This syllabus was created by Dr. Kevin Tvrdy, Department of Chemistry & Biochemistry, and is freely offered as a template for other faculty at UCCS.

Syllabus – Spring 2025

CHEM 4904, Research: Upper Division

CHEM 5904, Research: Graduate

Course Information

Name: Research: Upper Division and Research: Graduate

IDs: CHEM 4904, Sections 001 (all students) and 010, 020, 030, 040, 060, 070, 080, 090, and 110 (research advisor specific)

CHEM 5904, Sections 001 (all students) and 010, 020, 030, 040, 060, 070, 080, 090, and 110 (research advisor specific)

Credit Hours: 1-3 (variable)

Term Dates: January 21st, 2025 – May 16th, 2025

Mode of Instruction: In Person

Location: Centennial 191 (seminar presentations) and Research Labs (research advisor specific)

Time: Optional seminar presentations on select Thursdays from 3:05p – 4:20p; research work is coordinated on a per-advisor and per-student basis

Prerequisite/Corequisite: None

Sections/Research Advisors (emails):

The below information applies to both CHEM 4904 and CHEM 5904

Section	Research Advisor (email)	Advisor Office	Primary Research Lab
001	All students co-enrolled in Section 001	n/a	n/a
010	Andrew Klocko (aklocko@uccs.edu)	CENT 234	CENT 278
020	James Kovacs (jkovacs2@uccs.edu)	CENT 228	CENT 217
030	Amanda Morgenstern (amorgens@uccs.edu)	CENT 230	CENT 277
040	Janel Owens (jowens2@uccs.edu)	CENT 226	CENT 237
060	Ronald Ruminski (rruminsk@uccs.edu)	CENT 236	CENT 221
070	Allen Schoffstall (aschoffs@uccs.edu)	CENT 240	CENT 227
080	Kevin Tvrdy (ktvrdy@uccs.edu)	CENT 232	CENT 229

090	Crystal Vander Zanden (cvanderz@uccs.edu)	CENT 224	CENT 233
110	David Weiss (dweiss@uccs.edu)	CENT 238	CENT 238

Course Philosophy

The research laboratory is fundamentally unique from the teaching laboratory insofar as the student is addressing questions for which the answer is not yet known—by themselves, their research advisor, or the broader scientific community. Conducting research develops a student skillset that cannot be replicated in a traditional teaching classroom or laboratory environment and represents the pinnacle of practicing the chemical sciences.

The Scientific Method: A Brief Overview

The scientific method is a multi-step process used to expand the body of human knowledge in a way that is both rigorous and useful. While its breakdown into steps varies, one example of such is:

1. Understand a Scientific Topic/Subject/Concept

- Read scientific journal articles
- Read the lab notebooks of lab mates
- Discuss with research advisor and/or lab mates

2. Pose a "Scientific Question"

- Can also be formulated as a hypothesis
- The scientific question or hypothesis must not have already been answered (it must be novel)
- The scope and scale of the question (or hypothesis) must be addressable (or testable) through resources available at UCCS and/or through collaborations

3. Design Methods to Address the Posed Question

- Write out experimental procedure, making specific notes of data to be collected or observations to be made during execution of experiments
- Consideration of safety where relevant

4. Execute the Method(s)

- Adhere to any safety concerns
- Collect data and observations, record information in well organized and redundant fashion (lab notebook, digitized notes/data saved in cloud storage, etc.)

Make note of any deviation from planned methods/experiments

5. Analyze Collected Data

- Make lists of observations, plots, tables, or perform other analysis related observations made and data collected during execution of the method
- Perform analysis at a level that enables efficient and effective communication to intended audience (those that stand to benefit from learning about your results)

6. Interpret the Results

- Write about the findings
- Compare results with expected (hypothesized) trends
- Answer the posed scientific question and/or confirm/deny/amend the hypothesis
- Ensure that interpretation is performed at a level that enables efficient and effective communication with intended audience
- Consider returning to Steps 1 and 2 above to better understand the topic, the collected data, and how future experimentation could better inform overall understanding of the topic/subject/concept.

7. Disseminate the Key Findings

- Discuss with research advisor, lab mates, collaborators, etc.
- Present a poster or deliver a talk at a conference
- Draft a manuscript for publication

Learning Objectives and Skills

This course aims to develop and enhance students' hands-on research skills; their ability to quantify, manipulate, and predict chemical phenomena; and their scientific communication skills. Specifically, the learning objectives of this course fall into one of three categories centered around the **comprehension**, **manipulation**, and **analysis** of chemical systems, respectively. Importantly, note that wherever "chemical systems" are referenced within this and other sections of this document, this includes biochemical systems and systems explored *in silico*, that is, with computational methods.

Comprehension of and Interrelationship Between Chemical Concepts

1. Express the central design of a research project in both technical and layperson terms

- 2. Generate effective search queries to enable the return of relevant literature from online databases
- *3. Summarize* the relationship between articles from the literature and a research project
- *4. Relate* different articles from the literature to each other—both supporting and contradictory findings
- 5. Predict how a research project is likely to progress given both fundamental chemical concepts and a body of related literature

Hands-on Manipulation of Chemical Systems

- 1. Find and interpret chemical safety information, and *apply* safety protocols and procedures
- 2. Select appropriate measurement tools based on required precision and practical constraints
- *3. Demonstrate* safe and proper use of both common and specialized glassware and instrumentation
- 4. Manage lab time effectively through planning and execution of experimental procedures
- 5. Use scientific instrumentation to *measure* and *record* relevant properties (collect experimental data)

Organization, Analysis and Communication of Chemical

Observations and Data

- 1. Design and employ a logical method to record procedures, observations, and store data in an organized and secure fashion
- 2. Integrate chemical principles within brief explanations of experimental results
- 3. Organize experimental data within tables and graphs
- 4. Identify and analyze specific sources of random and systematic experimental error
- 5. Apply data analysis software to improve the efficiency of analysis and scientific communication
- 6. Practice effective communication of experimental results and key chemical findings in written format both within a prescribed structure and through original student composition
- 7. *Practice* effective communication of scientific concepts with research advisor(s) and research lab peers, both in oral and written formats

In summary, a general goal of CHEM 4904/5904 is to progress the student from a state of relative dependence to a state of relative independence in terms of their ability to practice the scientific method effectively and efficiently. Depending on the projectspecific methods employed, the student will also gain specialized technical skills in the manipulation and analysis of chemical systems.

Course Materials & Supplies

Participation in this course may require access to the following hardware, software, and supplies. Individual students should ask their research advisor(s) about requirements for their specific research project.

- **Canvas** used to make general announcements relevant to student researchers (seminars, etc.)
- Laptop/Tablet with Microsoft Word, Microsoft Excel, and Microsoft PowerPoint installed
- Lab Notebook can be either with or without carbon copies, a simple spiral notebook will suffice
- Lab coat must cover your entire upper body down to roughly your mid-thigh
- Goggles chemical splash goggles, UVEX brand is available at the bookstore

General Student Expectations

CHEM 4904/5904 is an In-person course and entails regular meetings between the student and the faculty research advisor(s), in a laboratory and/or office setting, to discuss progress throughout the semester.

Additionally, students are generally expected to:

- Put safety first. Demonstrate safe laboratory practices, including proper use of personal protective equipment, appropriate handling of chemical waste, and careful cleanup of experimental environment. All UCCS researchers are required to complete Lab Safety Training (more information can be found at the UCCS Environmental Health & Safety website or by contacting Cynthia Norton at cnorton@uccs.edu). Finally, students are expected to read, fully understand, and comply with the Lab Specific Safety Plan developed by their research advisor(s).
- 2. Conduct research with integrity (Responsible Conduct of Research, RCR). Students are expected to meet the RCR expectations outlined by the UCCS Office of Sponsored Programs and Research Integrity, which can be found on the <u>Responsible Conduct of Research website</u>. Additionally, researchers working on projects sponsored by the National Institutes of Health (NIR), the National Science Foundation (NSF), and potentially other sponsors, are required to complete RCR training.
- 3. **Come to campus in good health**. If you are experiencing symptoms of illness (i.e., flu, COVID-19, etc.) please do not come to campus. Contact your research advisor over email to let them know about your status and to initiate dialogue about next steps for CHEM 4904/5904 progress.

- 4. **Demonstrate a preparedness to learn.** Read procedures, arrive to lab and research meetings on time, and use lab time effectively. Submit required work completely and on time.
- 5. **Maintain a focus on the chemical system under investigation.** Complete research work with a mindset of trying to understand the chemical phenomenon while drawing connections between procedures/observations and topics from lecture courses and information from the literature.
- 6. **Be responsive over email.** Check UCCS email regularly and respond to communication prompts from the instructor and peers (such as lab partners) in a timely manner
- 7. **Be collaborative.** Work cooperatively and effectively with a lab partner or group to complete tasks.
- 8. **Embrace a mindset of growth.** Making a meaningful contribution to a research project is a challenging endeavor that oftentimes entails prolonged periods of frustration. Keep in mind that your goal as a student is to gain knowledge and skills, both of which can still be achieved when a research project unfolds in an unexpected way. Set reasonable expectations and goals for your research experience.

Specific Student Expectations

Expectations of each student enrolled in CHEM 4904/5904 can vary depending on the students' level of experience, the research advisor(s), and the research project itself. At the beginning of each academic term, students and their research advisor(s) are strongly encouraged to hold a meeting discussing expectations for success in CHEM 4904/5904. Some examples of topics that should be discussed include:

- **Training requirements.** Students may be required to complete safety and/or Responsible Conduct of Research (RCR) training.
- **Time commitment.** Students are typically expected to spend 4-8 hours per week actively engaged in research work per 1 credit hour of CHEM 4904/5904.
- Activities performed. Students are expected to spend their time "actively engaged in research" in a variety of ways related to the practice of the scientific method. What specific activities count toward expected research hours (and what do not), as well as a general expectation of how research time will be spent, should be clearly communicated at the beginning of the academic term.
- **Regular meetings.** Students may be required to meet regularly with their research advisor(s) or other lab mates to discuss project progress. Scheduling such meetings at the beginning of the academic term is highly recommended.
- Research support opportunities. Programs such as the UCCS

Undergraduate Research Academy (URA) and the NSF Graduate Research Fellowship Program (GRFP) represent regular opportunities for students to obtain financial support concurrent with their research activities. Students should discuss plans to apply to these or other programs, along with anticipated deadlines, with their research advisor(s).

- Research products generated. There are regular opportunities to present research results in the form of a poster or an oral presentation at a local, regional, and international conference. Additionally, research results are often communicated in the format of a report or a manuscript. If the research advisor(s) have an expectation of a CHEM 4904/5904 student generating one or more of these products, such expectations should be clearly communicated at the beginning of the academic term.
- Extra-research mentorship. Research students often consult their research advisor(s) for academic and/or career mentorship. A discussion of post-graduation and general career goals, and how a research experience relates to the accomplishment of such, should be held early (and potentially throughout) the semester.

An optional CHEM 4904/5904 contract intended to specifically layout specific student expectations is included within Appendix A of this syllabus.

Grading

Like the specific student expectations, the correlation between student performance and student grade in CHEM 4904/5904 can vary depending on the students' level of experience, the research advisor(s), and the research project itself. Expectations of such should be clearly communicated between the research advisor(s) and the student at the beginning of the academic term.

Notice of Exposure to Hazardous Materials

Laboratory work has an intrinsic level of hazard associated with it. It is the students' responsibility to both educate themselves about such hazards and to take the precautions necessary for self-protection. A common hazard in CHEM 4904/5904 is the chemicals used in the lab, the safe handling of which require students to be aware chemical specific potential hazards and safe disposal practices. Only after the potential hazards of a chemical have been determined can a student take the appropriate steps in the handling, storage, and disposal of that chemical to protect themselves and others. In addition, students need to recognize other hazards that may be present in the laboratory, such as biohazards, lasers, and radiological hazards.

Everyone who works with hazardous chemicals should know how to read and interpret hazard information. Signs, labels, placards, and symbols alert everyone to the known hazards in a particular location. Safety Data Sheets are available online and contain more detailed information on each specific hazardous material. If students would like more information about the hazards encountered in CHEM 4904/5904, they are asked to contact their research advisor(s) and/or the Laboratory Safety Officer Brett Mayer at bmayer@uccs.edu, and/or the UCCS Office of Environmental Health and Safety at cnorton@uccs.edu.

Student Support

Research Advisor(s)

Each research advisor is available to support their students during research meetings and over both email and in weekly office/student support hours. Students are strongly encouraged to contact their research advisor(s) directly (over email or in person) to seek help addressing circumstances that hinder their research progress in any way. The goal of the faculty at UCCS is for the academic and personal success of each of its students and strives to connect those students with any and all support systems capable of furthering that mission, including, but not limited to, each of the below student support services.

Mental Health, Wellbeing, and Belonging

UCCS is committed to facilitating the proactive wellbeing of all students. It is common for academic and personal stressors to interference with academic performance and/or negatively impact daily life. Students who are unsure of their need for mental health and wellbeing support are encouraged to take the free online mental health screening found at

<u>https://screening.mentalhealthscreening.org/UCCS</u>. Additionally, we welcome and encourage students to contact the following on-campus and off-campus services for assistance regarding their physical, mental, and fitness needs:

- National Suicide Prevention Lifeline: 800-273-8255, or text HELLO to 741741
- Colorado Crisis Services: 844-493-8255, text TALK to 38255, or visit: pikespeaksuicideprevention.org
- UCCS Wellness Center Health Services: 719-255-4444, recwellness.uccs.edu/health-services

• UCCS Campus Recreation: 719-255-7515, <u>recwellness.uccs.edu/campus-rec</u> Students struggling with their sense of belonging and/or with diversity, equity, and inclusion challenges are encouraged to consider reaching out to: • UCCS MOSAIC and LGBTQ+Resource Center: University Center 110, 719-255-3319, <u>mosaic.uccs.edu</u> Finally, the UCCS Office of the Dean of Students serves as both an advocate for students navigating academic or personal challenges and provides support to students through its direction of service programs that enhance both academic and life experiences. They can be found at:

• UCCS Office of the Dean of Students: Main Hall Room 201, 719-255-3091, dos.uccs.edu.

Disability Services

Student with a disability and/or those who believe they will need an accommodation for this class are able to receive appropriate accommodations only after registering with UCCS Disability Services and providing them with documentation of disability or need. Disability Services will work with each student individually to determine what accommodations are appropriate for their situation. To avoid delay, students wishing to use this service should contact Disability Services as soon as possible. Additional information can be found by visiting Main Hall room 105, calling 719-255-3354, or emailing dservice@uccs.edu.

Military Students

Students serving in the military who have the potential of being called to service or training during the semester are encouraged to contact their instructor no later than the first day of class to discuss the class attendance policy.

Additional information can be found at military.uccs.edu.

Office of Institutional Equity

The Office of Institutional Equity (OIE) administers the University of Colorado (CU) Sexual Misconduct policy (including Title IX), the UCCS Discrimination and Harassment Policy, and the CU Conflict of Interest in Cases of Amorous Relationships Policy. All UCCS faculty and staff, including student employees, are considered "responsible employees" and *must* report any suspected or known conduct that may be in violation of these policies ("prohibited conduct") directly to the OIE. This reporting requirement exists to support the safety of our campus community, and there is no statute of limitations. Prohibited conduct includes unwanted verbal or physical conduct that is sexual in nature, or based on a protected class (such as, gender, race, veteran status, disability, etc.). You may review the Applicable Policies and OIE's Resolution Procedures. While reporting prohibited conduct to the OIE is required by UCCS employees, participation in an OIE resolution process though the OIE is voluntary. Confidential reporting, and access to medical and mental health services, are available to students through the UCCS Wellness Center at 719-255-4444.

Subject to Change

All content specified in this document is subject to change at the sole discretion of the research advisor(s). The specific student expectations may be altered to accommodate the student research experience as it is uniquely developed each academic term.

Appendix A: Sample Contract of CHEM 4904/5904

Expectations

Training Requirements. Before conducting research, the student is required to complete the following:

- □ Lab Safety Training (General / Specific: _____)
- □ Lab Specific Safety Plan
- Responsible Conduct of Research Training (List Courses: _____)
- Other: ______

Time Commitment and Regularly Scheduled Meetings

- The student has enrolled in _____ credit hours of CHEM 4904/5904 during this academic term, which entails, on-average,
 - hours/week of lab related work over the week term
- The student will meet with their research advisor(s) every _____ week(s) during the academic term on _____ (day) at _____ (time)

Brief Description of the Research Activities Planned

Brief Description of the Expected Research Products Generated

Brief Description of the Correlation between Student Performance and Student Grade

Student.	Name:	/ Signature:	/
Besearch Adviso	- r Name:	/ Signature:	,
Date:	• Name.		,