Syllabus
"Lectures in Organic Chemistry" (2nd Semester)
Chemistry 241B (online), Spring 2023

Course Description
This course teaches the fundamentals of organic chemistry, with a focus on organic structures, properties, transformations (organic synthesis), and the mechanisms of those transformations (organic reaction mechanisms).

Course Prerequisites
CHEM 241A or CHEM 242A or CHEM 246A or consent of the instructor. *If your grade in the first semester Organic Chemistry lecture was below a "C", you are strongly urged to retake that course before proceeding on to the second semester Organic Chemistry lecture course.*

Instructor and Contact Information

Instructor:	Dr. Eugene Mash
Office:	CSML 618
Phone:	(520) 621-6321
email:	emash@arizona.edu
Office Hours:	As this is an online course, questions regarding course content should be posted to the discussion board on D2L. Responses to questions will be made by the instructor within 24 hours whenever possible. Individual assistance with course material is available via Zoom; contact the instructor to arrange a Zoom meeting time.
D2L link:	https://d2l.arizona.edu/d2l/home/1233883

Course Format and Teaching Methods
This is an online, lecture-only course. The organic laboratory courses are separate courses at the University of Arizona. Each student is unique and is responsible for their own learning process and outcome. The material to be learned is contained in the source textbook, "Organic Chemistry", 6th edition, by Janice Gorzynski Smith. Both traditional printed and electronic versions of the textbook are available. Videotaped lectures by the instructor are available for viewing and are accessible through D2L. These lectures closely follow the source textbook. Lectures make more sense if you familiarize yourself with the material beforehand, and students are encouraged to read the text before viewing the lectures. As you read the text and/or view the lectures, write down questions you wish to ask on the discussion page available on D2L. As with many other math and science courses, working problems is the only way to master organic chemistry. Problem sets will be assigned in the Connect online homework environment that accompanies the electronic version of the source textbook. As these required homework assignments will make up a significant portion of your course grade, you should make every effort to complete them by the due dates published on D2L. Keep in mind that those who put in the most effort are generally the most successful.

Required Textbook and Materials
We will be using the Connect/LearnSmart/SmartBook/Proctorio software package associated with the source text, "Organic Chemistry", Sixth Edition, by Janice Gorzynski Smith. If you are registered for the course, you should have access to this text through Inclusive Access. For more information about Inclusive Access, go to https://shop.arizona.edu/textbooks/inclusive.asp

To participate in this online course you will need a desktop or laptop computer, a broadband wired or wireless (3G, 4G/LTE, or 5G) internet connection, a webcam (built-in, USB plug-in, or wireless Bluetooth), speakers or headphones and a microphone (built-in, USB plug-in, or wireless Bluetooth), and access to Desire2Learn (D2L).

Course Objectives
This second semester course covers the chemistry of radicals, the chemistry of dienes, the chemistry of carbonyl-containing functional groups (including aldehydes, ketones, carboxylic acids, acid chlorides, acid anhydrides, esters, and amides), the chemistry of amines (including imines, enamines, and nitriles), the chemistry of carbohydrates (including a brief introduction to nucleic acids), the chemistry of amino acids (including a brief introduction to peptides and proteins), and the chemistry of lipids.

Expected Learning Outcomes
Overarching Learning Outcomes
Having completed Chemistry 241A and Chemistry 241B, students will be able to discuss, both orally and in writing:

•The structure and bonding, including molecular orbital theory, of organic compounds and the relationships of structure and bonding to physical and chemical properties.

•Reactions that transform one organic compound into another.

•The detailed mechanisms whereby organic reactions occur.

Specific Learning Outcomes for this Course
The following list is arranged in the order of the Units (topics) to be covered. It has been adapted from lists found at ochem.com, ©1990 by Thomas Poon, used with permission. This list is indicative, not comprehensive.

Unit 13 (Chapter 13 in the source text)
Having studied the material in this chapter, you should...

1. Be able to classify carbon-centered radicals and arrange the classes according to their stability.
2. Be able to list the major reactions of radicals.
3. Be able to write out chain mechanisms using the appropriate terminology and single-barbed curved arrows for halogenations of alkanes and alkenes (allylic halogenations).
4. Be able to predict the major and minor products of radical halogenations of alkanes and alkenes (allylic halogenations).

5. Be able to employ radicals to reverse the regiochemistry of ionic addition of HBr to alkenes and contrast the mechanism of the radical process with that of the ionic addition process.
6. Be able to describe the radical reactions of oxygen (O_2) with alkenes (allylic oxidation).
7. Be able to describe the structures and functions of radical inhibitors.

Unit 14 (Chapter 14 in the source text)
Having studied the material in this unit, you should...

1. Be able to construct π molecular orbitals (MOs) for conjugated compounds using shaded atomic 2*p* orbitals to "stand in" for the molecular orbitals.
2. Be able to explain thermodynamic and kinetic control of electrophilic addition reactions to conjugated systems and be able to predict the products of such reactions.
3. Be able to draw the mechanisms of electrophilic addition reactions to conjugated systems.
4. Be able to draw the mechanism of the Diels-Alder reaction, be able to predict products of Diels-Alder reactions, and be able to use this reaction in a multistep synthesis.

Unit 15 (Chapter 17 in the source text)
Having studied the material in this unit, you should...

1. Be able to define oxidation and reduction as used in organic chemistry.
2. Be able to describe the use of the reducing agents $NaBH_4$ and $LiAlH_4$ to generate alcohol products from aldehydes and ketones.
3. Be able to describe the use of $LiAlH_4$ and modified reducing agents [DIBAL-H, $LiAlH(O\textit{t}Bu)_3$] to generate products from aldehydes, ketones, carboxylic acids, and carboxylic acid derivatives.
4. Be able to draw mechanisms for the above reduction processes.
5. Be able to describe the use of various oxidizing agents to generate aldehydes, ketones, and carboxylic acids from alcohols.
6. Be able to describe the generation of organometallic reagents (RLi, RMgX, R_2CuLi) from appropriate starting materials.
7. Be able to describe the use of organometallic reagents as bases or nucleophiles in organic synthesis.
8. Be able to describe the use of protecting groups, such as *tert*-butyldimethysilyl ethers, to prevent unwanted processes from interfering with intended chemical reactions.

Unit 16 (Chapter 18 in the source text)
Having studied the material in this unit, you should...

1. Be able to name a given aldehyde or ketone using IUPAC and/or common nomenclature.
2. Be able to draw the structure of a given aldehyde or ketone from its IUPAC and/or common name.
3. Be able to describe and explain the physical properties of aldehydes and ketones and contrast them with those of other functional group families.
4. Be able to describe the use of reactions to synthesize ketones and aldehydes.

5. Be able to show how aldehydes and ketones undergo nucleophilic addition by drawing out reactions and mechanisms reflective of relative reactivity, regioselectivity, and/or stereoselectivity.
6. Be able to predict the products of irreversible additions to the carbonyl carbon.
7. Be able to show how aldehydes and ketones can act as Bronsted-Lowry or Lewis bases and explain the effect on reactivity of the carbonyl carbon.
8. Be able to explain the *Principle of Microscopic Reversibility* and be able to predict the products of reversible additions involving weak oxygen and nitrogen nucleophiles to the carbonyl carbon of aldehydes and ketones.

Unit 17 (Chapter 19 in the source text)
Having studied the material in this unit, you should...

1. Be able to name a given carboxylic acid using IUPAC and/or common nomenclature.
2. Be able to draw the structure of a given carboxylic acid from its IUPAC and/or common name.
3. Be able to describe and explain the physical properties of carboxylic acids and contrast them with those of other functional group families.
4. Be able to show how carboxylic acids engage in hydrogen bonding.
5. Be able to describe the use of reactions to synthesize carboxylic acids.
6. Be able to describe the use of carboxylic acids as Bronsted-Lowry acids in acid-base reactions.
7. Be able to explain the structural basis for differences in acidity among different carboxylic acids and to predict relative orders of acidity or basicity.

Unit 18 (Chapter 20 in the source text)
Having studied the material in this unit, you should...

1. Be able to name a given carboxylic acid derivative using IUPAC and/or common nomenclature.
2. Be able to draw the structure of a given carboxylic acid derivative from its IUPAC and/or common name.
3. Be able to show how the various carboxylic acid derivatives undergo nucleophilic acyl substitution reactions by drawing out reactions and mechanisms, reflecting relative reactivity.
4. Be able to explain how soaps are formed (saponification) and how/why soaps form micelles.
5. Be able to show how carboxylic acids can be “activated,” that is, made more reactive towards nucleophilic acyl substitution, by conversion to acid chlorides or mixed anhydrides, as with dicyclohexylcarbodiimide (DCC).

Unit 19 (Chapter 21 in the source text)
Having studied the material in this unit, you should...

1. Be able to describe why α-protons of ketones, aldehydes, and esters have enhanced acidity.
2. Be able to show mechanistically how to generate a keto/enol mixture under acidic or basic conditions.
3. Be able to show how to generate an enolate under basic conditions, under either thermodynamic or kinetic control.

4. Be able to describe the use of enolates as nucleophiles in organic synthesis.
5. Be able to describe the use of the malonic ester synthesis in construction of acetic acid derivatives.
6. Be able to describe the use of the acetoacetic ester synthesis in construction of acetone derivatives.
7. Be able to draw reaction mechanisms for the above processes.

Unit 20 (Chapter 22 in the source text)
Having studied the material in this unit, you should...

1. Be able to describe mechanistically the aldol reaction, crossed aldol reactions, and the aldol condensation.
2. Be able to describe the use of the aldol reaction, crossed aldol reactions, and the aldol condensation in organic synthesis.
3. Be able to describe the use of the directed aldol reaction and intramolecular aldol reactions in organic synthesis.
4. Be able to describe the use of the Claisen reaction, Crossed Claisen reaction, and intramolecular Claisen (Dieckmann) reactions in organic synthesis.
5. Be able to describe the use of the Michael reaction in organic synthesis.
6. Be able to describe the use of the Robinson Annulation in organic synthesis.
7. Be able to draw reaction mechanisms for the above listed processes.

Unit 21 (Chapter 23 in the source text)
Having studied the material in this unit, you should...

1. Be able to name a given amine using IUPAC and/or common nomenclature.
2. Be able to draw the structure of a given amine from its IUPAC and/or common name.
3. Be able to classify amines (1°, 2°, 3°, 4°; aliphatic, aromatic) and use these classifications to predict differences in the reactivity of the classes.
4. Be able to describe and explain the physical properties of amines and contrast them with those of other functional group families.
5. Be able to show how amines engage in hydrogen bonding.
6. Be able to describe the use of reactions to synthesize amines.
7. Be able to describe the use of amines as Bronsted-Lowry and Lewis bases in acid-base reactions.
8. Be able to describe the use of amines as nucleophiles in chemical reactions.

Unit 22 (Chapter 26 in the source text)
Having studied the material in this unit, you should...

1. Be able to draw, manipulate, and interpret Fischer projections.
2. Be able to name an aldose (C_3-C_6) given its structure.
3. Be able to draw an aldose (C_3-C_6) given its name.
4. Be able to convert carbohydrate Fischer projections to cyclic forms using Haworth projections and/or chair representations.
5. Be able to write mechanisms for conversion of open-chain carbohydrates to cyclic forms, accounting for the generation of regioisomeric and/or stereoisomeric product mixtures.
6. Be able to write reactions and mechanisms for the formation and hydrolysis of glycosides.

7. Be able to discuss the structures of complex carbohydrates.
8. Be able to define: monosaccharide, disaccharide, polysaccharide, aldose, ketose, epimers, anomeric carbon, anomers (α and β), pyranose, furanose, pyranoside, furanoside, glycogen, amino sugar, *N*-glycoside, nucleoside, nucleotide, DNA, RNA.
9. Be able to describe uses of the chemistry of carbohydrates (reduction, selective oxidations, Wohl degredation, Kiliani-Fischer synthesis) to convert sugars into various products.
10. Be able to explain how the structures and properties of the nucleic acids form the basis for the chemistry of DNA and RNA.

Unit 23 (Chapter 27 in the source text)
Having studied the material in this unit, you should...

1. Be able to discuss the structures and properties of the α-amino acids found in naturally occurring proteins.
2. Be able to predict the structure of an amino acid based on its p*K*a values and the p*H* of the surrounding solution.
3. Be able to draw peptide oligomers (including stereochemistry) and discuss the significance of the peptide bond.
4. Be able to write reactions and mechanisms for the formation and hydrolysis of peptides.
5. Be able to discuss the conformations of polypeptides.
6. Be able to define: N-terminus, C-terminus, zwitterion, isoelectric point, disulfide bond, primary structure, secondary structure, α-helix, β-pleated sheet, tertiary structure, quaternary structure.
7. Be able to describe uses of the chemistry of α-amino acids (protection, activation, coupling, deprotection, both in solution and on solid supports) to convert amino acids into peptide oligomers of a given sequence.

Unit 24 (Chapter 29 in the source text)
Having studied the material in this unit, you should...

1. Be able to identify the different subfamilies of lipids and discuss their structures, properties, reactions, and biological importance.
2. Be able to identify potential isoprene units in a terpene.
3. Be able to show mechanistically how the terpenes geraniol, linalool, nerol, farnesol are biosynthesized.
4. Be able to rationalize mechanistically how cyclic terpenes may form.
5. Be able to rationalize mechanistically how lanosterol is formed.

Absence and Class Participation Policy
Participation in this online course involves completing every homework assignment and examination on schedule (unless otherwise excused). Online courses are different from in-person courses in many ways, but the goal is the same—student learning. Learning a difficult subject like second-semenster organic chemistry requires commitment, effort, and follow-through. *You are strongly encouraged to log in to D2L to work on this course every day!* The material to be learned is presented in the source text and the video lectures, and is reinforced by the online homework assignments listed on the D2L web

page for this course. Due dates are intended to keep students progressing at a rate that is comensurate with a semester-long course. It is all too easy to get behind; don't let that happen to you! Make a commitment from the start of the semester to never be late with an assignment. Put in the effort required to do your very best work on every assignment. Follow through by maintaining your high level of effort throughout the semester.

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable. Please see: http://policy.arizona.edu/human-resources/religious-accommodation-policy**.**

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. Please see: https://deanofstudents.arizona.edu/absences

To request a disability-related accommodation to this attendance policy, please contact the Disability Resource Center at (520) 621-3268 or drc-info@email.arizona.edu. If you are experiencing unexpected barriers to your success in your courses, the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office is located in the Robert L. Nugent Building, room 100, or call 520-621-7057.

Required Texts or Readings

Required Text: Janice Gorzynski Smith, "Organic Chemistry", Sixth Edition (Connect/LearnSmart/SmartBook/Proctorio software package)

Coverage:

Unit (D2L)	Chapter (source text)	Unit (D2L)	Chapter (source text)
13	13	19	21
14	14	20	22
15	17	21	23
16	18	22	26
17	19	23	27
18	20	24	29

Recommended: an organic molecular model set

Connect/LearnSmart/SmartBook/Proctorio is an educational software package developed by McGraw Hill, the publisher of our source textbook. SmartBook refers to the electronic version of the source text. Required homework assignments make use of Connect, and so the Connect/LearnSmart/SmartBook/Proctorio software package is required in this course. If you are registered for the course, you should have access to this text through Inclusive Access. For more information about Inclusive Access, go to https://shop.arizona.edu/textbooks/inclusive.asp

To participate in this online course you will need a desktop or laptop computer, a broadband wired or wireless (3G, 4G/LTE, or 5G) internet connection, a webcam (built-in, USB plug-in, or wireless Bluetooth), speakers or headphones and a microphone (built-in, USB plug-in, or wireless Bluetooth), and access to Desire2Learn (D2L).

As organic molecules are three-dimensional objects, many students find working with a set of organic molecular models helpful and instructive. There are many organic molecular model kits available at student bookstores and on the web. Computer-based molecular modeling programs are also available. Note: Organic molecular model kits may be used during examinations, provided they are disassembled at the start of the examination. However, use of computer-based molecular modeling programs is not allowed during examinations.

Assignments and Examinations: Schedule/Due Dates

Examinations:
Midterm Exam #1 (100 points), Saturday, February 11, 2023, from 10:30 AM-11:50 AM
Midterm Exam #2 (100 points), Saturday, March 18, 2023, from 10:30 AM-11:50 AM
Midterm Exam #3 (100 points), Saturday, April 22, 2023, from 10:30 AM-11:50 AM
Final Examination (100 points), Saturday, May 6, 2023, from 10:30 AM-12:30 PM

Each examination will focus on a set of three units (Midterm #1, Units 13-15; Midterm #2, Units 16-18; Midterm #3, Units 19-21; Final Exam, Units 22-24). Nevertheless, the material builds, layer upon layer, and so is cumulative by its very nature. Knowledge and understanding of the principles, reactions, and mechanisms presented in earlier units/chapters is a prerequisite for success in later units/chapters and on subsequent examinations. To do well throughout this term, you must keep up, master the material, and remember it throughout your study of organic chemistry.

Midterm examinations will be given on Saturday mornings, from 10:30 AM-11:50 AM. The Final Examination will also be given on a Saturday morning, from 10:30 AM-12:30 PM. These examinations will be given synchronously using the Proctorio proctoring service, a browser-locking and remote proctoring solution designed to protect the integrity of online examinations. Please note that Proctorio will create a recording of your video, audio, and screen activity while you are taking the examinations, so a stable internet connection, a web camera, and a microphone are required for participation in course examinations. Please take the Proctorio Orientation Quiz, which will be accessible in the “Proctorio” module under the Content tab on the D2L home page of this course, during the week prior to the first midterm exam. This quiz will not count in the determination of your final grade, but it will help to illustrate the types of questions you might expect and to identify any problems you may have with the software before you attempt the first midterm exam. If you do not have access to the necessary technology, please let me know by email. For help with technology access directly from the University go to: https://student.it.arizona.edu/resources

Calculators, cell phones, and other electronic devices are prohibited during examinations. Organic molecular model sets may be used during examinations provided they are disassembled when the examination begins.

Each midterm examination will be worth 100 points. Your lowest midterm examination score will be dropped. The Final Examination will also be worth 100 points, and may not be dropped.

If you miss an examination you will receive a zero for that examination. Makeup examinations will be given at the discretion of the instructor.

Homework: Working problems is the only way to master organic chemistry. Online homework using the Connect/LearnSmart/SmartBook/Proctorio software package will be required almost every week. The aggregate homework score from the Connect homework assignments will be normalized to be worth the equivalent of one midterm examination (100 points), and may not be dropped. The due dates for the Connect homework assignments appear on the course calendar on the D2L page and are also given on the Connect web page for this course.

In addition, you may wish to work *on paper* as many of the in-chapter and end-of-chapter problems in the textbook as your time permits. There is no credit for working these extra exercises/problems. However, keep in mind that those who put in the most effort are generally the most successful.

Students can and should submit questions (about the reading, lectures, or homework) via the "Discussion" pages (there is a separate page embeded in each Unit to keep the questions focused and organized) available on D2L. Please succinctly identify the subject of your question in your post subject line (e.g., include the homework unit and question number) to help with organization of the Discussion page. I will endeavor to respond within 24 hours, and sooner if possible.

Grading Scale and Policies
University policy regarding grades and grading systems is available at http://catalog.arizona.edu/policy/grades-and-grading-system

Total points for the course will be determined as shown in the following table:

ASSIGNMENT	POINTS	
Homework[a]	100	Cannot Be Dropped
Examination #1	100	Your Lowest Examination Score Will Be Dropped
Examination #2	100	
Examination #3	100	
Final Exam	100	Cannot Be Dropped
TOTAL POINTS	**400**	

[a]The sum of the homework point total from Connect will be normalized to 100 points

Final grades will be assigned based on the breakdown shown in the following table:

GRADE	TOTAL POINTS
A	320-400
B	240-319
C	160-239
D	100-160
E	0-99

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

Dispute of Grade Policy
Exams will be returned upon request. Disputes regarding correct answers must be submitted via email before the date of the next examination.

Scheduled Topics/Activities
See the Course Calendar (available on the course D2L site under the "Content" heading).

Classroom Behavior Policy
To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed.

Threatening Behavior Policy
The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

Accessibility and Accommodations
At the University of Arizona we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu/) to establish reasonable accommodations.

Code of Academic Integrity
Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this

and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

UA Nondiscrimination and Anti-harassment Policy
The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Additional Resources for Students (recommended links)
UA Academic policies and procedures are available at
http://catalog.arizona.edu/policies

Student Assistance and Advocacy information is available at
http://deanofstudents.arizona.edu/student-assistance/students/student-assistance

Confidentiality of Student Records
For details, please see: http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa

Subject to Change Statement
Information contained in this course syllabus, other than the grade and absence policies, may be subject to change with advance notice, as deemed appropriate by the instructor.

University-wide Policies link
Links to the following UA policies are provided here:
https://academicaffairs.arizona.edu/syllabus-policies:

- Absence and Class Participation Policies
- Threatening Behavior Policy
- Accessibility and Accommodations Policy
- Code of Academic Integrity
- Nondiscrimination and Anti-Harassment Policy
- Subject to Change Statement