MATH 5110: Mathematical Biology I (Fall 2020)  
(Also Bio 5011 and Math 6830)  
**Time & Place:** TuTh / 09:10AM-10:30AM, CANVAS  
**Instructor:** Alla Borisyuk  
**E-Mail:** borisyuk@math.utah.edu  
**Office Hour:** on Zoom, Mondays 9-10 AM or by appointment.  
**Office Hour Zoom link:** in Canvas. Please do not distribute it or post it anywhere online.

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**CANVAS:** This is where I will post class announcements and grades. This is also where quizzes and tests will be administered.

**Course type:** Interactive Video Conferencing (IVC - synchronous online). This means that lectures are delivered via live Zoom meetings. You are expected to attend the lectures. This class does not always follow a textbook. You will be expected to follow the material in lectures. Lectures will be recorded and the recordings posted in Canvas 

**Class Zoom link:** is provided on CANVAS. Please do not distribute it or post it anywhere online.

**Attendance, punctuality, and etiquette:** Attendance of the Zoom meetings is strongly encouraged. I would like to ask you to be present with a camera ON. It will make our classes more interactive. Please attend class on time, not to disrupt the meetings. You will be automatically muted upon joining the meeting. To ask a question or make a comment you can temporarily unmute yourself by holding the space bar. Please make sure you are back to being muted after you are done asking your question.

**Technical requirements:** CANVAS and Zoom navigation skills are expected. Zoom meetings will require a strong internet connection with adequate bandwidth, plus a camera with a microphone. Please let me know as soon as possible if you think this will present a problem for you.

**Prerequisites:** C or better in MATH 2280 OR MATH 2250. You need to be comfortable with differential equations, including linearization, and with matrix eigenvalues

**Description:** Mathematical modeling in the biological and medical sciences. Topics will include continuous and discrete dynamical systems describing interacting and structured populations, resource management, biological control, reaction kinetics, biological oscillators and switches, and the dynamics of infectious diseases.

**Textbook:** We will mostly follow the book Mathematical Models in Biology by L. Edelstein-Keshet. It is available free as a collection of pdf files from the Society for Industrial and Applied Mathematics: [https://epubs.siam.org/doi/book/10.1137/1.9780898719147](https://epubs.siam.org/doi/book/10.1137/1.9780898719147). A tentative list of topics is listed at the end of this syllabus

**Forum:** I would like to encourage you to use CANVAS Discussion Board to ask and answer questions about class contents, logistics, assignments, and anything else the classmates may wonder about as well. This way the information is shared quickly to the entire class, and everyone can benefit from seeing other classmates’ questions. I will not answer posted questions instantaneously, but will check and respond at least daily. If you have a question that you prefer to ask more privately, please send me an email.
**QUIZZES, TESTS, HOMEWORKS, COMPUTING**

There will be a brief 5 minute **pop-up quiz** during lectures (administered in Canvas) to check that you are following the basic flow of the material being presented. Lowest 5 quiz grades will be dropped. There will be absolutely no make-up for the quizzes. **The quizzes will constitute 10% of your grade.** If you anticipate that attending lectures and taking these quizzes will present a problem for you, please talk to me IN ADVANCE.

Most lectures will also have a **lecture test** associated with it. It will available in Canvas from the end of each lecture until the beginning of the next lecture. It will take 5-10 minutes and test your understanding of the lecture material. If you need, in addition to attending the lecture, do make sure you listen to and understand the lecture video and ask any questions you have before attempting the test. Lowest 5 test grades will be dropped. **The tests will constitute 15% of your grade.** There will be no makeups. Keep in mind that asking questions about the lecture in the evening before class might not give you enough time to get answers and take the test as well.

There will be **homework** assigned most weeks and due on Tuesdays at class time. You submit it by uploading into CANVAS. When you have two weeks to do a homework, that means it includes problems that might require more work, additional reading or exploration. Treat these assignments as you would take-home exams, and give yourself ample time to do the assignments. **Homework will make 75% of your grade.** The lowest homework score will be dropped.

You can discuss homework with other students in class, but only after thinking about the problems hard yourself. After the discussion each student is expected to write their own solutions independently, in their own words. Soliciting ready solutions from other students of other sources, such as online resources (e.g. Chegg, Stack Exchange) **will be considered as academic misconduct and will be dealt with accordingly.**

**Computing:** The students will be expected to work with computing and/or graphing software to do some of the assignments. I will encourage you to use Matlab, and will show you in class how to do it, but I will not require you to use it. You can get access to it through library remote access, campus computer labs if you are on campus, or by buying the student license for use on your own computer. You will also be able to do the assignments by using free online software that I will also show you in class.

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**Further important information:**

- It is the student's responsibility to regularly check their Umail or have it forwarded to an address they check regularly. The Umail is the only way for me to communicate privately with the student. There will be occasions during the semester that we may need to reach out to individual students (e.g. regarding a grade or assignment) and it is in their best interest to respond promptly.

- I would like to encourage the students to email me only if it is something personal that requires individual attention. For questions about logistics of the class, course material and assignments, and anything else the classmates may wonder about as well, please post a question on the Discussions Board in CANVAS. This way the information is shared quickly to the entire class, and everyone can benefit from seeing other classmates’ questions.
- Please stay updated by regularly checking: the announcements on Canvas, your Umail, the posts on the Discussions Board, and pay attention to the announcements given in class. Students are also strongly advised to set up notifications for canvas so they do not miss any important notifications.

- Respectful participation in all aspects of the course will make our time together productive and engaging. Zoom lectures, discussion threads, emails and canvas are all considered equivalent to classrooms and student behavior within those environments shall conform to the student code.

- **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, veteran's 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.
Tentative list of lecture topics (will be updated as we go along).

The references are to the following books:

A Course in Mathematical Biology: Quantitative Modelling with Mathematical and Computational Methods, SIAM


**Lecture 1**: introduction (what is mathematical biology); discrete vs. continuous models; SIR model (dV 1.2)

**Lecture 2**: Computing training, working on homework 1.

**Lecture 3**: Solving general linear homogeneous difference equations (case of distinct real eigenvalues) (EK 1.1, 1.3, 1.6)

**Lecture 4**: Applications: red blood cells, aphid population, segmental organism (EK 1.9, exercises 15, 16 of chapter 1)

**Lecture 5**: Non-linear first order difference equations, fixed points and stability (analytically and graphically with cobwebbing) (EK 2.1, 2.2, 2.5; dV 2.2.2)

**Lecture 6**: Logistic difference equation: building it from data, fixed points and stability (dV 2.2.1, 2.2.2)

**Lecture 7**: Logistic difference equation: bifurcation diagram, periodic solutions, period doubling and chaos (EK 2.4, 2.5; dV 2.2.2-2.2.4)

**Lecture 8**: Systems of non-linear equations. Linearization, fixed points and stability. Romeo and Juliet model (EK 2.7-2.9, 1.4; dV 2.3.1-2.3.3)

**Lecture 9**: Nicholson-Bailey model, Poisson process. (EK 3.2, 3.3; dV 2.3.4)

**Lecture 10**: Application to population genetics. Hardy-Weinberg law, Moth wing model (EK 3.6, dV 2.2.5)

**Lecture 11, 12**: One-dimensional non-linear continuous systems (EK 5.1, dV 3.1, 3.2, extra: St ch2))

**Lecture 13, 14** Introduction to phase plane analysis, nullclines (EK 5.2-5.5, extra: St
ch6) Classification of fixed points in 2-dimensional systems (dV 3.4.1, 3.4.2, EK 5.6-5.9). Examples of two-population ineractions model (dV 3.3.2, 3.4.3; EK 6.2, 6.3).

**Lecture 15**: Finishing predator-prey model, SIR model (dV 3.4.4), NUmerical methods for ODEs as a connection between continuous and discrete systems (dV) - Euler's method as an example.

**Lecture 16**: Bifurcations: saddle-node, transcritical (dV 3.7, St ch.3, 8.2)

**Lecture 17**: Bifurcations: pitchfork, Hopf

**Lecture 18**: Applications. Cell cycle. Regulation of G1-checkpoint. Based on 13.2.1 of Keener and Sneyd "Mathematical Physiology" chapter.


**Lecture 22**: Introduction to cellular automata. 1d examples with Wolfram's enumeration. Game of Life. (dV 6.1)