Metagenomics 487 / 587

Interactive Learning Center 135; Tuesday and Thursday 12:30-1:45pm

Description of Course

Environmental genomics is revolutionizing our understanding of microbes from the environment to human health. At its core are new molecular methods called metagenomics to sequence DNA directly from an environment, capturing the genetic signature of entire microbial community and bypassing culture. Modern (Next-Gen) sequencing technologies produce massive sequence datasets that allow for these new insights, but also present new computational hurdles in interpreting data. This hands-on course teaches students the biological concepts behind working with genetic data from these complex communities, and practical bioinformatics approaches for analyzing data. Students work in a collaborative learning classroom to gain skills in (1) beginning Unix and python, (2) bioinformatics techniques for analyzing large-scale metagenomic datasets, and (3) high-performance computing for bioinformatics. These skills are taught by implementing a real-world metagenomics project to understand how genes, pathways, and environmental context can be translated into ecosystem-level knowledge.

Course Prerequisites or Co-requisites

MCB 181 Introductory Biology is required. MCB 416 Bioinformatics and Genomic Analysis, ABE 201 Introduction to Biosystems Engineering and MIC 205 General Microbiology are recommended.

Instructor and Contact Information

Instructor: Bonnie Hurwitz, PhD, Assistant Professor

Office: Shantz 624

Phone: 520-626-9819

E-mail: bhurwitz@email.arizona.edu

Office Hours: F 9:00am – 10:00am (and by appointment only)

Course Website: http://www.hurwitzlab.org/abe_487_2017

Course Format and Teaching Methods

The course is designed based on a weekly Learning Cycle format of Concept Exploration (Tuesdays; Metagenomics concepts) and Concept Application (Thursdays; Bioinformatics and Computation). Each component will have in-class assignments and homework to augment course learning objectives

Course Objectives and Expected Learning Outcomes

This course is designed to provide students with a foundational understanding of metagenomics and bioinformatics in a project-based collaborative work environment to: (a) understand metagenomic experimental design and concepts; (b) implement bioinformatics analyses using real-world metagenomes

from complex community samples, and (c) conduct and interpret results from bioinformatics analyses.

Absence and Class Participation Policy

Participating in the course and attending lectures and other course events are vital to the learning process. As such, attendance is required at all lectures and discussion section meetings. Students who miss class due to illness or emergency are required to bring documentation from their health-care provider or other relevant, professional third parties. Failure to submit third-party documentation will result in unexcused absences.

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, http://policy.arizona.edu/human-resources/religious-accommodation-policy.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: https://deanofstudents.arizona.edu/absences

Makeup Policy for Students Who Register Late

Students who register after the first class meeting may make up missed assignments/quizzes by the deadline 9/5/17.

Course Communications

Online communication, quizzes, and grading will be conducted through D2L. Course materials (reading, homework assignments, homework answers, and lectures) will also be available through the course website and D2L. Computational assignments will be turned in using github (http://github.com). Metagenomics assignments will be turned in using D2L. Example bioinformatics protocols will be available in protocols.io (https://www.protocols.io/groups/metafunc-course-2017).

Required Texts or Readings

A Primer on Metagenomics, PLoS Computational Biology, Wooley et al. 2010.

Beginning Python, Apress, Hetland, 2017.

All texts are available free of charge, required sections will be listed on the course website calendar and D2L. Additional required readings will be listed weekly on the course website and D2L.

Required or Special Materials

Students will be required to use protocols.io, the UA high-performance compute cluster and Github for completing and turning in assignments. Information on accessing these resources can be found under Getting Started. We walk-through these resources in-class during the first and second week of the course.

Required Extracurricular, Activities

Optional software carpentry workshops and events related to metagenomics and bioinformatics will be listed on the group site on protocols.io and announced in D2L.

Grading Scale and Policies

The final letter grades for the class are based on the TOTAL NUMBER OF POINTS that each student accumulates for the following assessments (see details for each section below):

30% Metagenomics term project (15 assignments, 20 pts each; 300 points total)

10% Metagenomics journal club (100 points)

10% Metagenomics final exam (100 points)

30% Computational homework (10 assignments, 30 pts each; 300 points total)

20% Computational quizzes (10 quizzes, 20 pts each; 200 points total)

University policy regarding grades and grading systems is available at http://catalog.arizona.edu/policy/grades-and-grading-system.

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

Dispute of Grade Policy: Disputes on a grade for an assignment, quiz, or exam must be made within three days of when the grade is posted.

Assignments and Examinations

All assignments, quizzes and examinations are listed in the course schedule on the class website and on D2L.

Metagenomics Term Project (30%)

300 points total: 15 bioinformatics assignments (20 pts each)

Term project theme: this year's groups will focus on metagenomics research in the Human and Earth microbiome. Each student will select a focus area (human or earth), and will work in a team (of two) where the team will compare and contrast two "biological states" from a recent metagenomics paper (potential papers will be posted for students to select from). Each student will be responsible for executing all of the analyses associated with one "biological state" independently, but will compare and contrast these results with their teammate in a final analysis (e.g. pristine vs polluted, healthy gut vs colon cancer). Each of the analyses will be demonstrated using a set of protocols from the skin microbiome comparing body sites in a single individual over two time points (in the class group on Protocols.io). See class schedule for assignments, links to protocols and due dates. All project assignments will be turned in using D2L.

Metagenomics Journal Club (10%)

100 points total: in-class presentation + participation (50 pts) and write-up (50 pts)

Metagenomics journal club presentations (50 pts): Undergraduates will be required to give a 5-minute

"lightning talk" on a metagenomics paper of their choice in their focus area. The paper must include an analysis from samples that were sequenced using whole genome shotgun sequencing (WGS).

Graduate students will be required to give a 15-minute talk on metagenomics for a specific topic associated with their focus area (e.g. nutrition and the gut microbiome). The talk should summarize recent metagenomics literature in this topic area.

All students are expected to participate in discussions following each talk.

Journal club write-up (50 pts): Undergraduates will be required to turn in a 1-page summary of the paper they presented in-class. Graduate students will be required to turn in a 5-page review article summarizing the literature in their metagenomics focus area.

Computational Homework (30%)

300 points total: 10 computational homework assignments (30 pts each)

Computational homework: computational homework will be assigned each Thursday and is due the following Thursday. The computational homework provides you with practice in scripting and the Unix command line. The homework will also prepare you for the 10-minute in-class quizzes each Thursday (as noted in the schedule). Homework is turned in by committing your code to Github in a repository that is shared with the instructor(s). At 12:30pm on the day assignments are due, we will download your code from Github. To receive credit for the assignment, your code must compile without syntax errors, and produce the "expected output" provided with the assignment (no logic errors). The final output for your program must match the expected output verbatim. We will provide a "make-test" suite, so you can check you code prior to turning it in. If any of the tests fail, you will not receive credit for the assignment. We encourage group work, but be sure the code you turn-in has been independently written. We check for plagiarism using a script that compares your code to all other students to find statistically significant similarities (see Code of Academic Integrity below).

Computational Quizzes (20%)

200 points total: 10 computational quizzes (20 pts each)

Computational quizzes: each week you will be tested on the computational homework from the previous week. Each of the quizzes will be multiple choice on D2L and in-class during the first 10 minutes of class on Thursdays. Correct answers for each quiz question are randomized in D2L.

Final Examination

The final exam is on December 8th, 2017 1-3pm.

Metagenomics Final Exam (10%)

100 points total. The final exam will focus on keys concepts in metagenomics discussed throughout the class in the metagenomics section. The core concepts will be highlighted each week as expected learning outcomes. No computational or applied bioinformatics analyses will be on the exam.

Final Exam Schedule: http://www.registrar.arizona.edu/schedules/finals.htm

Final Exam Regulations:

https://www.registrar.arizona.edu/courses/final-examination-regulations-and-information

Scheduled Topics/Activities

See the weekly schedule for assignment due dates, quiz and exam dates.

Honors Credit

Students wishing to contract this course for Honors Credit should email me to set up an appointment to discuss the terms of the contract. Information on Honors Contracts can be found at http://www.honors.arizona.edu/faculty-and-advisors/contracts.

Classroom Behavior Policy

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Threatening Behavior Policy

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

Accessibility and Accommodations

Our goal in this classroom is that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center (520-621-3268) to establish reasonable accommodations. For additional information on the Disability Resource Center and reasonable accommodations, please visit http://drc.arizona.edu.

If you have reasonable accommodations, please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Code of Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.

The University Libraries have some excellent tips for avoiding plagiarism, available at http://new.library.arizona.edu/research/citing/plagiarism.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct

Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

UA Nondiscrimination and Anti-harassment Policy

The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Additional Resources for Students

UA Academic policies and procedures are available at http://catalog.arizona.edu/policies

Student Assistance and Advocacy information is available at http://deanofstudents.arizona.edu/student-assistance/students/student-assistance

Confidentiality of Student Records

http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa

Subject to Change Statement

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.