CHE 451 – Advanced Laboratory: Synthesis and Analysis  
Fall 2018 Syllabus

Course Overview

Faculty on Record:
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While Drs. Lackey and Sarver are on record for teaching this course, Dr. Smith, Dr. Rodgers, and Dr. Wilson will also participate in teaching this unique upper-level laboratory course.

Course Description:
Chemistry 451 is a comprehensive and integrated experience in the chemical laboratory. It is a project-oriented course that integrates advanced synthetic and analytical methodologies. Projects may include inorganic synthesis, multi-step organic synthesis, and analysis of samples using various spectroscopy and chromatography instrumentation. This course includes participation in a weekly seminar.

Course Outcomes:
After completing this course, students will be able to demonstrate:

I. working knowledge of the process of systematic scientific inquiry. [MO1, MO3, MO4]
II. proficiency with standard laboratory techniques in advanced synthesis and instrumentation. [MO2, MO3]
III. proficiency with common chemical drawing and data analysis software. [MO5]
IV. safe lab practices and proper waste management techniques. [MO6]
V. working knowledge of contemporary chemical information resources. [MO2, MO3, MO5]
VI. proper documentation of laboratory and computational work. [MO5]
VII. effective communication of scientific information. [MO5]

*These course objectives support the chemistry/biochemistry major outcomes [MOs]:
1. To acquire appropriate discipline specific knowledge spanning the areas of Analytical, Biochemistry, Inorganic, Organic, Physical chemistry as well as appropriate supporting courses
2. To develop skills in modern laboratory methods, instrumentation, and data analysis.
3. To develop skills in appropriate research techniques including experimental design and scientific literacy.
4. To critically evaluate and solve relevant problems by applying the knowledge and skills of chemistry and/or biochemistry.
5. To effectively communicate the concepts of chemistry and/or biochemistry using accepted professional standards and language.
6. To demonstrate scientific responsibility, stewardship, and professional ethics as outlined by the American Chemical Society - Chemists Code of Conduct.

Grading System:

Grade Scale (out of 100%)

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<tr>
<td>A</td>
<td>90-100%</td>
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<td>B+</td>
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<td>B</td>
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Point Distribution (%)

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<td>Seminar</td>
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Note: If you fail to effectively communicate your results for any experiment, the best grade that can be earned for the course is a "D," which is not a passing grade for a major course.
**Academic Integrity Policy:**
The college’s Academic Integrity Policy (AIP) will be strongly enforced. Violations of the AIP include cheating, misconduct, plagiarism, and providing false information. Academic dishonesty will not be tolerated. The first citation for academic dishonesty will result in a grade of zero for the specific assignment as a minimum penalty. The second citation will result in a failing grade for the course as a minimum penalty. All citations for academic dishonesty will be reported to the Dean of the College, in accordance with college policy. Details of the AIP can be found in the Westminster College Undergraduate Catalog.

**Seminar Guidelines**
Refer to the seminar schedule for your assigned presentation date. Seminar assignments will be turned in electronically on the CHE 451 D2L course page.

**Seminar: (100 pts.)**
Your presentations, entitled “What is the CHEMISTRY behind this stuff?” will be mentored by participating faculty members according to the seminar schedule. Using several literature sources, you will present the chemistry involved in the production of a particular product. Sufficient background information for audience understanding is required. Clear explanation of chemical concepts, reactions, and manufacturing will be expected. The seminar is graded by the faculty members present during your talk and according to the grading rubric available on the course webpage. A detailed description of this assignment is available on the course website.

**Seminar preparation: (10 pts.)**
Students must meet with faculty mentors several days prior to their seminar presentation to practice their talks one-on-one with participating faculty members according to the seminar schedule. This session is imperative for a successful presentation, and the student is graded on preparedness and improvements between the practice run and formal presentation.

**Reflection papers on outside talks: (2 @ 10 pts. each)**
To expand their understanding of chemical knowledge and explore new areas, students are required to attend two external scientific talks/events that are approved by Drs. Lackey and Sarver. Potential outside talks include invited on-campus speakers (non-seminar), local ACS section meetings, and scientific seminars at other institutions or professional organization meetings. One of the two external talks must be off campus. A reflection paper must be submitted within one week of attending each outside talk. At least one reflection paper is due by fall break. The second reflection paper is due by 5:00 pm on the last day of classes. You are to turn in your reflection papers electronically on the course D2L page for CHE 451.

**Peer seminar evaluation: (10 pts.)**
To help improve the quality of seminars and to develop constructive criticism skills, students will be paired to evaluate a practice run of another student’s seminar. You will use a grading rubric to help you critically analyze his/her seminar presentation. This rubric should be discussed with the speaker to help him/her improve his/her seminar. A peer seminar evaluation paper will be submitted to the 451 course D2L page within one week of the peer’s seminar. The paper should include an analysis of his/her practice talk, your suggestions for improvement and a reflection on the overall evaluation process – use the grading rubric as a guide for the evaluation. A peer seminar evaluation guide is posted as a handout on the advanced lab D2L page.

**Attendance and Participation in Lab:**
All advanced laboratory students are required to participate in each weekly scheduled laboratory time unless Drs. Lackey and Sarver approves your absence or otherwise notified. This block of lab time is designated for productive work on your advanced lab project. Keep in mind that an additional 3 hours of lab work are expected outside this designated time for this 4 semester hour course.
Attendance and Participation in Seminar:
All advanced laboratory students are required to participate in each weekly seminar unless Drs. Lackey and Sarver approves your absence. An excused absence from seminar must be made up by attending an extra outside scientific talk and submitting a reflection paper. Each unexcused absence from seminar will result in lowering the seminar grade by one letter. Active participation in seminar is indicated by your ability to formulate intelligent, pertinent questions about the presentation topic. Over the course of the semester, you should strive to ask a few well thought out questions of the seminar speakers.

Evaluation of Projects
At the start of each project, the supervising instructor will provide materials detailing their project-specific guidelines including due dates and grading criteria. As a general rule, the following categories are important components of your advanced lab course grades:

- Pre-lab preparation, including library research, gathering of equipment, chemicals, and instrumentation.
- Demonstration of proper and safe laboratory skills and practices, including MSDS sheets, labeling and storing chemicals properly.
- The lab notebook (completeness, timeliness, accuracy, and organization).
- The quality of the data and results (accuracy, precision, percent yield, linearity...).
- Interpretation of data, analysis of errors, understanding of objectives and conclusions.
- The quality of the final report or summary.
- Lab clean up and disposal of chemicals.

Proper Preparation
A few minutes of planning before beginning a procedure can save many hours of discouragement. The projects in Advanced Laboratory are designed so that a well-prepared student will spend about five hours in the laboratory each week. (This does NOT include library work or report writing.) If you are not well-prepared, it may take much longer. Make sure you know what you are doing before you attempt to do it! This will also make your procedure safer and generally your results will be better.

Some specific preparations to be made are:
1. Do the literature work. In this step you need to determine the procedures you will need to use, hazards associated with procedures or reagents, safety precautions necessary and the theory behind the procedures. A solid understanding of the theory aids greatly in performing the experiment.

2. Make a list of apparatus and reagents needed. Get everything you need before you start and save time.

3. The first rule of working in the lab is to think about what you are doing and why you are doing it. This includes using the appropriate equipment. You need to decide what precision you need in cases of selecting which balance or volumetric device to use to make a measurement. This will not only make for better results, but will speed up your lab work.

4. The project supervisor will explain any special procedures or equipment needed for that project. If you are in doubt about how to use any of these tools, ask!

5. Any glassware taken from the stockroom or any of the research labs is to be cleaned, rinsed with DI water and dried prior to use. Repeat this cleaning procedure and return the glassware after each experiment. Under no circumstances is dirty glassware to be returned to the stockroom or research labs.

6. Frequent contact with the faculty member in charge of the project is important. If you run into problems, discuss them with the faculty member. For example, when a synthesis seems to have gone wrong, CONSULT with your project director. Oftentimes the synthesis can be "rescued," so do not throw away your "mistakes" before consultation.
Laboratory Safety
Due to the independent nature of the course, students must strictly follow laboratory safety procedures. At the beginning of the course, the laboratory safety officer, Lori Micsky will provide a safety handbook and review safety protocols.

A few important safety items to remember during lab time:
1. In case of an emergency, call campus security at 724-946-7777 and then contact the faculty member mentoring your current project.
2. Never work alone.
3. Always wear departmentally approved eye protection.
4. No food or beverages should be in the lab area.
5. Label all bottles, flasks, beakers, and especially waste identifying contents by name. Any materials that are unlabeled are likely to be removed by faculty members or the CHO.
6. When experiments must run overnight, or while you are out of the building, display a notice with your name, phone number, a list of chemicals involved, and any specific hazards associated with the process. This is very unlikely and should be first approved by your faculty mentor. Water hoses should be wired on to prevent flooding.
7. Determine hazard level associated with the use of each chemical (whether a starting material, an intermediate, or a product) and proper handling of waste associated with the experiment. For unknowns, consult the instructor. Consult The Merck Index, Material Safety Data Sheets, Dangerous Properties of Industrial Materials, Prudent Practices for Disposal of Chemicals from Laboratories, and Hazardous Laboratory Chemicals Disposal Guide for assistance.
8. Waste must be stored in properly labeled waste containers. It is almost impossible, and extremely expensive to dispose of unlabeled waste. The Chemical Hygiene Officer (CHO) is available for guidance in the proper handling and storage of all chemical waste. Students must notify the CHO when the experiment is complete so that the labeled waste can then be disposed of properly.
Notebooks and Documentation

As a primary guide, use “Writing the Laboratory Notebook” by Kanare; pages 37-39 and chapters 5 & 6 provide good examples to follow. “The Organic Chem Lab Survival Guide” by Zubrik chapter 2 is also very helpful.

The purpose of a laboratory notebook is to document ALL aspects of a procedure. It is your primary recording device in the lab. Other CHE 451 students should be able to reconstruct what was done and obtain the same results. It is very important to record qualitative observations even when following written instructions. Even the most insignificant observation could later become a crucial piece of information. Our evaluation of it will be in terms of proper documentation. The main criteria in evaluating your notebooks will be the completeness, and whether or not we think we could repeat your experiment from it.

A laboratory notebook is the property of the company in industrial research, and the property of the institution in academic research. It serves to document experiments performed and ideas generated by the researcher:

- To aid in writing reports and planning future work.
- In case the researcher leaves and someone else must continue the project.
- To aid the company in obtaining patents and in litigation.

**Things to remember about your notebooks:**

1. Maintain a table of contents
2. Title all pages and begin each new experiment with an explanation/purpose section.
3. Reference the formal procedure and document any changes in procedure clearly.
4. List all chemicals used in the experiment, include such information as specific hazards, manufacturer, lot number, state (solid, liquid, gas), molecular weight, and amount used.
5. Record **everything**, all original data and observations of what happens as you work. Even things that seem trivial may end up being important at the end.
6. Record all filenames and locations of computer generated and stored data and make a back-up copy.
7. Record the location (notebook and page number) of all spectra, chromatograms, or other paper-output from the experiment.
8. All pages **must** be signed and dated.
9. All entries **must** be in non-erasable ink.
10. Any errors should be "struck out" with a single line (i.e. 4.1876)
11. Any unused pages or erroneous data should be X'd out and signed and reason for error stated.
12. Label all sections and entries clearly.
13. Record all raw data in your notebook as you acquire it. Do not record data on scrap paper and transfer it to your notebook at a later time. This increases the chance of transcription errors and loss of important data.
14. Label all spectra, chromatograms, data files, and other paper-output from the experiment **immediately** at the time of recording. The label should include your name, the identity and state of the sample, the concentration, the instrument, and all instrument settings.

Turn in copies of each page to the supervising instructor **immediately after you finish each work session**. These data are essential for us to follow your progress and provide guidance in a timely manner. Failure to turn in these carbon copies **after each work session** may result in a grade reduction on that project.