

## CHEM 6410 Organometallic Chemistry, 3 credits

Syllabus, Spring 2024

**Lecture:** MWF 12:00–12:50, Rowell 102

**Instructor:** Rory Waterman, [rory.waterman@uvm.edu](mailto:rory.waterman@uvm.edu), 656-0278

Office: Innovation E334

I am available by email, phone, or Teams (chat or call) for questions or to schedule a meeting.

**Office hours:** Fridays 1:00–2:00 pm

You are welcome to stop by my office as needed to talk if I am free. You are also always welcome to make an appointment (in person or on Teams) as well.

**Course outline:**

- I. A skirmish with kinetics
- II. Transition metals and ligands
- III. Reaction types
- IV. Synthetic considerations
- V. Catalysis

### Technical support for students

Students, please read this technology check list to make sure you are ready for classes.

<https://www.uvm.edu/it/kb/student-technology-resources/>

Students should contact the Helpline (802-656-2604) for support with technical issues.

### Pre-requisites or co-requisites

CHEM 3400 Advanced Inorganic Chemistry, CHEM 5400 GR Advanced Inorganic Chem, or instructor permission

### Course Description

Organometallics, rigorously defined, deals with the interactions between metals and carbon-based molecules. The rich chemistry associated with metal compounds and main group elements has widened this description, and the old editorial scope of the journal *Organometallics* summarizes, albeit not concisely, the breadth of the field:

For the purposes of this journal, an “organometallic” compound will be defined as one in which there is a bonding interaction (ionic or covalent, localized or delocalized) between one or more carbon atoms of an organic group or molecule and a main group, transition, lanthanide, or actinide metal atom (or atoms). Following longstanding tradition, organic derivatives of the metalloids (boron, silicon, germanium, arsenic, and tellurium) will be included in this definition. Furthermore, manuscripts dealing with metal-containing compounds which do not contain metal-carbon bonds will be considered as well if there is a close relationship between the subject matter and the principles and practice of organometallic chemistry. Such compounds may include, inter alia, representatives from the following classes: molecular metal hydrides; metal alkoxides, thiolates, amides, and phosphides; metal complexes containing organo-group 15 and 16 ligands; metal

nitrosyls. Papers dealing with certain aspects of organophosphorus, organoselenium, and organosulfur chemistry also will be considered. In considering submissions that deal with subject matter that is peripheral to mainstream organometallic chemistry, our primary concern will be that the manuscript be of interest to our readers.

Thus, organometallic chemistry is a big tent,<sup>1</sup> meaning all are welcome. Our principal interest will be in organometallic complexes of the transition-series elements (groups 3–10). The elements of the *s*, *p*, and *f*-block certainly have interesting organometallic chemistry. The limits of time force us to largely ignore these elements. However, application of transition-metal compounds in catalysis and organic synthesis makes this course more topical. Of course, this class is conceptual in nature, and the fundamental principles we investigate are widely applicable throughout organometallic chemistry.

### Course Learning Objectives

At the culmination of the course, a student should be able to

- Determine key properties of organometallic compounds, such as oxidation state, d electron count, and total valence electron count.
- Identify the key organometallic reaction steps and how they are influenced by properties of a metal compound.
- Predict the stability and types of reactivity of metal compounds based the key properties of a given compound.
- Predict the products of reactions at organometallic compounds
- Apply kinetic and other mechanistic data to identify fundamental organometallic reaction steps
- Use experimental data to construct a catalytic cycle composed of fundamental organometallic steps.

These are aims in broad strokes. For each of the five sections of the course, specific learning objectives will be supplied with more precise readings and other supporting content for that specific material.

### Required Course Materials

- Optional: *Organometallic Chemistry* by Spessard & Messler, ISBN = 9780199342679, which will be available through the UVM Bookstore.
- We will also use primary literature. All articles will be available through UVM Libraries. DOIs will be provided when copies are not uploaded to Brightspace.

If you choose to use *Organometallic Chemistry*, our course will cover chapters 2–9, 11, and 12 with some aspects of other sections. Section syllabi will have specific readings. Many parts of the course such as kinetics and ligand types are not treated in this book but are important enough to provide other resources.

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<sup>1</sup> The same is true of inorganic chemistry if not more so. Makers, measurers, modelers, and any combination are all welcome in inorganic chemistry. Anyone who tells you otherwise is a liar...or worse.

Anticiapte at least one textbook chapter of reading per week in support of course content, whether that is from a textbook, journal articles, or both.

### **Required platforms and software**

- This course uses BrighSpace to collect assignments, upload some assignments, share and archive course content, and keep an accessible record of individual scores.
- ChemDraw is not required but is awfully helpful to you as a chemist. The department provides a free copy to every students.
- The search platform of your choice (i.e., Scifinder, Reaxis, etc.) will be useful in addressing essay prompts.

### **Attendance Policy and Classroom Environment Expectations:**

Attendance is expected. Rather than creating punishments for not attending, one will find that course content will be much more challenging without the context from class, practice in class, interactions with peers, and opportunity for questions.

This class will be a place where all ideas and views on the material can be shared by all members of the class. If a member of the class has difficulty in giving space to peers, allowing for other opinions on the content, or staying on course content, this is counter to our the learning environment and potentially a policy violation. Please monitor your own classroom behavior and accept any feedback I provide. When in doubt, Our Common Ground is good guidance for classroom conduct.

I will ask for your thoughts and input, and you should ask questions, both to clarify course content but also to satisfy your curiosity. If there are voices that dominate the conversation, those individuals may be asked to limit comments, and all indivudals will be asked to participate. Talking in class is not a requirement and is not graded. However, talking about science is a requirement for a scientist. This is a good, safe place to practice.

Sickness happens. Naturally, you should use your best public health judgement about attending a given class if you are ill, but if this should inhibit your ability to complete an assignment or be at an exam, I need prior notification. The execption to this is, of course, more serious instances where the Dean's office would provide verification of absence. Please use your best judgement knowing that if you are taking care of yourself and others in a responsible way, there are assurances for you.

### **Grading Criteria/Policies**

**Grading:** There will be two mid-term exams (20% each), a final exam (20%), problem-based homework (20%) and essays (ca. 2 pages/each; 20%).

**Homework:** Homework will be assigned approximately weekly. For an upper division class, I have found that students can be successful by turning in a homework assignment on time for 50% of the credit, if it addresses all the questions (not explicitly graded by me). One week

following, there will be opportunity to upload any corrections based on an answer key that will appear automatically after the due date. Even if all your answers are correct, uploading an acknowledgement that you checked your work against the key or provide any re-done questions will yield the remaining 50% of the credit. This is a system based on trust (I do reserve the right to 'audit' work, though, too). More important, it connects the process of grading homework to your interest in using it as a learning tool. You can make as many mistakes as you care to, and as long as you are continuing to learn from them, you will earn credit.

**In-class work:** In-class activities will be programmed into classes. For completion of this work, some additional credit as homework or exams will be applied.

**Essays:** There will be some short written assignments (ca. 2–4 pages) dealing with fundamental topics in organometallic chemistry, based on literature topics. I will be reading for you addressing the prompt by connecting it to class and/or literature content. Further details supplied in class. At most, a limited problem set will be due on the weeks of an essay assignment.

**Late policy:** Assignments are due at the *beginning* of class on the date noted or at the time on the LMS. Homework turned in within 24 hours of the due date will be given 50% credit and after 48 hours no credit. I will accept and correct homework after 48 hours: Practicing the concepts presented in class is more important than the grade on an individual assignment.

**Exams:** Exams are in-class and reflect the problems that have been seen in class, in readings, and in assignments. These are meant to probe at the learning objectives. Therefore, the learning objectives are an excellent guide for studying.

**Course grades:** For good or ill, students in even small classes tend to distribute by raw score, but we cannot rely on this for grades. At the same time, I make mistakes in overshooting for exams or assignments. Students who complete all assignments tend to be well prepared for exams and score in the B range or higher. I need to calibrate every year, but exam scores of 85% or greater tend to correlate to A-range grades, 75% or greater to B range, and 65% or greater to C range. My hope is that all students access material, learn, and can demonstrate core competency. Thus, I have no designs on the numbers or percents of various grades.

## All the good UVM-provided information

### Lived Name and Pronoun Information

The UVM Directory includes fields for indicating your lived name and your pronouns. Lived names (preferred names, names in use) are names that an individual wants to be known by in the University community. Entering your pronouns is strongly encouraged to help create a more inclusive and respectful campus community. To update your information, login to the UVM Directory. A preview box will allow you to see how this information will appear in other systems used on campus such as Microsoft Teams and Blackboard.

More information about how to make changes to your lived name and pronouns is available in the [Knowledge Base](#).

### Research and Citation Help

For help selecting research topics, finding information, citing sources, and more, ask a librarian. The UVM Libraries are eager to help. You may ask questions by phone, e-mail, chat, or text, or make an appointment for an individual consultation with a librarian.

Howe Library: <https://library.uvm.edu/askhowe>

Dana Medical Library: <https://dana.uvm.edu/help/ask>

Silver Special Collections Library: <https://specialcollections.uvm.edu/help/ask>

### Course Evaluation:

I will always accept your feedback, but an on-line survey will be provided in the closing days of the semester. Please complete the survey, and I will provide in-class time for that task. Your feedback is important, and this information is used by me and the department in considering how this course is run ([student instructions on how to access Blue course evaluations](#)).

### General statement regarding potential changes during the semester:

<http://catalogue.uvm.edu/>

The University of Vermont reserves the right to make changes in the course offerings, mode of delivery, degree requirements, charges, regulations, and procedures contained herein as educational, financial, and health, safety, and welfare considerations require, or as necessary to be compliant with governmental, accreditation, or public health directives.

## Intellectual Property Statement/Prohibition on Sharing Academic Materials:

Students are prohibited from publicly sharing or selling academic materials that they did not author (for example: class syllabus, outlines or class presentations authored by the professor, practice questions, text from the textbook or other copyrighted class materials, etc.); and students are prohibited from sharing assessments (for example homework or a take-home examination). Violations will be handled under UVM's Intellectual Property policy and Code of Academic Integrity.

## Tips for Success (optional):

Course-specific study/preparation tips

*Here are a few resources for students on remote/online learning:*

- Checklist for success in <https://learn.uvm.edu/about/support-for-students/checklist-online-credit-courses/>
- Academic support for online courses: <https://www.uvm.edu/academicsuccess/online-learning-student-resources-remote-instruction>
- 30-minute webinar on online learning success (Mar 2020): [https://www.youtube.com/watch?v=Xp\\_MYsqQyvE](https://www.youtube.com/watch?v=Xp_MYsqQyvE)

Helpful resources other than the professor (e.g., [Undergraduate/Graduate Writing Center](#), [Supplemental Instruction](#), [Learning Co-op tutors](#), supplemental course materials)

## Student Learning Accommodations:

In keeping with University policy, any student with a documented disability interested in utilizing ADA accommodations should contact Student Accessibility Services (SAS), the office of Disability Services on campus for students. SAS works with students and faculty in an interactive process to explore reasonable and appropriate accommodations, which are communicated to faculty in an accommodation letter. All students are strongly recommended to discuss with their faculty the accommodations they plan to use in each course. Faculty who receive Letters of Accommodation with Disability Related Flexible accommodations will need to fill out the Disability Related Flexibility Agreement. Any questions from faculty or students on the agreement should be directed to the SAS specialist who is indicated on the letter.

Contact SAS:

A170 Living/Learning Center;

802-656-7753

[access@uvm.edu](mailto:access@uvm.edu)

[www.uvm.edu/access](http://www.uvm.edu/access)

## Important UVM Policies

Academic Integrity:

The [Academic Integrity policy](#) addresses plagiarism, fabrication, collusion, and cheating.

Code of Student Conduct:

[UVM's Code of Student Conduct](#) outlines conduct expectations as well as students' rights and responsibilities.

FERPA Rights Disclosure:

The purpose of UVM's [FERPA Rights Disclosure](#) is to communicate the rights of students regarding access to, and privacy of their student educational records as provided for in the Family Educational Rights and Privacy Act (FERPA) of 1974.

Final Exam Policy:

The University [final exam policy](#) outlines expectations during final exams and explains timing and process of examination period.

Grade Appeals:

If you would like to contest a grade, please follow the procedures [outlined in this policy](#).

Grading:

[This link](#) offers information on grading and GPA calculation.

Religious Holidays:

Students have the right to practice the religion of their choice. If you need to miss class to observe a religious holiday, please submit the dates of your absence to me in writing by the end

of the second full week of classes. You will be permitted to make up work within a mutually agreed-upon time. The complete policy is [here](#).

### Promoting Health & Safety:

The University of Vermont's number one priority is to support a healthy and safe community:

[Center for Health and Wellbeing](#)

[Counseling & Psychiatry Services \(CAPS\)](#) Direct Phone Line: (802) 656-3340

C.A.R.E. If you are concerned about a UVM community member or are concerned about a specific event, we encourage you to contact the Dean of Students Office (802-656-3380). If you would like to remain anonymous, you can report your concerns online by [visiting the C.A.R.E. Team website](#).

### Alcohol and Cannabis Statement:

Statement on Alcohol and Cannabis in the Academic Environment

As a faculty member, I want you to get the most you can out of this course. You play a crucial role in your education and in your readiness to learn and fully engage with the course material. It is important to note that alcohol and cannabis have no place in an academic environment. They can seriously impair your ability to learn and retain information not only in the moment you may be using, but up to 48 hours or more afterwards. In addition, alcohol and cannabis can:

- Cause issues with attention, memory and concentration
- Negatively impact the quality of how information is processed and ultimately stored
- Affect sleep patterns, which interferes with long-term memory formation

It is my expectation that you will do everything you can to optimize your learning and to fully participate in this course.