Biology 423 Syllabus Spring 2019
Lab Experiments in Genetics

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Friday afternoons 3:30-4:30 are optimal.

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Course co-requisite: Biol 423L. Biol 423 and 423L should be taken at the same time. Together they compose a Course-based Undergraduate Research Experience (CURE)

Course prerequisite: Biol 202 Genetics and Molecular Biology or equivalent.

Instruction hours:
Section 001: Mondays 12:20 - 4:30 p.m. in Wilson Hall room 132
Section 002**:** Tuesdays 12:20 - 4:30 p.m. in Wilson Hall room 132

Course Description: Biol 423 and Biol432L combine to make a Course-based Undergraduate Research Experience (CURE) that is accepted as an elective biology course with lab for the Biology Major and as an Experiential Education course. This course combination offers students the chance to engage in cutting-edge genetic research related to an ongoing federally-funded research project lead by a UNC faculty member. The three hour lecture course is intermingled with the co-requisite 1 hour laboratory course so that both will be held in the same four hour block. Students will use the time to discuss the biological problem of study and relevant research publications, to learn techniques commonly used in genetic research, to evaluate and discuss possible research approaches to investigate the biological problem of study, to perform genetic research and to produce reports of their results in a conventionally accepted format. Students will produce a report useful to the research collaborator as their final exam.

Laboratory exercises will be done in small groups of two or three students. Students will share data to produce reports and they can coordinate coming in after instruction hours to complete experiments for themselves or other group members.

Target Audience: This course is designed for undergraduates with an interest in Genetics and Genome Biology. They will also be exposed to computation methods for genome analysis and statistically informed presentation of scientific observations. Students must have completed Biol 202 Genetics and Molecular

Biology, or an equivalent course. They do not require previous experience with computer coding. Students who have taken Seafood Forensics (Biol 221) are not encouraged to take this course because of overlap in the research methods used.

Diversity statement: The Department of Biology values the perspectives of individuals from all backgrounds reflecting the diversity of our students. We broadly define diversity to include race, gender identity, national origin, ethnicity, religion, social class, age, sexual orientation, political background, and physical and learning ability. We strive to make this classroom and this department an inclusive space for all students.

Text book: All reading materials will be available on Sakai at the course site. I will be using materials from Hartwell et al., 2011, Genetics from Genes to Genomes, Edition 4. A copy of this text is available for this course at Library Reserves.

Copyright policy All course materials including your class notes and in-class assignments are covered by University Copyright Policy, @http://www.unc.edu/campus/policies/copyright%20policy%2000008319.pdf. This means it is illegal and an honor code offense to share your notes or any other course materials with anyone not directly affiliated with this particular class, i.e., no uploading materials to non-class sharing sites.

The course project for Spring 2019: What happens to a genome after a catastrophic disturbance that leads to chromosome breakage? Biol 423 students will create such a catastrophic disturbance in yeast and use genome sequence analysis methods to understand how survivors have recreated a functioning genome. The disturbance will be initiated by creating a second centromere on one of the 16 yeast chromosomes. Normally, every chromosome has one centromere which is used to direct the chromosome to only one of the two daughter cells formed when cells divide. A chromosome with two centromeres can get pulled between the two daughter cells with a pressure so strong the chromosome will break at a random place between the two centromeres. Parts of the broken chromosomes go to each of the daughter cells where ultimately they will be repaired. Surviving yeast end up with chromosome rearrangements, deletions and integrations of broken DNA at new locations, even in other chromosomes. The organization of the repaired genomes gives us information about chromosome structure and DNA repair mechanisms. The Spring 2019 class will learn how the second centromere we will use is activated. They will then use genome sequence analysis methods to understand how the genomes of surviving yeast cells have been repaired. The class will involve organization of a research program, microbiological culture methods, genetic comparisons, statistical analysis and computation for genome sequence assembly. There will be two interim lab reports, two midterm exams and a poster presentation. The

final exam will be in the form of a lab report comprehensive of the semester's work.

Attendance: Instruction periods cannot be made up at another time but students may come to the lab room to work independently to finish experiments as necessary. If students cannot attend an instruction period because of another commitment such as an interview for professional advancement, an arrangement can be made in advance with the instructor. Contact her by email with the date you will have to miss, preferably in advance of that date. Students are excused in case of illness. The instructor must be informed of the circumstance to avoid losing participation points.

Grading: Weekly participation in lab activities and group discussion: Participation grades will depend on discussion of answers to homework assignments and instructor questions in lecture and on active participation in laboratory exercises. Participation points will be included in each homework and lab report evaluation.

Homework Assignments: Assignments will be designed to help students understand the research problem being investigated. Assignments will include reading primary research papers and preparing descriptions, answering questions posed by the instructor and solving representative problems. Homework Assignments will be posted as a word file in the resources folder on the class Sakai web site for each week. Answers will be posted to the Assignment section of the Sakai web page by 5 pm on the specified day. Instructors will assign a grade and return the assignment without further comment. Students and instructors will then discuss the answers the following week in class. 5% of the final grade.

Interim reports: Students will submit a report on completed work at two points in the semester. Each report will include 1) an introduction section, 2) a results section including illustrations and tables representing the experimental design used and the resulting data and 3) a discussion section summarizing the relevance of the result to the rest of the project. Students are expected to share data with their lab partners but they must prepare their own reports including their own figures and tables even though the figures and tables will have the same information as their lab partners. Students are encouraged to discuss the interpretation of their results with any member of the class and students may be requested to share data and interpretations with other class members by the instructor. See the course Sakai site for instructions on how to prepare lab reports. Each report will be 20% of final grade

Midterms: Students will have two closed-book midterms during the semester. Questions will be short answer, multiple choice format to evaluate students' comprehension of the genetic principles relevant to the lab work. The honor code

will apply to each quiz. Students are not permitted to collaborate on the quiz. Each quiz will be 10% of final grade.

Poster presentation: At the end of the semester there will be a university-wide undergraduate research symposium where students and instructors from multiple disciplines will present posters describing their semester research projects. Biol 423L Students will work in groups to produce posters describing their own research during the semester for this symposium. Students will design the posters and orally present the posters to other participants at the symposium. 10% of the final grade.

Final report: At the end of the semester, students will prepare a report on the results of the full semester. The report will have the same format as the interim reports. The rules on collaboration are the same as for interim reports. The final report will be submitted on the last day of classes, April 26. **This report will be prepared outside of the final exam period but it will serve as the final exam.** 25% of final grade.

Grade scale: After completing all the above, students will have a number of points out of 100. Points will be converted to letter grades based on the final grade distribution. Because the course content is different every year, it is impossible to predetermine the relationship between points and letter grades.

Penalty for handing research plans or reports in late: All homework, proposals and research reports must be submitted on Sakai or by email to the instructor by 5 pm on the due date. Work handed in late but within 24 hours of the due date will be graded for 50% of the points. Work submitted later will not be graded. Exceptions can be made in unusual circumstances by arrangement (email to instructor, preferably **before** due date)

Missed exams or homework: In the case of University Approved Absences or other exceptional circumstances, a student may arrange to take an exam at a different time that is convenient for both the student and the instructor. The same applies to homework and reports. If a student entirely misses a midterm, the weight of that midterm in the course grade will be added to the weight on the student's final report.

Regrade requests: Lab reports and homework: Regrade requests must be submitted within one week of receiving the graded work. Students must submit a graded file with grader's comments to the instructor. The complaint must be described in writing. It can be submitted by email with the graded file attached. The instructor reserves the right to regrade the entire paper, not just evaluate the complaint. In the case of incorrect addition of marks, students may discuss that directly with the instructor (after class is fine).

TIME LINE:
This is a suggested timeline. The instructor reserves the right to make changes to the syllabus, including project due dates and test dates when unforeseen circumstances occur. These changes will be announced as early as possible so that students can adjust their schedules.

Week 1: Jan 14/15 Introduction to the research goals of the course. We will consider what is going to happen when a second centromere on a chromosome is activated.
Introduction to wet lab techniques: Safety, sterile technique, pipetteman, dilution culture.

Week 2 Jan 21/22 MLK holiday - no class Monday or Tuesday. Instead there will be a Reading assignment and homework.

Week 3 Jan 28/29
Discuss Reading from week 1.
Begin whole genome sequence analysis by bioinformatics instruction.
Compare effects of initiation of a second centromere on Chromosome 3 in different genetic backgrounds.

Week 4 Feb 4/5 Discussion of yeast genotypes used in the study and function of the centromere.
Bioinformatics: using the UNC computation cluster for genome sequence analysis and introduction to BASH.
Wet lab: Evaluate survivorship of dicentric chromosome strains. Choose yeast colonies for genome analysis and evaluate their heritability.

Week 5 Feb 11/12. Regulation of a repressible centromere.
Bioinformatics: Illumina data and processing.
Workshop: Preparation of survivorship data using R statistical package.
Wet lab: Evaluate heritability of growth traits. Repeat if necessary. Choose colonies for DNA preparation.

Week 6 Feb 18/19
Bioinformatics: Alignment algorithms.
Dr Bloom visits to discuss R results and his research.
Wet Lab: DNA preparation from wild type parent lines
Repeat evaluation of isolate phenotype stability (heritability).
If possible, set up DNA preps of chosen survivor lines.

Week 7 Feb 25/26 Midterm 1
Bioinformatics: Identification of genome features.
PCR and Sanger sequencing methods
Wet lab: Finish parent line DNA preps and evaluate by nanodrop and gel electrophoresis. Set up PCR reactions. Likely set up DNA preps of chosen

survivor strains to sequence. Set up to repeat DNA preps of wild types if necessary.

Week 8 March 4/5 Report 1 due by the end of the week.
Bioinformatics: Visualize data
Wet lab: Do DNA preps from survivor strains. If possible, Evaluate DNA prep quality with Qubit. Evaluate PCR results with wild type DNA. Set up PCR reactions with DNA from chosen survivor strains.

Week 9 Mar 11/12 Spring Break.

Week 10 Mar 18/19
Bioinformatics: Review steps needed for analysis.
Discussion of methods for whole genome sequence preparation.
Wet lab: Evaluate quality of Survivor DNA preps. Do gels of PCR reactions, discuss, set up PCR products for Sanger sequences. Choose isolates for whole genome sequence. Introduction to library prep for whole genome sequence analysis. Start library prep with chosen DNAs. (this may have to wait until next week if DNA preps not evaluated)
Consider individual projects using PCR and Sanger sequence.

Week 11 Mar 25/26
Bioinformatics: analyze Sanger sequences
Wet lab: Complete DNA libraries for whole genome analysis, Present proposals for individual projects, Design PCR primers, start PCRs if possible.

Week 12 April 1/2. Second Midterm. Potentially complete WGS sequencing libraries. Evaluate and get to sequencing center.
Analyze example WGS data, catch up on PCR or Sanger sequencing that needs to be repeated. Work on individual projects. Prepare posters for Poster Session.

Week 13 Apr 8/9 Second lab report on PCR results due at end of the week.
Prepare poster mock-ups for Peer evaluation next week. Discuss final reports.

Week 14 Apr 15/16 all WGS data should be collected by now. Analysis. Peer review of poster mock-ups and get final product to photolab for printing.

Week 15 April 22/23 Lab clean-up. Analyze WGS data, work on final reports, collect posters from photo lab.

Poster session: April 25.

Final report due April 26.