PHC 6937 Statistical and Computational Analysis of Genomic Data (3 credit hours)
Semester: Fall 2023
Delivery Format: On-Campus

Instructor Name: Li Chen, Ph.D.

Room Number: HPNP G105

Time: Tuesday (11:45AM-1:40PM); Thursday (12:50PM-1:40PM)

Phone Number: 352-294-5770

Email Address: li.chen1@ufl.edu

Office Hours: Thursday (1:40PM-2:40PM)

Teaching Assistants: None

Preferred Course Communications: e-mail or Canvas message

Prerequisites

The students should have taken PHC 6937 "Introduction to Biostatistical Computing" and PHC6050c "Biostatistical Method" or equivalent. Permission at the discretion of the instructor may be granted if the student is familiar with R programming, linear algebra, maximum likelihood, simple hypothesis testing and linear regression. Students are not required to have any prerequisites in genomics/genetics and an overview of relevant genomic/genetic concepts will be covered in class.

Purpose and Outcome

Course Overview

The course will focus on statistical and computational methods/tools on next generation sequencing data analysis. Topics include introduction and analysis of DNA-seq, RNA-seq, ChIP-seq, ATAC-seq and single-cell genomics. In addition, the course will illustrate how to use R/Bioconductor R packages to handle common types of genomic data.

Course Description

The course will focus on statistical and computational methods/tools on next generation sequencing data analysis (NGS). The course will introduce different techniques and tools to generate and analyze the NGS data, ranging from DNA-seq, RNA-seq, ChIP-seq, ATAC-seq as well as human microbiome data. The course will also cover single-cell genomics such as single-cell RNA-seq, ATAC-seq and spatial transcriptomics. In addition, the course will emphasize on how to use R/Bioconductor R packages to handle common types of genomic data. Learning in the course is primarily assessed by three homework assignments and a final course project, which will be submitted on Canvas. Students are encouraged to bring their own laptops in the class to practice the demo codes for data analysis. The goal of this course is to prepare students for potential research in statistical genomics/computational biology/bioinformatics but is also open to a wider community.

Relation to Program Outcomes

To introduce a variety of statistical/computational methods commonly used in analyzing genomic data, with a focus on RNA-seq, ChIP-seq, ATAC-seq and single-cell genomics.

Course Objectives and/or Goals

Upon successfully completing this course, students should be able to:

1. Describe and interpret the basic principles of next generation sequencing technology.

2. Use R/Bioconductor to analyze basic types of genomic data.

3. Synthesize the biological background, data format, data processing steps and software for analyzing next generation sequencing data.

4. Evaluate basic statistical and computational methods for analyzing next generation sequencing data.

Description of Course Content

Topical Outline/Course Schedule

Instructor reserves the right to modify the course schedule with advance notice provided to students.

Week	Date(s)	Topic(s)	Due Dates
1	8/24	Introduction to molecular biology and next generation sequencing technology	
2	8/29, 8/31	Introduction to R programming using RStudio	
3	9/5, 9/7	Introduction to R programming using RStudio	
4	9/12, 9/14	Handling genome data using R/Bioconductor I	
5	9/19, 9/21	Handling genome data using R/Bioconductor II	HW1 due
6	9/26, 9/28	Introduction to DNA-seq I	
7	10/3, 10/5	Introduction to DNA-seq II	
8	10/10, 10/12	Introduction to DNA methylation	Project proposal due
9	10/17, 10/19	Introduction to RNA-seq I	
10	10/24, 10/26	Introduction to RNA-seq II	
11	10/31, 11/2	Introduction to ATAC-seq, ChIP-seq and Hi-C	HW2 due
12	11/7, 11/9	Introduction to single-cell RNA-seq I	
13	11/14, 11/16	Introduction to single-cell RNA-seq II	
14	11/21	Introduction to single-cell ATAC-seq and spatial transcriptomics I	HW3 due
15	11/28, 11/30	Introduction to single-cell ATAC-seq and spatial transcriptomics II	
16	12/5,12/7	Student Project Presentations	Paper due in the same day

Course Materials and Technology

There is no required text.

The course materials will be available through the Canvas course website at https://ufl.instructure.com. It is imperative that students familiarize themselves with Canvas, check Canvas frequently for possible announcements, and make sure that their e-mail account in Canvas is correct and active.

Students will be required to use their own computers in order to complete the assignments, and homework problems will require R programming. R is freely available to download on all operating systems at https://cran.cnr.berkeley.edu. Help can be found at https://www.r-project.org/help.html.

For technical support for this class, please contact the UF Help Desk at:

- Learning-support@ufl.edu
- (352) 392-HELP - select option 2
- https://lss.at.ufl.edu/help.shtml

Academic Requirements and Grading

Attendance

Attendance will be taken for a grade and students are expected to be at all class sessions and are responsible for any missed materials. If you know you will be absent, please notify me in advance.

Assignments

All assignments must be typed (unless otherwise noted in class) and submitted electronically in pdf format on Canvas. Your responses must be supported by both written explanations and the code you generate to produce your result.

Homework: There will be three homework assignments (9/21, 11/2, 11/21) throughout the course. Two weeks will be given to complete homework assignments and more specific information will be given in class. A typical assignment will include a variety of problems. The problems consist of a combination of written questions and programming questions. Students may be asked to: using R packages for genomic data analysis, provide and interpret the findings. Discussion on homework between students is allowable*, but plagiarism is prohibited.* Students must submit their own assignments written in their own words and own code. Copying of code or explanations is prohibited and will warrant a score of zero. Homework solutions will be reviewed in class.

Final Project:

There are two options for the final project: data analysis project and literature review project. Each option will be graded equally. For data analysis project, the instructions are (1) The project should be genetics and genomics relevant; (2) Students can either form groups of 2 or work individually; (3) Students can choose to

download publicly available genomic data and reanalyze the genomic data differently than the original authors using methods described in class or newly published statistical/computational methods. Students are also can choose to analyze the in-house genomic data from the PI's lab. For literature review project, the instructions are (1) The project should be genetics and genomics relevant; (2) Student will work individually; (3) The literature review should focus on reviewing and summarizing; (4) The review should compare at least 5computational/statistical methods and summarize the pros and cons of each method.

For data analys project, a final report is required and should contain an introduction and description of the data, the biological question of interest, detailed descriptions of the analysis and statistics performed, and a discussion of the results. The final report should also include the R code used in the analysis. For literature review project, a final report is required and should contain an introduction of the background, detailed descriptions of the compared methods in algorithms, and a discussion of the results of these methods performed on simulation/result data analysis. For both types of projects, a brief project proposal (3-pages) is part of the final project grade In addition to the report, an in-class presentation (10-15 min) will be scheduled and the exact details will depend on the size of the class. The final report is due in the same day of the presentation.

Details regarding expectations of the final report will be discussed in class.

Grading

Requirement	Due date	% of final grade
Attendance	NA	10%
Homework 1	9/21	10%
Project Proposal	10/12	10%
Homework 2	11/2	10%
Homework 3	11/21	10%
Project Presentation	12/5,12/7	25%
Project Paper	12/7	25%

Point system used:

Points	93-	90-	87-89	83-86	80-82	77-79	73-76	70-72	67-69	63-66	60-62	Below
Earned	100	92										60
Letter Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E

Letter grade to grade point conversions are fixed by UF and cannot be changed.

Letter Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E	WF	I	NG	S-U
Grade Points	4.0	3.67	3.33	3.0	2.67	2.33	2.0	1.67	1.33	1.0	0.67	0.0	0.0	0.0	0.0	0.0

Please be aware that a C- is not an acceptable grade for graduate students. The GPA for graduate students must be 3.0 based on 5000 level courses and above to graduate. A grade of C counts toward a graduate degree only if based on credits in courses numbered 5000 or higher that have been earned with a B+ or higher.

More information on UF grading policy may be found at:
http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Exam Policy

Policy Related to Homework or Other Work
Full credit can be considered for assignments turned in on the due date (by 11:59pm). NO credit given for late submission for unexcused. If you are out sick, no deduction will be taken if you inform me before the homework is due that you are ill. Please stay home and do not get other people sick.

Please note: Any requests for make-ups due to technical issues MUST be accompanied by the UF Computing help desk (http://helpdesk.ufl.edu/) correspondence. You MUST e-mail me within 24 hours of the technical difficulty if you wish to request a make-up.

Policy Related to Required Class Attendance
Attendance will be taken for a grade and students are expected to be at all class sessions and are responsible for any missed materials. If you know you will be absent, please notify me in advance.

Requirements for class attendance and make-up assignments, and other work in this course are consistent with university policies that can be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

Excused absences must be consistent with university policies in the Graduate Catalog

(http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance). Additional information can be found here: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

Student Expectations, Roles, and Opportunities for Input

Expectations Regarding Course Behavior

Students are expected to spend an average of at least 2-1/2 hours per week per credit hour on the course exclusive of class time. This time includes but is not limited to reading, research, preparation for class, and course work. Cell phones should not be used in class. Laptops are permissible and encouraged for notetaking or class related exercises. Questions in class are highly encouraged and should be addressed to the entire class to benefit everyone. Private conversations regarding course material should be conducted outside of class.

Communication Guidelines

For posting on Canvas or e-mails, please adhere to Netiquette Guidelines:
http://teach.ufl.edu/wpcontent/uploads/2012/08/NetiquetteGuideforOnlineCourses.pdf

Academic Integrity

Students are expected to act in accordance with the University of Florida policy on academic integrity. As a student at the University of Florida, you have committed yourself to uphold the Honor Code, which includes the following pledge:

"**We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity**."

You are expected to exhibit behavior consistent with this commitment to the UF academic community, and on all work submitted for credit at the University of Florida, the following pledge is either required or implied:

"On my honor, I have neither given nor received unauthorized aid in doing this assignment."

It is your individual responsibility to know and comply with all university policies and procedures regarding academic integrity and the Student Honor Code. Violations of the Honor Code at the University of Florida will not be tolerated. Violations will be reported to the Dean of Students Office for consideration of disciplinary action. For additional information regarding Academic Integrity, please see Student Conduct and Honor Code or the Graduate Student Website for additional details:
https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/
http://gradschool.ufl.edu/students/introduction.html

Please remember cheating, lying, misrepresentation, or plagiarism in any form is unacceptable and inexcusable behavior.

Recording Within the Course:

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

Policy Related to Guests Attending Class:

Only registered students are permitted to attend class. However, we recognize that students who are caretakers may face occasional unexpected challenges creating attendance barriers. Therefore, by exception, a department chair or his or her designee (e.g., instructors) may grant a student permission to bring a guest(s) for a total of two class sessions per semester. This is two sessions total across all courses.

No further extensions will be granted. Please note that guests are **not** permitted to attend either cadaver or wet labs. Students are responsible for course material regardless of attendance. For additional information, please review the Classroom Guests of Students policy in its entirety. Link to full policy: http://facstaff.phhp.ufl.edu/services/resourceguide/getstarted.htm

Online Faculty Course Evaluation Process
Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/ . Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/publicresults/.

SUPPORT SERVICES

Accommodations for Students with Disabilities

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the Disability Resource Center by visiting https://disability.ufl.edu/students/get-started/ . It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester. The College is committed to providing reasonable accommodations to assist students in their coursework.

Counseling and Student Health

Students sometimes experience stress from academic expectations and/or personal and interpersonal issues that may interfere with their academic performance. If you find yourself facing issues that have the potential to or are already negatively affecting your coursework, you are encouraged to talk with an instructor and/or seek help through University resources available to you.

- The Counseling and Wellness Center 352-392-1575 offers a variety of support services such as psychological assessment and intervention and assistance for math and test anxiety. Visit their web site for more information: http://www.counseling.ufl.edu. On line and in person assistance is available.

- You Matter We Care website: http://www.umatter.ufl.edu/. If you are feeling overwhelmed or stressed, you can reach out for help through the You Matter We Care website, which is staffed by Dean of Students and Counseling Center personnel.

- The Student Health Care Center at Shands is a satellite clinic of the main Student Health Care Center located on Fletcher Drive on campus. Student Health at Shands offers a variety of clinical services. The clinic is located on the second floor of the Dental Tower in the Health Science Center. For more information, contact the clinic at 392-0627 or check out the web site at: https://shcc.ufl.edu/

- Crisis intervention is always available 24/7 from:
  Alachua County Crisis Center:
  (352) 264-6789
  http://www.alachuacounty.us/DEPTS/CSS/CRISISCENTER/Pages/CrisisCenter.aspx

Do not wait until you reach a crisis to come in and talk with us. We have helped many students through stressful situations impacting their academic performance. You are not alone so do not be afraid to ask for assistance.

Inclusive Learning Environment

Public health and health professions are based on the belief in human dignity and on respect for the individual. As we share our personal beliefs inside or outside of the classroom, it is always with the understanding that we value and respect diversity of background, experience, and opinion, where every individual feels valued. We believe in, and promote, openness and tolerance of differences in ethnicity and culture, and we respect differing personal, spiritual, religious and political values. We further believe that celebrating such diversity enriches the quality of

the educational experiences we provide our students and enhances our own personal and professional relationships. We embrace The University of Florida's Non-Discrimination Policy, which reads, "The University shall actively promote equal opportunity policies and practices conforming to laws against discrimination. The University is committed to non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information and veteran status as protected under the Vietnam Era Veterans' Readjustment Assistance Act." If you have questions or concerns about your rights and responsibilities for inclusive learning environment, please see your instructor or refer to the Office of Multicultural & Diversity Affairs website: www.multicultural.ufl.edu.