**MMG232:** Advanced Bioinformatics (Spring 2023)

**Course Instructor:** Dr. Princess Rodriguez

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**Tuesday/Thursday** 10:05-11:20 Waterman 457

**Course Description:**

This course follows the introductory course of Bioinformatics & Data Analysis and is designed for microbiology and molecular genetics (MMG) majors. This course will provide more training in bioinformatics and major topics covered include: lntroduction to command line, genomic data processing and analysis on command line, advanced differential gene expression, and single-cell rna-seq analysis. Other topics such as NGS data interpretation, best practices for reproducible data, and data management will be covered. This course emphasizes a direct, hands-on approach. As such, most classes are interactive and will require student participation. Finally, a comprehensive website containing all materials will be maintained throughout the semester.

**Course Learning Objectives:**

1. Acquire bioinformatics skills, including those requiring functional knowledge of command line and R programming,
2. Gain the ability to adeptly apply new computational tools to genomics data sets, have confidence in the results, and comprehend new features and versions as they become available.
3. Be able to use and evaluate online bioinformatics resources including major biomolecular and genomic databases, genome browsers, and select quality control and analysis tools to solve problems in the biological sciences.

**Prerequisites:**

MMG231; MMG104 or BCOR101, or Instructor permission.

**Requirements:**

There is no textbook for this course. Primary literature will be assigned periodically. To fully participate in this course, students will be expected to use their own computers. Each student will be provided with a (VACC) account. Students will use VACC - Open OnDemand (OOD)  <https://vacc-ondemand.uvm.edu/pun/sys/dashboard> to access their VACC account, command line, and R/RStudio.

Students will be required to access class material using the course website (<https://prodriguez19.github.io/Intro-to-shell/>) but submit any graded assignments using blackboard (<https://bb.uvm.edu/>). Any confusion about accessing course materials and/or submission of assignments should be clarified with Dr. Rodriguez immediately.

**Schedule:**

All classes will be held in-person on Tuesdays and Thursdays at 10:05-11:20 in Waterman 457.

Below is a tentative course schedule that may change due to how quickly (or slowly) we progress through each week.

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| --- | --- |
| **Date** | **Topic to be covered** |
| 17-Jan | Syllabus, VACC-OOD overview.  Command Line 1/ Logging into the VACC, Introduction to Shell |
| 19-Jan | Command Line 2/ Basic commands continued, navigating the Filesystem |
| 24-Jan | Command Line 3/ Wild card & working with files |
| 26-Jan | Command Line 4/ Editing & searching files |
| 31-Jan | Command Line 5/ Loops & shell scripts |
| 2-Feb | Command Line 6/ Permissions |
| 7-Feb | Introduction to RNA-Seq & ChIP-Seq  Final Project Overview:  *“Experimental Planning & Considerations when selecting dataset to analyze”* |
| 9-Feb | Accessing data from GEO |
| 14-Feb | FASTQ to SAM File (RNA-Seq)  FASTQC |
| 16-Feb | FASTQ to SAM File (ChIP-Seq)  *Download ChIP-Seq dataset from GEO* |
| 21-Feb | SAM to BAM (RNA-Seq)  BAM to counts (RNA-Seq) |
| 23-Feb | SAM to BAM (ChIP-Seq)  BAM to narrowPeak/broadPeak (ChIP-Seq) |
| 28-Feb | MULTIQC file creation  BAM to BIGWIG (RNA-Seq + ChIP-Seq) |
| 2-Mar | Integrative Genome Browser (IGV)  Overview of Primary Paper assignment #1 |
| 7-Mar | No Class |
| 9-Mar | R/RStudio Introduction |
| 14-Mar | No Class |
| 16-Mar | No Class |
| 21-Mar | Advanced DE analysis/ QC |
| 23-Mar | Advanced DE analysis/ visualization (RNA-Seq) |
| 28-Mar | Advanced DE analysis/ visualization (RNA-Seq) |
| 30-Mar | Advanced DE analysis/ visualization (ChIP-Seq) |
| 4-Apr | Advanced DE analysis/ visualization (ChIP-Seq) |
| 6-Apr | Advanced DE analysis/ wrap-up |
| 11-Apr | Single-cell RNAseq/ Introduction & Primary paper assignment #2 |
| 13-Apr | Single-cell RNAseq/ Coding Part 1 |
| 18-Apr | Single-cell RNAseq/ Coding Part 2 |
| 20-Apr | Single-cell RNAseq/ Coding Part 3 |
| 25-Apr | Single-cell RNAseq/ Primary Paper Discussion |
| 27-May | Student Final Presentations Group 1/ + Attendance from Group 3 |
| 2-May | Student Final Presentations Group 2/ + Attendance from Group 1 |
| 4-May | Student Final Presentations Group 3/ + Attendance from Group 2 |

\*No final in this course

\*This schedule is subject to change at the course instructor’s discretion.\*

**Grading:**

**Undergraduate course grading scale:**

Your letter grade earned in the course will be based on the numerical ranges given below.

**<60 = F 60 - 63 = D- 70 - 73 = C- 80 - 83 = B- 90 - 93 = A-**

**64 - 66 = D 74 - 76 = C 84 - 86 = B 94 - 96 = A**

**67 - 69 = D+ 77 - 79 = C+ 87 - 89 = B+ 97 - 100 =A+**

**Graduate course grading scale**:

Your letter grade earned in the course will be based on the numerical ranges given below. *Please note the lack of D level grades for graduate students.*

**<70 = F 70 - 73 = C- 80 - 83 = B- 90 - 93 = A-**

**74 - 76 = C 84 - 86 = B 94 - 96 = A**

**77 - 79 = C+ 87 - 89 = B+ 97 - 100 =A+**

Decimals will be rounded up or down based on universal math conventions (.4 and below rounds down, .5 and above rounds up).

**Grading Criteria:**

Each week, students should expect 1-2 homework assignments that will facilitate fully grasping bioinformatic concepts taught that week. Weekly assignments will be posted online in the course website. Collectively, homework will account for 40% of the course grade. A total of 30% of the course grade will be assigned based on the final project. The purpose of this final project is to access, download, analyze, and explore sequencing data publicly available. Further details will be provided in class. Students will also be graded on two primary paper reflections, class participation, and attendance for select classes.

|  |  |
| --- | --- |
| Homework | 40% |
| Final Project | 30% |
| Primary article review/reflection | 20% |
| Class Participation & Attendance | 10% |
| Total | 100% |

**Homework Assignments:**

**Type 1: “mini” homework assignments (20 - 50 points)**

These “mini” homework assignments are developed to take students anywhere from 10 - 45 minutes to complete. Although students may be granted time during class to start the homework, students will typically have 48 hours after assigned to complete and submit the homework. No late work will be accepted as answers will be posted at the end of each week on the course website.

**Type 2: Homework assignments (80 - 150 points)**

These homework assignments are developed to take students anywhere from 1 - 4 hours to complete therefore students will be given 1-2 weeks to complete and submit. Late homework be accepted but will be docked 10% of the overall grade for every day that the assignment is late. An assignment is considered late if it is not submitted by the time and due date specified. Three days past the due date (weekend included), the assignment will no longer be accepted, and the student will receive a ZERO.

**Citing your Sources:**

You are required to appropriately cite your sources for any assignment submitted. If you do not cite your sources, your assignments will automatically be marked 50% off. Plagiarism in any form is not acceptable. If assignments are plagiarized, the responsible student will be reported to the academic integrity office. Please see section titled **Academic Integrity** in this syllabus for more details about the University of Vermont’s policies on cheating and plagiarism.

**Office Hours:**

Office hours are by appointment only. I am available to meet in-person or via zoom with sufficient notice. Please email me to ask questions or request meeting times if you need help with any assignment or project.

**Email:**

Please use proper etiquette when addressing your instructor. In the email subject please indicate the course in which you are enrolled and include all necessary information required to appropriately answer your question. My goal is to return emails within 24 hours but that is not always possible. If you send an email the night before an assignment is due, I cannot guarantee that we will be able to respond to your email promptly.

**Excused Absences:**

Any assignment will be granted additional time if the student provides an excused absence from the dean or student health services. It is the student’s responsibility to make sure that I received notice of the excused absence so further instructions can be given. If I am not notified of your illness or other extenuating circumstance, I am unable to provide further accommodation.

## Other Important UVM Policies:

**Student Learning Accommodations:**

In keeping with University policy, any student with a documented disability interested in utilizing ADA accommodations should contact Student Accessibility Services (SAS), the office of Disability Services on campus for students. SAS works with students and faculty in an interactive process to explore reasonable and appropriate accommodations, which are communicated to faculty in an accommodation letter. All students are strongly recommended to discuss with their faculty the accommodations they plan to use in each course. Faculty who receives Letters of Accommodation with [Disability Related Flexible accommodations](https://www.uvm.edu/academicsuccess/forms/disability-related-flexibility-agreement) will need to fill out the Disability Related Flexibility Agreement. Any questions from faculty or students on the agreement should be directed to the SAS specialist who is indicated on the letter.

**Contact SAS:**  
A170 Living/Learning Center;  
802-656-7753  
[access@uvm.edu](mailto:access@uvm.edu)   
[www.uvm.edu/access](http://www.uvm.edu/access)

Academic Integrity:   
The [Academic Integrity policy](https://www.uvm.edu/policies/student/acadintegrity.pdf) addresses plagiarism, fabrication, collusion, and cheating.

Code of Student Conduct:  
[UVM’s Code of Student Conduct](http://www.uvm.edu/policies/student/studentcode.pdf) outlines conduct expectations as well as students’ rights and responsibilities.

FERPA Rights Disclosure:   
The purpose of UVM’s [FERPA Rights Disclosure](http://catalogue.uvm.edu/undergraduate/academicinfo/ferparightsdisclosure/) is to communicate the rights of students regarding access to, and privacy of their student educational records as provided for in the Family Educational Rights and Privacy Act (FERPA) of 1974.

Grade Appeals:   
If you would like to contest a grade, please follow the procedures [outlined in this policy](https://www.uvm.edu/policies/student/gradeappeals.pdf).

## Grading:

[This link](https://www.uvm.edu/registrar/grades) offers information on grading and GPA calculation.

Religious Holidays:   
Students have the right to practice the religion of their choice. If you need to miss class to observe a religious holiday, please submit the dates of your absence to me in writing by the end of the second full week of classes. You will be permitted to make up work within a mutually agreed-upon time. The complete policy is [here](https://www.uvm.edu/registrar/religious-holidays).

Promoting Health & Safety:

The University of Vermont's number one priority is to support a healthy and safe community:

[Center for Health and Wellbeing](https://www.uvm.edu/health)

[Counseling & Psychiatry Services (CAPS)](https://www.uvm.edu/health/CAPS) Direct Phone Line: (802) 656-3340

C.A.R.E. If you are concerned about a UVM community member or are concerned about a specific event, we encourage you to contact the Dean of Students Office (802-656-3380). If you would like to remain anonymous, you can report your concerns online by [visiting the C.A.R.E. Team website](https://www.uvm.edu/deanofstudents/student_advocacy/care_form).

### Statement on Alcohol and Cannabis in the Academic Environment

As a faculty member, I want you to get the most you can out of this course. You play a crucial role in your education and in your readiness to learn and fully engage with the course material. It is important to note that alcohol and cannabis have no place in an academic environment. They can seriously impair your ability to learn and retain information not only in the moment you may be using, but up to 48 hours or more afterwards. In addition, alcohol and cannabis can:

* Cause issues with attention, memory and concentration
* Negatively impact the quality of how information is processed and ultimately stored
* Affect sleep patterns, which interferes with long-term memory formation

It is my expectation that you will do everything you can to optimize your learning and to fully participate in this course.