

BCHM 612
Bioinformatic Analyses of Genome Scale Data
Fall 2025 Syllabus

Course Information

Meeting Time: Mondays, 11:30 AM to 3:20 PM
Location: Stanley Coulter Hall 179
Modality: Face to face
Credit Hours: 3
CRNs: 25656, 25657

Course Instructor

Dr. Ben Carter
Office: BCHM 10
Email: BCCARTER@PURDUE.EDU
Office Hours: in person by appointment

Teaching Assistant

Nima Goodarzi
Email: NGOODARZ@PURDUE.EDU
Office Hours: in person by appointment

Course Objectives

This course provides hands-on experience for life science researchers in bioinformatic analysis of genome-scale data. The various disciplines in the life sciences are generating a wealth of experimental and annotation data. Today's graduate students need experience with modern tools that can help them to access, explore, analyze, interpret and manage the data that they generate in the lab.

Students will use the R programming language and packages from Bioconductor, the R bioinformatics project, as their principal tools for this course. Students will develop workflows in R that bridge established algorithms for bioinformatics such as limma, edgeR, or DESeq2, incorporating methods to import, QC, transform, and visualize genome-scale datasets derived from next generation sequencing experiments. A critical aspect of bioinformatics that is often inadequate is workflow documentation. This course will use Rmarkdown to integrate computer code, data, and results to manage complex bioinformatics projects.

Course Organization

Class sessions are divided into lecture and laboratory. Lectures will focus on the theoretical and biological aspects of bioinformatics analysis using recent examples from the literature. In lab, students will work on programming exercises or projects using published datasets. Advanced students will also have the opportunity to work with their own data. Distance instruction will include R tutorials and videos that students can work through at their own pace (subject to completion deadlines). Particular emphasis will be placed on the theoretical and practical limitations of next generation sequencing data. No prior computer programming experience is required, but it is assumed that students have a firm grasp of the fundamental principles of molecular biology and how they relate to complex processes such as gene expression and genome organization.

Learning Outcomes

- Students will write R scripts that utilize Bioconductor packages for bioinformatic analyses.
- Students will access genome-scale data sets from public repositories and import this data into R for further analysis.
- Students will visualize genome-scale data sets for both quality control and presentation purposes.
- Students will implement strategies to deal with genome-scale datasets including parallel computing.
- Students will be able to critically evaluate the bioinformatic methods and data from publications.
- Students will implement “literate programming” with Rmarkdown to document and share their bioinformatics projects.

Textbooks

We will occasionally use textbooks that are available for free online. Purdue Libraries also has many e-books on R. I have provided two examples below. You may also use online forums such as [STACKOVERFLOW](#) to search for solutions. However, read the forum rules carefully before you post questions! R is very popular, so a well-crafted Google search will often reveal multiple solutions for your problems.

There will be required readings from these free e-books (links will be posted on Brightspace):

[R FOR DATA SCIENCE](#), Garret Groolemund and Hadley Wickham
[STATISTICAL INFERENCE VIA DATA SCIENCE](#), Chester Ismay and Albert Y. Kim

These are other useful texts, but not required for this course.

[HANDS ON PROGRAMMING WITH R](#), Garret Groolemund
[INTRODUCTORY STATISTICS WITH R](#), Peter Daalgard

Brightspace

All course material will be distributed via Brightspace. If you cannot find assignments or your grade looks incorrect, let the instructor or TA know as soon as possible so that we can fix the problem.

Assessment

Assessment will be achieved with regular quizzes, homework, lab exercises, a midterm exam, and one project. The final grade will be determined using the following weighting:

Assignments	Grade Percentage
Lab exercises	40%
Midterm exam	30%
Final Project	30%
Attendance and participation	0%

Lab Exercises are programming assignments. This is NOT a computer science course. You will not be graded on elegant or efficient programming. Rather, you will be graded on accurately completing the assignment. Students are encouraged to collaborate on these exercises, but it is important that everyone contributes!

The **Midterm Exam** will use Brightspace and will be auto-graded.

The **Final Project** will encompass a significant bioinformatic project. Generally, these are RNA-seq analyses using public data sets or a data set from the students' research lab.

Grading Scale

Score	Grade
90% and above	A
80% to 89.9%	B
70% to 79.9%	C
60% to 69.9%	D
59.9% and below	F

How to Succeed in This Course

- Come to class prepared by completing assignments on time.
- This is a 600-level course. You will be expected to search for and find some information that you need to complete assignments.
- Ask questions! If you are confused, the instructor might have explained the material poorly or even made a mistake! Asking questions is an important skill for all scientists!
- Collaborate with your fellow students. They can help you to find errors or provide alternate ways of achieving your tasks. I learn from students every semester.
- Practice, practice, practice. Coding is hard. Like learning any language, you must practice to achieve mastery.
- The best students typically create a course notebook from their Rmarkdown reports to collate the course contents, create examples that are meaningful to them, and express their creativity. This is also extremely useful as a future resource!

Course Schedule

The course schedule will be shared on Brightspace. The schedule will be fluid (subject to change), but exam date will be provided well in advance. If you have specific topics beyond these that you are interested in, mention it to the instructor!

Week 1	Course Infrastructure and R	Quizzes/homework/exercises
Week 2	R: Tidyverse	Quizzes/homework/exercises
Week 3	R: Wrangling Genomic Data	Quizzes/homework/exercises
Week 4	Bioinformatics: Bioconductor	Quizzes/homework/exercises
Week 5	Bioinformatics: Sequences	Midterm (tentative)
Week 6	Bioinformatics: Ranges	Quizzes/homework/exercises
Week 7	Bioinformatics: NGS Data	Quizzes/homework/exercises
Week 8	Bioinformatics: Alignments	Quizzes/homework/exercises
Week 9	Bioinformatics: RNA-seq	Quizzes/homework/exercises

Week 10	Bioinformatics: RNA-seq	Quizzes/homework/exercises
Week 11	Bioinformatics: ChIP-seq	Quizzes/homework/exercises
Week 12	Bioinformatics: Project Management	Quizzes/homework/exercises
Week 13	TBD	Quizzes/homework/exercises
Week 14	Final Project	Final Project
Week 15	Final Project	Final Project

Extra Credit

There will be opportunity/no opportunity for extra credit.

Obtaining Extra Help

Nima and Dr. Carter will be available to answer your questions during the lab sessions or by appointment (arranged in class or by e-mail). Alternatively, you can submit questions by e-mail that can be answered in class or by return e-mail.

Class Attendance

This course follows the University Academic Regulations regarding class attendance, which state that students are expected to be present for every meeting of the classes in which they are enrolled. Attendance and participation will allow you to succeed in this course. **If you feel unwell, please do not come to class, but feel free to send me a quick email letting me know the reason for your absence.** I will use attendance only when I assign your final letter grade. If you have excellent attendance, I will typically round your grade up to the higher letter grade, e.g. if you had no unexcused absences, I will round 89% to 90% giving you and A rather than a B in the course.

Protect Purdue

Any student who has substantial reason to believe that another person is threatening the safety of others by not complying with Protect Purdue protocols 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 and the Violent Behavior Policy under University Resources in Brightspace.

Academic Misconduct

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](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

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 is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace under University Policies and Statements.

Responsible Use of AI in Completing Coursework

Advancements in Artificial Intelligence (AI) provide students with unparalleled access to information and problem-solving capabilities. However, with these advantages come the responsibilities of ethical use and academic integrity. This statement outlines the expectations and guidelines for the responsible use of AI in our course.

Objectives:

By adhering to these guidelines, students aim to:

1. Uphold academic honesty and personal integrity.
2. Ensure equitable access and opportunities for all students.
3. Develop skills for critical thinking and independent reasoning.
4. Understand the strengths and limitations of AI tools.

Guidelines for Responsible Use:

1. **Original Work:** Students should ensure that assignments submitted are original and based on their understanding. While AI can assist in research or provide general guidance, it should not produce work on behalf of the student.
2. **Citation:** Any content, ideas, or assistance obtained through AI tools must be appropriately cited, similar to any other reference or source. You will need to find the relevant citations from the primary literature (journal articles)!
3. **Collaboration:** If a student collaborates with AI tools, (and you are encouraged to do so in this course!) they must specify the nature and extent of this collaboration in their submission. This includes providing details of the prompts used to generate the AI responses.
4. **Prohibited Uses:** AI should not be used to complete quizzes, exams, or any other assessments unless explicitly permitted by the instructor.

5. Accessibility: All students must have equal access to AI tools. If a particular tool is used in a course, it should be free of cost for all users.
6. Data Privacy: Students must be cautious when sharing personal or sensitive information with AI platforms and should be familiar with the terms of service of any third-party AI tools.

Consequences for Misuse:

Misuse of AI tools in coursework, which includes but is not limited to producing unoriginal work, uncited use of AI-generated content, or unauthorized assistance on assessments, will be considered a breach of academic integrity. Consequences will follow the Purdue's policies on academic dishonesty as detailed in this syllabus, which may include grade penalties, course failure, or more severe disciplinary actions.

Reflection & Discussion:

Students are encouraged to reflect on their experiences using AI tools and to discuss openly any ethical or academic concerns. Periodic class discussions or forums might be held to address advancements in AI and their implications in academia. The promise of AI in enhancing learning and research is vast, but it must be used judiciously. Responsible use not only ensures academic honesty but also maximizes genuine learning and skill development. Students are urged to approach AI as a supplementary tool, not a replacement for their unique intellectual capacities and insights.

Notice of Copyright Protection of Course Materials

See the University Policies and Statements section of Brightspace for guidance on Use of Copyrighted Materials. Effective learning environments provide opportunities for students to reflect, explore new ideas, post opinions openly, and have the freedom to change those opinions over time. Students and instructors are the authors of the works they create in the learning environment. As authors, they own the copyright in their works subject only to the university's right to use those works for educational purposes. Students may not copy, reproduce, or post to any other outlet (e.g., YouTube, Facebook, or other open media sources or websites) any work in which they are not the sole or joint author or have not obtained the permission of the author(s).

Emergency Preparedness

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 beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

A link to Purdue's Information on Emergency Preparation and Planning is located on our Brightspace under "University Policies and Statements." This website covers topics such as Severe Weather Guidance, Emergency Plans, and a place to sign up for the

Emergency Warning Notification System. I encourage you to download and review the Emergency Preparedness for Classrooms document (PDF) or (Word).

The first day of class, I will review the Emergency Preparedness plan for our specific classroom, following Purdue's required Emergency Preparedness Briefing. Please make note of items like:

- The location to where we will proceed after evacuating the building if we hear a fire alarm.
- The location of our Shelter in Place in the event of a tornado warning.
- The location of our Shelter in Place in the event of an active threat such as a shooting.

Online Course Evaluations

During the last two weeks of the semester, you will be provided with an opportunity to evaluate this course and your instructor(s). 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. Your feedback is vital to improving education at Purdue University. I strongly urge you to participate in the evaluation system.

Non-discrimination Policy

Purdue University is committed to maintaining a community that 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 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. A hyperlink to Purdue's full Nondiscrimination Policy Statement is included in our course Brightspace under University Policies and Statements.

Mental Health

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 a.m.- 5 p.m.

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. Sign up is free and can be done on BoilerConnect. Students in Indianapolis will find support services curated on the Vice Provost for Student Life website.

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 offices in West Lafayette or Indianapolis.

Basic Needs Security

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed, and Student Support Services is available to serve students 8 a.m.-5 p.m. Monday through Friday.

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 welcome 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.

Disclaimer

This syllabus is subject to change.