BIOL 274 – Introduction to Bioinformatics – Fall 2014

Instructor: Eric S. Ho (hoe@lafayette.edu)
Office: Kunkel 13
Office hours: TTh 2-4 pm

Lecture: MWF 11:00-11:50 am, Venue: Kunkel 102
Lab: M/W 1:10-4:00 pm, Venue: Kunkel 313B

Course Description:
"Emerging technologies such as synthetic biology, proteomics, and information technologies, including bioinformatics and computational biology, have the potential to create a vibrant bioeconomy" – National Bioeconomy Blueprint, April 2012, The White House, Washington, p.15.

The integration of genomic and information technologies makes many once thought unattainable scientific pursuits possible such as the human genome project. The era of bioinformatics has arrived. Fusing experimental and computational methods in studying complex biological questions becomes a routine process for today's biologists.

This course provides a comprehensive overview of bioinformatics – the application of computational and information sciences in studying biology. The focus is to learn prevalent computational approaches used by biologists. Major topics include DNA/RNA/Protein sequence analysis, biological databases, gene expression analysis, protein structure, molecular phylogeny, and system biology. Basic understanding of statistics is preferable but not mandatory. No prior computer programming knowledge is required and no general-purpose computer programming will be taught in this course.

Additionally, lab classes are coupled with major topics discussed in lectures. The purpose is to provides students hands-on experience in using biological databases and tools to investigate a real biological problem such as identifying exons and introns of a novel sequence, highlighting the active sites of a protein structure, etc.

Learning Outcomes:
At the completion of this course, students should be able to:
- Harness tools and databases to unlock biological information encoded in biomolecules
- Conduct sequence analysis
- Visualize and compare genomes from different species
- Identify special purpose databases in supporting their biological research
- Analyze high throughput gene expression data
- Utilize modeling tools to understand protein folding
- Construct phylogenetic trees using DNA/protein sequences
- Obtain a quantitative picture of how genes interact in a network

Prerequisites:
BIOL 101 or 102

Grading Policy:

- ~~10~~ 9 labs (total ~~40~~ 36%)
- Two in-class exams (15% each) and a cumulative final exam (~~30~~ 34%) (total ~~60~~ 64%)

Students are required to submit the lab report after each lab. Unless otherwise specified, lab reports must be done individually and they are due in a week after the lab.

Grading policy for late lab report:

- If submission is late but within 24 hours of due time, it will be graded but 50% of the actual earned points will be deducted. E.g. the lab report scored 2 points out of 4, only 1 point will be given.
- If submission is late by more than 24 hours of due time, it will not be graded and receive a zero for that lab report.

Two written exams will be scheduled during regular class time. Dates are listed in the timetable included at the end of this document. There is a cumulative final exam. All exams are conducted in closed book/notes format. Tested materials are based on lectures, reading assignments, and lab works. Past exam questions and extra practice problems will be posted in Moodle.

Final grade is based on the percentage of total points earned for the course i.e. exams and lab reports. Letter grades are assigned according to the following scale:

A	93-100%	C	73-76
A-	90-92	C-	70-72
B+	87-89	D+	67-69
B	83-86	D	63-66
B-	80-82	D-	60-62
C+	77-79	F	0-59

Course Materials:

Required Textbook

Understanding bioinformatics. Marketa Zvelebil, Jeremy O. Baum. Garland Science.

Additional Materials

In order to save trees, lecture slides, reading materials, supplement notes, and assignments will be disseminated through Moodle. Students are expected to check the course's Moodle site regularly.

Attendance Policy:

Attendance and class participation are critical to learning. Although attendance will not be taken for lectures, statistics tells that attendance highly correlates with the final grade. If there is in-class quiz, absentees will receive a zero for that quiz.

Federal Credit Hour Policy:
The student work in this course is in full compliance with the federal definition of a four [two or one as appropriate for half and quarter unit courses] credit hour course. Please see the Registrar's Office web site (http://registrar.lafayette.edu/additional-resources/cep-course-proposal/) for the full policy and practice statement.

Academic Honesty:
You are expected to abide by the college policy on Intellectual Honesty (see Student Handbook p.7).

Disability Statement:
In compliance with Lafayette College policy and equal access laws, I am available to discuss appropriate academic accommodations that you may require as a student with a disability. Requests for academic accommodations need to be made during the first two weeks of the semester, except for unusual circumstances, so arrangements can be made. Students must register with the Office of the Dean of the College for disability verification and for determination of reasonable academic accommodations.

Privacy Policy:
Moodle contains student information that is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure to unauthorized parties violates federal privacy laws. Courses using Moodle will make student information visible to other students in this class. Please remember that this information is protected by these federal privacy laws and must not be shared with anyone outside the class. Questions can be referred to the Registrar's Office.

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Tentative Schedule for Lectures & Reading Assignment:

Week	Date	Major Topics	Assigned Reading
1	Aug 25	Introduction and overview of the course	
	Aug 27	The structure of DNA and RNA	Ch1 no evolution
	Aug 29	The structure of DNA and RNA	
2	Sep 1	The Central Dogma	
	Sep 3	The Central Dogma & Biological databases	Ch3.3
	Sep 5	Biological databases	
3	Sep 8	Biological databases demo	
	Sep 10	Pairwise sequence alignment	Ch4
	Sep 12	Dotplot & MSA	Ch5.1
4	Sep 15	MSA & BLAST	Ch5.3-5
	Sep 17	BLAST report	
	Sep 19	BLAST & Score matrices	
5	Sep 22	Score matrices	
	Sep 24	Mini-review	
	Sep 26	Exam 1 (covers Aug 25- Sep 22)	
6	Sep 29	Exam1 review	Ch9
	Oct 1	BLAST search	
	Oct 3	Comparative genomics	
7	Oct 6	Gene finding	Ch10
	Oct 8	Hidden Markov Model	
	Oct 10	Hidden Markov Model	
8	Oct 13	- Fall break -	
	Oct 15	Genome organization	Ch15.1
	Oct 17	Gene expression analysis	
9	Oct 20	DNA Microarray	
	Oct 22	DNA Microarray data analysis	Ch2
	Oct 24	t-statistic and t-test	
10	Oct 27	Clustering	Ch12
	Oct 29	NGS	Ch13.3-4
	Oct 31	NGS	Ch15.2
11	Nov 3	Mini-review	
	Nov 5	Amino acids	
	Nov 7	Protein structure	Ch6.4-5
12	Nov 10	Protein structure + PDB video	Ch1-evolution, Ch8.1
	Nov 12	Exam2	Ch8.2-5
	Nov 14	Phylogenetic trees	Phylo handouts
13	Nov 17	Exam 2 review	
	Nov 19	Phylogenetic trees	
	Nov 21	UPGMA	
14	Nov 24	Neighbor joining tree	
	Nov 27	- Thanksgiving -	
	Nov 29	- Thanksgiving -	
15	Dec 1	NJ tree	
	Dec 3	Maximum likelihood	
	Dec 6	ML Tree	Final Exam (to be scheduled)

Tentative Lab Schedule:

Week	Major Topics
1	No lab – first week
2	Lab1 – Movie week
3	Lab2 – Biological information in NCBI
4	Lab3 - DNA & protein sequence alignments
5	No lab – Exam 1
6	Lab4 - BLASTn, BLASTp, BLASTx, tBLASTn
7	Lab5 – Genome Browser
8	No lab – Fall break
9	Lab6 - Computational gene prediction
10	Lab7 – Sequencing technologies
11	No lab – Exam 2
12	Lab8 – Protein visualization
13	No lab
14	No lab - Thanksgiving
15	Lab9 - Building phylogenetic trees

Useful Links:

1. Lecture notes, additional reading materials, quizzes, and announcements are disseminated through Moodle http://moodle.lafayette.edu
2. NCBI educational resources: http://www.ncbi.nlm.nih.gov/education/
3. Biomedical literatures database, PubMed: http://www.ncbi.nlm.nih.gov/pubmed/
4. Web of Science: http://0-webofknowledge.com.libcat.lafayette.edu/WOS
5. Understanding evolution: http://evolution.berkeley.edu/evolibrary/article/evo_01
6. Chimera tutorials: http://www.cgl.ucsf.edu/chimera/tutorials.html
7. NetLogo: http://ccl.northwestern.edu/netlogo/