497-01 Experimental Biology Lab

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Welcome to BIOL497! This course is intended to be a capstone course that synthesizes much of what you have learned during your time as a biology student at Xavier. You have spent almost four years learning about science, and now you get to DO science for an entire semester! You have no doubt completed experiments and written lab reports in other classes. This course will allow you to really develop an experimental question of your choosing, and to really delve into how science is done by professional scientists every day.

You will develop skills in teamwork, written and oral communication, and data analysis. Most importantly, you will spend the semester thinking critically about all aspects of the scientific process as you complete your research project.

Even if you do not become an academic researcher like your professors, almost all of your future careers will require you to complete research on some scale, at least occasionally. You will also be exposed to science (some of it bad) in your daily lives on a regular basis. This course will help to prepare you to do good science, and to recognize bad science.

Course Objectives: By the end of this course, students will:

- Show competence in scientific literature searching and reading
- Demonstrate comprehension of the scientific method through experimentation
- Make observations and/or carry out an experiment to answer an unknown question
- Give evidence of ability to maintain accurate scientific records
- Evince understanding of the need for measurement accuracy, multiple trials and basic scientific statistical methods
• Improve oral and written scientific communication skills in each of the four common venues where scientists present: peer lab meetings, oral presentations, poster presentations and journal articles
• Demonstrate maturity through teamwork, independent work, and initiative

This course builds on Xavier Core Curriculum learning objectives; in particular, you will improve your ability to:
• Find, evaluate, and logically convey information and ideas in written and oral presentations
• Evaluate real-world problems using quantitative methods and arguments
• Identify and critically assess multiple dimensions of an ethical issue in an attempt to reach a conclusion
• Describe the evolution of your vocation and aspiration to contribute to the world

Course format: Each class period will usually consist of an hour of instruction in some aspect of the scientific process, followed by a second hour of practical application. The schedule details what will be covered in the first and second hour of each class period.

The focus of this course is on your critical thinking and skill development, so most of class time will be devoted to you DOING science. If I use any prepared PowerPoint slides during the first hour of class I will post them on Canvas for you to refer to.

Time spent on class: This is a capstone course, and as such is expected by the department to consume a large part of your time this semester. You will have an assignment due almost every class period. This will provide you with many opportunities to practice your critical thinking and other scientific skills, and will keep this course constantly on your mind. Doing science well is time consuming hard work. Plan to spend at least four hours a week on this course from the very beginning of the semester. You will be rewarded handsomely with the completion of a well thought out scientific project, and the development of many other skills that will serve you well in your future endeavors.

Attendance: I expect you to attend ALL classes – class attendance should not be considered optional. I do not take attendance for students enrolled in the class for credit, but I do make a mental note of who attends. In the case of truly excessive absences, I reserve the right to reduce your final grade by 50% (at my own discretion). Please notify me as soon as possible if you anticipate a necessary absence or have missed class because of illness.

I also expect you to be respectful of your peers and of me. Turn off your cell phone. Avoid texting, Facebooking, looking at Twitter, or otherwise browsing the internet. If you are smiling at your crotch, I know you are not doing something related to the class. If you are holding your phone in front of your face and scrolling with your thumb, I know you are not doing something related to the class. The only acceptable use of wireless-enabled devices is to take notes, look up
supporting materials, or to make sound recordings of the lecture. I reserve the right to ban technology that interferes with the learning environment.

Academic Honesty: Science is collaborative, and seldom does any scientist work alone. You may work with others on homework, but make sure you are benefiting intellectually from the collaboration—not simply copying.

Otherwise the policy is simple: don’t cheat. Demonstrate integrity. You or someone you love is paying a lot of money for you to attend Xavier. The value of your education decreases whenever you or one of your peers cheats to earn grades or a degree. Cheating hurts other students and harms the reputation of the university. Therefore, the penalty for intentional academic dishonesty in this course is a failing grade. Per university policy, academic dishonesty will be reported to the Dean’s office. It is your responsibility to educate yourself about what constitutes academic dishonesty.

GRADED COMPONENTS: Your graded work this semester will fall into eight categories that cover general research methods, development of your specific project, and completion of your specific project.

Research Methods Assignments (25%): Doing science well requires a solid foundation in a number of research method skills. After you learn about many of these skills in class you will practice those skills, and complete a short assignment to demonstrate your competence in those skills.

Project Preparation (5%): Doing science well requires a lot of thought and planning before ever entering the lab. These assignments will be completed as a team, and focus on the preparation of a well thought out proposal and research protocol that will allow you to successfully complete your project.

Drafts (5%): Doing science well requires clearly reporting results, and that requires much editing. You will write drafts of every part of your final Written Thesis. These drafts will be critiqued first by your peers, and then by me. Good faith efforts in writing your own drafts and critiquing your peers’ drafts will earn full credit.

Peer Presentations (5%): Doing science well requires getting regular feedback from peers throughout the process. Peer presentations often begin early in the development of a project because feedback from peers can correct issues with experimental design that are not apparent to the most careful of scientists when occurring in their own projects.

You will deliver two peer presentations. The first will be a team presentation of your proposal. You may very well receive feedback that stimulates you to alter your experimental design. Your second peer presentation will be an individual presentation of your results. Explaining your
results to a group of peers not intimately familiar with your project can help you see new ways to interpret your results.

Each of your peer presentations must:

• Be organized
• “Hook” the audience’s interest
• Give background information, with reference to published scientific literature on the topic (describe past studies methodologies and their findings)
• If appropriate, give background on past years of the project at Xavier
• Identify a clear hypothesis and the rationale for it
• Discuss the methods used to test that hypothesis
• Demonstrate evidence of advance preparation and general knowledge (asking and answering questions)
• In later presentations you will be expected to share results in progress and preliminary conclusions, along with any pitfalls your experimentation has revealed
• Use at least one visual aid (on paper or chalkboard). This visual aid should be made by the individual presenting student, and should include only minimal text. You need not make handouts for other students unless you believe it would be beneficial; handouts will be given to the faculty facilitator and returned to your faculty advisor with his/her evaluation of your talk
• This presentation should not entail you reading notes off a handout or card. Like your teachers in class, you should be prepared to speak without any notes beyond a few points on an outline. Reading from your notes indicates that you don’t understand your topic well enough to discuss it.

Lab Notebook (10%): Doing science well requires keeping a thorough clear log of everything that you do in the lab. You should get in the habit of always having your lab notebook open when you are working in the lab, and of jotting down everything that you do. Your lab notebook must be a record of what actually happens in the lab. That means that you cannot, ever, post-date an entry. If you have to repeat a measurement many times, with small adjustments, in order to get an assay to work, then you report each and every attempt instead of only the working methodology.

Your lab notebook must remain in the lab after you graduate, although if you would like a copy you may take a photocopy with you when you leave Xavier. Your project may be so fascinating that future students will want to continue it, and they will need to see all of your lab notes in order to be successful.

Each lab notebook entry must include a date, a detailed legible record of all your activities that day, the amount of time devoted to each task, and your initials or signature. See Chapter 9 of Pechenik for examples.

I will check your lab notebook twice, on unannounced dates, during the semester. You will turn in your lab notebook at the end of the semester for a final grade.
Doing science well requires that you share your results with your peers. There is an old scientific adage: “If it isn’t published, it didn’t happen”. The next three components represent different ways of sharing your hard won experimental results and conclusions with the broader scientific community.

**Oral presentation (10%)**: Near the end of the semester you will formally present your project to an unfamiliar audience (usually another class). This presentation should include all of the elements from your peer presentations (introduction, methods, results and conclusions), but incorporated into a formal PowerPoint slide show. We will cover how to use PowerPoint effectively in class, and you may also refer to Chapter 12 of Pechenik for tips. Your oral presentation should include the following elements:

- Good organization, with minimal distracting effects
- Graphs with real data
- Visually appealing and clear
- Bulleted text only; again, you should not have to read from your slides

**Poster (10%)**: A scientific poster (Pechenik, Ch. 12) is the most common mode of data presentation at professional conferences. Each April the Xavier College of Arts and Sciences hosts a conference to showcase student research. You will work individually or in groups (as mandated by your faculty mentor) to prepare a formal poster that will be graded for this course. You are also expected to present at the Celebration of Student Research (CSR). Examples of good scientific posters can be found throughout Albers Hall, in showcases and on walls.

**Written thesis (30%)**: Professional scientists often write up completed projects for publication in scientific journals. You will complete a formal written thesis following the structure of a scientific paper (Pechenik, Ch. 1-9). Your paper should include:

- Scientific title and authors with proper author order
- Abstract that succinctly summarizes the background, hypothesis, methods, results and conclusion
- An introduction, with significant reference to primary literature, culminating logically in your hypothesis
- Materials and methods, described well enough that someone else can repeat them
- Results, with figures and tables properly used and labeled, and discussed/referenced properly in results text. Results should include multiple trials and appropriate statistical analysis to assess their validity (Pechenik, Ch. 4)
- Conclusions or Discussion section that contextualizes results in the body of primary literature, discusses possible caveats and identifies future experiments
- References, using mostly primary sources (limited textbooks or review articles, no Wikipedia), in proper scientific format (Pechenik, Ch. 5)
- The author must have participated actively in the experiments in order to write about them. While work in teams is common and good in science, the author cannot claim credit for work that s/he had no part in
**Participation:** Your contribution to your team’s project will be judged by your team members and myself throughout the semester. The quality of your contribution can add or subtract up to 50% of your final grade.

**Lab safety procedures:** The biology department has compiled a list of Laboratory Safety Guidelines that each lab course modifies to fit its activities. The goals of these guidelines are to greatly limit the possibility for accidental injury to students and other department personnel, and to ensure that laboratory materials and equipment are protected from damage. A copy of this statement is posted on the Canvas course page. You need to read the guidelines carefully within the first week of class, and then SIGN THE FORM that will be circulated in lab indicating that you have done so. Please review the document from time to time to make sure you are thoroughly familiar with its contents and prepared to follow them.

**Research keys:** You may be provided with a key to access the research space that you will use while completing your project. These keys are a privilege and should not be misused for purposes other than senior research. If keys are not returned by the end of the year, and academic hold will be placed on your record and graduation will be blocked. For safety purposed, do not plan to come to the laboratory alone after hours. If you make a non-hazardous mess, you are responsible for cleaning it up.

**I will be available.** This is a challenging course – get help when needed. Stop by my office anytime. I will certainly be there during office hours, often at other times, and can arrange other appointments by e-mail.

**Universal grading policy:** Senior research (BIOL496-499) is designed around the assumptions that students who complete all requirements will earn a grade of C (satisfactory). In order to earn a B (good), students must show high quality effort, participation, oral and written work. The grade of A (excellent) is reserved for students who demonstrate outstanding ability and effort in all of these areas. Students who fail to complete any item to the instructor’s satisfaction will receive a grade of D (enough to graduate). Students who fail to complete multiple items, show poor effort and/or attendance, and/or cannot adequately meet the objectives listed above will receive a grade of F. Any student not completing a thesis will receive a grade of F.

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F < 60 \leq D < 67 \leq D+ < 70 \leq C- < 73 \leq C < 77 \leq C+ < 80 \leq B- < 83 \leq B < 87 \leq B+ < 90 \leq A- < 93 \leq A+ 
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