polar p-Bonds (Strong Nucleophiles) (3-4)**

*(Karty – Chapter 17)*

Addition of Strong Nucleophiles

Relative Reactivities of Ketones and Aldehydes

Oxidation/Reduction States for C-O Bonds

Hydride Reducing Agents

NADH as a biological reducing agent

Organometallic Reagents – Organolithium and Grignards, Organocuprates

Wittig Reagents

1,4-Addition vs 1,2-Addition

Selectivity of Organometallic Reagents

**Nucleophilic Addition to Polar p-Bonds (Weak Nucleophiles)(3-4)**

*(Karty – Chapter 18)*

Weak Nucleophiles: Acid and Base Catalysis

Cyanohydrin Formation

Formation and Hydrolysis of imines & enamines (Schiff Bases)

Formation and Hydrolysis of Acetals and Ketals

Ring Opening/Closing of Monosaccharides - Hemiacetals

Carbohydrate Chemistry

Enolate Nucleophiles

Aldol Condensations

Aldolase Reactions (Metal or Enzyme Catalyzed)

**Reduction and Oxidation Reactions (1-2)**

*(Karty – Chapter 19)*

Catalytic Hydrogenation of Alkenes and Alkynes

Oxidation of Alcohols and Aldehydes

Hydrogenation of Lipids

## **Carboxylic Acid Derivatives (6-8)**

*(Karty – Chapter 20 & 21)*

- Nucleophilic Acyl Substitution Reaction (Addition-Elimination)
  - Kinetics and Thermodynamics of substitution
- Reactions with Strong Nucleophiles – Brief
  - Grignards/Hydride Reducing Agents
- Reactions with Weak Nucleophiles (interconversion)
- Relative Rates of Hydrolysis
- Acidic and Basic Conditions
- Triacylglycerols – Hydrolysis of for biodiesel
- Synthesis of Amides and Esters
  - Fischer Esterification
  - Transesterification
  - Aminolysis
- Reactions of Nitriles (Hydrolysis/Reduction)
  - Application to Wohl Degradation/Kiliani-Fischer Synthesis (Carbohydrates)
- Baeyer-Villiger Oxidations
- Claisen Condensations
- Reaction of Thioesters (Acetyl CoA)
- ATP (Phosphoryl Transfer Reactions) – Acyl Phosphates
- Synthesis of Peptides

## **Electrophilic Aromatic Substitution (3-4)**

*(Karty – Chapter 22 & 23)*

- General Mechanism
- Friedel-Crafts Alkylations
- Nitration
- Sulfonation
- Regiochemistry of EAS
- Activating/Deactivating Groups
- Substituent Effects on EAS
- EAS on rings other than Benzene (Pyrrole, Pyridine)

## **Polymers (3-4)**

*(Karty – Chapter 26)*

- Polystyrene
- Polymer Reactions
  - Free Radical
  - Step-Growth
  - Chain Growth
- Copolymers
- Structure and Properties
- Green Polymer Syntheses
- Recycling and Biodegradable Polymers
- Biological Macromolecules – examination of secondary structures
  - Peptides
  - Polysaccharides
  - DNA

## **LAB EXPERIMENTS – 2<sup>nd</sup> Semester (1 credit class)**

### **Computational Chemistry Lab** (Adapt from Wissinger Manual) – 1 week

ChemBio3D

Cyclohexane Chair Conformation (Axial vs Equatorial) and Energy Differences

Examination of Resonance structures and charge distribution on atoms

Examination of the Structure of Biomolecules (Cholesterol, DNA, proteins – X-Ray structures) – 3D Shape of Molecules

### **Isolation of Chlorophyll and Carotenoid Pigments from Spinach** (Adapt from Pavia 4<sup>th</sup> ed) – 2 weeks

Isolation of a Natural Product

Extraction

Column Chromatography

TLC

Equipment Needs: Small Centrifuge (< 10 mL volume centrifuge tubes)

### **Titration of an Unknown Amino Acid** – 1 week

Acid/Base Titration

Determination of identity of amino acid

Equipment Needs: pH Meter

### **Buffers Project** - (Adapt from Driessen – Chem 1066 lab) - 2 weeks

Design a buffer of a specified pH

Experimentally determine the capacity of your buffer

Alter the characteristics of your buffer and retest its capacity

### **Determination of $K_{eq}$ for the Acid-Catalyzed Esterification of Benzoic Acid in Methanol** (Adapt from

Minard – PSU) – 1-2 weeks

Equilibrium Reaction

Extraction

Calculation of  $K_{eq}$  based on starting material to product ratios

### **Solvent Effects of $S_N1$ – Measuring Kinetics of Hydrolysis of *t*-Butyl Chloride** (Adapt from

Doxsee/Hutchinson) – 2 weeks

Study kinetics of  $S_N1$  reaction in 4 different solvent mixtures

Titration of HCl generated to measure kinetics

### **Elimination of 2-Bromoheptane: Influence of the Base** (Adapt from Mohrig) – 1-2 weeks

Reflux

Extraction

Gas Chromatography

(Optional Computational Chemistry to look at calculated  $H_f$  of products and compare with experimental)

### **Synthesis of a Degradable Biopolymer &/or Degradation of a Biopolymer** (Wissinger new expt) – 1-2 weeks

US-Vis Study of Degradation

Equipment Needs: UV-Vis Spectrometer

## **LAB EXPERIMENTS – 3<sup>rd</sup> Semester (2 credit class)**

**2 x 3hr labs/week**

**IR Tutorial & NMR Tutorial** (Adapt from Wissinger Manual) – 1 week

**Epoxidation of Cholesterol** (Adapt from PSU & Williamson) – 1 week

Epoxidation of alkene  
Column Chromatography  
Recrystallization  
NMR &/or MS

**UV-Vis – Spectrophotometric Analysis of a Fluorescent Compound** - 0.5 week

Equipment Needs: UV-Vis Spectrometer & Micropipets

**Synthesis of a Fluorescent Coumarin** (Adapt from Wissinger Manual) – 1 week

**Isolation of Essential Oils from Plants (Eugenol or Carvone)** – (Eugenol – Wissinger Manual, Carvone – Mohrig 2<sup>nd</sup> ed) – 1 week

Steam Distillation  
Extraction

**Synthesis of  $\alpha$  or  $\beta$ -D-Glucose Pentaacetate to Investigate Kinetic and Equilibrium Control** – (Adapt from Mohrig 2<sup>nd</sup> Ed.) – 1.5-2 weeks

Individual syntheses of  $\alpha$  or  $\beta$ -D-Glucose Pentaacetate  
Isomerization with HOAc to determine product mixtures  
NMR study of isomerization

**Oxidation of Borneol to Camphor** – (Adapt from Wissinger Manual) – 1 week

Green Chemistry Oxidation (Oxone)  
Sublimation

**Size Exclusion Chromatography – Identification of an Unknown protein** - 1 week (Biochemistry Expt)

Sephadex G-100 Column – separation of two known protein samples – determination of  $V_0$  (void volume)  
Purification of an unknown protein (UV-Vis analysis) – determination of MW based on calibration of column with standards

**Biodiesel** (Adapt from Wissinger Manual) – 1 week

**Enzymatic Reduction: A Chiral Alcohol from a Ketone** – (Adapt from PSU & Williamson) – 1 week  
(stereospecific reduction of Ethyl acetoacetate with yeast enzymes)

Fermentation  
Extraction  
TLC  
Optical Rotation

Equipment Needs: 35°C Incubator or Oven & Polarimeter

**Electrophilic Aromatic Substitution – Vanillin + Oxone** (Adapt from Wissinger – new) – 1 week

**Combinatory Chemistry: Antibiotic Drug Discovery** – (Adapt from Doxsee/Hutchison) – 1.5 weeks

Combinatorial Chemistry  
Hydrazine Library as Antibiotics  
Biological Assay – test against *E. coli* using Disk Diffusion Assay

Equipment Needs: 37°C Oven

**ADDITIONAL LAB EXPERIMENTS IF NEEDED**

Thiamine (Vit B<sub>1</sub>) Catalyzed Benzoin Synthesis (NMR)

Enantioselective Hydrolysis of Diester with Esterase Enzyme (NMR)

Polymer Experiment (Wissinger – current polymer expt)

Banana Oil (Wissinger – current expt)

**Chemistry XXXX, Section XXX**  
**Chemistry for the Life Sciences 1**  
**Fall 2016**  
**MWF time, location**

**Instructor:** Dr. Angela Perkins

**Office:** 16 Smith Hall

**Phone:** 626-1619

**Email:** [aperkins@umn.edu](mailto:aperkins@umn.edu) (best way to contact me)

**Website:** All class information will be posted on the course website - access through <https://moodle2.umn.edu/>

**Office Hours:** See Moodle Site as dates/times will be set after the first week of the semester.

If office hours don't work for you or you want to be sure to chat one-on-one, please email to set up an appointment.

**Materials:** *General Chemistry Textbook (Atoms first approach)* by Zumdahl or Burdge. (Required); Access to Online Homework (**Aleks**, Required); Molecular Model kit (highly recommended); Non-programmable scientific calculator (see below for specifics); iClicker2 – ISBN 9781429290471 (Required)

**General Course Information:** Chemistry XXXX with accompanying 1065 lab is the first semester in a three-semester sequence of courses designed to provide a strong chemistry background for students pursuing degrees and careers in the life sciences. Upon completion of these courses, the desired outcome is that the student (1) can identify, define and solve problems; (2) can locate and critically evaluate information; (3) has mastered a body of knowledge and a mode of inquiry; (4) can communicate effectively; and (5) has acquired the skills for effective and life-long learning. This semester we will cover the topics of molecular structure, bonding and shape, energy and enthalpy, gas laws, properties of solutions, and equilibrium.

**Prerequisite Material:** To register/remained registered in this course, you must meet all of the following criteria:

1. Registration in both XXXX (lecture) and 1065 (lab) during the same semester is required
2. Passed the chemistry placement exam (and been advised to take this course) or Completed CHEM 1015 or an equivalent course with a grade of a C- or better

If you do not meet these criteria, you should report your situation to the staff in Smith 115 (624-0026) immediately. They handle all registration issues pertaining to this course.

**Calculating Final Grades:** Your final grades will be calculated based on the three hour exams, the final exam, the online assignments and in class participation as described below.

<b>Final Grade:</b>	Three exams (100 points each)	300	(50%)
	12 of 15 Online Assignments (5 points each)	60	(10%)
	Class Participation (iClicker Questions)	40	(7%)
	Final exam points	<u>200</u>	(33%)
	Total Points possible	600	

Letter grades (A-F) will be assigned based on the cumulative points received during the semester. The B-/C+ borderline will be set close to the class average.

**Exams:** Three exams (60 minutes each) will be given on the dates provided. The final exam is 2 hours. All exams will start promptly at **x:xx** so do not be late as you will not be granted additional time. You must have your student ID (or other form of ID) with you to take the exams. All exams will be closed book and closed notes and no other study aids are permitted. You will be allowed to use a non-programmable scientific calculator (see below for specifics).

<b>Exam I</b>	Day, Date @ Time (1 hour)
<b>Exam II</b>	Day, Date @ Time (1 hour)
<b>Exam III</b>	Day, Date @ Time (1 hour)
<b>Final Exam:</b>	Day, Date @ Time (2 hour)

**All examinations must be taken at the times indicated above. Absolutely NO late make-up exams will be given.** See below on policy for exam absences.

In the case of a University sponsored activity that will require the student to be out of town, it may be possible to take the exam with the coach, team academic advisor, or another instructor as the proctor. Please see the instructor about such conflicts *as soon as possible* so that arrangements can be made.

**Calculators:** The presence or use of graphing and/or programmable calculators is FORBIDDEN on exams, this includes the calculator on your cell phone or smart phone. Their presence or use during an exam will be considered cheating. Only non-programmable calculators with limited memory will be allowed for use during exams. Any one-line display calculator is allowed. The TI-30Xa is the suggested calculator for this and all CHEM 1xxx courses, and for most intro Physics courses. The bookstore stocks this calculator for around \$10. The TI-30X IIS is an acceptable two-line calculator. Many other two-line calculators are programmable and would therefore not be allowed. If you have any questions about your particular calculator, see the instructor immediately. Calculators may not be shared during exams. *If you are concerned about battery failure during an exam, bring a second calculator or extra batteries with you.*

**Online Assignments:** There will be 15 online assignments due every Monday over the course of the semester. Each assignment will be worth 5 points. These assignments will cover the material that we are covering in class. These assignments will be due on Monday @ 11:59pm (CST). You will need to activate your Aleks Account by registering using the link for our class, which can be found on the course website. All graded assignments will be listed and submitted on this website. No late homework will be accepted (no exceptions). If you need computer access, there is a computer lab on first floor **Walter Library (RM 103)** that is for UMN student use. I recommend not waiting till the last minute to complete your homework, as it will take some time to become familiar with the online homework program. There will be no extensions given for failure to complete your homework on time.

These assignments are for your benefit and are designed to help you to keep pace with the material that we are covering in lecture. While these assignments are not timed, they should take roughly 30 minutes as long as you have already read and understand the material. I will drop your three lowest grades for the online assignments.

**Class Participation:** During lecture almost everyday we will work problems. You will be encouraged to work with those around you to discuss solutions. Your responses to some of these problems will be monitored using the iClicker2 system and will be part of your grade. You will receive credit for participation during the in-class problems, as well as for correct answers. These questions will help me to gauge student understanding of the course material and to reinforce information as needed. You must correctly register your iClicker device to receive credit. You can find information about iClicker registration on the course Moodle site or you can go to <http://z.umn.edu/iclickerstudent> for instructions and a list of frequently asked questions. You have until the first exam to register your iClicker to receive credit for your participation and answers.

**Policy on Exam Absences:** A student can be excused from one midterm exam for a true emergency, serious illness, or University sponsored activity. The student should contact the instructor as soon as circumstances allow and appropriate documentation must be provided. If the circumstances are deemed as appropriate for missing the exam, the unweighted average score of all other midterm exams and of the final exam in the course will be used in place of the missed exam. If circumstances lead to a student missing more than one midterm exam, the student should immediately schedule a meeting with the instructor to discuss any available options.

The final exam can only be missed due to illness or family emergency and documentation again must be provided. However, in cases where the final exam is missed an incomplete ("I") final grade will be assigned according to the policy outlined below.

**Policy on an Incomplete (I) Grade:** An incomplete grade will be assigned only when the final exam is not taken **AND** the work completed to that date is satisfactory (C- or better). An incomplete grade can only be corrected by taking a regularly scheduled **XXXX** final exam in the next semester. If the final exam is not taken and/or the work completed to that date is not satisfactory, and **F** grad or an **N** grade will be given depending on whether the course is taken under the A-F or S-N grading system. **The "Agreement for Making Up and I Grade" form must be completed and signed by the Instructor, student, and a third party within 48 hours after the final exam.**

**Exam Regrade Policy:** Regrade requests must be submitted in writing directly to the instructor by 1 week following the posting of exam results. **Altering an exam and submitting it for a regrade is an act of scholastic dishonesty and will result in a "0" for the entire exam.**

**Scholastic Dishonesty Policy:** "Scholastic dishonesty is any act that violates the rights of another student with respect to academic work or that involves misrepresentation of a student's own work. Scholastic dishonesty includes (but is not limited to) cheating on assignments or examinations, plagiarizing (misrepresenting as one's own, anything done by another), submitting the same or substantially similar papers (or creative work) for more than one course without consent of all instructors concerned, depriving another of necessary course materials, and sabotaging another's work." – *Classroom Grading and Examination Procedures*. College of Liberal Arts.

**A student guilty of scholastic dishonesty will be awarded a grade of zero (0) for the exam involved. Additionally, the incident will be reported to the Office for Student Academic Integrity and to the college in which the student is enrolled.**

As a student at the University you are expected to adhere to the Board of Regents Policy: Student Conduct Code. To review this policy see: [http://regents.umn.edu/sites/regents.umn.edu/files/policies/Code\\_of\\_Conduct.pdf](http://regents.umn.edu/sites/regents.umn.edu/files/policies/Code_of_Conduct.pdf)

#### **How to do well in this course:**

- **Be prepared for lecture.** Briefly scan the material that is going to be covered in the lectures before you come to class. It helps to have a basic knowledge of what is being discussed in class and can help you tailor questions for material you don't understand.
- **Participate in Class.** Ask questions if there is something that you don't understand.
- **Study the material covered in class.** It is helpful to reread the material covered in class while the lecture is still fresh in your mind. If there is something you do not understand, you should ask for help as soon as possible.
- **Work out the assigned problems.** Chemistry can only be mastered by applying concepts learned and the best way to do this is to work problems. Make sure you understand the concepts presented in the chapter and then attempt the problems related to these concepts. The best way to work the problems is without the aid of the solutions manual.
- **Participate in a study group.** Study groups are an effective way of succeeding in this class. Forming a group of 2-3 other students from the class can be a great tool for understanding what you have learned and discover with which concepts you are still struggling. Do not go to the study group hoping to learn the material you have not studied, rather complete your studying and take questions to the study group.
- **Get help early.** This class moves very quickly and we cover a lot of material each week, so if you get lost you need to be proactive about getting the help that you need, whether that means going to the tutor room or coming to office hours with questions.

**Tutor Hours:** Tutor hours are held in 124 Smith Hall throughout the semester from 8:00am – 5:00pm. These hours are limited so come prepared with direct questions. A reminder that the purpose of a tutor is to help you learn, not

simply give you answers to questions or problems. The tutors are instructed, in fact, to ask YOU questions that will help you understand what concept you are missing that is preventing you from solving a particular problem. Self-discovery will enhance the depth and retention of your knowledge.

**Private Tutors:** The department also maintains a list of people who are available for private tutoring. This list can be obtained from 115 Smith Hall during business hours or you can find it on the course website. The cost/hour for a private tutor is negotiated between you (the student) and the tutor.

**Problems:** For each chapter a series of problems have been chosen from within and at the end of each chapter. These problems can be found on the course website. These problems will be similar in concept and difficulty to the ones that you will see on the exams. These problems **will not be** collected but are to help you understand the concepts and practice the material, so feel free to do as many or few as needed to understand the concepts presented in the chapters and in class. I generally choose a large number of problems because the best way to learn and understand the concepts is to work problems and also because some students appreciate a lot of examples. Again, do as many or as few as you need to understand the concepts.

**Policy Statements:**

**Overlapping and Back-to-Back Courses:** Enrolling in overlapping or back-to-back courses that do not allow for enough travel time to arrive at our class meetings on time is prohibited. For more information see:

<http://policy.umn.edu/Policies/Education/Education/Overlappingclasses.html>

**Student Mental Health and Stress Management:** As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. University of Minnesota services are available to assist you with addressing these and other concerns you may be experiencing. You can learn more about the broad range of confidential mental health services available on campus via <http://www.mentalhealth.umn.edu/>.

**Teaching and Learning:** The materials provided in this course are intended only for the students officially enrolled in this section and are to be used to learn and practice the course material. Disseminating class notes, videos, exams, etc.... beyond the classroom community or accepting compensation (in the form of cash or trade, such as access to study website) undermines instructor interests in their intellectual property while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community and are not allowed. For additional information please see <http://policy.umn.edu/Policies/Education/Education/Studentresp.html>

**Disability Resource Center:** Students with special needs should contact the Disability Resource Center (<https://diversity.umn.edu/disability/>), which will provide a letter to share with the instructor on how those needs shall be accommodated.

**Sexual Harassment:**

<http://regents.umn.edu/sites/regents.umn.edu/files/policies/SexHarassment.pdf>

**Equity, Diversity, and Equal Opportunity:**

[http://regents.umn.edu/sites/regents.umn.edu/files/policies/Equity\\_Diversity\\_EO\\_AA.pdf](http://regents.umn.edu/sites/regents.umn.edu/files/policies/Equity_Diversity_EO_AA.pdf)

**Chemistry XXXX, Section XXX**  
**Chemistry for the Life Sciences 2**  
**Spring 2017**  
**MWF time, location**

**Instructor:** Dr. Angela Perkins

**Office:** 16 Smith Hall

**Phone:** 626-1619

**Email:** [aperkins@umn.edu](mailto:aperkins@umn.edu) (best way to contact me)

**Website:** All class information will be posted on the course website - access through <https://moodle2.umn.edu/>

**Office Hours:** See Moodle Site as dates/times will be set after the first week of the semester.

If office hours don't work for you or you want to be sure to chat one-on-one, please email to set up an appointment.

**Materials:** *General Chemistry Textbook (Atoms first approach)* by Zumdahl or Burdge. (Required); "*Organic Chemistry: Principles and Mechanisms*" by Joel Karty, 2<sup>nd</sup> Ed. (required); Access to Online Homework (**Aleks**, Required); Molecular Model kit (highly recommended); Non-programmable scientific calculator (see below for specifics); iClicker2 – ISBN 9781429290471 (Required)

**General Course Information:** Chemistry XXXX with accompanying XXXX lab is the second semester in a three-semester sequence of courses designed to provide a strong chemistry background for students pursuing degrees and careers in the life sciences. Upon completion of these courses, the desired outcome is that the student (1) can identify, define and solve problems; (2) can locate and critically evaluate information; (3) has mastered a body of knowledge and a mode of inquiry; (4) can communicate effectively; and (5) has acquired the skills for effective and life-long learning. This semester we will cover the topics of acids, bases and equilibrium, kinetics, nucleophilic substitution and elimination reactions, free radicals and electrochemistry, and alkene addition reactions.

**Prerequisite Material:** To register/remained registered in this course, you must meet all of the following criteria:

1. Registration in both XXXX (lecture) and XXXX (lab) during the same semester is required
2. Completed with a C- or better, CHEM XXXX (lecture) and XXXX (lab)

If you do not meet these criteria, you should report your situation to the staff in Smith 115 (624-0026) immediately. They handle all registration issues pertaining to this course.

**Calculating Final Grades:** Your final grades will be calculated based on the three hour exams, the final exam, the online assignments and in class participation as described below.

<b>Final Grade:</b>	Three exams (100 points each)	300	(50%)
	12 of 15 Online Assignments (5 points each)	60	(10%)
	Class Participation (iClicker Questions)	40	(7%)
	Final exam points	<u>200</u>	(33%)
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In the case of a University sponsored activity that will require the student to be out of town, it may be possible to take the exam with the coach, team academic advisor, or another instructor as the proctor. Please see the instructor about such conflicts *as soon as possible* so that arrangements can be made.

**Calculators:** The presence or use of graphing and/or programmable calculators is FORBIDDEN on exams, this includes the calculator on your cell phone or smart phone. Their presence or use during an exam will be considered cheating. Only non-programmable calculators with limited memory will be allowed for use during exams. Any one-line display calculator is allowed. The TI-30Xa is the suggested calculator for this and all CHEM 1xxx courses, and for most intro Physics courses. The bookstore stocks this calculator for around \$10. The TI-30X IIS is an acceptable two-line calculator. Many other two-line calculators are programmable and would therefore not be allowed. If you have any questions about your particular calculator, see the instructor immediately. Calculators may not be shared during exams. *If you are concerned about battery failure during an exam, bring a second calculator or extra batteries with you.*

**Online Assignments:** There will be 15 online assignments due every Monday over the course of the semester. Each assignment will be worth 5 points. These assignments will cover the material that we are covering in class. These assignments will be due on Monday @ 11:59pm (CST). You will need to activate your Aleks Account by registering using the link for our class, which can be found on the course website. All graded assignments will be listed and submitted on this website. No late homework will be accepted (no exceptions). If you need computer access, there is a computer lab on first floor **Walter Library (RM 103)** that is for UMN student use. I recommend not waiting till the last minute to complete your homework, as it will take some time to become familiar with the online homework program. There will be no extensions given for failure to complete your homework on time.

These assignments are for your benefit and are designed to help you to keep pace with the material that we are covering in lecture. While these assignments are not timed, they should take roughly 30 minutes as long as you have already read and understand the material. I will drop your three lowest grades for the online assignments.

**Class Participation:** During lecture almost everyday we will work problems. You will be encouraged to work with those around you to discuss solutions. Your responses to some of these problems will be monitored using the iClicker2 system and will be part of your grade. You will receive credit for participation during the in-class problems, as well as for correct answers. These questions will help me to gauge student understanding of the course material and to reinforce information as needed. You must correctly register your iClicker device to receive credit. You can find information about iClicker registration on the course Moodle site or you can go to <http://z.umn.edu/iclickerstudent> for instructions and a list of frequently asked questions. You have until the first exam to register your iClicker to receive credit for your participation and answers.

**Policy on Exam Absences:** A student can be excused from one midterm exam for a true emergency, serious illness, or University sponsored activity. The student should contact the instructor as soon as circumstances allow and appropriate documentation must be provided. If the circumstances are deemed as appropriate for missing the exam, the unweighted average score of all other midterm exams and of the final exam in the course will be used in place of the missed exam. If circumstances lead to a student missing more than one midterm exam, the student should immediately schedule a meeting with the instructor to discuss any available options.

The final exam can only be missed due to illness or family emergency and documentation again must be provided. However, in cases where the final exam is missed an incomplete (“I”) final grade will be assigned according to the policy outlined below.

**Policy on an Incomplete (I) Grade:** An incomplete grade will be assigned only when the final exam is not taken **AND** the work completed to that date is satisfactory (C- or better). An incomplete grade can only be corrected by taking a regularly scheduled **XXXX** final exam in the next available semester. If the final exam is not taken and/or the work completed to that date is not satisfactory, and **F** grad or an **N** grade will be given depending on whether the course is taken under the A-F or S-N grading system. **The “Agreement for Making Up and I Grade” form must be completed and signed by the Instructor, student, and a third party within 48 hours after the final exam.**

**Exam Regrade Policy:** Regrade requests must be submitted in writing directly to the instructor by 1 week following the posting of exam results. **Altering an exam and submitting it for a regrade is an act of scholastic dishonesty and will result in a “0” for the entire exam.**

**Scholastic Dishonesty Policy:** “Scholastic dishonesty is any act that violates the rights of another student with respect to academic work or that involves misrepresentation of a student’s own work. Scholastic dishonesty includes (but is not limited to) cheating on assignments or examinations, plagiarizing (misrepresenting as one’s own, anything done by another), submitting the same or substantially similar papers (or creative work) for more than one course without consent of all instructors concerned, depriving another of necessary course materials, and sabotaging another’s work.” – *Classroom Grading and Examination Procedures*. College of Liberal Arts.

**A student guilty of scholastic dishonesty will be awarded a grade of zero (0) for the exam involved. Additionally, the incident will be reported to the Office for Student Academic Integrity and to the college in which the student is enrolled.**

As a student at the University you are expected to adhere to the Board of Regents Policy: Student Conduct Code. To review this policy see: [http://regents.umn.edu/sites/regents.umn.edu/files/policies/Code\\_of\\_Conduct.pdf](http://regents.umn.edu/sites/regents.umn.edu/files/policies/Code_of_Conduct.pdf)

**How to do well in this course:**

- **Be prepared for lecture.** Briefly scan the material that is going to be covered in the lectures before you come to class. It helps to have a basic knowledge of what is being discussed in class and can help you tailor questions for material you don’t understand.
- **Participate in Class.** Ask questions if there is something that you don’t understand.
- **Study the material covered in class.** It is helpful to reread the material covered in class while the lecture is still fresh in your mind. If there is something you do not understand, you should ask for help as soon as possible.
- **Work out the assigned problems.** Chemistry can only be mastered by applying concepts learned and the best way to do this is to work problems. Make sure you understand the concepts presented in the chapter and then attempt the problems related to these concepts. The best way to work the problems is without the aid of the solutions manual.
- **Participate in a study group.** Study groups are an effective way of succeeding in this class. Forming a group of 2-3 other students from the class can be a great tool for understanding what you have learned and discover with which concepts you are still struggling. Do not go to the study group hoping to learn the material you have not studied, rather complete your studying and take questions to the study group.
- **Get help early.** This class moves very quickly and we cover a lot of material each week, so if you get lost you need to be proactive about getting the help that you need, whether that means going to the tutor room or coming to office hours with questions.

**Tutor Hours:** Tutor hours are held in 124 Smith Hall throughout the semester from 8:00am – 5:00pm. These hours are limited so come prepared with direct questions. A reminder that the purpose of a tutor is to help you learn, not simply give you answers to questions or problems. The tutors are instructed, in fact, to ask YOU questions that will help you understand what concept you are missing that is preventing you from solving a particular problem. Self-discovery will enhance the depth and retention of your knowledge.

**Private Tutors:** The department also maintains a list of people who are available for private tutoring. This list can be obtained from 115 Smith Hall during business hours or you can find it on the course website. The cost/hour for a private tutor is negotiated between you (the student) and the tutor.

**Problems:** For each chapter a series of problems have been chosen from within and at the end of each chapter. These problems can be found on the course website. These problems will be similar in concept and difficulty to the ones that you will see on the exams. These problems **will not be** collected but are to help you understand the concepts and practice the material, so feel free to do as many or few as needed to understand the concepts presented in the chapters and in class. I generally choose a large number of problems because the best way to learn and understand the concepts is to work problems and also because some students appreciate a lot of examples. Again, do as many or as few as you need to understand the concepts.

**Policy Statements:**

**Overlapping and Back-to-Back Courses:** Enrolling in overlapping or back-to-back courses that do not allow for enough travel time to arrive at our class meetings on time is prohibited. For more information see:

<http://policy.umn.edu/Policies/Education/Education/Overlappingclasses.html>

**Student Mental Health and Stress Management:** As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. University of Minnesota services are available to assist you with addressing these and other concerns you may be experiencing. You can learn more about the broad range of confidential mental health services available on campus via <http://www.mentalhealth.umn.edu/>.

**Teaching and Learning:** The materials provided in this course are intended only for the students officially enrolled in this section and are to be used to learn and practice the course material. Disseminating class notes, videos, exams, etc.... beyond the classroom community or accepting compensation (in the form of cash or trade, such as access to study website) undermines instructor interests in their intellectual property while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community and are not allowed. For additional information please see <http://policy.umn.edu/Policies/Education/Education/Studentresp.html>

**Disability Resource Center:** Students with special needs should contact the Disability Resource Center (<https://diversity.umn.edu/disability/>), which will provide a letter to share with the instructor on how those needs shall be accommodated.

**Sexual Harassment:**

<http://regents.umn.edu/sites/regents.umn.edu/files/policies/SexHarassment.pdf>

**Equity, Diversity, and Equal Opportunity:**

[http://regents.umn.edu/sites/regents.umn.edu/files/policies/Equity\\_Diversity\\_EO\\_AA.pdf](http://regents.umn.edu/sites/regents.umn.edu/files/policies/Equity_Diversity_EO_AA.pdf)

**Chemistry XXXX, Section XXX**  
**Chemistry for the Life Sciences 3**  
**Fall 2017**  
**MWF time, location**

**Instructor:** Dr. Angela Perkins

**Office:** 16 Smith Hall

**Phone:** 626-1619

**Email:** [aperkins@umn.edu](mailto:aperkins@umn.edu) (best way to contact me)

**Website:** All class information will be posted on the course website - access through <https://moodle2.umn.edu/>

**Office Hours:** See Moodle Site as dates/times will be set after the first week of the semester.

If office hours don't work for you or you want to be sure to chat one-on-one, please email to set up an appointment.

**Materials:** "Organic Chemistry: Principles and Mechanisms" by Joel Karty, 2<sup>nd</sup> ed. (required); Access to Online Homework (**Aleks**, Required); Molecular Model kit (highly recommended); Non-programmable scientific calculator (see below for specifics); iClicker2 – ISBN 9781429290471 (Required)

**General Course Information:** Chemistry XXXX with accompanying XXXX lab is the third semester in a three-semester sequence of courses designed to provide a strong chemistry background for students pursuing degrees and careers in the life sciences. Upon completion of these courses, the desired outcome is that the student (1) can identify, define and solve problems; (2) can locate and critically evaluate information; (3) has mastered a body of knowledge and a mode of inquiry; (4) can communicate effectively; and (5) has acquired the skills for effective and life-long learning. This semester we will cover the topics of spectroscopy, conjugation and Aromaticity, carbonyls and reactivity, carboxylic acid derivatives, electrophilic aromatic substitution, and polymers.

**Prerequisite Material:** To register/remained registered in this course, you must meet all of the following criteria:

1. Registration in both XXXX (lecture) and XXXX (lab) during the same semester is required
2. Completed with a C- or better, CHEM XXXX (lecture) and XXXX (lab)

If you do not meet these criteria, you should report your situation to the staff in Smith 115 (624-0026) immediately. They handle all registration issues pertaining to this course.

**Calculating Final Grades:** Your final grades will be calculated based on the three hour exams, the final exam, the online assignments and in class participation as described below.

<b>Final Grade:</b>	Three exams (100 points each)	300	(50%)
	12 of 15 Online Assignments (5 points each)	60	(10%)
	Class Participation (iClicker Questions)	40	(7%)
	Final exam points	<u>200</u>	(33%)
	Total Points possible	600	

Letter grades (A-F) will be assigned based on the cumulative points received during the semester. The B-/C+ borderline will be set close to the class average.

**Exams:** Three exams (60 minutes each) will be given on the dates provided. The final exam is 2 hours. All exams will start promptly at x:xx so do not be late as you will not be granted additional time. You must have your student ID (or other form of ID) with you to take the exams. All exams will be closed book and closed notes and no other study aids are permitted. You will be allowed to use a non-programmable scientific calculator (see below for specifics).

<b>Exam I</b>	Day, Date @ Time (1 hour)
<b>Exam II</b>	Day, Date @ Time (1 hour)
<b>Exam III</b>	Day, Date @ Time (1 hour)
<b>Final Exam:</b>	Day, Date @ Time (2 hour)

**All examinations must be taken at the times indicated above. Absolutely NO late make-up exams will be given.** See below on policy for exam absences.

In the case of a University sponsored activity that will require the student to be out of town, it may be possible to take the exam with the coach, team academic advisor, or another instructor as the proctor. Please see the instructor about such conflicts *as soon as possible* so that arrangements can be made.

**Calculators:** The presence or use of graphing and/or programmable calculators is FORBIDDEN on exams, this includes the calculator on your cell phone or smart phone. Their presence or use during an exam will be considered cheating. Only non-programmable calculators with limited memory will be allowed for use during exams. Any one-line display calculator is allowed. The TI-30Xa is the suggested calculator for this and all CHEM 1xxx courses, and for most intro Physics courses. The bookstore stocks this calculator for around \$10. The TI-30X IIS is an acceptable two-line calculator. Many other two-line calculators are programmable and would therefore not be allowed. If you have any questions about your particular calculator, see the instructor immediately. Calculators may not be shared during exams. *If you are concerned about battery failure during an exam, bring a second calculator or extra batteries with you.*

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**Exam Regrade Policy:** Regrade requests must be submitted in writing directly to the instructor by 1 week following the posting of exam results. **Altering an exam and submitting it for a regrade is an act of scholastic dishonesty and will result in a “0” for the entire exam.**

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**How to do well in this course:**

- **Be prepared for lecture.** Briefly scan the material that is going to be covered in the lectures before you come to class. It helps to have a basic knowledge of what is being discussed in class and can help you tailor questions for material you don’t understand.
- **Participate in Class.** Ask questions if there is something that you don’t understand.
- **Study the material covered in class.** It is helpful to reread the material covered in class while the lecture is still fresh in your mind. If there is something you do not understand, you should ask for help as soon as possible.
- **Work out the assigned problems.** Chemistry can only be mastered by applying concepts learned and the best way to do this is to work problems. Make sure you understand the concepts presented in the chapter and then attempt the problems related to these concepts. The best way to work the problems is without the aid of the solutions manual.
- **Participate in a study group.** Study groups are an effective way of succeeding in this class. Forming a group of 2-3 other students from the class can be a great tool for understanding what you have learned and discover with which concepts you are still struggling. Do not go to the study group hoping to learn the material you have not studied, rather complete your studying and take questions to the study group.
- **Get help early.** This class moves very quickly and we cover a lot of material each week, so if you get lost you need to be proactive about getting the help that you need, whether that means going to the tutor room or coming to office hours with questions.

**Tutor Hours:** Tutor hours are held in 124 Smith Hall throughout the semester from 8:00am – 5:00pm. These hours are limited so come prepared with direct questions. A reminder that the purpose of a tutor is to help you learn, not simply give you answers to questions or problems. The tutors are instructed, in fact, to ask YOU questions that will help you understand what concept you are missing that is preventing you from solving a particular problem. Self-discovery will enhance the depth and retention of your knowledge.

**Private Tutors:** The department also maintains a list of people who are available for private tutoring. This list can be obtained from 115 Smith Hall during business hours or you can find it on the course website. The cost/hour for a private tutor is negotiated between you (the student) and the tutor.

**Problems:** For each chapter a series of problems have been chosen from within and at the end of each chapter. These problems can be found on the course website. These problems will be similar in concept and difficulty to the ones that you will see on the exams. These problems **will not be** collected but are to help you understand the concepts and practice the material, so feel free to do as many or few as needed to understand the concepts presented in the chapters and in class. I generally choose a large number of problems because the best way to learn and understand the concepts is to work problems and also because some students appreciate a lot of examples. Again, do as many or as few as you need to understand the concepts.

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**Student Mental Health and Stress Management:** As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. University of Minnesota services are available to assist you with addressing these and other concerns you may be experiencing. You can learn more about the broad range of confidential mental health services available on campus via <http://www.mentalhealth.umn.edu/>.

**Teaching and Learning:** The materials provided in this course are intended only for the students officially enrolled in this section and are to be used to learn and practice the course material. Disseminating class notes, videos, exams, etc.... beyond the classroom community or accepting compensation (in the form of cash or trade, such as access to study website) undermines instructor interests in their intellectual property while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community and are not allowed. For additional information please see <http://policy.umn.edu/Policies/Education/Education/Studentresp.html>

**Disability Resource Center:** Students with special needs should contact the Disability Resource Center (<https://diversity.umn.edu/disability/>), which will provide a letter to share with the instructor on how those needs shall be accommodated.

**Sexual Harassment:**

<http://regents.umn.edu/sites/regents.umn.edu/files/policies/SexHarassment.pdf>

**Equity, Diversity, and Equal Opportunity:**

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**Chemistry XXXX, Sections XXX - XXX**  
**Chemistry for the Life Sciences, Semester 2 Lab**  
**Spring 2017**

**Instructor:** Dr. Angela Perkins

**Office:** 16 Smith Hall

**Phone:** 626-1619

**Email:** [aperkins@umn.edu](mailto:aperkins@umn.edu) (best way to contact me)

**Website:** All class information will be posted on the course website - access through <https://moodle2.umn.edu/>

**Office Hours:** See Moodle Site, as dates/times will be set after the first week of the semester. If office hours don't work for you or you want to be sure to chat one-on-one, please email to set up an appointment.

**General Course Information:** CHEM XXXX is the accompanying lab for CHEM XXXX, which is the second semester in a three-semester sequence of courses designed to provide a strong chemistry background for students pursuing degrees and careers in the life sciences. Upon completion of this course, the desired outcome is that the student (1) can identify, define and solve problems; (2) can locate and critically evaluate information; (3) has mastered a body of knowledge and mode of inquiry; (4) can communicate effectively; and (5) has acquired the skills for effective and life-long learning.

**Required Materials:**

- Internet capable laptop or tablet\*
- Course content provided through the class Moodle site and LabArchives
- Jerry R. Mohrig, David G. Alberg, Gretchen E. Hofmeister, Paul F. Schatz, and Christina Noring Hammond, "Laboratory *Techniques in Organic Chemistry*", 4<sup>th</sup> Ed.; W.H Freeman and Company, New York, **2014**.
- Splash proof goggles. Goggles will be available for purchase the first day of lab during check-in (standard quality \$X.XX or Univex higher quality for \$XX.XX) or you may use a pair that you retained from another U of MN course. Your TA must inspect all other goggles before use.

**Optional Materials:** Though not required, it is recommended that a laboratory coat be worn to protect both you and your clothing while doing experimental work. The laboratory coat should be 100% cotton (NOT a polyester blend – check the label carefully) and of the appropriate size so that sleeves do not extend beyond wrists. Laboratory coats are available for purchase in the medical section of the Coffman bookstore for \$22-25. Try on the coats hanging on the racks to be sure to purchase the correct size.

**Emails:** My email is the primary source of contacting me outside of lecture and lab. If you are ill or have an emergency situation, email me as soon as possible to let me know what the circumstances are so that I can best address the situation with you and your TA. Please copy or include the name of your TA on all relevant correspondences. Please be respectful of my email and look at the course Moodle site for answers to common questions.

**Dress Code:** You must be wearing approved safety goggles and have all skin covered from the chest down in order to participate in the laboratory. If you do not come to lab dressed appropriately, with goggles, you will be asked to leave and will not have the opportunity to make-up the experiment. Please see the full dress code and safety goggles information posted on the lab website.

**Safety:** Each student is expected to follow all safety protocols/information found in the class LabArchives and on the Moodle site. In addition, a contract confirming your understanding of the safety rules, waste handling and other important protocols of the course will be given and your signature is required before any laboratory work can be performed.

Any student found performing unauthorized experiments or behaving in an unsafe manner in the laboratory may be removed from the laboratory at any time. Whether or not behavior is unsafe is at the discretion of the instructors, and this includes failure to properly respond to instructions in a timely manner. Removal from this laboratory may be for a period of time as short as the remainder of the current lab period or as long as the remainder of the course itself, depending on the circumstances.

**Waste Disposal:** It is extremely important that each and every student disposes of their chemicals in the proper manner according to the Waste Disposal instructions given at the end of each experiment and summarized on the Moodle site. Improper handling of waste will initially be reflected in a low technique grade and repeated offenses will warrant removal from lab and a zero for that day's experiment.

**Website:** All course information, including the syllabus will be posted on the course Moodle website. You can access this site through <http://myu.umn.edu>. You will find many useful links and information here.

**Grading:** Your grade for this course will be based on the sum of the points earned from the following assignments and quizzes.

Lab Reports (8)	600 points (70%)
Preparation and Notebook	100 points (12%)
Technique	60 points (7%)
Discussion	90 points (11%)
<b>Total:</b>	<b>850 points</b>

In this course, it is expected that 30% of the students will earn an A or A- (evenly divided), ~40% B's (B+/B/B-), and ~20% C's (C+/C/C-). **The overall class average for this course will be a grade of a B.**

**Lab Reports:** The results of the 8 experiments will be reported in the format of a laboratory report. All reports are to be turned in at the beginning of the designated lab period. Formal lab reports must be turned in to the TurnItIn link found on the course Moodle site. Late points will be docked for failure to submit your report before the due date.

All written work should represent your own original data (from your experimental notebook) and scientific interpretations, whether the experiment was done individually, in pairs or in a group. On the Moodle site you may find any extra directions given for specific lab reports. For lab reports, it is preferred that chemical structures be drawn using ChemBioDraw available through a University of Minnesota site license or another drawing program. Instructions for downloading this software are posted on our website. This program is also available on the computers that are available for use in 103 Walter Library for your convenience. Optionally, chemical structures may be drawn by hand.

**Preparation and Notebook:** It is extremely important to come to lab prepared for each experiment. You can then work safely and efficiently and with understanding of the chemical principles or techniques being studied. Notebook preparation is described on the course Moodle site. For random experiments, your TA will evaluate your preparedness and grade your notebook pages. Additionally, the notebook is not only essential for preparation but also for recording all data and observations during an experiment. The course Moodle site also offers suggestions on how to organize your notebook for recording data such as properties, reaction times, color changes etc. during lab work. At the completion of lab on random days, notebook pages will be turned in for grading and checked for accuracy.

**Technique:** TA's will observe and grade your technique when working in the lab. This includes safety, the proper handling of waste, the ability to setup apparatus correctly, perform the required techniques and the ability to make/react to scientific observations. Students who do not follow procedures, are irresponsible with their waste

handling, or are unsafe will earn lower technique grades for each experiment. Additionally, repeated tardiness to lab will also be reflected in the technique grade.

**Discussion:** On multiple occasions during the semester, time will be devoted in lab for sharing data and discussing results. You will be graded on your participation and contribution to the discussions.

**Attendance:** Attendance in lab, for the entire lab period, is required. Missing more than 15 minutes of a lab period will be considered an absence. In the case of a true emergency, serious illness, or university-related trip that prevents a student from attending a lab meeting, an **excused absence may be granted**. To obtain an excused absence, students must contact the Instructor, as soon as circumstances allow, to discuss the nature of the emergency, and eventually to provide documentation. **ONLY ONE** excused absence will be granted during the course of the semester. If extenuating circumstances prevent a student from attending more than one lab period, a meeting must be scheduled immediately with the Instructor to discuss any options available.

If you are more than 15 minutes late to lab, you will be asked to leave. This will be considered an unexcused absence and you will receive a zero for that day's experiment.

**Makeup Policy:** Missed experiments can be made-up only for valid reasons with instructor approval. There is one makeup day scheduled at the end of the semester, which can be used to complete any experiment missed for valid reason. **You may not simply choose to miss a lab and plan to make it up on the makeup day. You must have a valid excuse for missing the regularly scheduled experiment time.** Work completed on makeup days is due on the final lab day. See TA for specific due date.

**Late Work:** All assignments are to be turned in at the beginning of the designated lab period or points will be deducted. Your assignment will be deducted 10% of the total points per day (including weekends). If an assignment is turned in late it should be given directly to your TA or placed in the lock box outside of 115 Smith Hall, designated for this class. You are responsible for contacting your TA to let them know that your assignment is located here. *Failure to send this email means that your assignment will continue to rack up late point deductions.*

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**Policy Statements:**

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**Teaching and Learning:** The materials provided in this course are intended only for the students officially enrolled in this section and are to be used to learn and practice the course material. Disseminating class notes, videos, exams, etc.... beyond the classroom community or accepting compensation (in the form of cash or trade, such as access to study website) undermines instructor interests in their intellectual property while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community and are not allowed. For additional information please see <http://policy.umn.edu/Policies/Education/Education/Studentresp.html>

**Sexual Harassment:**

<http://regents.umn.edu/sites/regents.umn.edu/files/policies/SexHarassment.pdf>

**Equity, Diversity, and Equal Opportunity:**

[http://regents.umn.edu/sites/regents.umn.edu/files/policies/Equity\\_Diversity\\_EO\\_AA.pdf](http://regents.umn.edu/sites/regents.umn.edu/files/policies/Equity_Diversity_EO_AA.pdf)

**Lab Schedule:**

<b>Week</b>	<b>Experiment</b>
<b>1</b>	Lab Syllabus, Check-In
<b>2</b>	Computational Chemistry
<b>3 &amp; 4</b>	Isolation of Chlorophyll from Spinach, TLC and Column Chromatography
<b>5</b>	Titration of an Unknown Amino Acid
<b>6 &amp; 7</b>	Design of a Buffer
<b>8</b>	Determination of $K_{eq}$ for the Acid-Catalyzed Esterification of Benzoic Acid in Methanol
<b>9</b>	Solvent Effects of $S_N1$ - Measuring Kinetics of Hydrolysis of <i>t</i> -Butyl Chloride
<b>10</b>	Elimination of 2-Bromoheptane: Influence of the Base
<b>11 &amp; 12</b>	Synthesis of a Degradable Biopolymer &/or Degradation of a Biopolymer
<b>13</b>	Makeup Day
<b>14</b>	Cleanup and Check-out

**Chemistry XXXX, Sections XXX - XXX**  
**Chemistry for the Life Sciences, Semester 3 Lab**  
**Fall 2017**

**Instructor:** Dr. Angela Perkins

**Office:** 16 Smith Hall

**Phone:** 626-1619

**Email:** [aperkins@umn.edu](mailto:aperkins@umn.edu) (best way to contact me)

**Website:** All class information will be posted on the course website - access through <https://moodle2.umn.edu/>

**Office Hours:** See Moodle Site, as dates/times will be set after the first week of the semester. If office hours don't work for you or you want to be sure to chat one-on-one, please email to set up an appointment.

**General Course Information:** CHEM XXXX is the accompanying lab for CHEM XXXX, which is the third semester in a three-semester sequence of courses designed to provide a strong chemistry background for students pursuing degrees and careers in the life sciences. Upon completion of this course, the desired outcome is that the student (1) can identify, define and solve problems; (2) can locate and critically evaluate information; (3) has mastered a body of knowledge and mode of inquiry; (4) can communicate effectively; and (5) has acquired the skills for effective and life-long learning.

**Required Materials:**

- Internet capable laptop or tablet\*
- Course content provided through the class Moodle site and LabArchives
- Jerry R. Mohrig, David G. Alberg, Gretchen E. Hofmeister, Paul F. Schatz, and Christina Noring Hammond, "Laboratory *Techniques in Organic Chemistry*", 4<sup>th</sup> Ed.; W.H Freeman and Company, New York, **2014**.
- Splash proof goggles. Goggles will be available for purchase the first day of lab during check-in (standard quality \$X.XX or Univex higher quality for \$XX.XX) or you may use a pair that you retained from another U of MN course. Your TA must inspect all other goggles before use.

**Optional Materials:** Though not required, it is recommended that a laboratory coat be worn to protect both you and your clothing while doing experimental work. The laboratory coat should be 100% cotton (NOT a polyester blend – check the label carefully) and of the appropriate size so that sleeves do not extend beyond wrists. Laboratory coats are available for purchase in the medical section of the Coffman bookstore for \$22-25. Try on the coats hanging on the racks to be sure to purchase the correct size.

**Emails:** My email is the primary source of contacting me outside of lecture and lab. If you are ill or have an emergency situation, email me as soon as possible to let me know what the circumstances are so that I can best address the situation with you and your TA. Please copy or include the name of your TA on all relevant correspondences. Please be respectful of my email and look at the course Moodle site for answers to common questions.

**Dress Code:** You must be wearing approved safety goggles and have all skin covered from the chest down in order to participate in the laboratory. If you do not come to lab dressed appropriately, with goggles, you will be asked to leave and will not have the opportunity to make-up the experiment. Please see the full dress code and safety goggles information posted on the lab website.

**Safety:** Each student is expected to follow all safety protocols/information found in the class LabArchives and on the Moodle site. In addition, a contract confirming your understanding of the safety rules, waste handling and other important protocols of the course will be given and your signature is required before any laboratory work can be performed.

Any student found performing unauthorized experiments or behaving in an unsafe manner in the laboratory may be removed from the laboratory at any time. Whether or not behavior is unsafe is at the discretion of the instructors, and this includes failure to properly respond to instructions in a timely manner. Removal from this laboratory may be for a period of time as short as the remainder of the current lab period or as long as the remainder of the course itself, depending on the circumstances.

**Waste Disposal:** It is extremely important that each and every student disposes of their chemicals in the proper manner according to the Waste Disposal instructions given at the end of each experiment and summarized on the Moodle site. Improper handling of waste will initially be reflected in a low technique grade and repeated offenses will warrant removal from lab and a zero for that day's experiment.

**Website:** All course information, including the syllabus will be posted on the course Moodle website. You can access this site through <http://myu.umn.edu>. You will find many useful links and information here.

**Grading:** Your grade for this course will be based on the sum of the points earned from the following assignments and quizzes.

Lab Reports (13)	875 points (70%)
Preparation and Notebook	150 points (12%)
Technique	100 points (8%)
Discussion	<u>125 points (10%)</u>
<b>Total:</b>	<b>1250 points</b>

In this course, it is expected that 30% of the students will earn an A or A- (evenly divided), ~40% B's (B+/B/B-), and ~20% C's (C+/C/C-). **The overall class average for this course will be a grade of a B.**

**Lab Reports:** The results of the 13 experiments will be reported in the format of a laboratory report. All reports are to be turned in at the beginning of the designated lab period. Formal lab reports must be turned in to the TurnItIn link found on the course Moodle site. Late points will be docked for failure to submit your report before the due date.

All written work should represent your own original data (from your experimental notebook) and scientific interpretations, whether the experiment was done individually, in pairs or in a group. On the Moodle site you may find any extra directions given for specific lab reports. For lab reports, it is preferred that chemical structures be drawn using ChemBioDraw available through a University of Minnesota site license or another drawing program. Instructions for downloading this software are posted on the Moodle site. This program is also available on the computers that are available for use in 103 Walter Library for your convenience. Optionally, chemical structures may be drawn by hand.

**Preparation and Notebook:** It is extremely important to come to lab prepared for each experiment. You can then work safely and efficiently and with understanding of the chemical principles or techniques being studied. Notebook preparation is described on the course Moodle site. For random experiments, your TA will evaluate your preparedness and grade your notebook pages. Additionally, the notebook is not only essential for preparation but also for recording all data and observations during an experiment. The course Moodle site also offers suggestions on how to organize your notebook for recording data such as properties, reaction times, color changes etc. during lab work. At the completion of lab on random days, notebook pages will be turned in for grading and checked for accuracy.

**Technique:** TA's will observe and grade your technique when working in the lab. This includes safety, the proper handling of waste, the ability to setup apparatus correctly, perform the required techniques and the ability to make/react to scientific observations. Students who do not follow procedures, are irresponsible with their waste

handling, or are unsafe will earn lower technique grades for each experiment. Additionally, repeated tardiness to lab will also be reflected in the technique grade.

**Discussion:** On multiple occasions during the semester, time will be devoted in lab for sharing data and discussing results. You will be graded on your participation and contribution to the discussions.

**Attendance:** Attendance in lab, for the entire lab period, is required. Missing more than 15 minutes of a lab period will be considered an absence. In the case of a true emergency, serious illness, or university-related trip that prevents a student from attending a lab meeting, an **excused absence may be granted**. To obtain an excused absence, students must contact the Instructor, as soon as circumstances allow, to discuss the nature of the emergency, and eventually to provide documentation. **ONLY ONE** excused absence will be granted during the course of the semester. If extenuating circumstances prevent a student from attending more than one lab period, a meeting must be scheduled immediately with the Instructor to discuss any options available.

If you are more than 15 minutes late to lab, you will be asked to leave. This will be considered an unexcused absence and you will receive a zero for that day's experiment.

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## Lab Schedule:

<b>Week</b>	<b>Experiment</b>
1	Lab Syllabus, Check-In
2	IR & NMR Tutorial
3	UV-Vis – Spectrophotometric Analysis of a Fluorescent Compound  Synthesis of a Fluorescent Compound
4	Isolation of Essential Oils from Plants
5 & 6	Synthesis of $\alpha$ or $\beta$ -D-Glucose Pentacetate to Investigate Kinetic and Thermodynamic Control
7	Green Oxidation of Borneol to Camphor
8	Size Exclusion Chromatography – Identification of an Unknown Protein
9	Biodiesel
10	Enzymatic Reduction: A Chiral Alcohol from a Ketone
11	Electrophilic Aromatic Substitution
12 & 13	Combinatorial Chemistry: Antibiotic Drug Discovery
14	Makeup Lab  Checkout

# UNIVERSITY OF MINNESOTA

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*Twin Cities Campus*

*Office of the Dean  
College of Biological Sciences*

*123 Snyder Hall  
1475 Gortner Avenue  
St. Paul, MN 55108-1095  
Office: 612-624-2244  
Fax: 612-624-2785*

September 4, 2015

Dr. David Blank  
Department of Chemistry

Dear David:

We are writing to express the strong support of the College of Biological Sciences for the new three-course series in Chemistry for the Life Sciences that you and your colleagues are developing. We understand that this is a very challenging project, and we greatly appreciate your effort in developing these courses for our students.

As you know, biological sciences have developed rapidly in recent years, creating a need for us to educate our majors about some of the recent advances. This has created pressure on the curriculum, resulting in a need to streamline foundational courses so that students can participate in more advanced courses in later years. The 18 credits devoted to the original Chemistry series were viewed as unsustainable in our majors. This led to many majors dropping requirements for second semester Organic Chemistry and its lab. From a pedagogical point of view, this is a terrible solution, as many concepts important for understanding biological chemistry were taught in these courses.

To improve this situation, we asked your department to develop a shorter Chemistry series, totaling 3 courses with laboratories, which would integrate General and Organic Chemistry and focus throughout on aspects most relevant to Biology. We are very pleased with your present plan. We have reviewed the list of proposed topics for each course, and we are confident that these courses will serve our students very well. In particular, we appreciate the new courses' emphasis on chemical reactions that take place within living cells. The new courses will provide our students with solid foundations in acid/base chemistry, properties of chemical bonds, and the kinetics and mechanisms of chemical reactions. The early introduction of organic chemistry principles and functional group chemistry will be especially beneficial to CBS students. We understand that the laboratory for the first course will be the same as the current CHEM1065 lab. We agree that this is reasonable, and we appreciate that it is much easier logistically than instituting a new laboratory course.

We are confident that this new series will serve our students much better than the existing one. It is a revolutionary approach to teaching essential concepts of Chemistry to life sciences students, and thus preparing them for Biochemistry, the key entry point into the life sciences. We think that the integrated laboratories in the new series will work better pedagogically than the separate lab courses of the existing series. The new series will meet the undergraduate course requirements of the great majority of professional schools such as Medical, Pharmacy, and Dental schools. For professional schools requiring four Chemistry courses or specific course titles, we will prepare a letter describing the content of the new courses. This is a common practice in professional school admissions, and will ensure that these courses will be accepted. We are confident that any concerns that might arise regarding the content of the new series would be swiftly allayed by sharing the summaries of the course content.

CBS demand for seats in CHEM 1061 runs at about 300 students per year. If your first offering of the new series can accommodate 250-300 students, we are confident that we can fill it. We will find solutions for the few students who cannot be accommodated in the new series. We hope that once this series is established, you may offer an additional section so that it will be possible to accommodate all of our students, as well as life sciences students from the College of Liberal Arts and the College of Food, Agriculture, and Natural Resource Sciences. Meanwhile,

please keep us informed as you schedule the new series. We will adjust our scheduling of courses that CBS students take concurrently with Chemistry to accommodate your scheduling needs.

Thank you for developing this new series for our students. We appreciate that this is a major change for your faculty and staff. We know how much work it is to develop three new courses and their labs. We are impressed by your ability to teach CHEM1061 and CHEM 1065 to 1700 students each fall, in the face of inadequate laboratory and lecture hall space. Against this background, development of a new series is an extremely challenging undertaking, yet you have successfully risen to this challenge.

We will continue to press the Provost's office on the need for more infrastructure and resources to teach Chemistry to all students on campus who seek Chemistry education. As you proceed with development of the new series, please don't hesitate to ask us for any help that we could possibly provide. We are more than willing to help in any way that we can.

Sincerely,



Valery E. Forbes  
Dean



Jane Glazebrook  
Associate Dean for Faculty and Academic Affairs



Paul Siliciano  
Director of Undergraduate Studies, Biochemistry



Leslie Schiff  
Director of Undergraduate Studies, Microbiology



Nikki Letawsky-Schulz  
Director of Student Services

# UNIVERSITY OF MINNESOTA

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*Twin Cities Campus*

*Office of the Associate Dean  
Undergraduate Programs  
College of Liberal Arts*

*115 Johnston Hall  
101 Pleasant St. S.E.  
Minneapolis, MN 55455  
Office: 612-624-8675  
Fax: 612-624-8799*

September 8, 2015

To: David Blank, Professor and Director of Undergraduate Studies, Department of Chemistry, College of Science and Engineering

From: Gary Oehlert, Professor of Statistics and Associate Dean of Undergraduate Education, College of Liberal Arts

I am writing to provide my strong support for the new proposed chemistry for life science sequence. There are a significant number of students in the College of Liberal Arts who are not chemistry intensive majors but who are interested in life science related subjects and majors and who are planning for futures working in life science related careers. For example, as of spring 2015, CLA had 822 declared Psychology BA majors and 408 declared Psychology BS majors, 230 Physiology majors, 470 Biology, Society and Environment majors and 261 Public Health minors. Many of these students will pursue careers and/or graduate work in the life sciences. While students in these majors and minor are the most obvious audience for the new sequence, there are many other CLA students who combine the study of chemistry with other majors such as anthropology or sociology or journalism or even art history. The new format of the sequence would better serve many CLA majors who have, in the past, opted out of the full four semester chemistry curriculum due to other curricular demands in their chosen majors and/or minors.

# UNIVERSITY OF MINNESOTA

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*Twin Cities Campus*

*Student Services Office  
College of Food, Agricultural and  
Natural Resource Sciences*

*190 Coffey Hall  
1420 Eckles Avenue  
St. Paul, MN 55108  
Phone: 612-624-6768  
Fax: 612-625-8737  
<http://www.cfans.umn.edu>*

9-8-15

To: Dr. David Blank  
From: Dr. Michael White, Associate Dean and Bill Ganzlin, Director, Student Services  
Re: New Chemistry Sequence for Life Sciences Students

In consultation with several Major Coordinators (Animal Science, Food Science and Nutrition) in CFANS whose majors would be most impacted by the new chemistry sequence, we determined that there is strong support for the new Chemistry Sequence for Life Sciences students.

The Major Coordinators noted that they expect that about 100+ students in their respective majors per year would potentially be interested in enrolling in the new chemistry sequence.

It is our understanding that the new sequence will be primarily available to CBS freshmen in the first year of the new offerings, but hope that these offerings will be available to CFANS students in 2017.

There were a only few concerns raised regarding the offerings. First, there was a general concern raised regarding the availability of seats being held for certain majors/colleges. How will the seats be managed after the first year pilot? Second, students who are required to enroll in Chem 1015 based on placement tests will have to wait to enroll in the new sequence if the courses are offered only once per year; this will increase time to complete the full chemistry sequence.

Again, there is strong support for the new chemistry offerings and we look forward to making these offerings available to CFANS students in the future.

September 8, 2015

Dr. David Blank  
Department of Chemistry

Dear David:

I am writing to express my very strong support for the work you and your colleagues in Chemistry have done to develop a new three-course sequence in Chemistry for the Life Sciences. you have undertaken truly transformational curricular redesign. What makes your efforts even more remarkable--is the fact that they are in response to needs largely outside of your own college.

Students in the biological sciences (in CBS, CFANS and CLA) require a strong foundation in Chemistry and have typically taken as many as five courses, including laboratories. This is in addition to significant coursework in Math and Physics offered by CSE. As information and technologies within the field of biology have grown, the traditional 18-credit/five-course sequence of inorganic (general chemistry) followed by organic chemistry has become untenable. Biologists understandably want their students to experience more cutting edge biology, yet degree programs need to be accommodated within 120 credits and allow students to graduate within four years. The 'fix' by many programs was to drop the very organic chemistry requirements that were most relevant to the life sciences. Your new Chemistry series will do much more than streamline the course sequence. It will bring back the critical chemistry of organic molecules/functional groups and integrates chemical principles in a novel way that should make more sense to students of life sciences.

In my recent work on scientific communication, I have had the opportunity to interact with colleagues from Duke University, University of North Carolina-Chapel Hill, and the University of Michigan. All are struggling with similar issues. I am convinced that your new course sequence will garner significant attention nationwide.

I will continue to do what I can underscore the critical role that Chemistry plays on this campus, and to help bring individuals together to solve logistical problems as they arise.

Best,



Leslie A. Schiff  
Associate Dean for the University Curriculum