Chemistry 327: Synthesis Laboratory

Instructor: Patrick Lutz (he/him/his), Sci. Ctr. N379, (440) 775-8892, patrick.lutz@oberlin.edu
I generally respond to emails within 24 hours during the week.

Lecture meetings: Monday/Wednesday, 3:30–4:20pm, Science Center A255

Laboratory meeting: Friday, 1:30–4:30pm, Science Center N389

Student hours: Your success in this course is one of my highest priorities. The times listed below are designated as student hours, but if my office door is open (even just a little bit), feel free to knock and I'll try to help out if I have time.

- Mondays from 4:30–5:30pm
- Wednesdays from 4:30–5:30pm (except seminar days)
- Thursdays from 11:00am–12:00pm

Pandemic-permitting, student hours are planned to be held in person by default, but feel free to drop me a line if you'd like to meet over Zoom.

Welcome to Synthesis Lab! This course is designed to introduce you to methods in synthetic chemistry beyond what you have encountered in previous courses. You will have the opportunity to synthesize small-molecule organic compounds, inorganic coordination and organometallic complexes, and polymers. You will also gain experience characterizing complex chemical structures. Overall, I hope this course builds confidence and helps prepare you to work as an independent scientist.

Learning goals. In this course, students will:

1. Acquire advanced laboratory techniques for synthesizing organic and inorganic compounds.
2. Develop a practical understanding of the theory and interpretation of NMR, mass, and infrared spectra, as well as the skill to use spectroscopic data to derive structural information about organic and inorganic compounds.
3. Enhance their ability to present and discuss scientific data in both written and oral formats.

Prerequisites: C– or better in CHEM 205 and CHEM 213

Required texts and materials:

1. *Spectrometric Identification of Organic Compounds*, 8th edition (2014) or 7th edition (2005) by Silverstein, Webster, Kiemle, and Bryce (referred to as "SWK").
2. *Chemistry 327 Laboratory Manual* (provided).
3. Laboratory notebook – any *permanently-bound* notebook is acceptable (e.g., a composition notebook); it need not be one of the blue notebooks previously sold in the

department. It is fine to continue using a notebook from a previous semester, but I do not recommend using the same notebook for two courses this term, as you will occasionally need to turn in your CHEM 327 notebook.

Course format:
In case you haven't noticed, it has been an unusual couple of years. Things seem to be returning to some semblance of normal, but we may find that we need to be flexible in response to public health considerations over the course of the semester. I reserve the right to make modifications to the format and procedures described in this syllabus in response to changing conditions, or just because we discover that some aspect of the course doesn't work out as well as I thought it will. Of course, I will let you know of any such changes as we move through the semester.

As senior chemistry majors in an elective course, I assume you are taking synthesis lab because you *want* to, not because you *have* to. You will get out of this course what you put into it, so please come to class prepared and ready to learn.

Evaluation:
Grades will be determined using the components listed below.

2 midterm exams	30%
lab reports	35%
lab notebook	10%
problem sets	10%
class presentation	10%
class participation	5%

The scale for determining final grades is shown below. Grades are based on your score alone; there is no "class curve" and you are not competing directly against your fellow students. It is possible that I could lower the grade borders if assignments prove more challenging than anticipated, but I will not *raise* the cut-offs.

A–	≥ 90%
B–	≥ 80%
C–	≥ 70%
D–	≥ 50%

Exams: There will be two midterm exams; there is no final exam for this course. Both midterms will be take-home but should be completed in one timed sitting; mored details will be provided prior to the first midterm. The exams will be available at the end of class on November 10 and December 15 and due by the beginning of class on November 15 and December 20. For both exams, you may consult the SWK textbook and your own course notes but no other outside sources.

Lab reports: Unless otherwise noted, lab reports are due at the start of lab two weeks after the experiment is completed. In some cases, you may need to collect characterization data

during the following lab period. Each student's preparation and performance in lab will also be assessed as part of the lab report grade. Experimental procedures, characterization data, and literature references should adhere to the *ACS Style Guide*; additional details about the contents of lab reports are provided in the lab manual. Late reports will be subjected to a 5% point deduction per day.

The report for Experiment I will take the place of a final exam and as such is due by Saturday, 1/22 at 9pm (the designated final exam time for this course).

Your lowest lab report score will be automatically dropped when deteriming your course grade, with the exception of the report for the Experiment I, which is not eligible to be dropped.

Lab notebook: A critical aspect of a scientist's work is maintaining a detailed log of operations performed and observations in the lab. To encourage good lab notebook recording skills, notebooks will be collected three times throughout the semester for evaluation: following the second week of lab, prior to Fall Break, and at the end of the semester. Details about the necessary content for the lab notebook can be found in the lab manual.

Problem sets: There will be five problem sets over the course of the semester; I will aim to distribute them a week before they are due. Late problem sets will not be accepted, but your lowest problem set score will be dropped when determining your course grade.

Class presentation: Each student will give a 12–15 minute presentation on a paper chosen by the student that highlights a recent (within the last 3 years) advance in organic or inorganic synthesis. Students will choose their own papers and are encouraged to consult with the instructor and/or the Head of the Science Library, Alison Ricker, when making their choice. Additional details will be provided on a separate handout.

Accommodations: If you have a disability that may have some impact on your work in this class and for which you may require accommodations, please see the instructor and the Office of Disability Resources [disability.resources@oberlin.edu, (440) 775-5588] so that appropriate accommodations can be arranged. A disability may be disclosed at any point during the semester but should be brought up with at least 24 hours' notice before an assignment is released in order to set up appropriate accommodations.

Inclusivity: The course instructor is committed to cultivating an inclusive and supportive learning environment that respects and celebrates a rich variety of backgrounds and perspectives. Please speak with the course instructor or the Chemistry Department chair, Jason Belitsky, if you have an experience in this class that is not consistent with this commitment.

Honor code: You must write and sign the Honor Pledge ("I have adhered to the Honor Code in this assignment") in order to receive credit for lab reports, problem sets, and exams in CHEM 327. You are welcome and encouraged to discuss problem sets and lab experiments with

your classmates, but all parts of the problem sets and lab reports (including data, calculations, and answers to any questions) must represent your own work. The exams must be completed ***independently*** and you should not discuss their contents with classmates until after the deadline.

Semester schedule: A tentative schedule of topics is shown beginning on the next page. This schedule is subject to change, and updates will be provided as necessary.

Day	Date	Topics	Assignments	Suggested reading in SWK/ CHEM 205 review videos
Mon	Oct 4	course introduction		
Wed	Oct 6	mass spectrometry		1.1–1.4; MS videos
Mon	Oct 11	fragmentation in mass spectrometry		1.5–1.6; degree of unsaturation video
Wed	Oct 13	ChemDraw and Scifinder tutorial (meet in Science Library computer lab)		
Mon	Oct 18	infrared spectroscopy	**turn in lab notebook**	2.1–2.6; IR videos
Wed	Oct 20	basic NMR theory	**Problem Set 1 due**	3.1–3.3, handout from SWK 7th ed.; NMR intro videos
Mon	Oct 25	basic NMR theory and chemical equivalence		3.8
Wed	Oct 27	^{1}H NMR: chemical shifts and integration		3.4, 3.6; chemical shift videos
Mon	Nov 1	^{1}H NMR: first-order coupling	**Problem Set 2 due**	3.5, 3.7; coupling video
Wed	Nov 3	^{1}H NMR: magnetic equivalence		3.9–3.17
Mon	Nov 8	^{13}C NMR		4.1–4.3, 4.7; ^{13}C NMR video
Wed	Nov 10	catch-up day	**Problem Set 3 due**; Midterm 1 distributed	
Mon	Nov 15	^{13}C NMR: DEPT	**Midterm 1 due**	4.4–4.6
Wed	Nov 17	heteronuclear NMR spectroscopy	**turn in lab notebook on Friday**	6.1–6.6
Mon	Nov 22	Thanksgiving Break		
Wed	Nov 24			

Day	Date	Topics	Assignments	Suggested reading in SWK
Mon	Nov 29	intro to 2D NMR; COSY		5.1–5.3
Wed	Dec 1	HSQC, HMBC		5.4–5.7
Mon	Dec 6	NOESY, ROESY	**Problem Set 4 due**	5.10
Wed	Dec 8	putting it all together		ch.7
Mon	Dec 13	dynamic effects in NMR		
Wed	Dec 15	catch-up day	**Problem Set 5 due**; Midterm 2 distributed	
Mon	Dec 20	example literature presentation	**Midterm 2 due**	
Wed	Dec 22	no class	**choice of lit. paper due by email**	
Mon	Dec 27	Winter Break		
Wed	Dec 29			
Mon	Jan 3	additional NMR experiments		5.8–5.9, 5.11
Wed	Jan 5	TBD		
Mon	Jan 10	literature presentations		
Wed	Jan 12	literature presentations		
Fri	Jan 14	literature presentations (during lab meeting time)		
Sat	Jan 22	**Experiment I report and lab notebook due by 9pm**		