Credit Hours: 1. This course has a 1 hour computational lab each week.

Instructor:

Brian K. Taylor

Assistant Professor of Biology

Email: brian.taylor@unc.edu Website: <http://taylorlab.web.unc.edu/>

Course Website:

Office: Coker Building – Room 301A

Office Hours: Wednesday 3:00 PM – 4:30PM

Target Audience: Biology majors who are interested in quantitative biology, mathematical modeling, and computer simulation. Mathematics, physics, chemistry, and computer science majors who are interested in biological applications of mathematics.

Course Prerequisites: MATH 231 and one of BIO 201/202/205

Course Goals and Key Learning Objectives:

* Write down mathematical models to describe molecular, cellular, and organismal processes.
* Solve the mathematical models numerically or analytically and evaluate them against experimental data.
* Become proficient in the use of MATLAB for biological applications, both in terms of writing programs and using software packages.

Course Requirements:

Students will be expected to review assigned readings from the course packet, lecture notes, and other materials posted on webassign and/or Sakai before each lab.

Grades: Graded work will consist of approximately ten lab exercises (60%), one lab report (20%), and a final exam (20%). Lab exercises include activities to demonstrate proficiency at mathematical modeling and the use of MATLAB. Lab reports are formal write-ups of two-week projects.

Help/Camaraderie: While all submitted work must ultimately be your own, I want to encourage you to help each other, and ask each other questions on assignments. This course should be a community where we all help to increase each other’s comprehension and understanding of the material. Therefore, if you agree with a classmate to help and/or receive help on a particular assignment via webassign, that exchange will be recorded. At the end of the semester, I will take the total number of times you received/gave help, compare that to the number of times possible (i.e., assignments given), and convert that to a maximum of 2 percentage points that will be added to your grade after the final grade has been computed. ***To get credit, you must both separately indicate the party that provided help, and the party that received it. If one party states that they gave/received help and the other does not, neither gets the extra credit for that assignment.***

Assignment Redos: If you don’t like your grade on an assignment, if you ***come and talk to me about what you did wrong***, you may resubmit a corrected version of the assignment ***within one week of when the grade is posted***. If you do this, and the assignment is correct (i.e., flawless), you will be given back half of the points that you lost ***up to an 85%***. For example, if you get a 50/100 on an assignment, talk to me about it to understand what you did wron, and resubmit something perfect, you will get back 25 points, so you now have a 75/100. ***THIS DOES NOT APPLY TO EXAMS***

Course Policies:

*Late Lab Report and Lab Activity Policy:* 10% will be deducted the first hour the assignment is late, and then 20% will be deducted each day unless the student can provide a written excuse with documentation for valid reasons (illness, family emergency, religious observance, university sponsored travel, etc.). A student should present his or her explanation for any absences in writing in advance if the reason for the absence could be foreseen, or within 5 days of the due date of the assignment if the reason could not be foreseen.

*Honor Code Statement:* “It is expected that each student will conduct him or herself within the guidelines of the Honor System. All academic work should be done with the highest level of honesty and integrity that this University demands.” In particular, all tests and quizzes should be taken without texts without consultation with other student’s work. Students are encouraged to work together on all homework assignments.

*Attendance:* Attendance will not be figured into your grade directly. However, attending class is highly recommended *as there may be things that are stated in class that are not posted* (e.g., class cancellations, concepts around the lecture material). You will be responsible for any in-class activities that may be assigned during your absence. While attendance will not be taken, I DO monitor who comes to class on a regular basis. Unless you contact me and work something out prior, exams MUST BE TAKEN IN CLASS.

*Contact with Dr. Taylor:* I STRONGLY encourage you to use my office hours, e-mail me, and come talk to me about the class, career advice, or things in life that are affecting your ability to perform in the class. It will help you do better in the class, maybe help you figure out future plans, help smooth out life, and I just like to hear and learn (yes, learn) from all of you! That being said, this class is not my only responsibility. Just as you all have other classes to balance on top of your personal lives, I have other personal and professional responsibilities to balance. While I want to be available and responsive to you, I cannot be available all the time. If you have a question about something, I *ENCOURAGE* you to ask. However, if you e-mail after 7:00PM, you may not receive a response until the following day. Please keep this in mind, especially if you are sending an e-mail about an assignment the night before it is due.

*Code:* If asked to turn in or submit code, ASSUME THAT I WILL PUT IT IN MATLAB AND RUN IT! If your code does not run, but you acknowledge this along with what might be wrong in your writeup, partial credit will be given. If your code does not run, and you make no acknowledgement that your code does not run, the question under consideration WILL RECEIVE ZERO CREDIT. Bottom line: Make sure your code works, or acknowledge that it doesn’t, and why you think it might be broken. Making mistakes is OK! But, we have to acknowledge them.

Course Resources:

*Suggested Text:* F.C. Hoppensteadt and C.S. Peskin. Modeling and Simulation in Medicine and the Life Sciences. Second Edition, New York: Springer-Verlag, 2002.

Sakai Resources: Supplemental reading and labs will be posted to [www.unc.edu/sakai](http://www.unc.edu/sakai) throughout the semester. Digital assignments will be maintained on [www.unc.edu/sakai](http://www.unc.edu/sakai).

*Webassign:* Homework will be assigned and submitted through webassign. Please create an account using your onyen as the username at <http://www.webassign.net>.

**Instructor Section Class Key**

**Brian K. Taylor BIOL 226 – Fall 2019 unc 6543 0098**

*Grading Scale:* A letter grade will be based on the following APPROXIMATE scale: A= 90-100%, B= 80-90%, C= 70-80%, D= 60-70%, F= less than 60%.

Tentative Time Table (Approximately 1 Lab/week):

NOTE: Lab order may be changed to better fit material being covered in class.

Lab 1: Introduction to Matlab

Lab 2 - 3: Random walks and programming in Matlab

(Mathematics: vectors, matrices, matrix addition and multiplication, linear maps, basic probability)

Lab 4: Vector representations of genomes and simple fitness functions

(Mathematics: Basic probability, expected value, normal distribution, independence, conditional probability, basic statistical tools).

Lab 5: Developing a model of diffusion

(Mathematics: Tangent lines, partial derivatives, tangent planes, boundary conditions)

Lab 6-10: Solving differential equations in Matlab, and looking at feedback loops

Lab 8: Simulating feedback loops using differential equations in Matlab

(Mathematics: numerical methods, Matlab tools, Numerical solution of nonlinear differential equations)

Lab 10-11: Simulating nerve dynamics in Matlab

(Mathematics: Numerical solving systems of nonlinear differential equations)

Lab 10-12: Simulating crossbridge attachments in Matlab and calculating force-velocity curves

(Mathematics: The probability density function, linear regression)

Final Exam:

The lab final exam will be held during the last lab. 20% **(i.e., 4% of your total grade in the course)** of it will be code-based, and is actually posted on Sakai right now, along with sample data sets so you can check to make sure your code works. For the final exam, you will submit a set of code to me that I will run for a given set of parameters. I will evaluate the outputs, and if they are correct, then you receive full credit for the problem. THERE WILL BE NO PARTIAL CREDIT FOR THIS PROBLEM

That probably sounds really scary, but I promise it’s not! As we move through the class, you will acquire the skills to write the code for the lab final, and you will be able to check your code against the sample data sets that are posted. So, you could actually walk into the lab final and know that you have this question right ahead of time! I will let you know what parts of the final you should be able to do as we move through the course so that you can work on it during the semester. I can’t make you do anything, but I STRONGLY ENCOURAGE YOU TO WORK ON THE FINAL AS WE MOVE THROUGH THE SEMESTER so that the end of the semester is low stress for you. If you don’t, you may not be able to do the final within the 50 minute lab period. I am more than happy to help you with your code, and go over code in class, but **I WILL NOT GO OVER THE CODING PORTION OF THE LAB FINAL AFTER NOVEMBER 27**. Therefore, **prioritize your time, do not procrastinate**, and if you have questions about the lab final, **ask early**.

Lab Report:

The lab report will consist of an extended writeup of a particular lab topic. The goal is that this should be similar to a scientific paper. *This is an open ended assignment*, so if you feel like there is a lack of guidance or instructions – you should! Much of the world and life is open ended, with no back of the book answer or clear guidelines on what to do next, so this is meant to give you some experience in tackling a challenge like that. When I say much of the world, this includes parts of government (basic and applied R&D – where I came from), industry (R&D, manuals – I interned there and have worked with people there too), academia (Research – I live there now), and medicine (diagnosing someone). You will HAVE to be able to write and communicate ideas in whatever career you choose, so this is good practice. That all being said, there are some guidelines that your report MUST have (i.e., if it doesn’t you WILL lose points).

* Organization – Include the following sections
  + Abstract: Summary of the work as a whole – 1 paragraph and should probably be the last thing you write. This gives me enough to decide that I want to read the paper/document
  + Introduction: Explain the background of what you are doing, what’s been done previously, what your work hopes to accomplish, and why it matters.
  + Methods: How did you do what you did? This should have enough information that I could repeat your work if I wanted to build off of it
  + Results: What did you find/learn?
  + Conclusion and Discussion: What do your results mean? How do they expand the body of knowledge (if applicable)? How can they be used to help others (if applicable)? If I was an investor or funder, this should convince me to give you money. If I am your boss, this should convince me to give you a raise. If I work for you, this should outline why I need to do something so I can help support the organization’s mission.
  + Future Work: What can you do in the future to improve your work, or take it in new directions
  + References (aka, works cited, aka bibliography, aka whatever you use that is not your own work, give those people credit!)
* Listing of who did what in the project
  + If one person does 90%, or the distribution of work is inequitable, that’s a problem
* Code that you used
  + If I can’t put your code into MATLAB, run it, and get results that agree with yours, that is a problem
* Presentation
  + You will give an in-class presentation on your work.
* General Guidelines
  + Repeatability: If you are doing something that has noise, or stochasticity, or randomness, you should probably do more than one trial, and report a mean and standard deviation
  + Readability: While impossible to do with everything, this should be readable by someone who is not in this class, or has never seen this topic. At the very least, your classmates should be able to understand what you wrote/did
  + Conciseness: I do not want to read War and Peace, or Principles of Neural Science (check out the 5th edition – all 1,521 pages BEFORE appendices), but you should have some detail. You should probably be between 5 and 10 pages (including figures)
  + Figures: USE PICTURES where you can – they help tell your story. Think about your textbooks