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
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Course Website: https://sakai.unc.edu/portal/site/ecogenomics
Graduate Research Consultant (GRC): Weida Gong

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 to the UNC Chapel Hill High Throughput Sequencing Facility (HTSF) 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 then work in the computer lab 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
- Develop skills using Linux, R, python, and a variety of online bioinformatics tools and databases.
- 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 report and collaborative class 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 bacterioplankton's carbon processing niche in the marine environment.

Graduate Research Consultant: For the undergraduate students, in this research-exposure course you will be working with a Graduate Research Consultant (Weida Gong) who will assist you in the research project. The GRC program 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, and 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.

Text and Readings: Each week, the students will be responsible for readings from 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.

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 by 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 reading quizzes, assignments, and a cumulative final project and presentation. The final project will consist of a 10 page written assignment (>3000 words) from each student

that will report on the cumulative results of the student's genomic research over the semester. Any contesting of grades must be initiated no later than one week after the grade has been posted.

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 quizes 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 quiz at the scheduled time and date. Make-up quizzes must be taken within 48 hours of the scheduled quiz time.

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.

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.

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.

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	Points/Item	Total Points
Quizzes	30%	10 out of 11	30	300
Midterm Portfolio Check	15%	1	150	150
Final Presentation	10%	1	100	100
Cumulative Final Project	45%	1	450	450
Total	100%			1000

Final letter grades will be assigned as follows for undergraduates:

Total Points	Percent	Letter Grade
940-1000	94-100	A
900-939	90-93.9	A -
870-899	87-89.9	B +
840-869	84-86.9	B
800-839	80-83.9	B -
770-799	77-79.9	C +
740-769	74-76.9	C
700-739	70-73.9	C -
650-699	65-69.9	D +
600-649	60-64.9	D
<600	<60	F

Final grades will be assigned as follows for graduate students:

Total Points	Percent	Letter Grade
900-1000	90-100	High Pass
800-899	80-89.9	Pass
700-799	70-79.9	Low Pass
<70	<70	Fail

Course Schedule

This is a tentative schedule. The topics and exact dates may change over the course of the semester.

Week	Date	Topic	Assessment
1	Tues. Aug 22	Introduction to microbial genomics	
	Thurs. Aug 24	DNA sequencing technologies, library preparation	
2	Tues. Aug 29	Microbiology Review, Wet lab: DNA extraction	quiz
	Thurs. Aug 31	The Marine Carbon Cycle and DOC	
3	Tues. Sep 5	Introduction to bioinformatics, Galaxy	quiz
	Thur. Sep 7	Sequence quality control and genome assembly	
4	Tues. Sep 12	Steps to annotating a genome	quiz
	Thur. Sep 14	BLAST searches, IMG	
5	Tues. Sep 19	Tour and guest lecture at UNC's Sequencing Facility	quiz
	Thur. Sep 21	Dr. Septer guest lecture	
6	Tues. Sep 26	Functional Genomics: Orthologs and Paralogs	quiz
	Thur. Sep 28	Integrated Microbial Genomes (IMG) database	
7	Tues. Oct 3	Identifying promoters and ribosomal binding sites	quiz
	Thur. Oct 5	Phylogenomics	
8	Tues. Oct 10	Comparative Genomics	quiz
	Thur. Oct 12	KEGG, pathway mapping, and metabolic networks	
9	Tues. Oct 17	Depositing genome sequences in national databases	quiz
	Thur. Oct 19	*Fall Break*	
10	Tues. Oct 24	Metagenomics	quiz
	Thur. Oct 26	Tara Ocean's databas	
11	Tues. Oct 31	Gene Ontologies (GO)	quiz
	Thur. Nov 2	Work on class comparative genomics projects	Portfolio check
12	Tues. Nov 7	Work on class comparative genomics projects	
	Thur. Nov 9	Field Work: Microbial isolation	quiz
13	Tues. Nov 14	Work on class comparative genomics projects	
	Thur. Nov 16	Work on class comparative genomics projects	
14	Tues. Nov 21	Work on class comparative genomics projects	
	Thur. Nov 23	*No Class. Thanksgiving*	
15	Tues. Nov 28	Work on class comparative genomics projects	
	Thur. Nov 30	Work on class comparative genomics projects	
16	Tues. Dec 5	Work on class comparative genomics projects	
	Thur. Dec 7	*Reading Day*	
	Sat. Dec 9	*12 pm. Final Report Due and Presentations*	

MASC 447 – Ecological Genomics

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 _____