Computation for 21st Century Biologists – BIOL 5360, MARB 6360
Department of Life Sciences
Fall 2023

A. COURSE INFORMATION

Course number/section: BIOL 5360, MARB 6360
Class meeting time: **F 2-4:30**
Class location: **CCH 206**
Course Website: GitHub.com

B. INSTRUCTOR INFORMATION

Instructor: **Dr. Christopher E. Bird**
Office location: **TH 234**
Office hours: **W-Th 2:30-5, See BlackBoard for Zoom Link**
Telephone: **361-825-6024 (office), 361-443-5676 (cell)**
e-mail: **chris.bird@tamucc.edu**
Appointments: **arrange via email or text**

C. COURSE DESCRIPTION

Catalog Course Description
This course is designed to prepare and enable students to use computational tools for bioinformatic applications in advanced courses and independent research projects. Students will be introduced to powerful open-source computing tools used in biological research for creation, organization, manipulation, processing, analysis, and archiving of big data. While not a formal requirement, it is assumed that students have a firm command of basic algebra.

Extended Course Description
This is a 3-credit course for graduate students that introduces the powerful open-source computing tools that are used in biological research for the creation, organization, manipulation, processing, analysis, and archiving of both small data sets and "big data". This course is designed to prepare and enable students to use computational tools for biological applications in advanced courses and independent research projects. The primary topics covered are: data formats and repositories, command line Linux computing and scripting, regular expressions, super-computing, data wrangling and visualization with R (tidyverse), computer programming with PYTHON, version control and dissemination of scripts and programs with git and GitHub, and typesetting with markdown. The usage of large language models (e.g. GPT) will be incorporated throughout the course.

D. PREREQUISITES AND COREQUISITES

Prerequisites

While not a formal requirement, it is assumed that students have a firm command of basic algebra.

Corequisites

NA, but it is a good idea to take this at the same time as (or before) statistics

E. REQUIRED TEXTBOOK(S), READINGS AND SUPPLIES

Required Textbook(s)

R for Data Science. Grolemund and Wickham. (Free)

Optional Textbook(s) or Other References

Computing skills for biologists: a toolbook. Allesina & Wilmes 2019.

Supplies

A computer designed for content creation (Linux, OSX, Windows, not chrome, not iOS, not Android).

F. STUDENT LEARNING OUTCOMES AND ASSESSMENT

Assessment is a process used by instructors to help improve learning. Assessment is essential for effective learning because it provides feedback to both students and instructors. A critical step in this process is making clear the course's student learning outcomes that describe what students are expected to learn to be successful in the course. The student learning outcomes for this course are listed below. By collecting data and sharing it with students on how well they are accomplishing these learning outcomes students can more efficiently and effectively focus their learning efforts. This information can also help instructors identify challenging areas for students and adjust their teaching approach to facilitate learning.

Upon the successful completion of this course, students should be able to:
1. *Recognize, describe, and organize data into "tidy" data structures*
2. *Locate scientific data repositories and download data*
3. *Operate UNIX/LINUX (super)computers from command line*
4. *Construct and modify computer programming/scripting logic structures for processing biological data*
5. *Describe and use regular expressions to query data*
6. *Use version control software (git) in coordination with GitHub to organize and manage projects*
7. *Typeset with LaTeX or MarkDown*
8. *Use the most popular open-source tools for biological data manipulation*
    a. *Shell scripting (bash)*
    b. *Statistical computing (R, tidyverse)*
    c. *Scientific computing (python)*
9. *Automate the processing/analysis of a data set following core data science philosophy and produce a GitHub repository that could be submitted as supplemental material for a*

manuscript to a peer-reviewed journal
   a.   MARB 6360: teach others how you automated your data processing and analysis
10. Use large language models effectively to assist in data processing.

G. INSTRUCTIONAL METHODS AND ACTIVITIES

Computation for 21st Century Biologists will convene once per week for 2.5 hours. Class periods will involve interactive lectures that require each student to have a computer designed for content creation (Linux, OSX, Windows, not chrome, not iOS, not Android). Homework exercises will embellish upon concepts addressed in lecture. **Participation** involves attending lectures and performance on unannounced quizzes. Weekly **Assignments** will be given to reinforce concepts covered in lectures and encourage students to start using computational tools. **Exams** will be used to evaluate comprehension of the materials covered in lectures and assignments.

Rather than having a final exam, *graduate students* are expected to complete a **Final Project** involving the automation of the manipulation and/or analysis of data, This project, including the code should be archived on GitHub. A report written in Latex or Markdown will be due during the final exam period (this can be a markdown document in your GitHub repo, such as the README.md. The report should be concise in stating what the problem is, describing the strategy used for the solution, and describing how the code works (be sure to include a flow-chart or outline describing what code does). Those taking MARB 6360 will give a 10-15 minute presentation during the Final period on their project.

Project examples: automatically process data from experimental apparatus; image analysis; automated reporting of experimental results; downloading and organizing data from online repositories; etc…

H. MAJOR COURSE REQUIREMENTS AND GRADING

Student learning outcomes will be assessed using in class exercises, semester-long assignments, and exams. Your final grade will be based on the percentage you earn out of the total possible points, extra points may be built into exams or other assignments. It is also possible to lose points by turning in assignments late. Statistical manipulations to adjust grades, *if* used (at the Instructor's discretion), will be performed for each exam individually and all assignments in aggregate. A standard grading scale will be used:

A = 90	-	100 %
B = 80	-	89.9 %
C = 70	-	79.9 %
D = 60	-	69.9 %
F = 0	-	59.9 %

Graduates:

ACTIVITY	% of FINAL GRADE
Participation	10

Assignments	20
Exam 1	10
Exam 2	10
Final Project	BIOL 5360: 50 MARB 6360: 40
Final Presentation	MARB 6360: 10

* See section I for breakdown of credit for Final Project

I. COURSE CONTENT/SCHEDULE

Date	Lecture Topic	HW Due
	Theme I: Welcome to the Matrix	
Wk 0	1. Course overview 2. Biological Data Repositories, Structures, Formats 3. Computer set up	
Wk 1	Linux Boot Camp I 1. UNIX philosophy 2. Navigating/creating/manipulating directories & files 3. How to get help: man pages 4. Basic commands: cd, ls, cp, mv, mkdir, rm, tr, cut, cat, head, tail, 5. Commands useful for manipulating data files in text streams	Assignment 0
Wk 2	Linux Boot Camp II 1. Wildcards, substituting characters, permissions, sudo 2. Pattern matching with grep & regex 3. Intro to Computer Programming: Shebang!, Scripting, For Loops	Assignment 1
Wk 3	Linux Boot Camp III 1. More Computer Programming with bash 2. Logic: if-then-else; looping with while, and GNU parallel 3. Functions: diy commands 4. Advanced text stream manipulation: sed, paste, …	Assignment 2 SuperComputer Acct
Wk 4	Version Control & Supercomputing 1. Linux repositories and tools for biologists 2. Version control with git 3. Super computing, ssh	Assignment 3
	Theme II: Wrangling and Visualizing Data With R	
Wk 5	R Boot Camp I 1. R Philosophy 2. Command line R	**Exam 1** Install R & R Studio

	3. R data types & structures 4. Math, equalities, logic 5. Basic statistical functions 6. Reading and writing data	

Wk 6	R Boot Camp II
	   1. Scripting & writing good code
	   2. Loops & if-then decision logic
	   3. R Studio
	   4. Functions
	   5. Libraries
	   6. Random numbers
	   7. Vectorized loops
	   8. Debugging
	   9. More basic stats
	   10. Base R plots
		Assignment 5

Wk 7	R Boot Camp III
	   1. tidyverse
	   2. Basic reading & manipulating data
	   3. Basic computing statistics
	   4. Visualization of data w ggplot2
		Assignment 6

Wk 8	R Boot Camp IV (Ch 9)
	   1. Advanced tidyverse, pipelines
	   2. Manipulating & wrangling data
		Assignment 7

	Theme III: Programming the Matrix	

Wk 9	Python Boot Camp I
	   1. Intro to Python
	   2. Data structures
	   3. Functions
	   4. Decision logic and loops
	   5. Reading and writing files
		Exam 2
		Install Anaconda

Wk 10	Python Boot Camp II
	   1. Writing code
	   2. Modules & Program Structure
	   3. Errors and exceptions
	   4. Debugging
	   5. Testing & Profiling
		Assignment 9

Wk 11	Scientific Computing w/ Python
	   1. NumPy and SciPy
	   2. Pandas
	   3. Biopython
	   4. Other modules
		Assignment 10

Wk 12	Scientific Typesetting w/ Latex 1. Latex document structure 2. Typsetting 3. Latex packages for biologists	Assignment 11
Wk 13	Putting It All Together	Assignment 12
Final	**Final Project: Becoming THE ONE**	

Date	Graduate Students: Final Project Schedule
	Theme I: Welcome to the Matrix
Wk 0	
Wk 1	
Wk 2	Submit Project Idea (2.5%)
Wk 3	
Wk 4	Submit Project Plan/Outline (2.5%)
	Theme II: Programming the Matrix
Wk 5	Link to GitHub repository for project w/ readme (2.5%)
Wk 6	Commit at least 1 working function to GitHub (2.5%)
Wk 7	Commit at least 2 working functions with data I/O to GitHub (2.5%)
Wk 8	
	Theme III: Becoming THE ONE
Wk 9	
Wk 10	Latex or Markdown draft/ progress report (see syllabus section G for description of report); include a description of tasks left to achieve. Code and data committed to GitHub (2.5%)

Wk 11	
Wk 12	
Wk 13	Final Report in Latex or Markdown; Working code and data committed to GitHub. (25%)
Final	MARB 6360 Final Presentations (10%)

J. COURSE POLICIES

Attendance/Tardiness: Attendance is expected. If you are late, don't make a disturbance and you will be responsible for catching yourself up to where we are.

Late Work and Make-up Exams: 10% of total possible score is deducted per day late. Inform professor as soon as you find out that you will miss and exam. Make arrangements with professor for make-up.

Cell Phone, Tablet, and Laptop Use: Required

Food in Class: food is not allowed in computer labs

Missed Exam: let me know ahead of time, when you realize you will miss an exam

Participation: Required

Student Safety Trainings
Required safety trainings and/or lab safety seminars must be successfully completed once every academic year, normally in the Fall. Students will be required to take the course from Blackboard in either the first lecture or first lab to complete their training assignments and show the certificate of completion before the end of the class or lab. Students who are still covered by having taken the safety training earlier should show their certificate of completion. For students unable to attend first day of class/lab (or still registering for the class), a reasonable completion date will be flagged in Starfish. A possible grade penalty can be enforced for non-completion.

K. COLLEGE AND UNIVERSITY POLICIES
COVID-19 Campus Safety Measures

While the University does not require face coverings or vaccinations, we encourage every Islander to consider getting vaccinated, wear a face covering while indoors, and wash your hands frequently to aid in reducing the spread of COVID-19.

Anyone with COVID-19 symptoms should not report to campus. Students, faculty, and staff who

test positive are required to report their test results to the University Covid-19 Reporting Form.

Please use the below links for COVID-19 guidelines:

If You Test Positive, Regardless of Vaccination Status

If you are exposed to Someone with COVID-19

If you have Symptoms Regardless of Vaccination Status

 Complete the COVID-19 Self Reporting Form and notify instructor.

More COVID-19 related information may be found on the university website at
https://www.tamucc.edu/campus-guide/covid-protocol.php

Campus Emergencies*

At TAMU-CC, your safety is a top concern. We actively prepare for natural disasters or human-caused incidents with the ultimate goal of maintaining a safe and secure campus.
- For any emergency, dial the University Police Department (UPD) at **361-825-4444** or dial 911. It's a good idea to have the UPD emergency number (and non-emergency number 361-825-4242) saved in your cell phone.
- There are nearly 200 classroom telephones throughout campus. If you feel threatened or need help and don't have a cell phone, dial 4444 (emergency) or 4242 (non-emergency) to be connected to UPD.
- If we hear a fire alarm, we will immediately evacuate the building and proceed to the Hector P Garcia Statue.
    - Proceed to the nearest building exit or evacuation stairway. Do not use the elevator. Persons who need help navigating stairs should proceed to a marked Area of Rescue Assistance, if possible.
    - Persons with disabilities should speak with their faculty about how to best assist them in case of an emergency.
    - Review the evacuation route (see specific Building Emergency Plan).
- TAMU-CC employs the Code Blue Emergency Notification System, an alert system which connects the campus community during emergency situations.
    - The notifications include emails, text and pre-recorded messages, as appropriate.
    - Code Blue emergencies may include severe weather warnings, threats, school closures, delays, evacuations and other incidents which disrupt regular campus activities.
    - Students can update personal contact information anytime at https://emergency.tamucc.edu/contactform/
- Shelter in Place via Code Blue.
    - "Shelter-in-place" means to take immediate shelter where you are and may be implemented for severe weather, hazardous material spills, active shooters or

other dangerous situations.
  - o If there is a shelter in place for a **tornado warning**, our preferred location is the bottom floor of this building, away from windows and doors.
- Active Threat Protocol. There are three things you could do that make a difference if there is an active threat: Run, Hide, and/or Fight. For more information about the Run, Hide, Fight protocol, including what to do when law enforcement arrives, visit https://www.tamucc.edu/finance-and-administration/facility-administration/ehs/.

For the *Quick Campus Guide to Campus Emergencies* (including a list of Areas of Rescue Assistance and additional protocols on assisting persons with physical disabilities, hurricanes, bomb threats, animal bites, crime reporting, elevator entrapment, etc.), visit https://www.tamucc.edu/finance-and-administration/facility-administration/ehs/emergency-management/assets/documents/finalbooklet.pdf

- **Academic Integrity (University)**
  University students are expected to conduct themselves in accordance with the highest standards of academic honesty. Academic misconduct for which a student is subject to penalty includes all forms of cheating, such as illicit possession of examinations or examination materials, falsification, forgery, complicity or plagiarism. (Plagiarism is the presentation of the work of another as one's own work.) In this class, academic misconduct or complicity in an act of academic misconduct on an assignment or test will result in a failing grade.

- **Classroom/Professional Behavior**
  Texas A&M University-Corpus Christi, as an academic community, requires that each individual respect the needs of others to study and learn in a peaceful atmosphere. Under Article III of the Student Code of Conduct, classroom behavior that interferes with either (a) the instructor's ability to conduct the class or (b) the ability of other students to profit from the instructional program may be considered a breach of the peace and is subject to disciplinary sanction outlined in article VII of the Student Code of Conduct. Students engaging in unacceptable behavior may be instructed to leave the classroom. This prohibition applies to all instructional forums, including classrooms, electronic classrooms, labs, discussion groups, field trips, etc.

- **Statement of Civility**
  Texas A&M University-Corpus Christi has a diverse student population that represents the population of the state. Our goal is to provide you with a high-quality educational experience that is free from repression. You are responsible for following the rules of the University, city, state and federal government. We expect that you will behave in a manner that is dignified, respectful and courteous to all people, regardless of sex, ethnic/racial origin, religious background, sexual orientation or disability. Behaviors that infringe on the rights of another individual will not be tolerated.

- **Deadline for Dropping a Course with a Grade of W (University)**

I hope that you never find it necessary to drop this or any other class. However, events   can sometimes occur that make dropping a course necessary or wise. ***Please consult with your academic advisor, the Financial Aid Office, and me, before you decide to drop this course.*** Should dropping the course be the best course of action, <u>you must initiate the process to drop the course by going to</u> **University Center 324** <u>and filling out a course drop form. Just stopping attendance and participation WILL NOT automatically result in your being dropped from the class.</u> You may also submit a PowerFormSigner online. (<mark>Insert date</mark>) is the last day to drop a class with an automatic grade of "W" this term.

- **Grade Appeals (College of Science and Engineering)**
  As stated in University Procedure 13.02.99.c0.03, Student Grade Appeal Procedures, a student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is upon the student to demonstrate the appropriateness of the appeal. A student with a complaint about a grade is required to first discuss the matter with the instructor. For complete details, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, see University Procedure 13.02.99.c0.03, Student Grade Appeal Procedures. These documents are accessible through the University Rules website at https://www.tamucc.edu/faculty/faculty-affairs/assets/student-grade-appeal-packet.pdf. For assistance and/or guidance in the grade appeal process, students may contact the chair or director of the appropriate department or school, the Office of the College of Science and Engineering Dean, or the Office of the Provost.

- **Disability Services**
  The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call (361) 825-5816 or visit Disability Services in Corpus Christi Hall 116.

  If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816.

  http://disabilityservices.tamucc.edu/

- **Civil Rights Complaints**
  Texas A&M University-Corpus Christi is committed to fostering a culture of caring and respect that is free from discrimination, relationship violence and sexual misconduct, and ensuring that all affected students have access to services. For information on reporting Civil Rights complaints, options and support resources (including pregnancy support accommodations) or university policies and procedures,

please contact the University Title IX Coordinator, Sam Ramirez (Samuel.ramirez@tamucc.edu) or Deputy Title IX Coordinator, Rosie Ruiz Rosie.Ruiz@tamucc.edu x5826, or visit website at [Title IX/Sexual Assault/Pregnancy](#)

Limits to Confidentiality. Essays, journals, and other materials submitted for this class are generally considered confidential pursuant to the University's student record policies. However, students should be aware that University employees, including instructors, are not able to maintain confidentiality when it conflicts with their responsibility to report alleged or suspected civil rights discrimination that is observed by or made known to an employee in the course and scope of their employment. As the instructor, I must report allegations of civil rights discrimination, including sexual assault, relationship violence, stalking, or sexual harassment to the Title IX Coordinator if you share it with me.

These reports will trigger contact with you from the Civil Rights/Title IX Compliance office who will inform you of your options and resources regarding the incident that you have shared. If you would like to talk about these incidents in a **confidential** setting, you are encouraged to make an appointment with counselors in the [University Counseling Center](#).

- **Statement of Academic Continuity**
  In the event of an unforeseen adverse event, such as a major hurricane and classes could not be held on the campus of Texas A&M University–Corpus Christi; this course would continue through the use of Blackboard and/or email. In addition, the syllabus and class activities may be modified to allow continuation of the course. Ideally, University facilities (i.e., emails, web sites, and Blackboard) will be operational within two days of the closing of the physical campus. However, students need to make certain that the course instructor has a primary and a secondary means of contacting each student.

- **Use of Artificial Intelligence**
  Students are expected to use "artificial intelligence" (e.g. large language models) in this course. When you submit work created using artificial intelligence, you are responsible for the content, not the ai. If you used ai in a novel fashion, you should describe how it was used to accomplish the task.

L. OTHER INFORMATION

- **Academic Advising**
  The College of Science & Engineering requires that students meet with an Academic Advisor as soon as they are ready to declare a major. The Academic Advisor will set up a degree plan, which must be signed by the student, a faculty mentor, and the department chair. Meetings are by appointment only; advisors do not take walk-ins. Please call or stop by the Advising Center to check availability and schedule an appointment. The College's Academic Advising Center is located in Center for

Instruction 350 or can be reached at (361) 825-3928.

GENERAL DISCLAIMER

I reserve the right to modify the information, schedule, assignments, deadlines, and course policies in this syllabus if and when necessary. I will announce such changes in a timely manner during regularly scheduled lecture periods.