

CHEM 8M – Organic Chemistry II Lab

| Instructor | Email | Office Hour Locations | Office Hours |
|------------------------|-------------------|--------------------------------------|--------------------------------------|
| Caitlin Binder, Ph.D. | cambinde@ucsc.edu | Baskin 152 Thimann Labs 313 / 329 | TuTh 9:15 – 9:50 am WF 1 – 2 pm |
| Rachel Snelling, Ph.D. | rsnellin@ucsc.edu | Thimann Labs 341 | M 4 – 5 pm W 12 – 1 & 3 – 4:30 pm |

Teaching Assistants & Office Hours – all students welcome in any TA's office hours

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Course Prerequisites: CHEM 8L and previous or concurrent enrollment in 8B. **Course Fees:** \$55 materials fee

Course Description: CHEM 8M (2 units) builds on the isolation and purification techniques learned in the 8L, including liquid-liquid extraction, chromatography, and distillation. Synthetic organic chemistry is a broad and exciting field that requires careful analysis of compounds, many of which are clear liquids and white solids (maybe not so exciting color-wise!). Students will become proficient in compound characterization *via* gas chromatography (GC), thin-layer chromatography (TLC), infrared (IR) spectroscopy, and nuclear magnetic resonance (NMR) spectroscopy. Technical scientific writing skills are emphasized.

Required Materials

- Access to the **course website** (<https://acrochem.sites.ucsc.edu/chem-108m/>)
- Mohrig, JR; Hammond, CN; Schatz, PF "Techniques in Organic Chemistry, 4th Edition" Freeman, 2010 (previous or newer editions are okay too, but pay attention to titles as section numbers may be different)
- Lab Notebook and approved safety goggles (shared goggles & lab coat)
- *Optional:* You may purchase your own lab coat and safety goggles.

Lecture webcasts at webcast.ucsc.edu. **User:** chem-8m

Password: @croCh3m

Enrollment Policies – see also page 5 for more details

- Enrolled students must be present and prepared at the first lab meeting. If you are more than **15 minutes** late for the first lab, **you will be dropped from the course**.
- Starting the second meeting of lab, you cannot be more than **two minutes late** for lab.
- There will be **no section switching** and **no lab make-ups in summer session**.
- Attendance to lab lecture is mandatory. You are responsible for getting the notes from another student if you miss lecture. We do not give out lecture notes but webcasts are available several days after lecture.
- If you are sick, it may not be safe for you to attend lab. Email Dr. B (cc your TA) as early as possible before your lab starts, otherwise your situation will be treated as an unexcused absence (see page 5).
- If you miss or come to lab late, unprepared, or are asked to leave the lab for violating safety rules, you are **not eligible for a make-up and will take a zero for the results portion of the lab**, at minimum. You may still receive credit for pre-lab questions and notebook pages if you make arrangements before the end of the lab period. You are also responsible for turning in the lab report due that day, if applicable.
- Consult the schedule for experiment due dates. Assume **no late lab reports** will be accepted unless **prior permission** is given by your TA in writing/e-mail before the due date.
- *Missing one full report means you drop one letter grade (ex. A to B).*
- *If you do not turn in two reports or if you miss two labs, you cannot pass the course.*

Disability Accommodation: UC Santa Cruz is committed to creating an academic environment that supports its diverse student body. If you are a student with a disability who requires accommodations to achieve equal access in this course, please submit your Accommodation Authorization Letter from the Disability Resource Center (DRC) to me privately during my office hours or by appointment, preferably within the first two weeks of the quarter. At this time, we would also like us to discuss ways we can ensure your full participation in the course. *This may include scheduling make-up labs if there are time conflicts due to extended exam times for other courses.* We encourage all students who may benefit from learning more about DRC services to contact DRC by phone at [831-459-2089](tel:831-459-2089) or by email at drc@ucsc.edu.

Academic Integrity - https://www.ue.ucsc.edu/academic_integrity: Students work in pairs and are encouraged to discuss experiments with each other, but *each student turns in an individual lab report*. The work you turn in should be your own. Avoid copy/pasting from someone else's work, including lab reports borrowed from a student from another term (**assignments change each quarter!**). Your TA will look out for blatant copying – it is pretty obvious! *Zero points will be assigned to duplicate lab reports, or sections of lab reports that are obviously copied, at the TA's discretion*. The following are a few suggestions and clarifications to avoid issues.

- Both students in a lab pair must perform roughly the same amount of hands-on lab work. If a TA finds only one student is performing the lab out of a pair, a warning will be issued. A second offense will result in dismissal from the lab and possibly from the course.
- Each student records his/her own raw data, not to be copied from a lab partner unless specifically instructed to do so.
- All calculations and analyses must be performed individually before comparing answers with another student.
- The technical writing assignments (abstract and experimental methods) are to be completed individually using the provided guidelines. Lab partners are encouraged to proofread each other's work only after a draft has been completed. Consult the TA for help as well.

Lab Conduct

Safety first! With more advanced labs comes the responsibility of more potentially dangerous chemicals and procedures. Students are expected to act responsibly in lab. A comprehensive list of safety rules is on p. 6-7 of this syllabus. An abbreviated version is below. **Violations are taken very seriously – point penalties, dismissal from lab, or dismissal from the course (D).**

- No food or drink in the lab
- Wear proper attire and arrive to lab on time.
- No running, or otherwise 'horsing around' during lab; keep belongings out of the way
- Take care of chemical spills immediately; consult the instructor
- Keep your work station clean and follow instructions on washing glassware
- **Your assigned locker must be complete, clean, and organized before leaving lab each day.**
- Be sure you understand the full procedure before beginning an experiment.
- Pay attention to waste procedures and chemical hazards
- Label all glassware at every stage of an experiment
- Act respectfully towards your TA and fellow lab-mates
- **ABSOLUTELY NO GLASS IN THE TRASHCANS, INCLUDING PIPETS**

Lecture

Students are expected to treat all instructors and fellow students respectfully!

Attendance to every lecture is mandatory and necessary for successful completion of this course. A lecture will be given on each experiment to aid in your preparation and understanding of the principles behind each lab.

* You are responsible for getting the notes from another student if you miss lecture. I do not give out lecture notes. Please do not email me to ask if I went over anything important in lecture; it's all important!!

* Lectures cover lab material in advance - sometimes the day before lab, other times the week before. Stick to the reading schedule to stay engaged. **It is recommended that students have as much of the notebook and pre-lab questions prepared as possible before lecture to aid in comprehension.**

* **Webcasts:** audio and anything projected in lecture will be posted online. This is not a substitute for attending lecture, as it may take four or more days to update lectures. Instead, use this to review material, supplement your notes, and/or help with reports.

* You are welcome to ask questions in lecture. It's more fun that way!

* Come to class on-time, stay for the duration. **Please wait to pack up until I have dismissed the class.**

* Please do not talk while the instructor is talking.

* **CELL PHONES OFF AND AWAY! Do not take pictures or video in class. I am not comfortable with this and you do not have my consent unless I say otherwise in class** (remember, the webcasts are available a few days after class). Please write notes by hand.

* **Electronic devices (tablets, laptops, etc.) are not permitted in the classroom** unless *prior permission* is obtained from the instructor and/or special accommodations are needed.

Description of Assignments:

Experiments and supplemental course materials, including links to video tutorials, are posted online. Reading assignments are from Mohrig, *et. al.* "Laboratory Techniques in Organic Chemistry, 4th Edition." A schedule of reading assignments is on the last page of the syllabus. Skim these sections before lecture and read the parts pertaining to the upcoming experiment more thoroughly before lab. Other editions and texts are suitable – use the lecture topics. Arrive to lab on time with a prepared lab notebook per the guidelines below. You cannot bring/use the text or handouts in lab unless otherwise instructed.

Notebook preparation: Your TA will check your lab notebook before you begin the lab. If your notebook is not properly prepared, you will be asked to leave, you will receive zero points for the results sections of the lab, and you will not be eligible for a make-up. **See sample notebook page provided online and read specific instructions in lab handouts.** Write in pen (no pencil). If you make a mistake, use a single-line strike-through (no scribbles), NO WHITE-OUT!

Summer session students may opt to create the lab notebook in a word processing program instead of a hand-written lab notebook. **All of the components below must be typed, printed out, and secured into a 3-ring binder before lab.** Electronic devices may not be used in lab. DO NOT copy/paste from the materials online or you will lose this privilege. You may leave spaces to hand-write figures, structures, and calculations. See further clarifications on the course website.

- Experiment Number, Title, Your Name, Lab Partner Name, Date, Section Day/Time
- **Purpose** – one sentence plus scheme with structures & abbreviations
- **Reagent Table**
 - For each chemical used, make a table with its chemical name, molecular mass, moles used (mmol), mass or volume used (mg or mL), molar equivalents (for reactions only) bp/mp, density, and relevant hazards (flammable, corrosive, lachrymator, pyrophoric, hygroscopic, etc.) The hazards are listed in the safety tables at the end of each handout and chemical properties can be found at www.sigmaaldrich.com.
- **Full hand-written, step-by-step procedure with diagrams.** DO NOT copy directly from the handouts. This should be in your own words. You can number your procedure, use bullet points, or any other format that will be useful to you or a lab mate in easily following your own instructions in the lab. The included diagrams should be of glassware, especially if it's new to you, and/or some type of flow chart that complements your written procedure. This is not a substitute for the hand-written procedure.
- **Waste and Clean-up Notes.** Copy and pay attention to notes in the handout and announcements in lecture/lab.

Introduction (Pre-Lab Questions)

- Include a header at the top of the page with your name, section letter, day, time, and room number. A title should appear as well, such as "Exp 1 Introduction".
- **Responses to pre-lab questions** are to be numbered, written in complete sentences, neatly *typed*, printed out, and handed to your TA at the very beginning of the lab period (as you walk in the door). Your TA will return these to you the day the report is due.
- DO NOT re-type the question exactly but DO re-word the question as part of your answer.
- You may leave space to hand-write structures, mechanisms, calculations, etc. in PEN. Responses in pencil will not be graded.
- **Do not wait until the last minute to print this out.** *This is your only opportunity to get credit for the pre-lab questions, no exceptions for printer issues, etc.*
- Altering pre-lab questions after turning them in would qualify as academic dishonesty and you will receive zero points for that section of the lab report. A second infraction will not be tolerated (see section on Academic Integrity above).
- **Get help with your introduction before it is due!** Take note of office hours and plan ahead.

In-lab Quizzes – There will be a short quiz at the beginning of lab to assess your preparation. If you read the lab handout and put thought into the pre-lab questions, this should be easy! If you are late to lab (more than 2 minutes), you cannot take the quiz.

Lab Reports

Reports are due in the beginning of lab on the due date (see schedule) and are to be **typed** (with the exception of notebook pages, figures, structures, and calculations) in the format outlined below and according to technical writing guidelines provided on the first day of lab and posted online.

The components are as follows. *No single lab report will contain all of these components.* Consult the specific grading rubric found at the end of each lab handout. The lab report must be in the order indicated in the grading rubric. Your TA may have specific instructions or expectations. Please pay attention to in-class announcements and **get help with your pre-lab questions and reports before they are due!**

- **Introduction** - original pre-lab responses with TA initials, see description on previous page
 - Enumerate the questions and separate each question into its own paragraph.
 - Reword the question into your answer. Do not re-write the question itself.
- **Results** – Typed responses to in-lab questions in complete sentences
 - You may hand-write calculations, structures, and mechanisms.
 - Reports due at the end of lab – results section hand-written in the lab notebook
 - Relevant tables should be given clear labels (**Table 1**, etc.) and a descriptive title.
- **Experimental Details and Characterization** – refer to Technical Writing Guidelines, additional notes given in the experiment handout, and sample experimental posted online
 - One **General Methods** paragraph
 - One additional paragraph for each reaction performed
- **Lab Notebook Pages** – the only hand-written component
 - Tear out the carbon-copy pages from your notebook for that lab and attach to the lab report. DO NOT re-write or alter your experimental notebook pages once the lab is completed, except to complete calculations or analysis.
 - TA initials for leaving lab with all the proper data and analysis.
- **Pre-Lab Quiz, Neatness & Organization**, 10-15% of each report.
 - Refer to report guidelines in the syllabus, experiment handout, and technical writing guidelines when putting together every report.
- **Lab Technique**, 5-10% of each report
 - Students will be assessed on their ability to safely carry out experiments using proper techniques as described in the safety rules (p. 5-6), experiments posted online, and any other demonstrations or instructions given by TAs in lab.
 - **Students must check out with the TA for a notebook and cleanup check before leaving every lab, otherwise zero points are awarded for this section.**

Lab Practical Exam (25%)

- Each student will perform this experiment individually using the provided procedure (no notebook) in 1 hr, 45 min without help from classmates or the TA (no talking).
- Your lab practical time will be assigned as either the *first or second half of your regular 4-hour lab time*. *If you come at the wrong time, you will get a zero for the exam.*

Tentative Grade Distribution – any changes made will be to your benefit.

| | | |
|--------------|-----------|------------|
| A+ 98 – 100% | A 93 - 97 | A- 90 - 92 |
| B+ 88 - 89% | B 83 - 87 | B- 80 - 82 |
| C+ 78 – 79% | | C 70 - 76 |
| D 55 - 69 | | F < 55 |

COURSE ASSESSMENT

Assignments Overview

- * Read **lab handouts and text assignments** before lecture and to prepare for lab.
 - * Prepare your **lab notebook** and **pre-lab questions** before each lab (see guidelines).
 - * Be prepared for a short **pre-lab quiz** at the beginning of every lab.
 - * Six individual **lab reports** (see due dates on schedule).
 - * **Final Lab Practical Exam** assessing student's ability to complete an experiment & analysis.
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Grade Breakdown

1000 Point Scale:

(50 points, 5%) **Orientation Activities (Safety, Writing, & Error)**

(700 points, 70%) **Lab Reports**

(250 points, 25%) **Final Lab Practical Exam – Tuesday August 29th in lab**

* **During 1st or 2nd half of regularly scheduled lab – pay attention to your assignment!**

* **Students must get a minimum of 60% on the final lab practical exam to pass the course, even if lab report grades are in the passing range.**

Grading Policies

- * **Students are to keep a record of their own graded assignments.**
 - * Grading rubrics indicate total possible point values for each lab report.
- * **Students must perform all labs and turn in all lab reports.**
 - * Missing one full lab report will drop one letter grade.
 - * Missing two labs - grade is dropped to a D and student will have to re-take the course.
 - * No make-up labs are provided in summer session.
 - * **Email your TA (cc Dr. B) as soon as possible** if you will miss lab or if you will be more than 2 minutes late to lab. We will consider partial credit on a case-by-case basis **as long as students communicate with us before the lab is over. Don't forget to turn in the lab report if there's one due!**
 - * The following conditions will keep students from performing the lab...
 - * Arriving to lab unprepared, including missing notebook components and improper attire.
 - * Arriving to lab late (more than 2 minutes).
 - * Not abiding by safety rules, procedures, or TA instructions.

"Meeting Half Way" Policy = 5+ min late, missed lab (illness or otherwise), or are not prepared...

- *You are not eligible for a make-up lab.*
- Go to your regular section before it ends if possible to turn in your pre-lab and lab report.
- If you cannot physically come to lab, send us (Dr. B & your TA) an email to make arrangements to show your pre-lab questions (intro) and notebook pages to your TA.
- Leave your lab report in your TAs mailbox in PSB if one is due the week you missed.
- Turn in a lab report with grading rubric the following week. At minimum, you will get credit for the intro and notebook pages (roughly 50% of the report is better than 0%!). You are welcome to complete other parts of the report for feedback but will not get credit.
- ***This offer expires when your lab is over!***
- **Students who miss lab and follow the "meeting half way" policy are still eligible for an A in the course, provided the rest of the reports have excellent scores. *You only get one of these!***

* Assume **no late lab reports** are accepted without prior permission from the TA (before the due date). This is handled on a case-by-case basis. Communicate with your TA.

LABORATORY SAFETY RULES AND AGREEMENT*Safety First!*

Violation of any of the rules below may result in you being removed from the lab and/or you will receive ZERO for results portions of the lab (credit granted for preparation only – introduction & notebook). A second violation will result in you being dropped from the course.

No make-up labs for students who violate these rules.

1. **Safety goggles must be worn** at all times when anyone in the room is working with chemicals, especially yourself!
2. **NO food, drinks, or gum** are allowed anywhere in the labs or in your mouth while you're in the labs.
3. **Appropriate lab attire** must be worn at every lab. Students cannot go home to change.
 - **OK LAB ATTIRE:** Pants or long skirt, short or long-sleeve shirt, closed-toe shoes that cover the entire top of the foot. Long hair and loose clothing are confined or tied back.
 - **NOT OK:** Shorts or short skirts (no exposed ankles), *leggings/tights*, cropped pants that expose ankles, ripped pants that expose skin, tank tops, sandals, ballet flats, or any other shoes that expose the tops of the feet (Crocs and Tom's are NOT OK!). High heels, baggy clothing, and dangling jewelry are strongly discouraged.
4. **Lab coats** must be worn over appropriate lab attire (see above).
5. **NO running, fighting, or other acts of mischief.**
6. **NO visitors**, including pets and side-kicks.
7. Know the **locations of emergency equipment** including fire alarms, fire extinguishers, chemical fume hoods, safety showers, and emergency eye washes.
8. **Notify your instructor immediately of any injury, spill, fire, or explosion.** You may clean up small spills (less than a few milliliters) yourself, but let the TA know. You're not in trouble unless you do it on purpose!
9. Keep your lab space **clean and organized**. Backpacks, purses, jackets, phones, etc. are not allowed where chemicals are being used.
10. **Never leave an ongoing experiment unattended.** If you need to leave the room, be sure a neighbor is watching your experiment.
11. Unless otherwise specified, dispose of broken glassware in broken glassware boxes only, including ceramics and disposable glass pipets. NO paper or other items in the broken glass boxes. **NO PIPETS OR OTHER GLASSWARE IN THE TRASH!** Not cool and you'll lose points.
12. **DO NOT TASTE ANYTHING IN THE LAB. EVER.**
13. **Never remove chemicals or equipment** from the labs or stockroom without permission.
14. **NO unauthorized experiments.** Stick to the given procedure.
15. Follow appropriate procedures for inserting glass into a stopper and/or have the stockroom or your TA assist you. Seriously, students stab themselves when they're not paying attention.
16. **Wash your hands and arms with soap and water before you leave the lab**, even if you've been wearing gloves.

17. Always know the **hazards** as well as the physical and chemical properties of the materials used. Your lab notebook should include a brief note on the safety hazards for each chemical being used based on **Material Safety Data Sheets (MSDS)** available online.

18. **Read labels carefully.** Read labels twice. Know what you're working with!

19. **Label all containers** with chemical/mixture names, your name, and the date **before** anything goes into that container.

20. **Use pluringes and pipet bulbs with glass pipets.** NEVER pipet by mouth. It's gross.

21. Check all **glassware for cracks and cleanliness** before using...or you'll be sorry later that you didn't.

22. **Avoid contamination.** Take only what you need from reagent bottles and NEVER return unused chemicals to the original bottle that other students are sharing.

23. **Fume hoods** are often used to minimize chemical exposure. Handle chemicals six inches into the hood, **DO NOT PUT YOUR HEAD IN THE HOOD** and **DO NOT KNEEL IN FRONT OF THE** hood, or anywhere in the lab.

24. **Wash all glassware before leaving lab for the day.**

25. **Dispose of all waste as instructed in the lab handout or by the TA.** Read waste container labels carefully to be sure it's going to the right place. Waste containers are typically in the fume hoods. Let your TA know if a waste container is full. **DO NOT LET THE WASTE CONTAINERS OVERFLOW!** *Seriously, who does that?!*

26. **NO use of flame in the lab.** Nearly everything in the organic chemistry labs is flammable.

27. **Wear gloves** when appropriate in the lab and **change your gloves** if you get chemicals on them. They're cheap! Gloves are only a first line of protection. They do not make you invincible! Take off gloves before you leave the room. **DO NOT touch door handles or your face with gloved hands.**

28. **Minimize chemical exposure** and treat every chemical as if it were hazardous.

29. **No cell phones or electronic devices are allowed to be used in the labs.** If you'd like to take a picture or video of your experiment, ask your TA for permission, but take your gloves off first.

30. Treat your TA respectfully and abide by any of his/her instructions and additional rules announced.

GOLDEN RULE: Your drawer must be *pristine* at the end of each lab.

- All equipment must be clean and organized in the drawer. Check the equipment list and picture of the perfect drawer on the bulletin board in the lab.
- Obtain any missing items from the stockroom. Do not bring broken items to the stockroom!
- **Drawer penalties - points taken off for each missing, dirty, broken, or extra item. Additional points taken off for disorganization, at the TA's discretion.**
 - 1 point per item Exp 1
 - 2 points per item Exp 2, Day 1
 - 3 points per item Exp 2, Day 2 and so on...

Violation of any of the rules above may result in you being removed from the lab and you will receive ZERO POINTS for that lab. A second violation will result in you being dropped from the course. No make-up labs for students who violate these rules.

You will sign a contract on the first day of lab, stating that you agree to abide by these rules.

LAB AND LECTURE SCHEDULE

| Week | Lecture Topic (MW) Reading Assignment "Sections" in Mohrig 4 | Labs (Tu/Th) Experiments online |
|------|--|--|
| 1 | 7/31 Column (Liquid) Chromatography <i>Exp 1; Chapter 19.1, 19.2, 19.5a, 19.7</i> | 8/1 Check-in & Safety Safety, Writing, and Error Analysis |
| | 8/2 Acid-Base Extractions <i>Exp 2; Chapter 10.1-10.5</i> | 8/3 - pairs Exp 1 Separation of Limonene & Carvone <i>Due 8/8</i> |
| 2 | 8/7 TLC; ¹H NMR Chemical Shifts & Integration <i>Exp 2; Chapters 18, 22.1-22.7</i> <i>*McMurry Chapter 13.1-3, 13.8-10</i> | 8/8 - pairs Exp 2 Acid-Base Extraction (Excedrin) <i>Due 8/15</i> |
| | 8/9 Oxidation Rxns; ¹H NMR Chemical Shifts <i>Exp 3; Chapter 22.7-8</i> <i>*McMurry Chapter 13.8-10, 17.7</i> | 8/10 - pairs Exp 2 - Excedrin Analysis <i>Due 8/15</i> |
| 3 | 8/14 Dyes <i>Exp 4; Chapters 4-5</i> <i>*McMurry p. 971-972</i> | 8/15 - solo Exp 3 Oxidation of Benzylol <i>Due 8/22</i> |
| | 8/16 – Indigo Synthesis & Fischer Esterification <i>Exp 4 & 5</i> <i>Chapters 5.1, 5.3, 6.1-2, 7.1, 22.9, 22.11</i> <i>*McMurry Chapter 13.11, 21.10</i> | 8/17 – pairs Exp 4 Synthesis and Application of Organic Dyes <i>Due 8/24</i> |
| 4 | 8/21 Esters; ¹H NMR Splitting <i>Exp 5; Chapters 22.9, 22.11</i> <i>*McMurry Chapter 13.11, 21.3, 21.10</i> | 8/22 - pairs Exp 4 Synthesis and Application of Organic Dyes <i>Due 8/24</i> |
| | 8/23 Esters; ¹³C NMR <i>Exp 6; Chapter 23</i> <i>*McMurry Chapter 13.4-5, 13.7</i> | 8/24 - pairs Exp 5 Fruity Fragrances <i>Due 8/29</i> |
| 5 | 8/28 Aspirin Synthesis; ¹³C NMR <i>Exp 6, Chapter 22-23</i> | 8/29 PRACTICAL EXAM Exp 6 Synthesis of Aspirin <i>Due at the end of lab</i> |
| | 8/30 No Lecture | 8/31 No Lab |