INTRODUCTION TO BIOINFORMATICS (Fall 2013)

Undergraduate: BIOL 47800 (3 credits)
Graduate: BIOL 59500-12 (4 credits)

Instructor: Michael Gribskov (gribskov@purdue.edu)
Hockmeyer 331, 494-6933; office hours TBA and by appointment
Time & Place: MWF, 12:30 - 1:20 pm, Lilly G420

Graduate and undergraduate students attend the same lectures and take the same exams. The undergraduate section of the course is intended for juniors and seniors from various science backgrounds. Graduate students also participate in a literature-based seminar with Dr. Gribskov (time to be arranged), in which they will learn to read and critically analyze bioinformatics research literature.

Course Description: Bioinformatics is broadly defined as the computational study of biological information, particularly targeting the enormous volume of information in DNA and protein sequences, gene expression data, protein structure and function, and networks describing interactions of cellular components. Topics in this course will include understanding how sequences of DNA and proteins are used to understand biological function, the structure and function of proteins, the dynamics of gene expression (transcriptomics), and the interactions of pathways and processes (systems biology). Bioinformatics is interdisciplinary, melding biology with applications of computer science and statistics. This course introduces analytical methods from biology, statistics and computer science that are necessary for bioinformatic investigations, and demonstrates some applications of these methods to biological problems.

Biol47800 provides a survey of the major areas of bioinformatics at the macromolecular level. There are many interesting areas of bioinformatics that we won't be able to cover in a semester, such as cellular modeling, organismal interactions, and ecology. The course material is divided into four sections:

- Genomics (DNA and protein sequence analysis, genome sequencing)
- Evolution and Phylogenetics
- Protein structure
- Systems Biology

Prerequisites: Background in both biology and computer science is helpful in this course. Background in molecular biology as represented by BIOL 24100 or 41500, and background in computer science as represented by CS 15800, 15900, 17700, 18000 or an equivalent first-year introductory programming course is desirable. Students who have not achieved grades of C or better in these courses should consult with the instructor. Admission for students who have not taken these courses is also possible by consent of the instructor.

Course Activities

Regular lectures: Unless indicated on the schedule below all classes will be regular lectures. Readings for the next lecture will be announced before each lecture, usually well in advance. I expect that you will have read the assigned material before the lecture and be prepared to discuss it if called on to do so. See *Course Materials* below for a description of the text and background references.

Homework: Homework assignments, generally weekly. Generally homework assignments will be published on Friday, and will be due the following Friday, *e.g.*, published on blackboard 24 August, due 31 August.

Exams: Two midterms are tentatively scheduled for 27 September and 8 November. The exams will be closed book. Calculators and computers are not allowed. The material to be covered will be described in detail in class. Each midterm will each emphasize material covered during the relevant portion of the class, but the second will include some material from the first exam. The final exam will be comprehensive, emphasizing, but not be limited to, the material covered since the second midterm. My general policy is to include questions on which students did poorly on previous exams.

Quizzes: There will be at least two quizzes. Each quiz will last 20-30 minutes. Quizzes will be closed book, closed notes and no calculators or computers.

Assessment and Grading: Grades in the course will be based on two midterms and one final exam, two quizzes homework assignments, and extra credit assignments. An approximate breakdown of points follows (note that this distribution may vary somewhat):

Activity	**Points Each**	**Points Overall**
Final	300	300
Midterms	100	200
Homework	20	240
Quizes	30	60
Total		800

Note: If the grade on the Final is better than the grade on one of the Midterms, the grade on the final can replace one Midterm, making the Final worth 400 points. Letter grades will be awarded based on the following performance minima

Grade	Total Points	Grade	Total Points	Grade	Total Points	Grade	Total Points
A+	95%	B+	83%	C+	73%	D	50%
A	90%	B	77%	C	67%	F	<50%
A-	85%	B-	75%	C-	65%		

These thresholds may be adjusted downwards at the instructors' discretion so that it may be easier to get each letter grade, but the thresholds will not be raised. There will be no strict curve (everyone can earn an A, and I hope they do).

Course Policies

Attendence: Purdue expects students to be present at every class meeting. What I discuss in class is, I hope, not merely repetition of the text. You are free to make your own decision about whether attending class is valuable, but it is not the TAs or my responsibility to perform a custom lecture if you choose not to attend. If you must miss class due to sickness or conflicts, I am happy to meet with you after you have reviewed the class notes. Absences affecting exams, quizzes, or homework should be arranged in advance.

Academic behavior: Purdue University values intellectual integrity and the highest standards of academic conduct. Academic dishonesty of any kind (cheating, plagiarism, copying, use of cribs, fabrication of data, improper collaboration, etc.) is not tolerated and is grounds for failing the course (grade F) and notification of University administration for further disciplinary action. All assignments will be explicitly labeled for individual versus group effort; groups will be instructed as to the rules for collaboration. All questions about course policy and administration should be directed to the instructor.

Students with Disabilities: Any student who feels s/he may need an accommodation based on the impact of a disability should contact me privately to discuss your specific needs. Please contact the Disability Resource Center in room 830 Young Hall to coordinate reasonable accommodations for documented disabilities

Important dates and policies to note if the course proves unsuitable:

Last day to cancel a course without it appearing on your record	2Sep
Last day to withdraw with grade of W	16 Sep
Last day to withdraw from a course with W or WF	23 Oct

I realize that there are many reasons that this course may turn out to not be the right course at the right time for a student so I am happy to give a W rather than WF. You should not feel forced to stick with a course that does not meet your needs.

Course Materials

Course Web Page: http://blackboard.purdue.edu

Primary Text:
Understanding Bioinformatics
Zvelebil and Baum
Garland Science
ISBN: 978-0-8153-4024-9
Additional readings may be provided for specific lectures.

Biology and Biochemistry Background:

The Zvelebil book includes a certain amount of basic biological background for those who haven't taken biology for some time. For more detail, a general text on biochemistry or molecular biology should be consulted. An excellent text to refresh your knowledge of the biochemistry underlying bioinformatics. is

Berg, Jeremy M. 2006. Biochemistry. Sixth Edition. W. H. Freeman. ISBN 0-71678-724-5 (hardcover)
The Fifth Edition is also available on the web at:
http://www.ncbi.nlm.nih.gov/books/bv.fcgi?call=bv.View..ShowTOC&rid=stryer.TOC&depth=2.

Syllabus

The readings shown in the Zvelebil text are approximately aligned with the lectures in which their content will be discussed. Therefore you should read this material **BEFORE** the date shown. I'll give more details on exactly which material will be discussed in which lectures as we move along. This syllabus should be sufficiently accurate to plan your reading in advance. This schedule may be adjusted as the course progresses

Date	Lecture #	HW & Quizes Due	Lecture Topic	Zvelebil Reading
August				
19-Aug	1		Introduction, Motivating Examples	Syllabus
21-Aug	2		Tree thinking, Sequences and Evolution	Tree thinking Handout
23-Aug	3	HW1	Comparing Sequences/dotplots	Ch 4.1-4.4 Ch 5.2
26-Aug	4		Comparing Sequences/alignments	
28-Aug	5		Comparing Sequences/scoring	Ch 4.3 Ch 5.1
30-Aug	6	HW2	Comparing Sequences/scoring	Ch 4.5
September				
2-Sep	**Labor day**			
4-Sep	7	Quiz	Comparing Sequences/practical	
6-Sep	8	HW3	Searching for Sequences	Ch 4.6-4.7 Ch 5.3
9-Sep	9		Searching for Sequences	Ch 5.4
11-Sep	10		Searching for Sequences	
13-Sep	11	HW4	Sequence Motifs	Ch 4.8-4.10
16-Sep	12		Sequence Motifs	
18-Sep	13		Sequence Motifs	
20-Sep	14	HW5	Trees and Phylogeny	Ch 7 (all)
23-Sep	15		Trees and Phylogeny	Ch 8.1-8.2
25-Sep	16		Trees and Phylogeny	Ch 8.4
27-Sep			Midterm1 (blue and green material)	
30-Sep	17		Trees and Phylogeny	Ch 8.5
October				
2-Oct	18		Multiple Alignments	Ch 6.4-6.5
4-Oct	19	HW6	Multiple Alignments	
7-Oct	**October break**			
9-Oct	20		Profiles & HMMs	Ch 6.1-6.3
11-Oct	21	HW7	Profiles & HMMs	
14-Oct	22		Genome Sequencing	Ch 9 (all) Ch 10 (all except 10.1)
16-Oct	23		Genome Sequencing	Ch 5.5
18-Oct	24	Quiz	Gene Finding & Annotation	

21-Oct	25		Gene Finding & Annotation	
23-Oct	26		Gene Finding & Annotation	
25-Oct	27	HW8	Gene Finding & Annotation	
28-Oct	28		Protein Structure Prediction/Comparison	Ch 11.1-11.4 Ch 12.1-12.3
30-Oct	29		Protein Structure Prediction/Comparison	Ch 11.5-11.8 Ch 12.4-12.5
November				
1-Nov			Midterm2 (yellow material)	
4-Nov	30		Protein Modeling/Threading	Ch 13.1-13.2
6-Nov	31		Protein Modeling/Threading	
8-Nov	32	HW10	Protein Modeling/Homology	Ch 13.3-13.6
11-Nov	33		Protein Modeling/Homology	Ch 13.6
13-Nov	34		Protein Modeling/Docking	Ch 14.4
15-Nov	35	HW11	Systems Biology	Ch 17.1
18-Nov	36		Systems Biology	Ch 15.1 Ch 16.1-16.3
20-Nov	37		Systems Biology	
23-Nov	38	HW12	Systems Biology	Ch 15.2
25-Nov	39		Systems Biology	
27-Nov	**Thanksgiving**			
29-Nov				
December				
2 Dec	40		Systems Biology	Ch 17.2-17.3
5-Dec	41		Systems Biology	
7-Dec	42		Review	
			Comprehensive Final (emphasizing pink and green)	

Classroom Emergency Preparedness

EMERGENCY NOTIFICATION PROCEDURES:

- Dial 911from any public or campus telephone.
- Over 250 Emergency Telephone System (ETS)
  - For assistance push the ETS button which will connect you to the Purdue Police Department
- Immediate warning notifications focuses on two basic concepts:
  - Fire Alarms mean to immediately evacuate the building and proceed to your Emergency Assembly Area (should be specified in the Building Emergency Plan).
  - All Hazards Outdoor Emergency Warning Sirens means to immediately seek shelter (Shelter In Place) in a safe location within closest facility/building.

    "Shelter in place" means seeking immediate shelter inside a building or University residence. This course of action may need to be taken during a tornado, earthquake, release of hazardous materials in the outside air, or a civil disturbance. When you hear the sirens immediately go inside a building to a safe location and use all communication means available to find out more details about the emergency. Remain in place until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.

    (In both cases, you should seek additional clarifying information by all means possible…Purdue Home page, email alert, TV, radio, etc. Review the Purdue Emergency Warning Notification System multi-communication layers at *http://www.purdue.edu/emergency_preparedness/warning_system.htm)*

EMERGENCY RESPONSE PROCEDURES:

- Purdue's Emergency Procedures Guide should be periodically reviewed and referenced for all emergencies. Located at https://www.purdue.edu/emergency_preparedness/flipchart/index.html
- Be familiar with the Building Emergency Plan (each building is required to have a BEP) for:
  - evacuation routes, exit points, and location to report for roll call after evacuating the building.
  - when and how to evacuate the building.
  - shelter in place procedures and locations
  - additional building specific procedures and requirements.
- Understand the University's emergency warning notification system…Purdue ALERT *http://www.purdue.edu/emergency_preparedness/warning_system.htm*

EMERGENCY PREPAREDNESS AWARENESS VIDEOS

- "Shots Fired on Campus: When Lightning Strikes," is a 20-minute active shooter awareness video that illustrates what to look for and how to prepare and react to this type of incident. See: *http://www.purdue.edu/securePurdue/news/2010/emergency-preparedness-shots-fired-on-campus-video.cfm* (Link is also located on the EP website)

MORE INFORMATION

- Reference the Emergency Preparedness web site for additional information: *http://www.purdue.edu/emergency_preparedness/index.htm*