PURDUE
UNIVERSITY

DEPARTMENT OF BIOCHEMISTRY

BCHM 521 – Comparative Genomics
Spring, 2021

Instructor Dr. Jen Wisecaver
  pronouns: she/her/hers
  office: BCHM A343C
  TEL: 494-4157
  e-mail: jwisecav@purdue.edu

Course TA Kate Eastman
  pronouns: she/her/hers
  office: BCHM A343A
  e-mail: eastman@purdue.edu

Course Information

Meeting day(s) and time: Tuesday and Thursdays 9:30 – 11:20 AM

Instructional Modality: Synchronous Online *(For students needing to use a campus computer for lab activities, the computer lab in NLSN 1225 has been reserved for our class on Tuesdays and Thursdays from 10:30 – 11:20 AM)*

Course credit hours: 3

Prerequisites: Undergraduates must have 1 or more credit hours of BCHM498 (Research in Biochemistry) or equivalent independent research credit.

Course Objectives

This course provides a basic understanding of the forces that act on genome content and organization, and the ability to interpret genetic variation between genomes. You will acquire skills to utilize public genome databases, visualize genomic regions/features of interest using a genome browser, and perform phylogenetic analysis.

The knowledge you gain here is central within the fields of genetics, bioinformatics, microbiology, and evolutionary biology and have important applications in numerous related fields including medicine, biotechnology, agriculture, and ecology.

Learning Outcomes

After completing the course, students will be able to:

- **Understand the basic structure of genomes and the processes that cause genomes to vary over time.**
    - Method of evaluation: Quizzes, participation in weekly discussions

- **Describe the evolutionary history of genes and how evolution influences our ability to predict gene function.**
    - Method of evaluation: Quizzes, participation in weekly discussions

- **Use the campus computer cluster to evaluate and employ common programs for genome interpretation and analysis**
    - Method of evaluation: Homework assignments, independent research project

- **Design and implement an independent research project and educate others on the background and significance of the project**
    - Method of evaluation: Independent research project

- **Value the diversity and complexity of genomes across the tree of life**
    - Method of evaluation: Quizzes, participation in weekly discussions

Learning Resources, Technology & Texts

Brightspace: Access the course via Purdue's Brightspace learning management system. Begin with the Start Here tab, which describes how the course Brightspace is organized. It is strongly suggested that you explore and become familiar not only with the site navigation but with content and resources available for this course. See the Student Services widget on the campus homepage for resources such as Technology Help, Academic Help, Campus Resources, and Protect Purdue

Textbook: There is no required textbook for this course.

Required readings: As a graduate level course, readings will typically draw from the primary literature (research articles, opinions, and reviews). We will read approximately 1-2 articles a week. Reading assignments will be posted on Brightspace under the relevant learning module.

Microsoft Teams: Synchronous sessions will take place using Microsoft Teams. You can access Microsoft Teams via login at https://portal.office.com or with your Purdue career account email address and password. Links to the virtual meetings will be emailed and posted on Brightspace.

Scholar Campus Computer Cluster: Comparative genomics is a field of biological research wholly reliant on the high performance computer clusters (HPCCs). Over the course of the semester you

will handle gigabytes, perhaps even terabytes, of data requiring more computer memory, more compute cores, and more storage disk space than is available on most personal computers. To overcome this computational bottleneck, Purdue Research Computing (RCAC) maintains the Scholar HPCC for classroom learning. You will be given access to the Scholar HPCC the week before instruction starts, and you will learn how to log on to the HPCC during our first lab activity.

Other Technology Requirements

- A reliable internet connection - capable of consistently streaming video and stable enough to finish short exams without dropping connection.
- Headset/Microphone (for synchronous sessions)
- Word Processor and presentation program (e.g., MS Word and PowerPoint). Note that MS Office is free for all students.

Assessment

The grading for this course will be as follows:

	Points
Quizzes (10 pts each)*	100
Lab homework (10 pts each)*	100
Independent Research Project (see below)	100
Class Participation and Attendance	6-12 bonus points
Total	**300**

* There will be 11 quizzes and 11 assignments each worth 10 pts each. The lowest score from each category will be dropped.

Independent Research Project: Credit for the research project will be broken up into multiple assignments

	Points
Project significance and problem statement	10
Methods Writeup	10
Draft report for peer review	10
Peer review comments	10
Final research presentation	30
Final research written report	30
Total	**100**

Extra credit: Class attendance and participation is the only way to achieve extra credit. No exceptions will be made.

Getting Help

Kate and I are both passionate about comparative genomics and we want you to learn the material presented in this course!

During/After Class: I will hang around after all synchronous sessions on Microsoft Teams to answer questions. Teams has a group chat function that is saved after the meeting ends. I encourage

you all to utilize this chat to post questions as you think of them. Kate will be monitoring the chat to answer questions in real time and take note of questions for me to answer at the end of class.

Office Hours: I will be in my office in the Biochemistry Building BCHM A343C from 11:30 – 12:30 on Tuesdays and Thursdays. I'm happy to meet face-to-face with students individually during that time. **Please let me know in advance** so that we don't have too many students in the lab at once. Face masks are required at all times.

Brightspace forums: Each learning module on Brightspace will have a discussion forum for questions. Please utilize this resource to get help from me, Kate, and your peers.

Email: You can always get help from me or from Kate via e-mail. We will respond to email questions by the end of the next business day. You can also email either of us to set up a face-to-face meeting for additional help.

Grading Scale

The cutoff values for letter grades are as follows:

Grade	Points
A	300 – 270
B	269 – 240
C	239 – 210
D	209 – 180
F	179 or less

Regrade Requests

If you disagree with the way any of your exams have been graded, please consult the grading key and then discuss them with the TA. In the event this does not resolve your concerns, you may email me to schedule an appointment to discuss.

Requests for re-grades must be submitted no later than the end of the second-class period after the graded test or assignment has been returned.

Missing an Assignment or Quiz

Assignments must be turned in by the beginning of class on the day that they are due. Failure to turn assignments in on time will result in docked points (20% per day late). Assignments will not be accepted if greater than two days late. Missing an assignment or exam will result in a grade of 0 being recorded unless documented justification for the absence is presented. Any request to be excused from an assignment/exam must include official documentation (doctor's note, request from academic advisor, etc) explaining why the assignment was or will be missed.

Online Course Evaluations

During the last two weeks of the semester, you will be provided an opportunity to evaluate this course. To this end, Purdue has transitioned to online course evaluations. On Monday of the fifteenth week of classes, you will receive an official email from evaluation administrators with a link to the online evaluation site. You will have two weeks to complete this evaluation. Your participation in this evaluation is an integral part of this course, and your feedback is vital to improving education at Purdue University. I strongly urge you to participate in the evaluation system.

Attendance Policy during COVID-19

Students are expected to attend all synchronous sessions unless they are ill or otherwise unable to attend class. If they feel ill, have any symptoms associated with COVID-19, or suspect they have been exposed to the virus, students should stay home and contact the Protect Purdue Health Center (496-INFO).

In the current context of COVID-19, online attendance cannot be a factor in the final grades. **However,** timely completion of online assignments and class participation (via synchronous class discussion or web forums) is still expected. Students need to inform the instructor of any conflict that can be anticipated and will affect the timely submission of an assignment or quiz.

Classroom engagement is extremely important and associated with your overall success in the course. The importance and value of course engagement and ways in which you can engage with the course content even if you are in quarantine or isolation, will be discussed at the beginning of the semester.

Only the instructor can excuse a student from a course requirement or responsibility. When conflicts can be anticipated, such as for many University-sponsored activities and religious observations, the student should inform the instructor of the situation as far in advance as possible. For unanticipated or emergency conflicts, when advance notification to an instructor is not possible, the student should contact the instructor/instructional team as soon as possible by email, through Brightspace, or by phone. In cases of bereavement, quarantine, or isolation, the student or the student's representative should contact the Office of the Dean of Students via email or phone at 765-494-1747.

Academic Guidance in the Event a Student is Quarantined/Isolated

This class will take place entirely online. If you must quarantine or isolate at any point in time during the semester, you are still expected to continue with the course material. Importantly, if you find yourself too sick to progress in the course, notify your academic case manager and notify me via email or Brightspace. We will make arrangements based on your particular situation.

Classroom Guidance Regarding Protect Purdue

"The Protect Purdue Plan, which includes the Protect Purdue Pledge, is campus policy and as such all members of the Purdue community must comply with the required health and safety guidelines. Required behaviors in this class include: staying home and contacting the Protect Purdue Health Center (496-INFO) if you feel ill or know you have been exposed to the virus, properly wearing a mask in classrooms and campus building, at all times (e.g., mask covers nose and mouth, no eating/drinking in the classroom), disinfecting desk/workspace before and after use, maintaining appropriate social distancing with peers and instructors (including when entering/exiting classrooms), refraining from moving furniture, avoiding shared use of personal items, maintaining robust hygiene (e.g., handwashing, disposal of tissues) prior to, during and after class, and following all safety directions from the instructor.

Students who are not engaging in these behaviors (e.g., wearing a mask) will be offered the opportunity to comply. If non-compliance continues, possible results include instructors asking the student to leave class and instructors dismissing the whole class. Students who do not comply with the required health behaviors are violating the University Code of Conduct and will be reported to the Dean of Students Office with sanctions ranging from educational requirements to dismissal from the university.

Any student who has substantial reason to believe that another person in a campus room (e.g., classroom) is threatening the safety of others by not complying (e.g., not properly wearing a mask) may leave the room without consequence. The student is encouraged to report the behavior to and discuss the next steps with their instructor. Students also have the option of reporting the behavior to the Office of the Student Rights and Responsibilities. See also Purdue University Bill of Student Rights."

Academic Integrity

Academic misconduct of any kind will not be tolerated in any course offered by the Department of Biochemistry. Information on Purdue's policies with regard to academic misconduct can be found at http://www.purdue.edu/studentregulations/student_conduct/regulations.html

Any incidence of academic misconduct will be reported to the Office of the Dean of Students. Academic misconduct may result in disciplinary sanctions including expulsion, suspension, probated suspension, disciplinary probation, and/or educational sanctions. In addition, such misconduct will result in punitive grading such as:
- receiving a lower or failing grade on the assignment, or
- assessing a lower or failing grade for the course

Punitive grading decisions will be made after consultation with the Office of the Dean of Students. Please note reported incidences of academic misconduct go on record for reference by other instructors. Further, a record of academic misconduct is likely to influence how current/future situations are handled.

To provide you with an unambiguous definition of academic misconduct, the following text has been excerpted from "Academic Integrity: A Guide for Students", written by Stephen Akers, Ph.D., Executive Associate Dean of Students (1995, Revised 1999, 2003), and published by the Office of the Dean of Students in cooperation with Purdue Student Government, Schleman Hall of Student Services, Room 207, 475 Stadium Mall Drive West Lafayette, IN 47907-2050.

"Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, Student Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]

More specifically, the following are a few examples of academic dishonesty which have been discovered at Purdue University.
- substituting on an exam for another student
- substituting in a course for another student
- paying someone else to write a paper and submitting it as one's own work
- giving or receiving answers by use of signals during an exam
- copying with or without the other person's knowledge during an exam
- doing class assignments for someone else
- plagiarizing published material, class assignments, or lab reports
- turning in a paper that has been purchased from a commercial research firm or obtained from the internet
- padding items of a bibliography
- obtaining an unauthorized copy of a test in advance of its scheduled administration
- using unauthorized notes during an exam
- collaborating with other students on assignments when it is not allowed
- obtaining a test from the exam site, completing and submitting it later
- altering answers on a scored test and submitting it for a regrade
- accessing and altering grade records
- stealing class assignments from other students and submitting them as one's own
- fabricating data
- destroying or stealing the work of other students

Plagiarism is a special kind of academic dishonesty in which one person steals another person's ideas or words and falsely presents them as the plagiarist's own product. This is most likely to occur in the following ways:
- using the exact language of someone else without the use of quotation marks and without giving proper credit to the author
- presenting the sequence of ideas or arranging the material of someone else even though such is expressed in one's own words, without giving appropriate acknowledgment
- submitting a document written by someone else but representing it as one's own"

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern.

Purdue's Honor Pledge was developed by students to advance a supportive environment that promotes academic integrity and excellence. It is intended that this pledge inspires Boilermakers of

all generations to stay "on track" to themselves and their University. "As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue."

Notice of Copywrite Protection of Course Materials

Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.

Notes taken in class are, however, generally considered to be "derivative works" of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the course instructor. To obtain permission to sell or barter notes, the individual wishing to sell or barter the notes must be registered in the course or must be an approved visitor to the class. Course instructors may choose to grant or not grant such permission at their own discretion, and may require a review of the notes prior to their being sold or bartered. If they do grant such permission, they may revoke it at any time, if they so choose.

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. To get information about changes in this course consult the class Brightspace site or e-mail or phone the instructor.

Accessibility and Accommodations

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are encouraged to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

Nondiscrimination Policy

Purdue University's non-discrimination policy will be upheld in this classroom. Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The

University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life.

Purdue University views, evaluates, and treats all persons in any University related activity or circumstance in which they may be involved, solely as individuals on the basis of their own personal abilities, qualifications, and other relevant characteristics.

In this course, each voice in the classroom has something of value to contribute. Please take care to respect the different experiences, beliefs and values expressed by students and staff involved in this course. We support Purdue's commitment to diversity, and welcome individuals of all ages, backgrounds, citizenships, disability, sex, education, ethnicities, family statuses, genders, gender identities, geographical locations, languages, military experience, political views, races, religions, sexual orientations, socioeconomic statuses, and work experiences

For more information, see http://www.purdue.edu/purdue/ea_eou_statement.html.

Mental Health and Wellness

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack**.** Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Lecture Schedule[1]

Date	Lecture Topic	Lab Activity	Quiz[2]	HW[3]	Research Project
Jan-19	Introductions - Me	Getting started on the HPC			Share your idea(s) for a research project in HW1
Jan-21	Introductions - You	Jupyter notebook & markdown		HW 1.1	
Jan-26	Homology	Unix Basics		HW 1.2	
Jan-28	Prokaryotic genomes	Unix Basics Cont.	Quiz 1.1		
Feb-2	Eukaryotic genomes	IGV Genome Viewer		HW 1.3	
Feb-4	Point Mutations	SLURM and HPC queues	Quiz 1.2	HW 1.4	
Feb-9	Single Nucleotide Variation	DNA Sequence Alignments		HW 1.5	
Feb-11	Population Genomics - GWAS	Calling SNPs	Quiz 2.1		
Feb-16	Population Genomics - Fst	Calculating Fst		HW 2.1	
Feb-18	Case Study – Whales	Features of a compelling abstract	Quiz 2.2		
Feb-23	Discussion – Anthropology	Open time for research projects		HW 2.2	
Feb-25	Structural Variation	Structural Variation in IGV	Quiz 2.3		
Mar-2	Sequence Alignment	BLAST and HMMER			Project significance and problem statement (Due Mar-2)
Mar-4	Pan Genomes and Synteny	Mummer and Mauve			
Mar-9	Functional Annotation	Interproscan	Quiz 3.1	HW 3.1	
Mar-11	Metabolic Gene Clusters	AntiSMASH			
Mar-16	Horizontal Gene Transfer	Open time for research projects	Quiz 3.2	HW 3.2	
Mar-18	READING DAY	NO CLASS			

[1] This schedule is subject to change.
[2] Quizzes must be completed on Brightspace prior to the beginning of class.
[3] Homework must be submitted on Brightspace prior to the beginning of class.

Date	Lecture Topic	Lab Activity	Quiz[2]	HW[3]	Research Project
Mar-23	Gene Dup & Gene Fates	Reciprocal Best Blast			
Mar-25	Orthogroups	OrthoFinder	Quiz 4.1		
Mar-30	Orthogroups Cont.	Multiple sequence alignment		HW 4.1	
Apr-1	Phylogenetics	Building phylogenetic trees	Quiz 4.2		
Apr-6	Phylogenetics Cont.	Gene trees and Species trees			
Apr-8	Case study – Microsporidians	Open time for research projects	Quiz 4.3	HW 4.2	
Apr-13	READING DAY	NO CLASS			Methods Writeup (Due Apr-16)
Apr-15	Case study - Nucleomorphs	Open time for research projects			
Apr-20	Case study – Dinoflagellates	Open time for research projects			Rough Draft (Due Apr-23)
Apr-22	Discussion – Neutral Theory	Open time for research projects	Quiz 5.1		
Apr-27	Final Presentations	Final Presentations			Peer Review (Due Apr-30)
Apr-29	Final Presentations	Final Presentations			
FINALS WEEK					Final Report (Due May-7)

---

[1] This schedule is subject to change.
[2] Quizzes must be completed on Brightspace prior to the beginning of class.
[3] Homework must be submitted on Brightspace prior to the beginning of class.