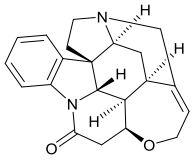
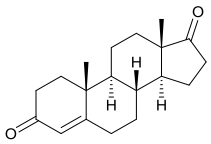
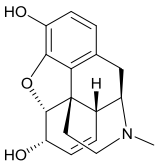


Strychnine (poison)

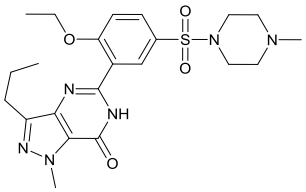


Androstenedione (estrogen and testosterone precursor)

Organic Chemistry For Majors 2
Chemistry 48



Morphine (opiate analgesic drug)



Viagra (vasodilation by inhibition of PDE5)

Instructor: Matthias Brewer; Office: Innovation Hall 324; Matthias.Brewer@uvm.edu

BlackBoard Site: bb.uvm.edu

Lecture: 10:50am – 11:40am MWF, Hills Agricultural Science, Room 122

Office hours: Monday, Tuesday, Friday 2:00pm-3:00pm or by appointment

First Laboratory Meeting: Feb 16 (Check-in and Spectroscopy Boot Camp) **but all students must attend Chem. 52 for the first two weeks of the semester – Thursday 2/4 and 2/11. These meetings will occur in TEAMS and if you are not available to attend "live" you may watch the recorded lecture asynchronously.**

Required Course Materials:

Organic Chemistry 6th ed., Loudon and Parise, Roberts and Co., 2016 (ISBN: 9781936221639)

Organic Chemistry Study Guide and Solutions Manual 6th ed., Loudon and Parise, Roberts and Co., 2016

Sapling Learning account: account can be purchased as part of book order.

Recommended Course Materials:

Molecular Structure Models (e.g.: ISBN: 0471-362719)

Books in library that may be useful:

Organic Chemistry I as a Second Language: Translating the Basic Concepts 2nd ed., D. Klein; ISBN: (978-0470-12929-6)

Organic Chemistry II as a Second Language: Second Semester Topics 2nd ed., D. Klein; ISBN: (978-0-471-73808-4)

The Art of Writing Reasonable Organic Reaction Mechanisms R.B. Grossman ISBN:0-387-95468-6

Writing Reaction Mechanisms in Organic Chemistry A. Miller ISBN: 0-12-496711-6

Course Prerequisite: Chemistry 47

Statement on inclusion: I believe that all people are created equal with no exceptions. Anyone who attends a University does so in an effort to gain knowledge, expand their opportunities, and have experiences that will make them successful members of our society. All members of our community should be respected for that, and should be afforded the opportunity and support necessary to achieve these goals to the best of their abilities. Closed minded and repressive attitudes run counter to the mission of a university and will not be tolerated in this class. It is important to acknowledge that science and scientists are not immune to bias and bigotry, and sadly there is plenty of historic and current evidence and examples of that fact. However, repressing anyone only serves to hurt our society by limiting potential achievement. With this in mind, my goal is to create a welcoming and supportive environment within the classroom wherein everyone has an equal opportunity to succeed and excel. A list of resources focused on diversity, equity, and inclusion are listed on page 4 of this syllabus. If you experience any form of bias at UVM please feel free to use me as a resource. Likewise, if you feel uncomfortable in my classroom for any reason (especially if it is related to me) I encourage you to speak with me.

General Comments

In Chemistry 48 we continue to explore the basic principles of Organic Chemistry with a greater emphasis on the chemical reactivity of various functional groups (i.e. more similar to the last 1/3 of the first semester course). We will cover a lot of reactions, and you will be expected to learn them and be able to apply them in proposed multi-step syntheses (i.e. "Show me how you could make compound **2** from compound **1** in 3 steps using reactions you know"). Note: Keeping track of all the reactions is hard, and most people find this semester's material more challenging than last semester.

By now you have probably noticed that Organic Chemistry involves many new concepts, a large number of rules and a very large number of reaction mechanisms. However, as the course progresses and your organic "repertoire" grows, you will also find that a relatively small subset of rules serves to tie together the vast amount of information contained in the text. A special effort made at the beginning of the course to review and master important concepts from Chemistry 47 will pay off as the course progresses. Topics that are especially important to review include:

Arrow Pushing: Arrow pushing is one of the most important "tools" of organic chemistry because it allows you to show a pictorial representation of a reaction mechanism. When done properly, arrow pushing will allow you to keep track of **electrons** as bonds are made and broken throughout the course of a reaction, as well as keep track of any formal charges that develop. Having a good grasp of arrow pushing will make learning the large number of reactions you will see in this course easier, because you will then understand the underlying mechanism of the reaction rather than trying to memorize it as a "fact". ***I can't overemphasize the importance of having a good working knowledge of arrow pushing.*** Be forewarned that arrow pushing will be used on a daily basis in class and you will be expected to write mechanisms using correct arrow pushing on exams and laboratory reports.

Resonance: This is a very important concept and you will see resonance used over and over again to rationalize why molecules react the way they do. A good understanding of the rules for writing proper contributing "structures" to resonance hybrids will make the understanding of reaction mechanisms considerably easier. In order to have a good understanding of resonance you must also have a good grasp of electronegativity and arrow pushing.

Electronegativity: Knowledge of the relative electronegativities of atoms is essential to understanding why molecules react the way they do. For example, the concept of electronegativity allows you to rationalize why some atoms are good leaving groups and others are not.

Chemical Reactions: You will be expected to know all the chemical reactions we covered in Chem. 47.

Nomenclature: I will assume you know the names of all the functional groups as well as the standard IUPAC rules for naming simple organic compounds. If you don't know the functional groups, you will not be able to follow the discussion in class. In my view, it is more important that you be able to draw a structure from a given name than write a name for a given structure.

Stereochemistry: Determining R/S designations as well as E/Z. Understanding the difference between different types of stereoisomers (enantiomers/diastereomers) and being able to correctly identify the stereochemical relationship between compounds (i.e. are they diastereomers, enantiomers, constitutional isomers, different molecules, etc.).

Keys to success in Organic Chemistry:

- Do not try to cram!
- **Work as many practice problems as possible.** Practice problem reinforce the new concepts and are the only way to test your understanding of the material. There are many organic chemistry textbooks in the

library and they all cover similar material. Work problems in other books once you have finished the problems in our book.

- Do not look at a problem's answer until you have really tried the problem. After seeing the answer, it often seems obvious and you may assume you understand.
- When you get a problem wrong, try to understand where your thinking was in error and attempt to identify what concept you missed.
- You will see many new concepts in this course. Try to write out an explanation of the concepts in your own words as if explaining them to someone else.
- Ask questions! Come to office hours or make an appointment with me or your T.A. to resolve any questions early!
- Review the material frequently… many people find that flash cards are a good way to learn this material.

For each chapter you should work as many of the suggested problems as possible. I strongly urge you to keep up with your reading and problem solving. Learning organic chemistry takes a combination of **patience, practice, and repetition.** Cramming does not work well in this subject!

Academic Conduct: Cheating will be considered grounds for failing the course. All graded assignments must be your own work. Cases of cheating or plagiarism *will* lead to further disciplinary action which may include dismissal from the University according to the rules set forth in The University of Vermont's *Code of Academic Integrity*.

Policy of Electronic Device Usage on Exams: In short, you can't use them! The use of any electronic device (calculator, cell phone, ipod, or anything else with batteries or a solar cell) is strictly forbidden on exams and will be considered cheating.

Grading: Your course grade will be based on on-line homework assignments, three examinations, a cumulative final examination, and your laboratory grade. (**Note**: You must earn a passing grade in the laboratory to receive a passing grade for the course. More than two laboratories missed for any reason will result in a failing grade for the course unless you are granted an incomplete by your Dean).

Lab	20%
Quizzes	15%
Online Homework	5%
3 Midterm Exams	40%
Cumulative Final	20%

On-line homework: We will continue to use Sapling this semester. No homework grades will be dropped.

Standardized Exam: To assess student learning over this yearlong course sequence I typically give the ACS standardized exam at the end of the semester. It is a hard-copy exam, but I will try to figure out a way to include it this semester if possible. Stay tuned!

Exam Re-grades: If you have any questions concerning the grading of an exam, you must see me within one week after the day the exam is returned to the class.

Midterm Exams will be given on-line (Blackboard) on:
Feb 25
March 25
April 22

Final Exam Date: Date, time and place have not been released yet.

This course will address learning goals 1,2,3, and 5 below for chemistry majors:

1. Students will demonstrate general knowledge in chemistry and will be able to apply chemical and physical principles in the solution of qualitative and quantitative chemical problems.
2. Students will understand the interplay of observational data, hypotheses, and hypothesis-driven experimentation through application of the scientific method.
3. Students will become proficient in chemical laboratory techniques and be able to apply these to practical and current problems in research.
4. Students will be able to read and critically evaluate the chemical and scientific literature.
5. The students will learn to present scientific data clearly and effectively through both written and verbal communication.

Religious Holidays: Students have the right to practice the religion of their choice. Each semester students should submit in writing to their instructors by the end of the second full week of classes their documented religious holiday schedule for the semester. Faculty must permit students who miss work for the purpose of religious observance to make up this work.

Diversity, Equity, and Inclusion Resources

UVM Women in STEM: A student led group at UVM with a focus on gender equality in the STEM fields. Their mission is to connect students at the UVM and to support diversity in STEM fields at all levels of education, including undergraduate, graduate, and postdoctoral. Additionally, we aim to address and discuss issues for underrepresented groups in STEM, hold meetings to improve professional skills, and form a community that is inclusive of all gender identities that support equality in STEM.
Blog: https://blog.uvm.edu/wstem/uvm-womxn-in-stem-network/
Email: women.in.stem@uvm.edu

UVM oSTEM: oSTEM is a national chapter-based organization (https://ostem.org/) that empowers LGBTQ+ people in STEM to succeed personally, academically and professionally.
https://www.facebook.com/groups/ostemvermont/

The Division of Diversity, Equity, and Inclusion: We believe excellence should be inclusive of the entire University of Vermont (UVM) community and is steadfastly committed to this belief. Every day, our Division strives to make our work accessible, affirming, and action-oriented to help ensure excellence is inclusive of everyone. https://www.uvm.edu/diversity

UVM Prism Center: We support and empower lesbian, gay, bisexual, transgender and queer students, as well as students whose identities fall in between or expand beyond those categories, and work to create a campus community where people of all sexual and gender identities can thrive. https://www.uvm.edu/prism

Interfaith Center: Each of us engages those questions differently, perhaps through a religious tradition, philosophy, or spiritual practice. No matter how you make meaning of your life, you are welcome at the Interfaith Center for reflection, spiritual practice, education, and community building. https://www.uvm.edu/interfaithcenter

Mosaic Center for Students of Color
The Mosaic Center for Students of Color (MCSC) Vision is to create a diverse and rich community of empowered, engaged, and enthusiastic students of color at UVM. We fully support the holistic development of self-identified students of color so that they can obtain their goals for academic achievement, personal growth, identity formation, and cultural development. https://www.uvm.edu/mcsc

Women & Gender Equity Center
The UVM Women & Gender Equity Center cultivates joyful community while advancing gender equity across identities. We provide advocacy services for those in our community who have experienced sexual or intimate partner violence, and strive to provide programming, education, and events that ask our community to explore the intersections of their gender and other identities. https://www.uvm.edu/wagecenter

The American Chemical Society
The ACS has curated a number of resources on Diversity and Inclusion:
https://www.acs.org/content/acs/en/membership-and-networks/acs/welcoming/diversity.html
In addition, the American Chemical Society has a Committee on Minority Affairs:
https://www.chemdiversity.org/

Outline of Readings

NOTE: The following two chapters cover material you will see in CHEM 052. *However, you will be responsible for knowing this material for our class*. We will work some practice problems in class and in lab, but your primary introduction to this material will occur in CHEM 052:

Chapter 12: Introduction to spectroscopy. IR and MS

All sections (12.6C will not be covered in depth)

Chapter 13: Nuclear Magnetic Resonance Spectroscopy

Sections: Read 12.1 first 13.1-13.7, 13.9-13.11

Problems: 3, 6-9, 10-12, 13-21, 22, 24-28, 31-37, 39-48, 51-59, 62

Chapter 10. The Chemistry of Alcohols and Thiols

Sections: 10.1-10.7

Problems: 3-17, 19-21, 23-26, 28, 30-31, 38-40, 45, 47-51, 57, 59, 67, 68

Chapter 11: The chemistry of ethers, epoxides, glycols and sulfides (~3 Lectures)

Sections: 11.1, 11.2, 11.4, 11.3, 11.5, 11.6, 11.8, 11.10

Problems: 1-28, 32, 38-40a,b,d, 44-45c-j, 46, 48, 50, 51, 53-60, 61a-c,e-k, 62-65, 69, 70, 72, 74, 77, 79, 80

Chapter 14: The chemistry of alkynes. (~3 lecture)

Sections: 14.1-14.3 (read yourself), 14.4-14.8, 18.2 (p. 882)

Problems: 7-14, 18-25, 26, 27, 29, 31, 33-35, 38-40, 42-47a-e

Chapter 19: The chemistry of aldehydes and ketones. Carbonyl addition reactions (~4 lectures)

Sections: 19.1-19.4 (review), 19.5-19.7, 19.8-19.9 (review), 19.10-19.14

Problems: 12, 14-20, 22-31, 33, 34, 36-38, 40-45, 48, 49, 52-56, 62-65, 69

Chapter 20: The chemistry of carboxylic acids (~2 lectures)

Sections: 20.1-20.4 (review), 20.6-20.10

Problems: 8-16, 18-24, 27a-f, 28a,c,d, 31-34, 36-38, 42, 46, 47a-c,f-i, 48, 50a-f,53

Chapter 21: The chemistry of carboxylic acid derivatives (~5 lectures)

Sections: 21.1-21.5 (review), 21.6-21.11

Problems: 1, 8-12, 14-16, 18, 20, 22, 24-28, 32, 33a-d,g-h, 36-39a, 40, 41, 43, 44, 47, 49, 50, 54, 56a-f,h, 57, 58

Chapter 22: The chemistry of enolate ions, enols and α,β-unsaturated carbonyls (~7 lectures)

Sections: 22.1-22.4, 22.6-22.12

Problems: 1, 3-8, 11, 14a,b, 15, 17-23, 25-31, 35-37a, 38, 40, 41, 43, 46-49, 51-53, 55a-g, 56a-e, 57a,b, 60, 64-66, 70-72, 74, 75a, 78-83, 87, 88a,b,d-k, 90, 91a-d,g, 92, 95

Chapter 15: Dienes, resonance, and aromaticity (~4 lectures)

Sections: 15.1-15.4, 14.6 (review), 14.7

Problems: 13-24, 36-40, 42-44, 46-48, 61-65, 68, 74, 76, 79, 80-84

Chapter 16: The chemistry of benzene and its derivatives: (~4 lectures)

Sections: 16.1-16.6, 18.1 (p. 880), 18.3 (p. 883), 18.4 (p. 885), 18.9 (p. 925)

Problems: 12-27, 30-32, 35, 36, 39, 40, 43-46, 48, 53-55, 61-63, 65

Chapter 17: Allylic and benzylic reactivity: (~1 lecture)

Sections: 17.5

Chapter 27: Amino acids, peptides and proteins (~2 lecture)

Chapter 23: The chemistry of amines (~1 lecture)

Chemistry 48 Laboratory

Text: Ault, "Techniques and Experiments for Organic Chemistry" 6th Ed., University Science Books, 1998.

General Considerations:

Read the entire chapter/handout before doing the experimental work. The experiments designated within each chapter describe the procedures that you will actually carry out in the laboratory.

Date	Experiment	Ault Experiment # or Handout	Ault Page
Thursday 2/4	**All students attend Chem 52**		
Thursday 2/11	**All students attend Chem 52**		
Feb 16	Check-in and Spectroscopy Boot Camp	Handout	
Feb 23	Generation and Reaction of an Organometallic Compound Part 1	Handout	
Mar 3	No Lab (Town Meeting Day)		
Mar 9	Generation and Reaction of an Organometallic Compound Part 2	Handout	
Mar 16	Biodiesel	Handout	
Mar 23	Vanillin oxime from vanillin	E58	490
Mar 30	Prep trans,trans-1,4-diphenylbutadiene	E71	524
April 6	Prep of methyl salicylate: oil of wintergreen	E77	538
April 13	Tetraphenylcyclopentadienone	E95	595
April 20	Diels-Alder Reaction	E66	508
April 27	Nitration of methyl benzoate	Handout	
May 4	Super Critical CO_2 Extraction of Limonene Check-out	Handout	
May 11	ACS Standardized Exam (If possible)		