Ecological Genomics – MASC 447

Meeting Place: Murray Hall, G205
Meeting Time: 2:00 to 3:15 pm, Tuesdays and Thursdays
Credits: 3 Semester Hours

Instructor: Dr. Scott M. Gifford
Office Location: 4202G Venable Hall
Phone: 919-962-0269
Email: sgifford@email.unc.edu
Course Website: https://sakai.unc.edu/portal/site/ecogenomics
Teaching Assistant: Acacia Zhao

Office Hours: Office hours are by appointment. E-mail is a reliable means of contacting me if you have questions about the course or about any related issues.

Course Description: Genomics and related 'omics' technologies have revolutionized our study of ecology and biogeochemistry by revealing the microbial populations that comprise a community and their potential functions and connections within an ecosystem. Ecological Genomics (MASC 447) is a hands-on undergraduate/graduate level course that exposes students to the world of genome sequencing as it applies to inferring ecological function of environmental microbes. The course will develop students' skills in sequencing, bioinformatics, and ecological interpretation of genomics data, as well as develop students' knowledge of microbes in the environment, including taxonomy, metabolism, and physiology. These concepts are continuously applied throughout the course to understand how gene content can identify the roles of microorganisms in the ecology and chemistry of the natural environment. MASC 447 is part of UNC's Course-based Undergraduate Research Experience (CURE) program.

Course Organization and Goals: MASC 447 is centered on active learning through both field-work, laboratory-based molecular biology, and computer focused bioinformatics' exercises. The course will begin with a field trip in which students culture microbes from a local aquatic environment. The students will then learn to extract DNA from their isolates and submit the samples for genome sequencing. Upon return of their data, students will learn how to assemble complete genomes from the raw sequence reads. They will then characterize the basic features of the genomes and the class will develop a database allowing them to cross-compare each other's genomes. The students will work to annotate their genomes using the IMG and NCBI pipelines and compare the resulting functional annotations to a variety of public databases. Finally, students will use the gene content they generated from their genomes to infer the ecological roles of their isolated organism in the ecosystem from which they were obtained. Throughout the course, students will learn about the types and uses of bioinformatic tools and how they have been applied to microbial genomics.

At the end of this course, students should:

- Develop skills in the cultivation of microbes and the preparation of isolate material for DNA sequencing.
- Be familiar with the types of sequencing technologies used to sequence microbial genomes as well as the bioinformatic workflows for processing the raw sequencing reads
- Be able to use the latest computational tools to assemble microbial genomes on the command line and using the Galaxy environment.
- Develop bioinformatic skills needed to characterize microbial genomes
- Be able to cross-compare genomic information to identify unique ecological features that may indicate the organism's role in biogeochemistry, biogeography, ecosystem metabolism, etc.

- Communicate their new found knowledge of genomics to their peers and to the instructor through their final project.

MASC 447 is part of UNC's experiential learning initiative and is based on the CURE structure: Course-based Undergraduate Research Experience. As part of this program, the course will focus on an active area of research, specifically, how the information contained within genomes can identify bacteria's niche in aquatic environments. This CURE course is sponsored by the Office for Undergraduate Research (our.unc.edu). I encourage you to visit this website to see other ways that you might engage in research, scholarship and creative performance while you are at Carolina.

Prerequisites: This is an upper-level undergraduate and graduate course. Thus, this course is designed for students that are science majors and have previously taken foundational courses in the biological sciences. In addition, a large portion of the course will focus on bioinformatic exercises, so the student should have a firm grasp of basic computer skills. If you have questions about whether you will be able to navigate this course successfully you should contact the instructor.

Graduate Teaching Assistant: In this research-exposure course you will work with Graduate Teaching Assistant Acacia Zhao who will assist you in the research project, and help with field, lab, and classroom components.

Text and Readings: Each week, the students will be responsible for readings from texts and primary literature articles relevant to topics discussed in class. Primary literature readings will be assigned the week before they are due and will be made available to download on the course Sakai page.

Required Reading Materials:

Lakes: A Very Short Introduction, by Warwick Vincent, Oxford University Press (April 1, 2018). ISBN-10: 0198766734

Microcosm: E. Coli and the New Science of Life, by Carl Zimmer ISBN-10: 0307276864

Course Requirements

Teaching Strategies and Techniques: In this class, expect to take an active part in the learning process. You can expect that we will engage in a variety of active learning strategies such as student-pair and group discussions, group exercises, demonstrations, simulations, case studies, and problem-based learning. Expect interactive lecturing with active learning exercises to reinforce the concepts covered.

Required Weekly Preparations: To be successful in this course, you must complete the assigned readings before class, review your notes weekly, complete all bioinformatic exercises and assignments and turn them in on time. I expect that you will take this class seriously by: arriving on time and your readiness to focus on the lesson objectives; keeping track of your absences and the due dates for assignments; keeping an open mind to what others have to share as we engage in daily class discussions. Teaching and learning is a two-way street, so you can expect certain things from me as well. I will make myself available to help you answer questions. I will provide you with information about your assignments well ahead of their due dates. I will provide you with feedback on your assignments in a timely fashion. I will ask you for informal feedback about the course throughout the semester and make an effort to incorporate your ideas to improve the course as we move forward.

Evaluation: This course will be evaluated from assignments, a midterm, and a cumulative final project and presentation. Any contesting of grades must be initiated no later than one week after the grade has been posted.

Final Project. The course will culminate in a final project consisting of oral and written reports that will describe the cumulative results of the student's genomic research over the semester. This includes the creation of a research poster to be presented both to the class and at UNC's Research and Making Expo in December (see below). Please note that students are required to cover the cost of poster printing (~$50.00).

Attendance and Participation: Attendance and participation is expected and absolutely necessary for successful completion of this course. Absence from class does not relieve the student from any course requirement. If a student needs to miss class and it is known ahead of time, they should notify me about the planned absence as earlier ahead of the absences as possible. If an emergency arises and a student has to miss class unexpectedly, the student should notify me as soon as possible to arrange for making up any missed assignments or materials.

Make-up exams will only be offered if you present a letter from your Healthcare Provider or from the Dean of Students that explicitly states that you were unable to take the exam at the scheduled time and date. Make-up must be taken within 48 hours of the scheduled exam time. For **late assignments**, each day that the assignment is late will result in a 10% reduction per day.

Student Responsibilities

Provisions of the UNC Chapel Hill Honor Code are in effect at all times for this course. *Read your Honor Code and be aware of its implications* (http://honor.unc.edu). Please set up an appointment to meet with me if you have questions about how the Honor Code pertains to this course.

Unauthorized Aid**:** All academic work in this course including your assignments, quizzes, and the cumulative project are to be your own. You will be required to sign a pledge sheet that will be provided with all assignments and exams that you turn in for grading.

Commercial use of notes**:** UNC's Copyright Policy clearly prohibits students from making commercial use of notes taken in class or labs; you may not sell or otherwise acquire financial or commercial gain from notes you take in this class. Students found to have violated this prohibition are in violation of the Honor Code and are subject to Honor Court proceedings.

Plagiarism**:** The Instrument of Judicial Governance defines plagiarism as "a deliberate or reckless representation of another's words, thoughts, or ideas as one's own without attribution in connection with submission of academic work, whether graded or otherwise."

Sakai**:** You will be required to use Sakai in this class. Spend some time familiarizing yourself with Sakai if you have not done so already. This will give you instant access to PowerPoint presentations from class meetings and to your grades. In addition, I will place announcements on Sakai from time to time. Also, readings, assignments and other materials relevant to this course will be available to you via Sakai.

Data Backup**:** Students are responsible for maintaining backup copies of files and data generated during the course. Loss of data will not be considered an excuse during evaluation of class assessments.

Computers, Cell Phones, and Other Devices**:** The use of computers in class should be limited to note taking and bioinformatics tools. Web browsing and visiting social media sites during class is distracting and disrespectful to yourself, your peers, and to me. Cell phones and other devices should be turned off or placed in silent mode. Absolutely no texting during class. If you have to make an emergency call please step outside so as to avoid disrupting the rest of the class.

Your performance will be evaluated as follows:

	Percent	Quantity
Assignments*	40% (5% each)	8
Midterm	20%	1
Cumulative Final Project	40%	1
Total	100%	

Graduate students will have an additional class presentation assignment worth 10% of their grade.

Final letter grades will be assigned as follows for undergraduates:

Percent	Letter Grade
94-100	A
90-93.9	A -
87-89.9	B +
84-86.9	B
80-83.9	B -
77-79.9	C +
74-76.9	C
70-73.9	C -
65-69.9	D +
60-64.9	D
<60	F

Final grades will be assigned as follows for graduate students:

Percent	Letter Grade
90-100	High Pass
80-89.9	Pass
70-79.9	Low Pass
<70	Fail

Course Schedule: This is a tentative schedule. The topics and exact dates may change over the semester.

Week	Date	Topic	Lab activity	Assessment due
1	Tues. Aug 20	Introduction to microbial genomics and lakes		
	Thurs. Aug 22	Jordan Lake Sampling	Collection and Isolation	
2	Tues. Aug 27	Sequencing Technologies	Check and select isolates	
	Thurs. Aug 29	DNA extractions	DNA extractions	
3	Tues. Sep 3	HTSF tour	Submit to MiGS	
	Thur. Sep 5	Introduction to Galaxy	Using Galaxy	1
4	Tues. Sep 10	Genome properties	Sequence Analysis and Assembly	
	Thur. Sep 12	Steps to annotating a genome		
5	Tues. Sep 17	Taxonomy	Functional Annotation	2
	Thur. Sep 19	Phylogenomics	MIGA	
6	Tues. Sep 24	Functional Genomics: Gene Annotation	Functional Annotation	3
	Thur. Sep 26	BLAST search		
7	Tues. Oct 1	Functional Genomics: Orthologs and Paralogs	Anvio	4
	Thur. Oct 3	Integrated Microbial Genomes (IMG) database		
8	Tues. Oct 8	Comparative Genomics		5
	Thur. Oct 10	KEGG, pathway mapping, and metabolic networks		
9	Tues. Oct 15	Gene Ontologies (GO)	Design Experiments	6
	Thur. Oct 17	*Fall Break*		
10	Tues. Oct 22	Midterm review / Metagenomics		
	Thur. Oct 24	*Midterm*		
11	Tues. Oct 29	Depositing sequences in national databases		
	Thur. Oct 31	Metagenomics / MAGS /SAGS		7
12	Tues. Nov 5	Work on class comparative genomics projects		
	Thur. Nov 7	Work on class comparative genomics projects		8
13	Tues. Nov 12	Work on class comparative genomics projects		
	Thur. Nov 14	Work on class comparative genomics projects		
14	Tues. Nov 19	Work on class comparative genomics projects		
	Thur. Nov 21	*No Class. Thanksgiving*		
15	Tues. Nov 26	Work on class comparative genomics projects		

	Thur. Nov 28	Work on class comparative genomics projects		
16	Tues. Dec 3	Presentation – UNC Research and Making Expo (3:30 – 5:00pm)	*Blue Zone, Kenan Memorial Stadium*	
	Thur. Dec 5	*Reading Day*		
	Saturday Dec 7	*12pm. Final, Class poster session and competition*		

MASC 447 – Ecological Genomics

Fall 2019

Instructor: Dr. Scott M. Gifford

Student Syllabus Receipt

Please read the following paragraph, sign your name, date the form, and return to your instructor by (*month/ day/ year)*.

I acknowledge receipt of the attached syllabus and understand the course requirements as they are written above. I also acknowledge that the information stated above has been explained by the instructor and I have been given ample opportunity to clarify any questions that I may have. I will abide by the Honor Code of the University of North Carolina at Chapel Hill in all matters relevant to this course.

Signature _____

Name _____

Date _____