Course Number: 11:216:465

Spring 2015 "Fundamentals of Genomics"

Organizer and instructor: Debashish Bhattacharya (bhattacharya@aesop.rutgers.edu)

Summary of content: This course will focus on the foundations of modern genomics: from experimental design to data acquisition, analysis, and interpretation. The course will be of an introductory nature and is intended to provide students with the tools and understanding to take part in the on-going genomics revolution. Areas to be covered include de novo genome sequencing and assembly, gene prediction and annotation, functional genomics (RNA-seq), and single cell genomics. Applications of these tools in the environmental, medical, and evolutionary biology fields will be covered with each of these broad areas being looked at in detail through lectures, paper-readings, and discussions. Students in this semester-long theory course are expected to enter with basic training in biology (particularly fundamental genetics) and an interest in bioinformatics and evolution.

Learning goals:

Goal 1: Describe the evolutionary origins, processes and patterns over geologic time.

Goal 2: Develop a comprehensive understanding of software, hardware, field and laboratory techniques commonly used in the study of ecology, evolution, and natural resources management.

Goal 3: Demonstrate the ability to design experiments and interpret numeric and graphical data.

Goal 4: Think criticially and solve problems using evidence-based reasoning.

Student audience: Advanced undergraduate and graduate students at SEBS and SAS will benefit from training in approaches to genomics and its application to life sciences.

Prerequisites: Two semesters of general biology (01:119:101/102 or 01:119:115/116).

Course website and online content: A course website will be developed using the SAKAI course shell and include readings and links to online resources such as websites and articles.

Course assessment: Two exams, 2 in-class debates, 1 presentation and 1 essay on a chosen genomics research area.

Readings: A variety of selected textbook chapters, scientific articles, and writings from the popular press.

Evaluation and Grading:

Midterm: 20%
Debates: 10%
Final exam: 20%
Presentation: 20%
Essay: 30%

Lecture content (preliminary):

1. Genome structure in prokaryotes and eukaryotes
2. Endosymbiosis and the chimeric origin of cells
3. Gene duplication and polyploidization

4. Birth and early history of genome sequencing
5. Modern high throughput sequencing technologies
6. Genome assembly and gene prediction methods

7. Similarity searching and BLAST
8. Multiple sequence alignment and databases
9. Phylogenetics
10. Phylogenomics
11. Horizontal gene transfer in prokaryotes
12. Horizontal gene transfer in eukaryotes
13. Debate 1 (e.g., Does horizontal gene transfer disqualify the concept of a tree of life?)
14. Mid-term exam
15. Functional genomics (RNA-seq)
16. Role of small RNAs in the genome
17. Functional genomics (methylomics)
18. Single cell genomics
19. Human disease genomics
20. Metagenomics
21. Debate 2 (e.g., Is personal genomics a savior or a threat to privacy?)
22. Student presentations
23. Student presentations
24. Student presentations
25. Student presentations
26. Final exam