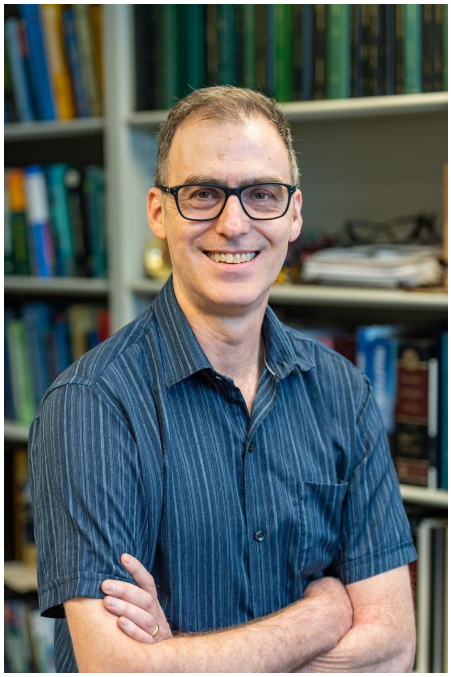
Chemistry 215H: Structure and Reactivity II (Honors)

Instructor: John Montgomery



Instructor Bio

Professor John Montgomery is the Margaret and Herman Sokol Professor and Arthur F. Thurnau Professor in the Department of Chemistry at the University of Michigan. His research focuses on the discovery and development of enabling technologies for organic synthesis, and his lab has active programs in organometallic chemistry, synthetic chemistry, biocatalysis, and carbohydrate chemistry. His research group is currently part of the National Science Foundation Center for Selective C-H Functionalization (CCHF) and the National Institutes of Health Common Fund Program in Glycoscience. He serves as the Director of the Michigan Chemistry-Biology Interface Training Program, and he is a member of the Interdepartmental Program in Medicinal Chemistry and the Program in Chemical Biology.

Montgomery teaches courses in organic chemistry at the beginning undergraduate to advanced graduate level at Michigan. He specializes in teaching large (>350 student) introductory courses, and he developed a new course offering in the Comprehensive Studies Program designed to improve course outcomes for students who come from a variety of backgrounds including first-generation students, underrepresented students, and those from smaller or under-resourced high schools.

Course Description

Chemistry 215H is the honors section of second-semester introductory organic chemistry at the University of Michigan. The purpose of the class is to introduce students to the field of organic chemistry, illustrate its impact on related fields and the world around us, and to prepare students for a range of academic paths including focused study in higher-level chemistry or related STEM fields. The class is closely coordinated with a companion honors lab class led by a second professor and an evening study group led by advanced undergraduates and advised by a third professor. Graduate student instructors also participate in academic support for the lecture and in the instruction of laboratory sections, and a separate team of advanced undergraduates offer additional academic support in small groups in our Science Learning Center. The lecture component, which was Professor Montgomery's focus, includes four lectures per week. The grading structure for the lecture component includes three major exams plus the final exam, weekly quizzes, an alumni engagement project, and a literature project overseen and graded by the advanced undergraduate study group leaders.

In the winter 2020 semester, the class was made up of 84 students, mostly at the freshman and sophomore level, and includes highly motivated students in a range of majors across the College of Literature, Science, and the Arts and the College of Engineering. Students self select for participation in the course, and the makeup of students largely comes from the top-performing group in the prerequisite first-semester course in organic chemistry, which is the first or second course in chemistry that students take at Michigan. Many of the students will major in chemistry, and a large percentage of students enter the course with an interest in attending medical school after completing their undergraduate degrees.

Redesign Challenges

A number of challenges were introduced by the transition to remote teaching just prior to our second exam. Before the change in format, class meetings included structured lectures that incorporated time for breakout discussions to discuss problems, and office hours were structured in an open format, where students came with questions in a setting where the entire class was encouraged to attend and participate. Some course activities, such as an alumni engagement project, required a carefully planned timeline that became impossible to execute in the originally planned form once time was lost during the transition to remote instruction. The student-led literature project was a semester-long project, also with a very tight timeline for completion once the remote instruction began. Coordinating and prioritizing the various class features and activities of the student leaders, graduate student instructors, and collaborating professors was a major challenge once we moved to remote instruction.

The class size, being considerably smaller than the regular sections of Chem 215, typically allows a lot of student engagement as a key component that needed to be preserved. This was complicated by the matter of technology limitations in quickly writing and projecting the chemical structures that are an essential component of the lecture and small group discussions. Maintaining the structure of student collaboration and active discussions between the professor and students were essential components of the class that immediately became challenging in remote format.

How would you characterize the greatest challenge or area of concern that you faced before moving into the phase of emergency remote teaching? This could include concerns regarding teaching content, student well-being and equity, and uncertainty around the use of technology.

Adopting the Zoom platform for live discussions and rush ordering a document camera from Amazon largely addressed the technical hurdles that were initially posed by the transition. Helping students keep motivated, however, was probably the biggest challenge, as losing the structure of in-class meetings was clearly very difficult for some students. Trying to recognize the motivational challenges and to support the students who were facing them was probably what I struggled most with as an instructor.

Learning how to support the students who experienced other challenges such as having ill family members, financial stresses, lack of a quiet environment for studying and test taking, and lack of access to resources such as textbooks and adequate wifi was a challenge throughout the term. Routinely encouraging students to communicate challenges to me and then working with them on solutions to their specific issue was a priority to me throughout the term, but trying to provide an equitable course experience for students in such a variety of unusual circumstances was incredibly difficult. I maintained a very high level of rigor in assessment, but I tried to do so in a flexible and supportive way that enabled students to thrive despite their unique challenges.

Describe your decision making process when faced with the need to move online? What aspects of your course design did you prioritize? What aspects did you change? What "course corrections" did you need to make even after the period of emergency remote teaching began?

All lecture content was provided as recordings for asynchronous viewing, and regular time slots for class and office hours were transitioned to open discussion with the class and visits from alumni. I was really pleased with the engagement from students who participated in the well-attended discussion sessions with me. I joined each session early and spent 5-10 minutes chatting informally with students as they came online. On occasion, we introduced our pets and shared ideas for quarantine activities as we started the class meetings. I provided recordings of all class discussions, holding sessions in the morning and evening to accommodate different time zones to enable as much participation as possible.

There was a planned class activity before the shutdown where students were expected to reach out to a U of M alumnus through email to get insights into their career path. When the shutdown occurred, we decided to expand this aspect of the course by having nine alumni visit our live meetings for Q&A sessions with the students. The alumni joined our class from across the country representing careers in academia, medicine, government labs, pharma, law, and business, showing how organic chemistry is integrated in each of these areas. The alums discussed the formative choices they made as undergrads at Michigan and openly discussed

their challenges and setbacks as well as the things they loved about their careers. Many students highlighted this as their favorite part of the course, and it was great to have a course component that was significantly improved as a result of the remote instruction.

Even amidst challenging times, sometimes unexpected bright spots appear. For instance, we have heard from some instructors that video conferencing provided unexpected benefits, such as instructors being able to more easily refer to students by name (as each student's name appeared beneath their profile picture or video) or being able to hear from each student in a more consistent and equitable way. Can you think of any bright spots from this experience?

I loved the Zoom breakout room feature. In face-to-face instruction, I incorporate brief breaks for students to take a few minutes to discuss questions that I pose. In person, it's impossible to manage the size of groups, avoid cliques, integrate students who don't know other classmates, mix up the groups so that students hear different perspectives, and physically reach the students in a large class to participate in their discussions. The Zoom breakout rooms address each of these challenges. As the meeting host, I can decide on the group size, randomly reassign groups each time, and jump from room to room to touch base. I thought this aspect worked much better than in-person discussions. Breakout sessions can also be used for office hours, so that students can chat with each other while they're waiting to talk with me one-on-one, which I can then do in a two-person breakout room.

I went exclusively to open-book, open-notes exams. Introductory organic chemistry has a reputation of being memorization intensive in a painful sort of way, so I actually really liked removing the memorization component. The exams I wrote were certainly more difficult than the exams I would normally give in a closed-book in-class setting. The exams were structured in a way that better assessed the students' ability to apply concepts and to think creatively about questions where there isn't a specific, well-defined, correct answer. Students didn't necessarily like the difficulty of the exams, but many did appreciate being challenged in new ways, and I believe they learned more about the discipline by thinking about problems in the way that a chemist would approach a question in a real-world setting with all resources available. Grading, however, became much harder to delegate, and there are limits on how to effectively scale this approach to assessment.

What evidence did you hear from students about how they experienced this transition?

The students were incredibly gracious. They understood that the transition was difficult for all of us, and they were always flexible and understanding when I struggled with the inevitable challenges in instruction. Students generally liked the asynchronous instruction so they could work at their own pace, and they liked the new experience of interacting with alumni in a class setting. Students also really appreciated that I allocated bits of time during the course getting to know them individually rather than just delivering content, and they enjoyed the activities that helped to build a sense of community within the class.

After going through this transition, what lessons will you carry forward into future course designs?

I think I provided a lot of useful resources in recorded videos, but some students found the volume of material overwhelming and difficult to prioritize when time pressed. In future course designs, I will continue to make some material available as recordings to free up time for informal class discussions, but I will provide a more detailed listing of contents of recordings with time points from the videos so that students can identify key information they are looking for more easily and quickly. I also think that building in more frequent, smaller-stakes assessments is a good idea to help ensure that students are keeping up and recognizing when they are struggling before it's too late.

Additional Resources

For additional course information and alumni highlights from Chemistry 215H, see this Twitter thread:

https://twitter.com/john_montg/status/1248299969225863168