The goals of the class are (i) to introduce the students to a range of modern mathematical tools (from dynamical systems, stochastic processes and partial differential equations); (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 will include elements of linear algebra, geometric dynamical systems, bifurcation theory, probability theory, partial differential equations

Biological topics will include modeling heart and circulation, brain rhythms, HIV, insulin-secreting cells, antibiotic resistance in bacteria, regulation of gene expression, biological pattern formation

Computing: A large component of this class is programming in Matlab. Be prepared to learn if you don’t know Matlab yet! Start with installing it on your computer – it is available for free campuswide

Class time: TTh 12:25-1:45 in zoom, through Canvas
Required computer lab: Friday 12:55-1:45 in zoom through Canvas
Prerequisites: Math 2250 or Math 2270-2280 sequence
4 credit hours (3 lecture hours + a computer lab a week)

With any questions, please, contact me by email: borisyuk at math.utah.edu

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 follow a textbook. You will be expected to follow the material in lectures. Lectures will be recorded and the recordings posted in Canvas. I will also post class announcements and grades on Canvas.

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

Class participation: This will be an interactive class, in which students are expected to attend lectures with their cameras on and microphones available. There will be presentations by students, breakout room group work and discussions. Students are expected to take part. If this presents a problem for you in any way, please contact the instructor to discuss accommodations as soon as possible. Class participation will contribute to your grade (see grade breakdown below)

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.

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.

**Text:** there is no required text. Students are expected to take notes in class. Supplementary material in the form of book excerpts, and research papers will be provided as necessary.

**Homework:** Included with weekly lab assignments, contains both mathematical exercises and simulations in Matlab.

**Tests:** In class midterm March 11 (preliminary date), take-home final exam

**Grade:** class participation (10%) + labs (40%) + midterm (25%) + final (25%)

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**List of Topics:**

I. Introduction to mathematical models, review of ideas from calculus and ODEs  
- Heart and circulation. Dynamics of the pulse

II. Dynamical systems: geometric analysis, phase planes. Introduction to bifurcation theory. Phase oscillators, phase response curves (Supplementary material, Strogatz).  
- Law of mass action, Hill's function  
- Gene activation model. Bistability and biological switches.  
- Hodgkin-Huxley equations  
- Pancreatic beta-cells  
- Epidemics  
- HIV modeling  
~ 5 weeks.

III. Probability, random variables, Markov chains.  
- Natural selection  
- Plasmids (antibiotic resistance in bacteria)  
- Regulation of gene expression  
~ 4 weeks.

IV. Introduction to partial differential equations  
- Models for cancer-immune system interaction and for cancer-growth inhibitor interaction  
~ 2 weeks.

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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.