Biology 523-01/523L-02 (Fall 2016)
Genomics Lecture/Lab

Lectures:	TTh 9:00 - 10:20 am, SSMB 245
Labs:	F 12:30-3:30pm, SSMB 141 (wetlab) or SSMB 255 (computer)
Instructor:	Dr. Christine Byrum
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Office:	150 SSMB, College of Charleston (Downtown campus)
Office Hours:	By appointment

Course Overview: This graduate course is designed to familiarize students with the field of genomics and current topics of interest in this quickly expanding discipline. We will explore several subdisciplines in the field and learn about a variety of techniques applicable to genomic analysis. Particular attention will be devoted to new advances in the area of marine genomics as well as biomedically relevant areas of genomics. Materials will be presented as lectures, classroom discussions of journal articles, and labs/workshops.

Course Objectives/Student Learning Outcomes:

1) Students should become familiar with terminology used by genomicists as well as key principles and theories associated with this field.
2) They will be expected to coherently explain genomic concepts and to apply these concepts to new situations or to predict outcomes based on what they have learned in class.
3) Students will learn how to use bioinformatic tools to find/identify genes in a genome and to better characterize gene products.
4) Become familiar with recent genomic research through discussion of the scientific literature.
5) Learn techniques in phylogenetic analysis that are applicable to genomic studies.
6) Become familiar with all aspects of QPCR analysis including sample preparation, primer design, primer testing, calibration of the QPCR machine, controls necessary for QPCR analysis, running QPCR reactions, and analysis of QPCR results.
7) Learn about sequencing technologies, gene expression analysis, and proteomics.
8) Discuss ethical issues relevant to genomics.
9) Become more aware of local genomic resources.
10) Learn how to present genomic information in a talk and/or a paper.
11) Graduate students will each present a discussion topic independently. They will review and critically evaluate recently publications in that area and present this in a term paper to accompany their discussion.

12) Graduate students will be expected to answer an additional question in each of the two tests. This question will require a more detailed, critical answer than those given to both levels of students.

Optional Texts:

Bioinformatics and Functional Genomics, 3rd edition. J. Pevsner, 2015 (Wiley Blackwell).
Principles of Gene Manipulation and Genomics, 7th edition. S.B. Primrose and R.M. Twyman, 2006 (Blackwell Publishing).
A Primer of Genome Science, 3rd edition, G. Gibson and S. Muse, 2009 (Sinauer Associates).
Phylogenetic Trees Made Easy, 4th edition. B.G. Hall, 2011 (Sinauer Associates).

Prerequisites: Genetics (BIOL 305), Molecular Biology (BIOL 312) / Cell Biology (BIOL 313) or permission of the instructor.

Course Policies

Attendance: Regular classroom participation is critical in this course. If the student is unable to attend a class, he/she should be sure to get the information from a classmate or from the instructor so that he/she doesn't fall behind. If an absence is anticipated, the instructor should be informed ahead of time.

Class Assignments:

Tests: There will be five quizzes and two tests during the course of the semester in which the students will be assessed to determine their knowledge concerning recent and/or previous materials. Quizzes will typically consist of five to ten short answer/essay questions and tests will be comprehensive with essay/short answer and multiple choice/matching sections. This is a significant portion of your grade. Be sure to prepare thoroughly for each evaluation. Graduate students are expected to answer an additional question on each test that will require a more detailed, critical answer than to questions given to students taking the course for undergraduate credit.

Discussions: Students will also lead class discussions about topics in genomics. This will be done in teams of two. Students should introduce the class to the topic and lead a discussion reviewing two papers (30 minutes/person). Students should prepare typed notes for these discussions (notes highlighting key points in the introduction and listing discussion questions with written answers.). These notes will be handed in following the discussion session.

Those not presenting are expected to read the assigned papers before class and to participate in class discussions. Participation involves the following: A) Did the student take time to carefully read this paper? Is he/she able to answer questions raised during discussions? Can he/she describe what was done in the paper? Has he/she thought about implications of this

work? B) Is the student willing to contribute to classroom discussions? Even if one is shy, it is important to actively participate. C) Has the student taken extra steps to build on what they've learned after reading the paper? Does he/she contribute extra information in discussions? How participation is to be evaluated will be decided by students at the beginning of the semester.

Solo Discussion/Paper: In addition to the two team-led discussions, each graduate student will be expected to lead a third discussion session independently. He/she will select 1-2 papers to discuss and will prepare a Powerpoint presentation (20-25 minutes) to present before the discussion that will give the other students some background on the topic. Following this introduction, the student will lead a classroom discussion about the chosen paper(s) and they will submit a paper reviewing this topic to the instructor following the presentation.

Out of Class Exercises: These are short "homework" assignments. Often these are worksheets to fill out or exercises to do that will improve understanding of a technique previously discussed in class or lab. Students are encouraged to talk to each other about these assignments but should not copy work. Make sure that all work is shown and turn in assignments at the beginning of the next class period. Assignments will not be accepted after all papers have been corrected and turning in an assignment late may result in a penalty.

Class Project: Over the semester, students will work together to complete a course project in the lab during which they analyze expression of a set of genes in the sea urchin. Students will find members of a gene family, identify domains present in the members of that gene family, identify human genes that are likely homologues based on gene alignments and perform phylogenetic analysis to characterize the evolutionary relationships of these genes to those in other phyla. They will also design primers and perform QPCR analysis to determine levels of gene expression at different developmental stages. Each individual will submit his/her project as a paper.

Grading of Assignments: A single grade based on performance in both the lecture and lab will be assigned for the 4-credit Genomics course. The following criteria will be used to calculate the grade.

Tests	30% (Quiz Avg. 10%, Test Avg. 20%)
Participation in Class Discussions (lecture)	10%
Leading Class Discussions in Team of Two (2) (lecture)	15%
Solo Class Discussion/Paper (1) (lecture)	15%
Out of Class Exercises (lab/lecture)	10%
Class Project (lab)	20%

Grading Scale:

90 and above: A	77-79.9: C+
87-89.9: B+	70-76.9: C
80-86.9: B	<70: F

Classroom Courtesy: Students are expected to turn off cell phones, beepers, and any other disruptive devices during lectures and discussions. Exceptions will be made in extreme situations such as spouses anticipating the birth of a child or a serious emergency. Permission to leave an electronic device on should be obtained prior to class.

Academic Integrity: Students are expected to behave in an honest and responsible manner. Violations of the honor code are offensive and will generally be dealt with severely. We will adhere to the following policy as quoted from the Honor Council's recommended guidelines:

> "Lying, cheating, attempted cheating, and plagiarism are violations of our Honor Code that, when identified, are investigated. Each incident will be examined to determine the degree of deception involved.
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> In cases where the instructor determines that the student's actions are related more to a misunderstanding, the instructor will handle the situation. A written intervention designed to help prevent the student from repeating the error will be given to the student. The intervention, submitted by form and signed by both the instructor and the student, will be forwarded to the Dean of Students and placed in the student's file.
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> Cases of suspected academic dishonesty will be reported directly by the instructor and/or others having knowledge of the incident to the Dean of Students. A student found responsible by the Honor Board for academic dishonesty will receive a XXF in the course, indicating failure of the course due to academic dishonesty. This grade will appear on the student's transcript for two years after which the student may petition for the XX to be expunged. The F is permanent. The student may also be placed on disciplinary probation, suspended (temporary removal) or expelled (permanent removal) from the College by the Honor Board.
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> Students should be aware that unauthorized collaboration--working together without permission--is a form of cheating. Unless the instructor specifies that students can work together on an assignment, quiz and/or test, no collaboration during the completion of the assignment is permitted. Other forms of cheating include possessing or using an unauthorized study aid (which could include accessing information via a cell phone, tablet, or computer), copying from others' exams, fabricating data, and giving unauthorized assistance.
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> Research conducted and/or papers written for other classes cannot be used in whole or in part for any assignment in this class without obtaining prior permission from the instructor.

Students can find the complete Honor Code and all related processes in the *Student Handbook* at the following site:

http://studentaffairs.cofc.edu/honor-system/studenthandbook/index.php ."

Center for Student Learning: Students are encouraged "to utilize the Center for Student Learning's (CSL) academic support services for assistance in study strategies, speaking & writing strategies, and course content. They offer tutoring, Supplemental Instruction, study strategy appointments, and workshops. Students of all abilities have become more successful using these programs throughout their academic career and the services are available to you at no additional cost. For more information regarding these services please visit the CSL website at http://csl.cofc.edu or call (843) 953-5635."

Accommodations for Students with Disabilities: Any student who needs accommodations because of a disability should talk to the professor about this during the first week of classes or as soon as they have been approved for these services so that this can be addressed. For more information on Disability Services, please refer to the following website: http://disabilityservices.cofc.edu/for-faculty/faqs.php

Lecture Schedule

Date	Topic
Aug. 23 T	Gene and Genome Structure
Aug. 25 Th	Genome Size
Aug 30 T	*Discussion* - Origins of Genomics– Quiz 1
Sept. 1 Th	Sequencing Genomes
Sept. 6 T	*Discussion* - Genome Sequencing Technologies
Sept. 8 Th	Finding Genes/Annotation
Sept. 13 T	*Discussion* – Alternative Splicing – Quiz 2
Sept. 15 Th	Measuring Gene Expression
Sept. 20 T	*Discussion* – Stem Cell Research
Sept. 22 Th	QPCR
Sept. 27 T	**Test 1**
Sept. 29 Th	*Discussion* – Gene Expression
Oct. 4 T	Personalized Medicine
Oct. 6 Th	Proteomics
Oct. 11 T	*Discussion* – Proteomics – Quiz 3
Oct. 13 Th	Microbial Genomics
Oct. 18 T	Studying Genome Variation
Oct. 20 Th	*Discussion* – Microbial Genomics
Oct. 25 T	Comparative Genomics
Oct. 27 Th	*Discussion* – Comparative Genomics – Quiz 4

Nov. 1 T Sequence Alignment

Nov. 3 Th *Discussion* – Genome Defense/CRISPR-Cas8

Nov. 7, 8 M, T Fall Break

Nov. 10 Th Phylogenetic Analysis

Nov. 15 T **Test 2**

Nov. 17 Th *Discussion* - Ethical Issues

Nov. 22 T Functional Genomics

Nov. 24 Th Thanksgiving Break

Nov. 29 T *Discussion* – Functional Genomics

Dec. 1 Th Discussion/Presentation of Results from Lab Projects – Quiz 5

** Schedule may vary subject to scheduling changes and other modifications as needed.*

Objectives/Student Learning Outcomes for the *Genomics* Lab: In the *Genomics* Lab, a mixture of computer-based labs and "wet lab" exercises are used to familiarize students with key procedures regularly used to study genomics. We will work together in teams to ask real scientific questions. Students will learn how to:

1) Retrieve nucleotide (transcriptomic and genomic DNA) and protein sequences from scientific databases.
2) Perform simple and advanced BLAST searches.
3) Design standard and QPCR primer sets for reverse transcriptase PCR and QPCR.
4) Extract RNA from an organism and produce cDNA.
5) Perform and analyze the results of reverse transcriptase PCR and QPCR.
6) Extract DNA from a gel after electrophoresis and prepare samples for sequencing.
7) Analyze sequence data.
8) Find homologous genes for phylogenetic analysis.
9) Perform phylogenetic analyses using MEGA.

Lab Safety and Attire: Before attending the first lab, each student should review the official SSM safety manual posted on OAKS. Many of the labs are computer-based, but others involve the use of hazardous chemicals. During "wet labs", students should dress appropriately, wearing pants rather than shorts and closed-toed shoes. These protect more in the case of a chemical mishap.

Genomics Lab Schedule

Date	Topic
Aug. 26	Technical Foundations of Genomics (lecture) *Goal:* Review key molecular techniques that preceded development of high throughput approaches used in Genomics.
Sept. 2	Finding Genes in a Genome/Domain Analysis *Goal:* Outline lab organization, goals for semester. Learn to search for annotated and unannotated genes. Discuss how to deal with "problematic" sequences. Learn to do domain searches (Pfam, NCBI, SMART, TMHMM) and how to make drawings showing key domains. *Assignment:* Practice finding genes and characterizing domain structure in these products.
Sept. 9	Performing BLAST Searches *Goal:* Become proficient at performing different types of BLAST searches on NCBI's BLAST site. Learn how to select the correct BLAST program for your question, which databases are available on BLAST, parameters available, and how to perform specialized BLAST searches. *Assignment:* Complete BLAST worksheet before next lab.
Sept. 16	Standard and QPCR Primer Design/Review of PCR *Goal:* Learn how to make primers for standard PCR and QPCR analysis. *Assignment:* Design standard PCR and QPCR primer sets to be used later this semester.
Sept. 23	Collecting Specimens for QPCR Analysis *Goal:* Learn how to prepare specimens for QPCR analysis. Induce spawning in sea urchins, culture and collect embryos at specific developmental stages, and prepare for RNA extraction. *Assignment:* Obtain specimens for QPCR labs.
Sept. 30	Extracting RNA/Producing cDNA *Goal:* Collect/extract RNA and use reverse transcriptase to produce cDNA for RT-PCR or QPCR. *Assignment:* Isolate mRNA and produce cDNA.
Oct. 7	Performing the Standard PCR Reaction *Goal:* Test standard primers you made using standard PCR . *Assignment:* Obtain PCR products (if possible) using your primer sets before the next lab.

Oct. 14 Electrophoresis of PCR products/Gel Extractions for Sequencing
Goal: Evaluate PCR products obtained in last lab using gel electrophoresis and prepare samples for sequencing.
Assignment: Determine whether primers amplified genes of interest and verify by sequencing the product.

Oct. 21 Optimizing for QPCR/Running Reactions
Goal: Run a QPCR reaction after performing necessary tests.
Assignment: Acquire QPCR data.

Oct. 28 Optimizing for QPCR/Running Reactions
Goal: Continue collecting data for class project.
Assignment: Acquire QPCR data.

Nov. 4 Finding Potential Homologues /Sequence Alignment
Goal: Introduce websites useful for finding homologous genes (Ensembl, Homologene, HUGO, Mouse Genome Informatics, etc.). Learn to how to do pairwise and multiple sequence alignments. Discuss editing multiple sequence alignments.
Assignment: Perform pairwise and multiple sequence alignments on your project genes to prepare for phylogenetic analysis. Edit the multiple sequence alignment.

Nov. 11 Generating Phylogenies to Identify Homologues
Goal: Learn to generate neighbor-joining & maximal parsimony trees.
Assignment: Produce a neighbor-joining tree and a maximal parsimony tree for a family of genes you are working on. Compare your genes to potential homologues in humans. Then perform a second analysis in which the genes are compared to a range of organisms to assess evolution of the gene.

Nov. 18 Analyzing QPCR data
Goal: Complete QPCR analysis for class project and related analysis.
Assignment: Analyze QPCR data.

Dec. 2 Summary Lab
Goal: Discuss final outcomes of class project.

** Schedule may vary subject to scheduling changes and other modifications as needed.*
Bold dates: Lab will be held in SMB 255