Syllabus
11:776:485 Functional Genomics for Research
Fall 2018
Monday / Wednesday 05:35-06:55pm Foran Hall rm. 124

Organizer and instructor: Dana C. Price, Ph.D. (d.price@rutgers.edu)
Headlee Labs rm. 214B
Office hours upon request

Pre-requisites: (01:119:116) AND (11:216:251/486 or 01:447:380 or 11:115:301/403 or 01:694:315/407)

Summary of content: This course will focus on execution of tools and protocols used to elucidate the biology, ecology and life histories of organisms through analysis of their genomes. Using genome research projects recently completed by the instructor and collaborators as templates, students will carry out each step of the research pipeline (unique to that project) in depth - from taxon selection, bioinformatic analysis of next-generation sequencing data, genome assembly, gene prediction/functional annotation, and finally how these data answer a functional biological hypothesis or question about the target organism. As new topics are introduced, they will be framed in the context of their applicability to the current project. At the end of the course, students will be able to select the appropriate protocols and analysis pipelines to complete the majority of today's genome research. Each topic (or introduced research project) will consist of one or more lectures with background discussion, tool and material review, and a second hands-on computer (or dry) lab period during which students will apply the concepts and tools to complete a phase the genomic analysis. This course illustrates evolutionary concepts current tools in a hands-on manner within the confines of a goal or results-oriented genome research project.

Student audience: Advanced undergraduate (esp. Plant Biology and Biotechnology) and graduate students at SEBS and SAS will benefit from training in approaches to genomics and its application in a research environment.

Course website and online content: A course website using the Canvas course management system is available, and will include readings and links to online resources such as websites and journal articles.

Course assessment: Two exams, 1 research paper discussion, 1 written/*in-silico* project, 1 presentation (grad students only).

Readings: Selected scientific articles, book chapters, and writings from the popular press. Each lab will use a research paper authored by the instructor as a model for the analyses to be carried out with expected results. There is no assigned textbook.

Evaluation and Grading:

Exam 1 (10/28/18): 25%
- Written exam with material from first half of semester

Exam 2 (11/25/18): 25%
- Written exam, 3/4 material from second half of semester

Paper Discussion (Last two class periods): 30%
- Students will present a recent genome paper on a topic of their choosing and recap the methods used and conclusions inferred from the analyses.

Write-up (Emailed prior to end of course): 20%
- 2-page written evaluation of the subject on which you presented

Learning Goals:

Upon completion of course requirements, students will be able to:

Goal 1: Apply knowledge of genome sequencing and bioinformatics analyses to test hypotheses regarding organismal biology and evolution.
Goal 2: Communicate effectively how various bioinformatic analyses are impacted by similarities and differences in eukaryote genomes.
Goal 3: Apply appropriate bioinformatic tools and analysis protocols for individual genome sequencing projects.
Goal 4: Analyze and report on recent published research in the field of genomics.

Goal Assessments:

Goal 1: Specific questions on exams; final project.
Goal 2: Specific essay/long-answer questions on exams; paper discussion; final project.
Goal 3: Final project; exam questions; class participation.
Goal 4: paper discussion; presentation and class participation.

Topic order (Preliminary):
1. Introduction / Next-gen sequencing
2. Basics I: Genome/transcriptome assembly; Gene prediction and annotation
3. Basics II: Homology search and public databases / Phylogenetics
4. The algal tree of life and origins of photosynthesis – The *Cyanophora paradoxa* genome project
5. Horizontal and Endosymbiotic gene transfer
6. RNAseq / Differential expression
7. Homology and function
8. Gene Ontologies
9. Eukaryotic HGT and EGT revisited: The *Porphyridium purpureum* genome
10. Orthologous gene families / Protein evolution and selection
11. *Paulinella* and the role of HGT in endosymbiosis
12. *Paulinella* and the role of HGT in endosymbiosis II
13. Metabolic pathways, KEGG maps and dinoflagellate metabolism

14. Lab exercises – Differential expression, PhySortR and branch-site selection
15. Transcriptional regulation / CRISPR-Cas9 and RNAi
16. Single-cell genomics
17. Protein-DNA interactions / ChIP-seq, ATAC
18. Metagenomics
19. Presentations

Accommodations for Students with disabilities

Please follow the procedures outlined at https://ods.rutgers.edu/students/registration-form. Full policies and procedures are at https://ods.rutgers.edu/