The University of Western Ontario
Department of Biology
Winter 2026

Biology 9340A Course Outline
Design Principles of Biological Circuits

1. Course Description

The course focuses on the use of interdisciplinary systems-level methods to understand both biochemical reaction networks and transcriptional gene regulatory networks. In addition to providing a theoretical foundation for the study of dynamic biological systems, the course also aims to highlight the practical application of derived models using examples from the current literature. The applications of network modelling to the emerging discipline of synthetic biology will also be discussed. Students will construct and analyze their own models using Insight Maker (https://insightmaker.com), an online simulation and modelling platform. While mathematical modeling forms an integral part of the course, the material presented is suitable for and accessible to all who are competent in the basic mathematical skills taught at the first-year undergraduate level.

2. Course Information

Instructor:	Dr. Jim Karagiannis
Office:	BGS 3080
Office Hours:	Thursdays 3:30 - 5:00 p.m.
Phone:	ext. 80975
Email:	jkaragia@uwo.ca
Lecture Hours:	One 2-hour lecture/week (at a time to be determined)
Lecture Location:	To be determined

Any emails to Dr. Karagiannis must contain “Bio9340B” in the subject line. Emails not containing this keyword will not be read.

3. Course Materials

All course material will be posted to OWL: https://westernu.brightspace.com/. Students are responsible for checking the course OWL site regularly 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 Brightspace Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

A textbook will not be used as a learning resource in the course. Instead, the course will make extensive use of contemporary articles from the field's most respected journals.

Although the intent is for this course to be delivered in person, should any university-declared emergency require some or all of the course to be delivered online, either synchronously or asynchronously, the course will adapt accordingly. The grading scheme will not change. Any assessments affected will be conducted online as determined by the course instructor.

4. Technical Requirements

- Stable internet connection
- Computer with working microphone and webcam (microphone and webcam will only be required if circumstances force a return to fully online learning)
- Insight Maker account (https://insightmaker.com)

5. Course Objectives and Topics

To better understand complex biological systems through the identification and characterization of common "design principles" that are conserved throughout evolution and that can be understood using a simple mathematical framework. Topics of study will include:

- Introduction to Mathematical Models
- Modelling Chemical Reaction Networks
- Modelling the Cell Cycle
- Transcription Networks
- Negative Autoregulation
- Positive Autoregulation
- Feedforward Loops
- Oscillators
- Temporal Programs
- Robustness of Protein Circuits
- Optimal Gene Circuit Design

6. Learning Outcomes

- Students will develop the mathematical skills needed to describe and analyze biochemical reaction networks and apply these skills within a broader biological context.
- Using modelling software, students will be able to construct sets of ordinary differential equations (ODEs) to describe and analyze dynamic biological systems (e.g. cell cycle control systems).
- Students will be able to define a network motif and relate its biological function to selective pressures experienced over evolutionary time.
- Students will be able to construct models of common transcriptional circuits (negative autoregulation, positive autoregulation, feedforward loops) and analyze these systems with respect to their temporal and regulatory characteristics.
- Students will relate their newly developed knowledge of systems biology to the rational design of synthetic genetic circuits.
- Students will be able to critically analyze select, high impact articles from the primary literature and assess their contribution to the continuing development of the discipline of systems biology.

7. Evaluation

The mark breakdown will be as follows:

Assignment	20%
Computational Essay	20%
Presentation	20%
Participation	20%
Midterm Test	20%

Essays will be written on an individual basis. Presentations may be carried out in groups depending on class size. Missed components (for which relief/consideration has been approved) will result in a reweighting of the mark breakdown. Please note that this course adheres to the university-wide descriptors for the meaning of letter grades:

A+	90-100	One could scarcely expect better from a student at this level
A	80-89	Superior work which is clearly above average
B	70-79	Good work, meeting all requirements, and eminently satisfactory
C	60-69	Competent work, meeting requirements
D	50-59	Fair work, minimally acceptable
F	below 50	Fail

8. Course and University Policies

Student Absences

Notify the instructor as soon as possible if you are unable to attend a class. Note that regardless of the reason for the absence, the student remains responsible for the material covered.

Late assignments

If you are unable to complete an assignment by the deadline date, please notify the instructor as soon as is possible. A 5% penalty/day will be assessed for late assignments.

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%20Accommodation_disabilities.pdf.

Scholastic offences

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_grad.pdf

Plagiarism

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).

Support Services

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.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Learning-skills counsellors at the Student Development Centre (https://learning.uwo.ca) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

9. Land Acknowledgment

We acknowledge that Western University is located on the traditional lands of the Anishinaabek, Haudenosaunee, Lūnaapéewak and Attawandaron peoples, on lands connected with the London Township and Sombra Treaties of 1796 and the Dish with One Spoon Covenant Wampum. This land continues to be home to diverse Indigenous peoples (e.g. First Nations, Métis and Inuit) whom we recognize as contemporary stewards of the land and vital contributors of our society.

More information about Indigenous Services (https://indigenous.uwo.ca/) and this Land Acknowledgement (https://communications.uwo.ca/comms/land-acknowledgement/) are available.