*We recognize and acknowledge that McMaster University meets and learns on the traditional territories of the Mississauga and Haudenosaunee nations, and within the lands protected by the “Dish With One Spoon” wampum, an agreement amongst all allied Nations to peaceably share and care for the resources around the Great Lakes.*

# BIOPHYS 3G03 / Life Sci 3BP3 – Modelling Life

# 2022 Winter Term

**Instructor:**  Paul Higgs |  **E-mail:** [higgsp@mcmaster.ca](mailto:higgsp@mcmaster.ca) | **Office Hours:** TBA

**Teaching Assistants:**  James Lambert, Felipe Rivera-Madrinan |

**E-mails:** [lambej3@mcmaster.ca](mailto:lambej3@mcmaster.ca) [riveraf@mcmaster.ca](mailto:riveraf@mcmaster.ca) | **Office:** TBA

**Class Schedule:** Monday, Thursday 12:30 – 1:20 pm, Tuesday 1:30 – 2:20 pm (see Mosaic)

### Equity, Diversity, and Inclusion

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Physics & Astronomy is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexualities, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Chair of Undergrad Studies, Undergraduate Advisor (Level I), and/or Undergraduate Advisor (Levels II to IV) (contact details listed [here](https://www.physics.mcmaster.ca/contact/contact-us.html)) or to contact the [Equity and Inclusion Office](https://equity.mcmaster.ca/).

## Course Description

Introduction to simulating computational models in the life sciences, including examples from molecular and cell biology, ecology and evolution. Designing models to link to experimental questions and to test scientific hypotheses. The course is aimed at Life Sciences and Biology students, as well as other students interested in scientific computing. No prior computing experience will be assumed. Students who have previously attended Physics 2G03 are welcome to attend this course, but prior knowledge from 2G03 is not required.

**Prerequisite(s):** PHYSICS 1A03 or 1C03; and one of MATH 1A03, 1LS3, 1X03, 1ZA3 (or ISCI 1A24 A/B)

## Course and Learning Objectives

### Learning Objectives

By the end of this course, students should be able to:

* Characterize biological problems with simple computational models
* Create and modify NetLogo programs
* Test scientific hypotheses with computational models

## Materials & Fees

### Required Materials/ Resources

* You will need to use NetLogo in this course (this is a free program that you can download on Mac, Windows or Linux). You will need a laptop on which to run Netlogo programs during lecture times and homework.

**Website:** Materials and announcements will be provided via the course website on [Avenue to Learn](http://avenue.mcmaster.ca/).

## Virtual Course Delivery

The course is intended to run in person in Winter 2022, although there may be some occasions where we will make use of Microsoft Teams for virtual meetings.

## Course Overview and Assessment

This is an introduction to computational modelling using the NetLogo agent based programming system. We will build simple computational models that help to understand biological problems. Students will be given first versions of the programs for each topic, and will be asked to develop the program by adding additional features. Assessment will be via written reports explaining the results of the programs and the biological background to the model that was studied. There will be no final exam.

**The course is organized as follows:**

• 3 classroom-based lectures per week

• 5 assignments

• 1 group project

### Course Schedule

|  |  |  |
| --- | --- | --- |
| Weeks | Topics | Due |
| 1-2 | Introduction to computational modelling  Simple birth and death models for population dynamics. Growth of a species with limited resources. Logistic growth and patchy growth. | Assignment 1 |
| 3 | Models involving coupled differential equations. Comparison of deterministic differential equations with agent-based models. | Assignment 2 |
| 4-5 | Gene Expression. Following fluctuations in the numbers of mRNAs and proteins per cell due to transcription and translation events. Comparison with data from studies with green fluorescent protein. | Assignment 3 |
| 6-7 | Spread of an Infection. Modelling the spread of a pine beetle infection in a forest. Evolutionary simulations to study the evolution of virulence of parasites and diseases. | Assignment 4 |
| 8-9 | **Either:** Evolutionary Game Theory. Hawks and Doves model of animal aggression. The Prisoner's Dilemma model for the evolution of cooperation.  **Or:** Dynamics of Ribosomes. Traffic Jam model for movement of multiple ribosomes along an mRNA | Assignment 5 |
| 10-13 | Group Project on subject of choice | Group Project report and presentation to class |

## Evaluation

|  |  |  |
| --- | --- | --- |
| Assessment | Due Date | Weight |
| Assignments | Throughout term | 65% |
| Group Project | End of Term | 35% |
|  |  | 100% |

## Assignments

Assessment will be via written reports explaining the results of the programs and the biological background to the model that was studied. There will be 5 assignments covering the topics above.

## Group Project

In the second half of the course students will work in groups on a project of their own design. These are examples of titles of the topics studied by previous groups.

• Accumulation of toxins in the fish food chain

• Predator-prey model of invasive lionfish with an age-structured population

• Competition of specialist and generalist plants in a patchy environment

• Spread of antibiotic-resistant bacteria via horizontal transfer of plasmids

• The Impact of Different Vaccination Rates on the Number of Influenza Infections

• Modelling the unfolding of a protein by denaturants

• Modelling Michaelis-Menten enzyme kinetics

• Chemotaxis and Competition in a C. elegans Population

• Transport of ions and neurotransmitters across a synapse

• Model of muscle cell growth and differentiation

## Requests for Relief for Missed Academic Term Work

[McMaster Student Absence Form (MSAF):](https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/msaf-mcmaster-student-absence-form/) In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

### MSAF Course Specific Information

1. It is the students’ responsibility to regularly check the course webpage (ex. Avenue to Learn) for updates and announcements.
2. The penalty for late assignments is a 10% deduction per day, up to two days. After two days, assignments will no longer be accepted without an MSAF or other documentation.

## Academic Accommodation of Students with Disabilities

Students with disabilities who require academic accommodation must contact [Student Accessibility Services (SAS](https://sas.mcmaster.ca/)) at 905-525-9140 ext. 28652 or [sas@mcmaster.ca](mailto:sas@mcmaster.ca) to make arrangements with a Program Coordinator. For further information, consult McMaster University’s [*Academic Accommodation of Students with Disabilities*](https://secretariat.mcmaster.ca/app/uploads/Academic-Accommodations-Policy.pdf) policy.

## Academic Accommodation for Religious, Indigenous Or Spiritual Observances (Riso)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](https://secretariat.mcmaster.ca/app/uploads/2019/02/Academic-Accommodation-for-Religious-Indigenous-and-Spiritual-Observances-Policy-on.pdf) policy. Students should submit their request to their Faculty Office ***normally within 10 working days*** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

## Courses with An On-Line Element

McMaster is committed to an inclusive and respectful community. These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms.

**Some courses** **may** use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

## Online Proctoring

**Some courses may**use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

### Inclusivity

The University values integrity, inclusiveness and teamwork, and strives to support the personal and collective growth of the McMaster student community. These values are foundational to ensuring campus environments – both in-person and virtual –are conducive to personal wellbeing and academic success.

## Academic Integrity

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

**It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the [*Academic Integrity Policy*](https://secretariat.mcmaster.ca/app/uploads/Academic-Integrity-Policy-1-1.pdf)*,* located at [https://secretariat.mcmaster.ca/university-policies-procedures- guidelines/](https://secretariat.mcmaster.ca/university-policies-procedures-%20guidelines/)

**The following illustrates only three forms of academic dishonesty:**

* plagiarism, e.g. the submission of work that is not one’s own or for which other credit has been obtained.
* improper collaboration in group work.
* copying or using unauthorized aids in tests and examinations.

## Authenticity / Plagiarism Detection

**Some courses may**use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For

more details about McMaster’s use of Turnitin.com please go to the [McMaster Office of Academic Integrity's](https://www.mcmaster.ca/academicintegrity/) website.

## Conduct Expectations

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all our living, learning and working communities. These expectations are described in the [*Code of Student Rights & Responsibilities* (the “Code”).](https://secretariat.mcmaster.ca/app/uploads/Code-of-Student-Rights-and-Responsibilities.pdf) All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

## Copyright and Recording

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

**Research Ethics** -NA

## Extreme Circumstances

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.