Genomic Data Analysis

(BioSci 469) – Fall 2018

Monday 2:00 – 3:40pm, LAP 271 (computer lab)

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Course Description: This course is designed for students interested in learning current techniques for the analysis of large-scale genomic data sets. High-throughput sequencing has become widespread in biology and medicine over the past decade due to both rapid technological advances and decreases in overall cost. The class will discuss study design, choice of methods, including practical issues of sequencing facilities, cost and computing resources, and then proceed to hands-on data analyses used in whole genome (re)sequencing, transcriptome analysis, and reduced-representation sequencing (e.g., RAD-seq, GBS). The schedule below gives some introductory topics. Additional topics will be covered depending on the interests of students and time available.

This course is designed to build competence in the computing and statistical methods for analyzing high-throughput genomic data. The only background assumed is a basic knowledge of statistics and genetics, familiarity with your computer and interest in learning current genomic methods. Knowledge of Linux operating systems is desirable, but not necessary. All that is required is a willingness to work hard (ie, not quit after the first [or second] error message).

Course Objectives: The primary objectives of this course are:
• to learn how genomic data are being used in biology, and evolutionary biology in particular.
• to become familiar with the software and databases available for bioinformatics
• to develop the ability to formulate and investigate genomic research questions, and to effectively communicate your questions, methods, and results.

Prerequisites: Genetics (BioSci 325 or equivalent) and Biostatistics (465 or equivalent) or consent of instructor.

Computers: Computers are not required as we will be using the computer lab in Lapham, but students can also use their own laptops if desired. Note, however, I will not be spending a lot of time troubleshooting installations on personal computers.

Readings: Papers and other readings for the introductory topics/assignments will be chosen by the instructor (some are listed below). Readings will be provided on D2L. Papers for
graduate student led discussions will be chosen by students in consultation with the instructor.

**Credits and Evaluation:** This is a 2-credit course. Grades are based on in-class assignments, the final project, and participation or presentations (graduate student only). Some assignments will need to be completed outside of class time. Final assessment is based on the cumulative grades received and a final project, as follows:

**Undergraduates:** seven in-class assignments 70% (10 pts each), Final project 20%, class participation (10%).

**Graduate students:** seven in-class assignments 56% (8 pts each), Final project 10.7%, class presentation 33.3%. Graduate students will be required to make a 20-30 min presentation to the class on a topic of interest (chosen after consulting the instructor). This is based on GFC Doc 916 (see [http://uwm.edu/graduateschool/subcommittee-graduate-course-curriculum/](http://uwm.edu/graduateschool/subcommittee-graduate-course-curriculum/)).

**Attendance and Assignment requirements:** Attendance is required at each class unless excused for documented reasons, such as sickness or other serious reasons. The penalty is a zero grade for assignments missed in that class and a deduction of 5% in the grade for other days missed, unless excused for documented reasons.

**Policy on work submitted late and missed classes:** Assignments must be completed in class, unless approved by the instructor. Note that missing classes will result in a zero for the grade for each missed in-class assignment and a deduction of 5% in the grade for other days missed, unless excused for documented reasons.

**Time investment for this course:** Students should plan to spend an average of 4 hours outside of class per week doing homework or reading in preparation for in-class assignments. This amount of time is based on the campus credit hour policy (Faculty Document # 2838); ie, two hours out-of-class work for each credit hour per week of class.

Letter grades will be assigned based on the final total points listed below.

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<thead>
<tr>
<th>Grade</th>
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<tbody>
<tr>
<td>A</td>
<td>92 – 100%</td>
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<td>71 – 75%</td>
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<tr>
<td>A-</td>
<td>89 – 91%</td>
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<td>B+</td>
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<td>C+</td>
<td>76 – 78%</td>
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**Need for Special Accommodation**
* Students who require note-taking or test-taking accommodations in order to meet any of the requirements of this course, please contact me as soon as possible to make suitable arrangements.

Schedule of Topics (tentative):

(some of these may be spread over several weeks or the order may change)

Week # and topic

1. Introduction. What is your question? DNA or RNA? What technique should I use?
2. Methods to analyze genomes, transcriptomes, meta-genomes & SNPs. What sequencers, data and software are available?
6. SNP calling / genotyping. Exercise #4. - using the dDocent pipeline & VCFtools.
7. Genome wide association studies (GWAS). Exercise #5. - using PLINK.
9. Transcriptome analysis overview. de novo or reference-guided. Sampling strategies
10. Differential gene expression. Exercise # 6. - using the new 'Tuxedo' Suite on Zika data
11. Gene ontology. Exercise # 7. - using EdgeR (Chen et al. tutorial)
12. Network analysis with KEGG, DAVID, Cytoscape etc.
13. Miscellaneous topics (Meta-genomics, Chip-Seq, SNP chips) and Overview of final homework assignment
14. Grad student presentations
15. Grad student presentations

Readings for corresponding weeks

Some of the class material is based on: “The Biostar Handbook: A Beginner’s Guide to Bioinformatics” (2017) by Istvan Albert (available online at: https://read.biostarhandbook.com/)

3. Unix primer for Biologists: http://korlab.ucdavis.edu/unix_and_Perl/


Chapters 19-21 in the Biostars handbook.


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University Guidelines of Interest


1. Students with disabilities. Notice to these students should appear prominently in the syllabus so that special accommodations are provided in a timely manner. http://www4.uwm.edu/arc

2. Religious observances. Accommodations for absences due to religious observance should be noted. http://www4.uwm.edu/secu/docs/other/S1.5.htm

3. Students called to active military duty. Accommodations for absences due to call-up of reserves to active military duty should be noted. Students: http://www4.uwm.edu/academics/military.cfm

4. Incompletes. A notation of "incomplete" may be given in lieu of a final grade to a student who has carried a subject successfully until the end of a semester but who, because of illness or other unusual and substantiated cause beyond the student's control, has been unable to take or complete the final examination or to complete some limited amount of term work. https://www4.uwm.edu/secu/docs/other/S_31_INCOMPLETE_GRADES.pdf
5. Discriminatory conduct (such as sexual harassment). Discriminatory conduct will not be tolerated by the University. It poisons the work and learning environment of the University and threatens the careers, educational experience, and well-being of students, faculty, and staff. [https://www4.uwm.edu/secu/docs/other/S_47_Discrimina_duct_Policy.pdf](https://www4.uwm.edu/secu/docs/other/S_47_Discrimina_duct_Policy.pdf)

6. Academic misconduct. Cheating on exams or plagiarism are violations of the academic honor code and carry severe sanctions, including failing a course or even suspension or dismissal from the University. [http://uwm.edu/academicaffairs/facultystaff/policies/academic-misconduct/](http://uwm.edu/academicaffairs/facultystaff/policies/academic-misconduct/)

7. Complaint procedures. Students may direct complaints to the head of the academic unit or department in which the complaint occurs. If the complaint allegedly violates a specific university policy, it may be directed to the head of the department or academic unit in which the complaint occurred or to the appropriate university office responsible for enforcing the policy. [https://www4.uwm.edu/secu/docs/other/S_47_Discrimina_duct_Policy.pdf](https://www4.uwm.edu/secu/docs/other/S_47_Discrimina_duct_Policy.pdf)

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9. Other The final exam requirement, the final exam date requirement, etc. [http://www4.uwm.edu/secu/docs/other/S22.htm](http://www4.uwm.edu/secu/docs/other/S22.htm)
Syllabus Links

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Instructional Guidelines
A. Cancellation of Classes
1. Anticipated absence from class must be accounted for by colleague coverage or some other suitable accommodation.

The attached amendments satisfy the Codification Committee’s criteria for clarity