

## Independent Study: Chemistry 491

### Course Description:

Research at the undergraduate level is designed for two major purposes. First, independent study is meant to introduce the student to *real* research (not textbook experimentation) meant to solve a fundamental scientific problem that is at the cutting edge of physical chemistry. Second, through this research the student should begin to develop his/her own strategies for problem-solving, troubleshooting and critical thinking. In addition, students should *on their own* begin to conceive of directions their research should take. Each project is designed to develop independent thought, to practice experimental techniques and synthesize scientific theories, to sharpen literature search skills, and to hone scientific communication both oral and written.

**Laboratory/Readings:** Each credit represents approximately 2 to 3 hours of work per week (either laboratory or readings as established by prior verbal agreement between the instructor and student and as indicated on the Mary Washington College Individual Study Registration form obtained by the student and completed by him/her, the instructor and department chair), such that

credits	hours
1	2 - 3
2	4 - 6
3	6 - 9
4	8 - 12

It is the responsibility of the student to arrange to meet with the instructor at least once a week to discuss progress, difficulties, etc. If there are multiple students conducting individual research, a convenient time may be arranged for all parties (students and instructor). The latter provides the student with the benefit of learning to explain his/her problems and results to multiple audiences (i.e. peers, experts, etc.).

### Grading:

Grades will be established by the instructor based on the following criteria: research/readings proposal, time spent in the laboratory or searching the literature for readings (see Honor System and Laboratory Notebook below), quality of the work accomplished, understanding of the research topic and methodology in conducting experimental work, quality of the laboratory notebook, final research paper. These factors vary depending on the student and the nature of the scientific investigation/project. The overall grade scheme will reflect the following from the *Dictionary of Academic Regulations*:

A	excellent
A-	
B+	
B	commendable
B-	
C+	
C	acceptable
C-	
D+	
D	marginal
F	failure

### **Honor System:**

All graded work (i.e., research proposal and final research report) must be your own and pledged according to the Honor Code: *I hereby declare upon my word of honor that I have neither given nor received any unauthorized help on this work.*

*Signature*

In addition, it is expected that the work(s) of others are properly referenced in any written report according to the guidelines and style of the American Chemical Society. (A copy of the *ACS Style Guide* is available in Jepson 308.) Submission of a report devoid of appropriate referencing presupposes that all of the ideas/statements are your own and therefore constitutes plagiarism. Finally, a proper laboratory notebook must be kept, detailing all experimental work. The use of such a notebook reflects ethical, scientific responsibility. The notebook must be signed by the instructor on a weekly basis (see Laboratory Notebook below).

### **Expectations:**

- conduct *independent* research at a high level
- discover if you enjoy research despite its many frustrations
- become self-motivated (I expect that you will push yourself in the laboratory/readings and will contact me as needed *for guidance*)
- gain confidence in a laboratory setting, both in your own hands-on abilities and problem solving skills
- take pride in your accomplishments and your failures (each failure is a learning experience no matter how painful)

These expectations are not novel. Most scientists who work with students at the undergraduate, graduate and postdoctoral levels have similar goals. (See for example Monte, A. Mentor Expectations and Student Responsibilities in Undergraduate Research. *Council on Undergraduate Research Quarterly* **December 2001**, 66 - 71.)

### **Research Proposal:**

A research proposal is due by the end of the third week of the semester. This proposal should describe what you hope to accomplish and the methodology you will use. It should also contain a schedule of the hours and days that you plan to work on the project (see Laboratory/Readings above). Within the 1 to 2 page (maximum amount of text)

proposal, you should include the title of your research project, your name, the semester and year. The three major topics to discuss are

*Objectives* (a summary of your planned work and *why* it is important)

*Experimental* (a plan of how you will accomplish your objectives, including citations to the literature)

*Schedule* (days and hours of work; timeline for accomplishing various phases of the project, etc.)

### **Laboratory Notebook:**

In the research environment, it is critical that all findings/data (it does not matter how trivial you think they are) be recorded **in ink** in a permanent, bound laboratory notebook. You will utilize carbonless, duplicate, laboratory notebooks. All data must be recorded neatly and legibly. Mistakes are crossed out with a **single line**, so that the original mistake can be seen. A mistake is **never** obliterated. The colored carbonless copy must be submitted to the instructor at the end of the semester. In addition, the notebook will be brought to weekly meetings with the instructor. The instructor will then “sign off” on the pages, concluding that week’s work, by initializing and dating the last page used.

On each page of the notebook, include the title of the experiment, the date and your name. Each new experiment is started on a new page of the laboratory notebook and the pages should be numbered in successive order. Calculations performed in the laboratory are recorded in the laboratory notebook. Deviations from the stated experimental procedure (as found in the literature or developed on your own) and any (seemingly) odd occurrences are also recorded. A laboratory notebook never contains too much information. The more information recorded, the better the conclusions that can be drawn from the data.

**Final Research Report:** The “final exam” for this course is a final research paper constructed in the style of a standard research laboratory report (with an introduction, experimental section, results and discussion, and references following the American Chemical Society guidelines. See the instructor if you feel that you need more direction.) In addition, copies of the laboratory notebook pages, in which data were collected, should be provided to the instructor. (Notebook pages are not necessary for Independent Study courses run under the designation of “Readings” although a listing of all literature read with summaries is useful for compiling the final report.) The exact due date for the final research paper will be determined by the instructor prior to the end of the semester. The research report must be submitted during final exam week.