

# **Syllabus**

BIOS 784: Introduction to Computational Biology

Fall 2024

3 credits

## Course Description

Molecular biology, sequence motifs identification by Monte Carlo Bayesian approaches, dynamic programming, hidden Markov models, computational algorithms, statistical software, high-throughput sequencing data and its application in computational biology.

Prerequisites: BIOS 661 and 663, or previous or concurrent enrollment in BCB 720; Permission of the instructor for students lacking the prerequisites.

## Instructor

* Michael Love, PhD
* Associate Professor
* Department of Genetics, and Department of Biostatistics
* 5009 GMB
* Phone: 919-966-7266
* Email: milove@email.unc.edu

## Teaching Assistant

* Isabela Gyuricza
* igg@email.unc.edu

Office Hours: Available by appointment.

[**Course Website**](https://edtech.unc.edu/service/canvas/)**:** On Canvas, use your ONYEN and password.

Class Days, Times, Location: 1:25-2:40 MoWe – McGavran 2306

See <https://biodatascience.github.io/compbio> for detailed, updated schedule.

## Course Format

The course format will consist of a seminar-style class that meets twice weekly. The lectures starting at 1:25 PM are given by the instructor. Lectures will be supplemented with in-class exercises. At the end of the course, students will work on a group project.

## Required Readings

See <https://biodatascience.github.io/compbio> for suggested readings (not required).

## **Course-at-a-Glance**

The instructor reserves the right to make changes to the syllabus, including topics, readings, assignments, and due dates. Any changes will be announced as early as possible. For session-by-session course schedule details, please the course website. The following homeworks will be assigned roughly following the date provided for the listed topic.

|  |  |  |
| --- | --- | --- |
| **Date/****Session Number** | **Topic** | **Assignment Due** |
| 1 | Exploratory data analysis | HW1 |
| 2 | Genomic data objects | HW2 |
| 3 | Accessing genomic annotations and DNA strings |  |
| 4 | Calculating distances in high dimensions | HW3 |
| 5 | Multiple test correction for genomic data | HW4 |
|  | Mid-term (take-home) |  |
| 6 | Batch effects and solutions |  |
| 7 | Optimization of models with EM algorithm | HW5 |
| 8 | Hierarchical models | HW6 |
| 9 | Hidden Markov Models (HMM) | HW7 |
| 10 | Network Analyses |  |
| 11 | Tidy genomic data analysis |  |

## **Course Assignments and Assessments**

This course will include the following graded assignments that contribute to your final grade in the course. For assignment descriptions and assignment grading rubrics, please see the course site. Assignments are described on the course homepage and will be reviewed in the first week of class.

|  |  |
| --- | --- |
| **Graded Assignments** | **Points/Percentages of****Final Course Grade** |
| 1. Homework | 60 |
| 2. Mid-term (take-home) | 20 |
| 3. Group Project | 20 |
| TOTAL | 100 |

## Course Grading Scale(s)

Final course grades will be determined using the following [UNC Graduate School grading scale](https://handbook.unc.edu/grading.html). The relative weight of each course component is shown in the Graded Assignments section.

* **H**—High Pass (93-100): Clear excellence
* **P**—Pass (80-92): Entirely satisfactory graduate work
* **L**—Low Pass (70-79): Inadequate graduate work
* **F**—Fail (0-69)

## Map of Competencies to Learning Objectives and Assessment Assignments

Below you will see the program competency(ies) you will develop in this course, the learning objectives that comprise the competency, and the assignment(s) in which you will practice demonstrating each competency.

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**Competency:** As an elective course, BIOS 784 does not fulfill any CEPH competencies. It also does not fulfill any required competencies for the PhD in biostatistics.

BIOS 784 fulfills the following course-specific competencies: the course is an introduction to computational biology, with emphasis on practical examples of statistical analysis of real biological datasets, and on statistical methods and frameworks commonly used in modern biological and biomedical research. Therefore, the focus is on both practical competence as well as theoretical competence, covering a set of methodological topics.

Examples of practical competencies:

* Use of data science tools for code management, and reproducible analyses,
* High-dimensional data cleaning, data normalization, and visualization,
* Software frameworks for performing genomic data analysis.

Examples of methodological topics include:

* multiple testing paradigms,
* factor analysis / surrogate variable analysis (SVA),
* expectation-maximization (EM),
* hierarchical models,
* hidden Markov models (HMM),
* network analyses

At the conclusion of the course, a student will be able to:

* Make exploratory plots of modern biological datasets
* Perform basic statistical analyses of biological data
* Comprehend computational Methods sections of biological/genomic publications
* State the goals and scope of current biological/genomic research
* Postulate new statistical methods building on the frameworks presented in BIOS 784

## Expectations, Policies, and Resources

### Accessibility at UNC Chapel Hill

The University of North Carolina at Chapel Hill facilitates the implementation of reasonable accommodations, including resources and services, for students with disabilities, chronic medical conditions, a temporary disability or pregnancy complications resulting in barriers to fully accessing University courses, programs and activities. Accommodations are determined through the Office of Accessibility Resources and Service (ARS) for individuals with documented qualifying disabilities in accordance with applicable state and federal laws. See the [ARS Website](https://ars.unc.edu/) for contact information or email ARS.

### Attendance/ Participation

Your attendance and active participation are an integral part of your learning experience in this course. If you are unavoidably absent, please notify the course instructor (and Teaching Assistant if one is assigned). No right or privilege exists that permits a student to be absent from any class meetings, except for these University Approved Absences:

1. Authorized University activities
2. Disability/religious observance/pregnancy, as required by law and approved by [Accessibility Resources and Service](https://ars.unc.edu/) and/or the [Equal Opportunity and Compliance Office](https://eoc.unc.edu/what-we-do/accommodations/).
3. Significant health condition and/or personal/family emergency as approved by the [Office of the Dean of Students](https://odos.unc.edu/), [Gender Violence Service Coordinators,](https://lgbtq.unc.edu/programs/community-building/queerfallfest/campus-resources/gender-violence-services-coordinators/) and/or the [Equal Opportunity and Compliance Office](https://eoc.unc.edu/what-we-do/accommodations/).

### Course Communication Expectations

Students must maintain course communications (e.g., email, course announcements, course discussions, etc.) with their peers and instructor(s) to be successful in this course. You are expected to check, read, and respond when necessary to your course communications regularly (i.e., at least two times during the business week). Not reading email is an unacceptable excuse for missing course communications.

Student well-being is my/our primary concern. To ensure you have the support needed to be successful in this program, your academic coordinator, faculty mentor, assistant dean of master’s degree programs, associate dean for student affairs, and/or dean of students may get involved if non-responsiveness becomes a significant concern.

All UNC affiliates (including students, faculty, and staff) must use their University email account to conduct UNC business. Use of personal email addresses, including auto-forwarding to external/personal accounts, is not allowed for conducting University business. For more information, see the [Individual Email Address Policy](https://policies.unc.edu/TDClient/2833/Portal/KB/ArticleDet?ID=131262).

### Counseling and Psychological Services (CAPS) at UNC Chapel Hill

[CAPS](https://caps.unc.edu/) is strongly committed to addressing the mental health needs of our diverse student body through timely access to consultation and connection to clinically appropriate services. They offer a [variety of services](https://caps.unc.edu/services/) to meet your mental health needs and are available 24/7. Note: All counseling services provided are completely confidential and in no way connected to your academic record.

### Honor Code

I expect all students to follow the guidelines of the UNC Honor Code. In particular, students are expected to refrain from “lying, cheating, or stealing” in the academic context. You can read more about the honor code at [studentconduct.unc.edu](https://studentconduct.unc.edu/). In any course, including mine, what constitutes cheating can change from one activity to another. For example, collaboration may be encouraged for an assignment but qualify as cheating during an exam. Please see my guidelines for each activity, and if you are unsure, please ask me to clarify.

If you have any questions about your rights and responsibilities, consult the [Office of Student Conduct](https://studentconduct.unc.edu/) or review the following resources: [Honor System](https://studentconduct.unc.edu/honor-system); [Honor System module](https://studentconduct.unc.edu/honor-system-module); [UNC Library’s plagiarism tutorial](https://guides.lib.unc.edu/plagiarism); [UNC Writing Center’s handout on plagiarism](https://writingcenter.unc.edu/tips-and-tools/plagiarism/).

### Use of Generative AI

Generative artificial intelligence (AI) tools (e.g., ChatGPT) that generate text, images, and media, could aid brainstorming, research, and content creation, and may be useful in public health practice. However, these tools must be used ethically, transparently, and with the understanding of their limitations including circumstances when AI use hinders rather promotes learning.

In this course, Gen AI cannot be:

* Used as a replacement for doing the assigned course readings
* Used solely for the output for completing mathematical computations
* Used solely for the output for submitting written work
* Used for cheating or to gain unfair advantages

If you have any questions, please contact me. I reserve the right to submit written assignments to AI detection programs (e.g., iThenticate). Suspected violations will be reported to the University Honor Court.

**Unless I provide other guidelines for an assignment or exam, you should follow these guidelines:**

Students are expected to follow the policy provided by the UNC Generative AI committee.  Briefly, this policy allows the use of AI for a variety of tasks (including topic selection, brainstorming, research, source valuation, outlining, drafting, media creation, revising, and polishing).  Importantly, when you use Gen AI in your work, you must document it as specified at the website above.  **This policy is at your instructor's discretion and may be modified with written notice for specific tests and assignments.**

### iThenticate

[iThenticate](https://research.unc.edu/systems/ithenticate/) is a writing tool to help ensure that scholarly and research documents such as written assignments, manuscripts, theses, dissertations, and grant applications follow proper citation practices. You may choose to use this software to improve your writing and citations. However, your instructor reserves the right to use the software if any written assignment is suspected of having un-cited or improperly cited work.

### Appropriate Use of Course Resources

The materials used in this class, including, but not limited to, syllabus, exams, quizzes, and assignments are copyright protected works. Any unauthorized copying of the class materials is a violation of federal law and may result in disciplinary actions being taken against the student. Additionally, the sharing of class materials without the specific, express approval of the instructor may be a violation of the University's Student Honor Code and an act of academic dishonesty, which could result in further disciplinary action. This includes, among other things, uploading class materials to websites for the purpose of sharing those materials with other current or future students and sharing assessments from prior terms. Instructors are required to report suspected misuse of course resources to the Office of Student Conduct.

You are not permitted to upload any content from this course to the web in any form, including but not limited to Chegg, Course Hero, Coursera, Google Drive, etc. If you post my course content, you may be violating my intellectual property rights. If you post your own work from this course, you are allowing sites to profit from your intellectual property. In utilizing web sources to upload or download course content, you risk violating the [University’s Honor Code](https://studentconduct.unc.edu/instructors/honor-syllabus/).

### Inclusive Excellence

We are committed to expanding diversity and inclusiveness across the School — among faculty, staff, students, on advisory groups, and in our curricula, leadership, policies and practices. We measure diversity and inclusion not only in numbers, but also by the extent to which students, alumni, faculty, and staff members perceive the School’s environment as welcoming, valuing all individuals, and supporting their development.

For more information about how we are practicing inclusive excellence at the Gillings School, visit the following webpages: [Inclusive Excellence](https://sph.unc.edu/resource-pages/inclusive-excellence/), [Inclusive Excellence Action Plan](https://sph.unc.edu/diversity/inclusive-excellence-action-plan/), [Minority Health Conference](https://minorityhealth.web.unc.edu/), and [National Health Equity Research Webcast](https://sph.unc.edu/mhp/nat-health-equity-research-webcast/).

Additional campus resources include: the [LGBTQ Center](https://lgbtq.unc.edu/); [Non-Discrimination Policies at UNC Chapel Hill](https://eoc.unc.edu/our-policies/policy-statement-on-non-discrimination/); [Ombuds](https://ombuds.unc.edu/); and [Prohibited Discrimination, Harassment, and Related Misconduct at UNC Chapel Hill](https://eoc.unc.edu/our-policies/ppdhrm/).

In this class, we practice the Gillings School’s commitment to inclusion, diversity, anti-racism and equity in the following ways.

* Develop classroom participation approaches that acknowledge the diversity of ways of contributing in the classroom and foster participation and engagement of *all* students.
* Structure assessment approaches that acknowledge different methods for acquiring knowledge and demonstrating proficiency.
* Encourage and solicit feedback from students to continually improve inclusive practices.
* Treat all members of the Gillings community (students, faculty, and staff) as human persons of equal worth who deserve dignity and respect, even in moments of conflict and disagreement.
* Contribute to creating a welcoming and inclusive classroom environment, where all are able to learn and grow from one another.
* Acknowledge and respect the diversity of experiences that others bring to the classroom and the ways in which this richness enhances everyone’s learning
* Strive to maintain a spirit of curiosity and generosity, particularly in the face of new and/or seemingly contradictory information and perspectives Encourage and solicit feedback from students to continually improve inclusive practices.

### Land Acknowledgement

Please read The Gillings School’s [Land Acknowledgement](https://sph.unc.edu/diversity/land-acknowledgement/).

### Student Feedback and Equity Concerns

Please use the [Student Academic Complaint Process](https://sph.unc.edu/students/student-academic-complaint-process/) for issues related to administrative processes, curriculum, academic and/or classroom activities.  We also value your feedback and suggestions including specific equity concerns and bias-related issues. You can use this form to submit feedback and suggestions, both positive and negative, and share equity related issues.  This form will allow you to specifically describe incidents in which racial or other equity-related bias, or microaggressions, occurred. You may submit this form anonymously. However, for us to follow up and provide the necessary support, we encourage you to include your contact information. For further information, please visit the [Student Feedback and Equity Concerns FAQ](https://sph.unc.edu/students/student-feedback-and-equity-concerns-faq/). Please note that this form does not take the place of any University process or policy. If you would like to report an incident under the University’s policy on [Prohibited Discrimination, Harassment, and Related Misconduct including Sexual and Gender Based Harassment, Sexual Violence, Interpersonal Violence, and Stalking](https://policies.unc.edu/TDClient/2833/Portal/KB/ArticleDet?ID=132487#autoid-drq2r), please visit [Safe at UNC](https://safe.unc.edu/) or the [Equal Opportunity and Compliance Office](https://eoc.unc.edu/) (EOC) for additional information, including resources, contact, and reporting options.

### Technical Support

The best way to help prevent technical issues from causing problems for assignments and quizzes is to submit them at least 24-36 hours before the due date and time. Your instructor cannot resolve technical issues, but it’s important to notify them if you are experiencing issues. If you have problems submitting an assignment or taking a quiz in Sakai, immediately do the following:

1. Contact the UNC Information Technology Services (ITS) department with the time you attempted to do your course action and what the course action was.
2. Email your instructor with the information you sent to ITS and what time you sent the information.

The ITS department provides technical support 24-hours per day, seven days per week. If you need computer help, please contact the ITS Help Desk by phone at +1-919-962-HELP (4357), or by [online help request](http://help.unc.edu/help/olhr), or by [UNC Live Chat](http://help.unc.edu/chat.).

### Safety and Emergency Information at Gillings

Though unlikely, there is always a possibility that there might be some type of emergency during the semester. Emergencies come in many different forms – weather, medical, fire and ones involving people intending to do harm.

As you probably know from your own experience, pre-K through 12th-grade students prepare in advance for emergency situations. As college students, you too need to think in advance about emergency situations. I would like to take a few moments to talk about actions to take in the event of an emergency in our classroom setting.

**If there is an emergency, I will stop teaching right away.**

* When it is safe to do so, we will call 9-1-1 and identify our building and room number, as well as the issue.
* There are some areas on campus, such as indoors, where you can’t hear the Alert Carolina siren. The first warning of an emergency may come to our attention via a messenger at the classroom door or through a personal electronic device.
* If you see or experience something unusual or concerning – before, during or after class – that may lead to an emergency, please let me or another faculty member/administrator or Gillings School security know as soon as possible. Alert me even if you have only an inkling that something may not be right.

**It is very important that you make me aware.**

***In a weather emergency,*** you may not be able to hear the emergency siren if you are inside of a building. If you are inside, move to an interior room on the lowest floor, and stay away from windows. ***In a medical/mental health emergency,*** please make space for first responders to do their work. UNC Police, Fire Department and EMS respond to all medical calls on campus. ***In the case of fire,*** do not attempt to carry anything in your hands. Exit quickly in as orderly a way as possible. Help others as much as possible. ***In a situation in which one or more people intend to do harm,***assess the situation and make a decision. Unfortunately, there may not be a clear “right” answer. However, your circumstances may make one of these actions the only viable option to protect yourself.

* **Run:** Have an escape route and plan in mind, leave your belongings behind, keep your hands visible, exit the building as quickly and safely as possible, distancing yourself from the threat, and follow law enforcement’s direction.
* **Hide:** If you cannot safely evacuate your building or are unsure of the location of the threat, secure your room, classroom or office, creating as many barriers between you and the threat. If you are caught outside, seek shelter inside the nearest building, and secure an interior space. Take the following actions: Lock or secure doors, turn off lights, move into concealed areas of the room away from doors and windows, silence your mobile devices and remain calm and quiet.
* **Fight:** Use this as a last resort if your life is in imminent danger. If there are no other options to safely escape and you are confronted by the intruder, attempt to disrupt or incapacitate the intruder using all available resources (e.g., acting aggressively, yelling, throwing items, improvising weapons).

If you need to exit the building in an emergency, seek cover behind buildings, cars and other solid structures – go as far away as possible while still staying safe. Keep going until you know that you are out of danger.

**Here is what you need to do next:**

Take the time you need to identify the different entrances and exits in this room and this building. There are many ways in and out of this building. The next time you come to class, think about possible routes. Try different routes so you are aware.

Be better prepared for UNC-specific safety procedures by visiting [Carolina Ready.](https://campussafety.unc.edu/carolina-ready/)

#### **Important Contacts:**

#### **Emergencies, anywhere: Call 911**

#### **Gillings School Resources:**

#### **Gillings DPS Security:** (919) 357-8037

#### **Building Issues:** (919) 843-7872

#### **Gillings Student Affairs:** (919) 966-2499

### Title IX at UNC Chapel Hill

Any student who is impacted by discrimination, harassment, interpersonal (relationship) violence, sexual violence, sexual exploitations, or stalking is encouraged to seek resources on campus or in the community. Please contact the Director of Title IX Compliance / Title IX Coordinator (Adrienne Allison), Report and Response Coordinators in the Equal Opportunity and Compliance Office, Counseling and Psychological Services (confidential), or the Gender Violence Services Coordinators (confidential) to discuss your specific needs. Additional resources are available at the [“Safe at UNC” website](https://safe.unc.edu).

### Syllabus Changes

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