**Course Description**: Independent, original research in biology involving extensive library, computation, field, and/or laboratory study, under the guidance of a biology faculty member.

**Objectives & Outcomes**: After successfully completing this course, students will be able to:

- perform experiments using molecular biology techniques
- interpret the results of experiments
- plan additional experiments based on prior results
- maintain an appropriate record of work in a laboratory notebook
- find and evaluate primary and secondary literature related to the project
- communicate experimental results to the broader scientific community

**Course Requirements**:

1. **Laboratory attendance**: You are required to work in the lab 10 hours per week. Please add your schedule (including contact information – e-mail address, home phone #, cell phone #) to the "student researchers’ schedule” binder in the laboratory. Please stick to the schedule you devise as much as possible. It is likely that you may wish to shift an experiment/procedure to a different time/day in order to study for an exam, etc. This is not a problem, but please notify me in advance if you plan to reschedule.

2. **Lab notebook**: The laboratory notebook is a critical form of documentation of lab work. You will depend upon this document throughout your research project, and it will undoubtedly be consulted by others later on. It is thus essential to carefully and thoroughly document all parts of the independent research project you conduct in the lab. The results/reagents you obtain/generate (e.g., gel results, assay data, new yeast strains, computer files, etc.) are **very important**. They form the basis of research presentations, grant applications and many (many!) hours of future work. You are required to keep your notebook up-to-date and prepared for my examination at any time. I will evaluate your laboratory notebook as part of your grade for this course.

3. **Laboratory meetings**: The members of the lab convene once a week to share and discuss experimental progress and relevant scientific papers. You are required to attend these meetings **every** week. These meetings typically last about an hour, and this hour does count toward the total hours of lab work required per week. In the meeting, each student researcher will summarize/present his/her results for the week. To facilitate the interpretation of data by lab meeting participants, results should be presented in annotated form (e.g., diagrams should be drawn to aid interpretation, gel images should be scanned/digitized and important information such as content of various lanes and sizes of standards should be noted, etc.).

4. **Contributions to the lab team**: The lab is a cooperative learning environment. To keep things running smoothly in the lab (for yourself and your labmates) please contribute to the team effort. For example, you should maintain a clean and organized lab bench area, make solutions/reagents for the lab as necessary, fill a pipette tip box or two while waiting for an incubation, etc. These sorts of efforts help yourself and others at the same time.

5. **Summary of lab work**: You are required to present a summary of your lab work in written or oral form. This will be either as a two page written summary or research poster at the end of the semester, or a presentation at the EMU Undergraduate Research Symposium. Details of which form of summary is required will be discussed individually with Dr. Casper.

6. **Annotated Bibliography**: (*This requirement applies to BIO 698 only.*) You are required to submit one annotated bibliography entry to Dr. Casper each week. Instructions for this requirement are found on the last page of this syllabus.
Grading: students will be assigned grades based on the following criteria:
- time spent in lab to conduct project-related benchwork
- laboratory notebook
- attendance & contribution to laboratory meetings
- contributions to the lab team
- summary of lab work

Letter grades will correspond to the following (please note that one of the major differences between an "A" and a "B" is the quality of the final summary):

A = Excellent Performance
- engages in persistent, hard work
- exhibits ability to work independently
- delivers reliable and reproducible experimental work
- lab notebook is excellent, with up-to-date recording and good analysis of data
- gives clear presentations of data and displays critical thinking in lab meetings
- final summary is of outstanding quality and demonstrates a full, comprehensive understanding of the project

B = Good Performance
- engages in persistent, hard work
- demonstrates an ability to work with limited supervision
- delivers reliable and reproducible experimental work
- lab notebook is organized and up-to-date
- gives competent presentations of data in lab meetings
- final summary is of fair quality, but does not demonstrate full, comprehensive understanding of the project

C = Average performance
- engages in persistent, hard work
- performance in experimental work is fair but not always reproducible
- lab notebook displays evidence of confusion
- final summary displays inadequate grasp of project goals

D = Poor Performance
- work is inadequate or sloppy
- displays inability to work without direct supervision
- does not maintain an organized lab notebook
- final summary displays inadequate grasp of project goals
An annotated bibliography, in which each paper is summarized, is valuable because it helps the reader understand the particular uses of each paper. The ideal bibliography discusses the relationships of one paper to another.

Each week, add one more paper to your annotated bibliography. Keep a “running document” and e-mail it to me each Monday by 8:00am – I’ll look at the bottom for the newest paper each week.

For each annotation, first list the citation of paper you are annotating. Use the reference format required by the PLoS family of journals. For example:


Then write a paragraph that includes the following 4 points (length should be ~300 words):

1. Explain the main findings of the research. This is usually done in a few sentences. Unlike an abstract, which is an abridgement or synopsis, the writer cannot hope to summarize the total content of the work – only the main points. For example, "Lobachev et al. report that inverted repeats can form “hairpin” or “cruciform” structures in the DNA. These structures are cut by an as-yet unknown nuclease to generate hairpin-capped double-strand breaks. They found that Mre11p is needed to cut open the capped ends of these breaks, to allow the cell to repair the break. If Mre11p is absent, and the end remains capped, then during DNA replication, the polymerase copies the broken chromosome in a way that generates an inverted dicentric chromosome.”

2. Place the article in context in the field by relating it to other published papers: "Lobachev's conclusions about the role of Mre11p were supported by similar findings in a report by Cote and Lewis (Molecular Cell 31: 800–812). However, Cote and Lewis report that the structure formed by inverted repeats is first cut by Mus81p before it is further processed by Mre11p. Lobachev et al. studied Mus81p, but did not observe it cutting such structures.”

3. Indicate what makes this paper unique compared to other published research. If the findings disagree with other publications, why might this be? If the findings are similar to other publications, why was it important to publish something we already knew? If the findings agree with other publications and build on and extend their data, explain this. For example: "However, Lobachev et al. studied an inverted repeat that was integrated on a yeast chromosome, while Cote and Lewis studied an inverted repeat that was carried on a plasmid.”

4. Conclude with a summary comment that relates to your own research: "This article makes me think that Mre11p may be needed for proper repair of breaks at FS2, since FS2 is an inverted repeat.”

Adapted from California State San Marcos Library, 2009.