

# Course Outline

## Introduction to Mathematical Biology

### Fall 2022

## 1. Overview

- **Course codes:** Undergraduate: Math 3958A  
Graduate: AM 9576A
- **Delivery mode:** In person @ **UCC room 41.**  
Tuesdays 10:30-12:30  
Thursdays 11:30-12:30
- **Instructor:** Dr. Jason Bertram  
**Email:** [jason.bertram@uwo.ca](mailto:jason.bertram@uwo.ca)  
**Office hours:** Thursdays 12:30-13:30. In person. Middlesex College room 116.
- Classes begin: September 8  
Fall Reading Week: October 31 – November 6  
Last day to withdraw without academic penalty: November 14  
Classes end: December 8

Prerequisite(s): Multivariate calculus and linear algebra. One of Calculus 2302A/B, Calculus 2402A/B, Calculus 2502A/B; plus one of Mathematics 1600A/B or the former Linear Algebra 1600A/B, or Applied Mathematics 1411A/B. Or permission of instructor. Some exposure to differential equations is recommended: **please let me know if you have never been exposed to differential equations.**

Note: Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

## 2. Objectives, Syllabus and Schedule

Course objectives:

A general overview of the key ideas and mathematical methods used in mathematical biology, particularly those related to the dynamics of populations. Single- and multi-type population

models. Evolution from trait and genetic perspectives. Systems of ODEs, stochastic population models, diffusion approximations.

Learning outcomes:

1. You will be able to conceptually interpret and mathematically analyze canonical single- and multi-type population growth models using differential equations.
2. You will be able to construct your own population models starting from a general description of the processes involved.
3. You will be familiar with the principles of trait-based models of evolution, including the basic techniques of invasion analysis.
4. You will have an introductory understanding of how evolution is modeled at the genetic level.
5. You will be able to describe three fundamental processes of evolution – mutation, selection, and drift – and be able express these processes mathematically.

#### Tentative Schedule of Topics

<b>Date</b>	<b>Tues (2 hours)</b>	<b>Thurs (1 hour)</b>	<b>Assessment/Homework</b>
Sep 8		Welcome and Introduction	OWL survey on background and interests
Sep 13, 15	Introduction to single-type population models. Density regulation.	Interactive Tutorial: Chaos in the logistic map.	Assignment 1 open. Growth equation & ODE fundamentals. <b>Due Sep 19. Individual.</b>
Sep 20, 22	Breakpoints and thresholds.	Interactive Tutorial: Spruce budworm outbreaks.	Assignment 2 open. Single-type population models and breakpoints. <b>Due Sep 26.</b>
Sep 27, 29	Multi-type population models: predator-prey interactions.	Interactive Tutorial: Dynamics of the Lotka-Volterra equation.	Assignment 3 open. Multi-type population models. <b>Due Oct 6.</b>
Oct 4, 6	Multi-type population models: competition.	Interactive Tutorial: Limiting similarity.	
Oct 11, 13	Evolution and natural selection: trait-based models.	Interactive Tutorial: Evolution of mutualism.	Assignment 4 open. Trait evolution and genetic evolution. <b>Due Oct 28.</b>
Oct 18, 20	Evolution and natural selection: introduction to population genetics.	Interactive Tutorial: Deciphering COVID-19 evolution.	
Oct 25, 27	Limitations of deterministic models. Probability essentials.	Interactive Tutorial: The random walk.	
<b>Reading Week</b>			

Nov 8, 10	Stochastic models of random genetic drift.	Interactive Tutorial: General features of genetic drift.	Assignment 5 open. Stochastic population model fundamentals. <b>Due Nov 16.</b>
Nov 15, 17	Diffusion approximations.	Interactive Tutorial: Properties of simple diffusions.	
Nov 22, 24	Fixation of new mutations.	Interactive Tutorial: Fundamental processes of evolution: mutation vs selection vs drift.	Assignment 6 open. Diffusion theory and the fate of new mutations. <b>Due Nov 30.</b>
Nov 29, Dec 1	The site frequency spectrum.	Interactive Tutorial: Analysis of canonical site frequency spectra.	OWL survey to choose final example application.
Dec 6, 8	Class-chosen example application.	Wrap-up.	
<b>Final Exam</b>	Date, time and venue to be announced.		

### Contingency plan for an in-person class pivoting to 100% online learning

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, affected course content will be delivered entirely online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will **not** change. Any remaining assessments will also be conducted online as determined by the course instructor.

## 3. Course Materials

No required textbook. All course material will be posted to <http://owl.uwo.ca>.

Students are responsible for checking the course OWL site (<http://owl.uwo.ca>) on a regular basis (every 24-48 hours) for news and updates. This is the primary method by which information will be disseminated to all students in the class.

If students need assistance with the course OWL site, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

### Technical Requirements

It is recommended that you be prepared to switch to online delivery in the event of a health lockdown. You will need a stable internet connection, and a home laptop/desktop computer equipped with a microphone and camera.

## 4. Evaluation

The overall course grade will be calculated as listed below:

Assignment 1	5%	Take-home. Must be completed individually.
Assignments 2-6	12% each = 60%	Take-home. Approximately biweekly. Groupwork allowed.
Final Exam	35%	Open book. Covers entire syllabus. 3 hours.

**Graduate students will be assigned more advanced problems in assignments and the examination.** Undergraduates who wish to be assessed at the graduate level can do so with permission.

Note: although attendance and classroom participation do not directly contribute to your final grade, they are strongly recommended for succeeding in (and enjoying) this course. In-class active learning and group discussions will be an integral part of course delivery.

## 5. Student Absences

If you are unable to meet a course requirement due to illness or other serious circumstances, please follow the procedures below.

For work totalling 10% or more of the final course grade, you must provide valid medical or supporting documentation to the Academic Counselling Office of your Faculty of Registration as soon as possible. For further information, please consult the University's medical illness policy at

[https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_medical.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf).

The Student Medical Certificate is available at

[https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/medicalform.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf).

### Assignment submission and lateness policy

All assignments are due at 11:55 pm EST on the date specified in the schedule unless otherwise specified. Assignments will be submitted to Turnitin (statement in policies below).

Late assignments without an accommodation notice from the Academic Counselling Office will be penalized 15% per day.

Late assignments with an accommodation notice from the Academic Counselling Office (see below) will be given an extension. If the solutions to an assignment have already been returned the class, the weight of the assignment will be added to the final examination.

## **Absences from Final Examinations**

If you miss the Final Exam, please contact the Academic Counselling office of your Faculty of Registration as soon as you are able to do so. They will assess your eligibility to write the Special Examination (the name given by the University to a makeup Final Exam).

You may also be eligible to write the Special Exam if you are in a "Multiple Exam Situation" (e.g., more than 2 exams in 23-hour period, more than 3 exams in a 47-hour period).

If a student fails to write a scheduled Special Examination, the date of the next Special Examination (if granted) normally will be the scheduled date for the final exam the next time this course is offered. The maximum course load for that term will be reduced by the credit of the course(s) for which the final examination has been deferred. See the Academic Calendar for details (under [Special Examinations](#)).

## **6. Accommodation and Accessibility**

### **Religious Accommodation**

When a course requirement conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request accommodation for their absence in writing at least two weeks prior to the holiday to the course instructor and/or the Academic Counselling office of their Faculty of Registration. Please consult University's list of recognized religious holidays (updated annually) at

<https://multiculturalcalendar.com/ecal/index.php?s=c-univwo>.

### **Accommodation Policies**

Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

[https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/Academic\\_Accommodation\\_disabilities.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Accommodation_disabilities.pdf).

## **7. Academic Policies**

The website for Registrarial Services is <http://www.registrar.uwo.ca>.

In accordance with policy,

[https://www.uwo.ca/univsec/pdf/policies\\_procedures/section1/mapp113.pdf](https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf),

the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at their official university address is attended to in a timely manner.

No electronic devices are permitted on the final examination.

**Scholastic offences** are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

[http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/scholastic\\_discipline\\_undergrad.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf).

All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

In the event of a health lock-down, the final examination may be conducted using a remote proctoring service. By taking this course, you are consenting to the use of this software and acknowledge that you will be required to provide **personal information** (including some biometric data) and the session will be **recorded**. Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. More information about this remote proctoring service, including technical requirements, is available on Western's Remote Proctoring website at: <https://remoteproctoring.uwo.ca>.

## 8. Support Services

Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: <https://www.uwo.ca/sci/counselling/>.

Students who are in emotional/mental distress should refer to Mental Health@Western (<https://uwo.ca/health/>) for a complete list of options about how to obtain help.

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at

[https://www.uwo.ca/health/student\\_support/survivor\\_support/get-help.html](https://www.uwo.ca/health/student_support/survivor_support/get-help.html).

To connect with a case manager or set up an appointment, please contact [support@uwo.ca](mailto:support@uwo.ca).

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at

[http://academicsupport.uwo.ca/accessible\\_education/index.html](http://academicsupport.uwo.ca/accessible_education/index.html) if you have any questions regarding accommodations.

Western University is committed to a thriving campus as we deliver our courses in the mixed model of both virtual and face-to-face formats. We encourage you to check out the Digital Student Experience website to manage your academics and well-being: <https://www.uwo.ca/se/digital/>.

Additional student-run support services are offered by the USC, <https://westernusc.ca/services/>.