-Syllabus for Biol 309 Mathematical Models in Biology (Fall 2022)

week 1	Sept 1	Introduction
week 2	Sept 6	Difference Equations 1 (Hill & linear difference equations)
	Sept 8	Difference Equations 2 (stability and cobweb diagrams)
week 3	Sept 13	Difference Equations 3 (the logistic map)
	Sept 15	Difference Equations 4 (stability and linearization)
week 4	Sept 20	Difference Equations 5 (cycles and chaos)
	Sept 22	Difference Equations 6 (quasiperiodicity and bifurcations)
week 5	Sept 27	Computer Workshop 1
	Sept 29	Boolean Networks 1 (boolean networks dynamics)
week 6	Oct 4	Boolean Networks 2 (random boolean networks)
	Oct 6	Cellular Automata 1 (1D cellular automata)
week 7	Oct 11	no class (reading week)
	Oct 14 (F)	Cellular Automata 2 (2D cellular automata)
week 8	Oct 18	review
	Oct 20	MIDTERM (in class)
week 9	Oct 25	1D Differential Equations 1 (intro to differential equations: stability)
	Oct 27	1D Differential Equations 2 (population models - limited growth)
week 10	Nov 1	1D Differential Equations 3 (multiple fixed points - cows in a field)
	Nov 3	Fractals 1 (fractal dimension)
week 11	Nov 8	Fractals 2 (Mandelbrot sets)
	Nov 10	Computer Workshop 2
week 12	Nov 15	2D Differential Equations 1 (the harmonic oscillator, phase plane)
	Nov 17	2D Differential Equations 2 (nullclines, flow, and nonlinearity)
week 13	Nov 22	2D Differential Equations 3 (mutual inhibition and gene networks)
	Nov 24	2D Differential Equations 4 (Fitzhugh Nagumo equations)
week 14	Nov 29	**Student Presentations**
	Dec 1	**Projects/critiques due** (and exam review)
	(Final during exam week)	

The schedule (subject order, time spent on each chapter, and midterm date) *will likely change*. Check for updates and announcements on MyCourses or in class.

Grading scheme:

Homework	20% (best 4 of 5)
Midterm	15%
Critique / project	25%
Computer labs	5%
Final	35%

1) Tests are ‘closed-book’. Calculators are allowed (but **no** phones or graphing calculators).
2) Homeworks to be submitted in class. Late homework is not accepted.
3) Projects/critiques to be handed in on MyCourses. Late projects/critiques are not accepted.

Location: Stuart Biology N2/2.

Instructor: Gil Bub (gil.bub@mcgill.ca)
Office hours (zoom) Tuesdays at 3pm
https://mcgill.zoom.us/j/7296093514

Teaching assistant: Khady Diagne (khady.diagne@mail.mcgill.ca)
Tutorials: TBD

TEAM mentors: Glisant Plasa and Jammie Lee

Textbook: "Understanding Nonlinear Dynamics" by Kaplan & Glass
(available through the McGill Bookstore & McGill library)
The course covers chapters 1-5, with some added topics.

What we cover and what you should expect:

The goal of the course is to give the student basic skills necessary to understand the ways mathematics can be applied to study biological systems. The course is specifically directed towards students who have interest in mathematics, and who have solid foundations in algebra and differential calculus. Most students enjoy the introduction to current applications of modern mathematics (including the topics of chaos and fractals) to biology, and are able to master the requisite techniques. However, not all students enjoy the challenge of problem solving. Since it is essential to do problems in order to learn the material, if you do not enjoy working on problems you should reconsider taking this course.

Final project:

- Four pages or 500 words/page **plus** one page per group member.
- Figures and references do not count to this limit.
- Work in groups of 4 or 5.
- Projects will include a short (3-5 minute) presentation to be given at the end of term.
- Projects for the class will fall under a common theme (theme TBD)
- Projects will generally be critique or simulation/analysis focused
  - Critique projects will be in the form of a literature review, with supplemental simulations if appropriate.
  - Simulation/analysis projects will include simulations with text to put the work in context.
- Projects may have an appendix (e.g. for code) that doesn't count toward the page limit.

Critique rubric:

Writing:	Overall clarity and conciseness	20%
	Description of the paper objectives	
	Description of the mathematical model	
	Use of references	
Comprehension:	Biological problem (what was being modeled?)	20-30%
	The equations / models (how was it modeled?)	
	Model findings & author conclusions	
Critique:	Is the model appropriate?	30-40%
	What can be improved?	
	Are the author's conclusions justified?	
	What have other researchers done?	
	Is the paper impactful (important) and why?	
Originality/extra:	Added insight	0-20%
	Value (e.g. added simulations / analysis)	
	Phenomenal writing	
Oral Presentation:	Slide quality	10%
	Clarity and timing	
	Questions: quality of answers	

Simulation/analysis rubric

Writing:	Overall clarity and conciseness	20%
	Description of project objectives	
	Description of the mathematical model	
Context:	Relation to other published work	10%
	Rationale for developing your model	
Content:	The model/simulation	50%
	Data visualization	
Conclusions:	What can you conclude?	10%
	What’s next?	
Oral Presentation:	Slide quality	10%
	Clarity and timing	
	Questions: quality of answers	

These rubrics are given as guides but can change based on the students' submission. For example, a project that is badly written may prevent the marker from understanding the content, and result in low content scores in addition to low writing scores.