

MATH 4600-001 Spring 2023: Mathematics in Medicine

Lecture: TuTh 12:25 - 1:45 PM Room: CSC 25
Lab Section: Fr 12:55 - 1:45 PM Room: AEB 360

Course Instructor: Jake Madrid (he/him)
Office: LCB 313
Email: madrid@math.utah.edu (preferred method of contact)
Office Hours: TBD

Course Instructor: Filip Belik
Office: LCB Loft
Email: filip.belik@utah.edu
Office Hours: TBD

Course Web Page:

All course information and announcements will be posted on CANVAS

Referenced Texts: (you are NOT required to purchase any of the following)

- Beuter et al., eds. Nonlinear Dynamics in Physiology and Medicine: Interdisciplinary Applied Mathematics; v.25
- G. de Vries, T. Hillen, M. Lewis, J.Muller, and B. Schoenfish, A Course in Mathematical Biology: Quantitative Modelling with Mathematical and Computational Methods, SIAM, 2006
- Hoppensteadt, Peskin. Modeling and simulation in medicine and the life sciences, Springer, 2nd edition
- J.Keener and J. Sneyd. Mathematical Physiology I : Cellular Physiology, Vol. 1. Springer-Verlag New York, 2008
- J.Keener and J. Sneyd. Mathematical Physiology II : Systems Physiology, Vol. 2. Springer-Verlag New York, 2008

Prerequisites:

- C or better in MATH 2250 OR MATH 2280

Course Description: The goals of the class are (i) to introduce the students to a range of modern mathematical tools; (ii) to teach the students the skill of building tractable mathematical models of biological processes; (iii) to show how to combine the mathematical knowledge, the numerical simulations (in Matlab) and biological intuition to derive new insights into the functioning of living systems. Mathematical topics include introduction to linear algebra, complex numbers, geometric dynamical systems, bifurcation theory, probability, Markov chain, partial differential equations. Biological topics may include modeling heart and circulation, kidneys, circadian clocks, brain rhythms, HIV, antibiotic resistance in bacteria, regulation of gene expression, biological pattern formation.

Course Work and Evaluation

Grading: Grades will be determined by performance on weekly homework assignments and two exams

Homework	50%
Midterm Exam	20%
Final	30%

Using the above weights, letter grades will be assigned as follows: A (93-100), A- (90-92), B+ (87-89), B (83-86), B- (80-82), C+ (77-79), C (73-76), C- (70-72), D+ (67-69), D (63-66), D- (60-62), E (0-59).

I reserve the right to change the grade scheme as I see fit. Any other grade schemes will only be beneficial to your grade as compared to the above standard.

Homework: Homework will be posted weekly on CANVAS, and due at the beginning of lab sessions. The assignments will require coding in MATLAB, however prior MATLAB experience is not required as the necessary techniques will be introduced in the lab sessions each week.

Midterm Exam: One in-class midterm is scheduled for **Thursday, March 2**. A make-up midterm will not be offered unless the student notifies me BEFORE the day of the exam that they will be unable to attend.

Final Exam: A take home final will be posted on the last day of lecture (**Tuesday, April 25**) and will be due on **Wednesday, May 3**.

Gradescope: Assignments and exams will be submitted on gradescope.com. A link can be found on the course CANVAS page

Important Dates:

Drop DeadlineFriday, January 20
Last Day to Elect CR/NCFriday, January 20
Midterm Exam **Thursday, March 2**
Spring Break (NO CLASS) March 5-12
Last Day to Withdraw from ClassesFriday, March 31
Last Day to Reverse CR/NC OptionFriday, April 21
Classes End Tuesday, April 25
Final Exam Due **Wednesday, May 3**

Course Topics:

- Introduction to mathematical models, review of ideas from calculus and ODEs (*~ 1 week*)
 - Heart and circulation, dynamics of the pulse
- Dynamical systems: geometric analysis, phase planes, introduction to bifurcation theory, phase oscillators, phase response curves (*~ 5 week*)
 - Law of mass action, Hill's function
 - Gene activation model, bistability and biological switches
 - Hodgkin-Huxley equations
 - Pancreatic beta-cells
 - Epidemics
 - HIV modeling
- Probability, random variables, Markov chains (*~ 4 week*)
 - Natural selection
 - Plasmids (antibiotic resistance in bacteria)
 - Regulation of gene expression
- Introduction to partial differential equations (*~ 2 week*)
 - Models for cancer-immune system interaction and for cancer-growth inhibitor interaction

Note: The schedule of topics is not set in stone. I may adjust the pace as necessary for the learning needs of the class.

Other Policies and Resources

COVID-19: Please visit <https://coronavirus.utah.edu/> for the most up to date information on coronavirus guidelines

Inclusivity Statement: It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: age, color, disability, gender, gender identity, gender expression, national origin, political affiliation, race, religion, sexual orientation, and veteran status, and other unique identities. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.

LGBT Resource Center: If you are a member of the LGBTQIA+ community, I want you to know that my classroom is a safe zone. Additionally, the University of Utah has an LGBT Resource Center on campus. They are located in Room 409 in the Olpin Union Building. Hours: M-F 8-5pm. You can visit their website to find more information about the support they can offer, a list of events through the center and links to additional resources: <https://lgbt.utah.edu/>. Please also let me know if there is any additional support you need in this class.

Names/Pronouns: CANVAS allows students to change the name that is displayed AND allows them to add their pronouns to their CANVAS name. Class rosters are provided to the instructor with the student's legal name as well as "Preferred first name" (if previously entered by you in the Student Profile section of your CIS account, which managed can be managed at any time). While CIS refers to this as merely a preference, I will honor you by referring to you with the name and pronoun that feels best for you in class or on assignments. Please advise me of any name or pronoun changes so I can help create a learning environment in which you, your name, and your pronoun are respected. If you need any assistance or support, please reach out to the LGBT Resource Center: <https://lgbt.utah.edu/>.

English Language Learners: If you are an English language learner, please be aware of several resources on campus that will support you with your language and writing development. These resources include: the Writing Center (<http://writingcenter.utah.edu/>); the Writing Program (<http://writing-program.utah.edu/>); the English Language Institute (<http://continue.utah.edu/eli/>). Please let me know if there is any additional support you would like to discuss for this class.

Undocumented Student Support: Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles to engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center. Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence. The Dream Center offers a wide range of resources to support undocumented students (with and without DACA) as well as students from mixed-status families. To learn more, please contact the Dream Center at 801.213.3697 or visit dream.utah.edu.

Veteran's Center: If you are a student veteran, the University of Utah has a Veterans Support Center located in Room 161 in the Olpin Union Building. Hours: M-F 8-5pm. Please visit their website for more information about what support they offer, a list of ongoing events and links to outside resources: <http://veteranscenter.utah.edu/>. Please also let me know if you need any additional support in this class.

Wellness Statement: Personal concerns such as stress, anxiety, relationship difficulties, depression, cross-cultural differences, etc., can interfere with a student's ability to succeed and thrive at the University of Utah. For helpful resources contact the Center for Student Wellness at www.wellness.utah.edu or 801-581-7776.

Student Success Advocates: The mission of Student Success Advocates is to support students in making the most of their University of Utah experience (ssa.utah.edu). They can assist with mentoring, resources, etc. Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact a Student Success Advocate for support (<https://asuu.utah.edu/displaced-students>).

The Americans with Disabilities Act: The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability & Access, 162 Olpin Union Building, 801-581-5020. CDA will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability & Access.

Addressing Sexual Misconduct: Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a Civil Rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veterans status or genetic information. If you or someone you know has been harassed or assaulted on the basis of your sex, including sexual orientation or gender identity/expression, you are encouraged to report it to the University's Title IX Coordinator; Director, Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or to the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to police, contact the Department of Public Safety, 801-585-2677(COPS).

Campus Safety: The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit safeu.utah.edu.

University Counseling Center: The University Counseling Center (UCC) provides developmental, preventive, and therapeutic services and programs that promote the intellectual, emotional, cultural, and social development of University of Utah students. They advocate a philosophy of acceptance, compassion, and support for those they serve, as well as for each other. They aspire to respect cultural, individual and role differences as they continually work toward creating a safe and affirming climate for individuals of all ages, cultures, ethnicities, genders, gender identities, languages, mental and physical abilities, national origins, races, religions, sexual orientations, sizes and socioeconomic statuses.

Office of the Dean of Students: The Office of the Dean of Students is dedicated to being a resource to students through support, advocacy, involvement, and accountability. It serves as a support for students facing challenges to their success as students, and assists with the interpretation of University policy and regulations. Please consider reaching out to the Office of Dean of Students for any questions, issues and concerns. 200 South Central Campus Dr., Suite 270. Monday-Friday 8 am-5 pm.