MBIO 4442 Research in Systems Microbiology

Syllabus Contents

Course Details

Course Title	MBIO 4442 Research in System Microbiology
Course Number	CRN 22394
Term	Fall 2022
Credit Hours	3
Pre-requisites	MBIO 3030 or MBIO2110 and MBIO/CHEM2370
Class Times & days	Tuesdays and Thursdays 1:00 PM to 2:15 PM
Class location	Buller Bldg Room 315
Tutorial times & days	Thursdays (Check specific dates) 2:30 PM to 3:45 PM
Tutorial location	University College 244

Instructor Contact Information

Lectures	Tutorials/Assignments
Dr. Silvia T. Cardona, Professor, Microbiology Buller Bldg. Room 414A silvia.cardona@umanitoba.ca Website: cardonalab.org	Dustin Maydaniuk , PhD Student, Microbiology Nelsond8@myumanitoba.ca Dr. Anna Motnenko, Post-doctoral research fellow, Microbiology Anna.motnenko@umanitoba.ca Zisanur Rahman, PhD Candidate, Microbiology rahmasmz@myumanitoba.ca Andrew Hogan, PhD Candidate, Microbiology Hogana34@myumanitoba.ca

Office/Student/Learner Hours

Dr. Cardona: Office hours with Dr. Cardona will be prescheduled individually by e-mail request. Email Dr. Cardona to arrange an appointment.

Traditional Territory/Land Acknowledgment

The University of Manitoba campuses are located on original lands of Anishinaabeg, Cree, Oji-Cree, Dakota and Dene peoples, and on the homeland of the Métis Nation. We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

Equity And Inclusion Commitment

We are committed to providing an environment where diversity in all its forms is celebrated. We respect student identities and are committed to take action against forms of oppression in and out of the

classroom. We will support all students by removing barriers to their learning and connecting them with needed support.

Course Description

Systems microbiology integrates physiological information and functional genomics (genomics, transcriptomics, proteomics, metabolomics) data, as well as large-scale mutagenesis and chemogenomics to create models of the complex interactions within microbial cells to understand how a bacterial cell functions as an integrated whole. Applications to more complex microbial communities will also be discussed.

Course Learning Outcomes

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

- recognize the impact of the "Omics" revolution in the microbiology field
- apply genomic approaches to the understanding and control of microbial systems
- learn about career opportunities in Systems Microbiology

Course Materials

Required Materials

Technology

- A laptop (PC or Mac) with Internet connection will be required
- Accounts to dedicated servers (Galaxy Australia, Biocyc) will be required

UMLearn

- All materials can be found on the course UM Learn site. You will need your UMNet ID and password to login. It is your responsibility to get access to UM Learn.

Lectures and Course Lecture Notes

Besides in-person lectures, pre-taped lecture presentations from previous years and presentation files with notes will be posted on UMLearn. You are responsible for what is written in the presentation files and what transpires during in-person lectures

Please note:

- The lecture notes available on UM Learn may not be complete. It is your responsibility to attend class and take notes.
- If you miss a lecture/tutorial that is not posted it is your responsibility to get notes from a classmate, or to get the missing information from the original source.
- Electronic devices used in class must not disrupt the normal education process.
- Lecture notes and any other material related to this course MUST NOT be posted or distributed on unauthorized websites or individuals not registered to this course. Any unauthorized reprint or use of course materials is prohibited.

Suggested Materials

- Microbial Functional Genomics. J. Zhou, D.K. Thomson, Xu, Y., and J.M. Tiedje J.M. John Wiley & Sons, Inc. Hoboken, New Jersey, 2004.
- Microbial Genomes. CM Fraser, T.D Read, and K.E. Nelson Humana Press, Totowa, New Jersey, 2004.
- Computing for Comparative Microbial Genomics. Ussery D., Wassenaar T and Borini S. Springer-Verlag London, 2009.
- Next-Generation DNA Sequencing Informatics. Stuart M. Brown Ed. Cold Spring Harbor Laboratory Press, New York, 2015.
- Bioinformatics for High Throughput Sequencing. N. Rodriguez Ezpeleta, M. Hackenberg and A.M. Aransay.
- Scientific articles used for lectures Visit UM Libraries (https://umanitoba.ca/libraries/help-and-services/instruction-support/open-educational-resources) for more information and support.
- (https://umanitoba.ca/libraries/)

Course Schedule

This schedule is subject to change at the discretion of the instructor and/or based on the learning needs of the students but such changes are subject to Section 2.8 of ROASS (https://umanitoba.ca/governance/governing-documents-academic#responsibilities-of-academic-staff-with-regard-to-students).

Units and Topics

Unit 1) Examples of Microbial Systems The cell cycle in *E. coli* and *Caulobacter crescentus* Bacteria exposed to antibiotics Microbial communities
Unit 2) Microbial Genomes • Genome sequencing • Genome assembly • Genome visualization • Genome annotation
Unit 3) Microbial Functional Genomics • Microarrays, RNA-seq, Chlp-seq • Metabolic Pathways analyzed by Transcriptomics • Functional analysis of cells exposed to antibiotics

Unit 4) Genome-scale Mutagenesis
• Random vs systematic mutagenesis
• Knockout vs knockdown
• Tn-seq and Bar-seq
• CRISPRi methods
• Systems Microbiology approaches to microbial control:
  ○ Chemogenomics applied to antimicrobial discoveries
  ○ Probiotics and microbiome

Lecture Schedule

Unit	Date	Activity
Unit 1	Sep 13	Lecture 1: Microbial cells as systems: The *E. coli* cell cycle
	Sep 15	Lecture 2: Microbial cells as systems: Caulobacter cell cycle
	Sep 20	Lecture 3: Other microbial systems: bacteria exposed to antibiotics, microbial communities
	Sep 22	Lecture 4: Microbial Genomes: Shotgun Sequencing
Unit 2	Sep 27	Lecture 5: Microbial Genomes: next Generation sequencing (NGS). Library preparation
	Sep 29	Lecture 6: Next generation sequencing (NGS) platforms
	Oct 4	Lecture 7: NGS projects
	Oct 6	Lecture 8: Assembly, annotation, and genomic databases Quiz 1 opens
	Oct 11	Review of Quiz 1.
Unit 3	Oct 13	Lecture 9: Transcriptomics: Introduction, Microarrays, RNA-seq Chlp-seq
	Oct 18	Lecture 10: Transcriptomics: analysis of the cell cycle
	Oct 20	Lecture 11: Functional analysis of cells exposed to antibiotics Quiz 2 opens
	Oct 25	Review of Quiz 2
Unit 4	Oct 27	Lecture 12: Genome-wide mutagenesis: random vs. systematic; ordered vs. redundant
	Nov 1	Lecture 13: Genome-wide mutagenesis: high density transposon mutagenesis;
	Nov 3	Lecture 14: Genome-wide mutagenesis: the essential genome *of Caulobacter crescentus*
	Nov 8	Fall break
	Nov 10	Fall break
	Nov 15	Lecture 15: Knockdown mutagenesis: Quiz 3 opens inducible promoters
	Nov 17	Review of Quiz 3
	Nov 22	Lecture 16: Knockdown mutagenesis: protein degradation tags
	Nov 24	Lecture 17: Knockdown mutagenesis: CRISPRi
	Nov 29	Lecture 18: Antibiotic classic screens: target-based, whole-cell based
	Dec 1	Lecture 19: Antibiotic chemogenomic screens
	Dec 6	Lecture 20: Systems Microbiology approaches to understand Microbiomes and probiotics
	Dec 8	Course Review

Tutorials

Expectations

Instructions for in silico assignments will be delivered by teaching assistants during tutorial sessions and posted on UM learn. Students will work on the assignments with the support of the teaching assistants during scheduled consultations sessions. The assignments will follow tutorial sessions on the below topics:

Tutorial 1: Next Generation Sequencing (NGS) *de novo* genome assembly

Tutorial 2: Biocyc Enrichments and Pathway Perturbations

Tutorial 3: Designing and Analyzing TnSeq and BarSeq Experiments

Tutorial 4: CRISPRi for Gene Silencing and Fitness Quantification in Bacteria

Tutorial Schedule

Unit	Date	Activity	Instructor
Tutorial 1	Oct 6th	Tutorial: NGS de novo genome assembly	Anna Motnenko
	Oct 13th	Tutorial session: time to work on assignment	
	Oct 20th	**Tutorial Assignment 1: due by 11:59pm**	
Tutorial 2	Oct 20th	Tutorial: Biocyc Enrichments and Pathway Perturbations	Dustin Maydaniuk
	Oct 27th	Tutorial session – time to work on assignment	
	Oct 28th	**Tutorial Assignment 2: due by 11:59pm**	
Tutorial 3	Nov 3rd	Tutorial: Designing and Analyzing TnSeq and BarSeq Experiments	Andrew Hogan
	Nov 17th	Tutorial session – time to work on assignment	
	Nov 20th	**Tutorial Assignment 3: due by 11:59pm**	
Tutorial 4	Nov 24	Tutorial: Designing and application of CRISPRi based approaches	Zisan Rahman
	Dec 1	Tutorial session – time to work on assignment	
	Dec 2	Assignment due by 11:59 pm	

Course Evaluation/Assessments

Summary

Examination schedule:

In silico Tutorial/Assignments	40 %
Quizzes	30%
Final exam	30%

Assessment Descriptions

Details for quizzes will be provided in each case including submission deadlines (including instructions, grading scheme, or rubrics).

In-silico Assignments: Students will be required to submit the assigned before the established deadlines. Students that cannot meet a deadline must contact the instructor before the assignments open to request a time extension. Assignments are mandatory and their marks cannot be replaced by final exam marks.

Quizzes: Three quizzes will be delivered through UM Learn. Students will be required to submit the quizzes before the established deadlines. Students that cannot meet a deadline must contact the instructor before the assignments open to request a time extension. Students that submit the assignments after the deadlines may not receive marks. Students may transfer the missed marks to the final exam mark upon approval of the instructor.

Final Exam: The final exam is an open-book evaluation in the form of essay/short answer.
A grade of 45% in the final exam is required to pass the course.

Grading

Letter grades are assigned taking into consideration the grade distribution in the class and the University of Manitoba. A tentative scale is indicated below.

Letter Grade	Percentage out of 100	Grade Point Range	Final Grade Point
A+	95-100	4.25-4.5	4.5
A	86-94	3.75-4.24	4.0
B+	80-85	3.25-3.74	3.5
B	72-79	2.75-3.24	3.0
C+	65-71	2.25-2.74	2.5
C	60-64	2.0-2.24	2.0
D	50-59	Less than 2.0	1.0
F	Less than 50		0

Expectations

Students are expected to attend all lectures and tutorials. Students are encouraged to review any material posted in anticipation of the lecture or tutorial. Students are expected to participate by asking questions, discussing the research presented and completing assignments

and quizzes. All students should behave in a respectfull manner according to the Respectful Work and Learning Environment Policy (https://bit.ly/3aMl7nE)

Course Policies

Academic Integrity

The University of Manitoba's policy for academic integrity is located within the Student Discipline Bylaw and Student Academic Misconduct Procedure. In addition to drawing students' attention to the policy and procedures as listed in the UM Policies section below, it is important to include an academic integrity statement pertaining to your course and/or discipline. Here is an example of a general statement that you may wish to include:

Each student in this course is expected to compete their coursework and programs of study with integrity by making a commitment to the six fundamental values of honesty, trust, fairness, respect, responsibility, and courage.

Please refer to these specific course requirements for academic integrity for individual and group work in this course:

I. *Unless otherwise stated, complete your assignments, quizzes, tests, and exams by yourself with no help from your class peers, family members, or from tutors that are not approved by the instructor. If you are in need of assistance, please contact the instructor immediately for support and/or to arrange for approved supports.*
II. *Do not share course materials (e.g., notes, exam questions, assignment instructions, article) that have been created by the instructor or were authored by another person. Unpermitted sharing of such materials with your peers or with note-sharing companies, such as One Class, Course Hero, or Chegg (or other similar websites), is a violation of Copyright Law.*
III. *Group members must ensure that a group project adheres to the principles of academic integrity. This means that all students are required to check that all sourced material has been cited and referenced.*
IV. *Students should review specific instructions concerning study groups and individual assignments.*
V. *Do not submit lab reports or other types of assignments already graded in another course.*

Plagiarism, duplicate submission, cheating on quizzes, tests, and exams, inappropriate collaboration, academic fraud, and personation are violations of the Student Discipline Bylaw and will lead to the serious disciplinary action. Visit the Academic Calendar, Student Advocacy, and Academic Integrity web pages for more information and support.

Accessibility

The University of Manitoba is committed to providing an accessible academic community. Students Accessibility Services (SAS) (https://umanitoba.ca/student-supports/accessibility) offers academic accommodation supports and services such as note-taking, interpreting, assistive technology and

exam accommodations. Students who have, or think they may have, a disability (e.g., mental illness, learning, medical, hearing, injury-related, visual) are invited to contact SAS to arrange a confidential consultation.
520 University Centre
(204) 474-7423
Student_accessibility@umanitoba.ca

Attendance

We expect students to attend all lectures and tutorials. At the same time, we are aware that some students may be impacted by personal circumstances (e.g., students observing religious holidays, with disabilities, facing food and housing insecurity, those who are parents, illness, etc.). Please, talk to the instructor if you have concerns. In those cases, please see the syllabus resource guide for more information. Keep in mind the University of Manitoba's Self-Declaration for Brief and Temporary Student Absences Policy and Procedure.

Class Communication

To ensure Dr. Cardona prioritizes your email, please use MBIO 4442 as the subject of your email. You are required to obtain and use your University of Manitoba email account for all communication between yourself and the instructor. All communication must comply with the Electronic Communication with Students Policy:
http://umanitoba.ca/admin/governance/governing_documents/community/electronic_communication_with_students_policy.html.

Recording Class Lectures

Pre-recorded lectures from previus year will be available through UMLearn. Students are allowed to record new lectures, if the instructor and everyone in the class is in agreement. Please, be aware of copyright concerns and the ease of information-sharing on the internet. UMFA members own their course content; the university owns the content and copyright to courses created and taught by sessional instructors).

Using Copyrighted Material

Please respect copyright. We will use copyrighted content in this course. I have ensured that the content I use is appropriately acknowledged and is copied in accordance with copyright laws and university guidelines. Copyrighted works, including those created by me, are made available for private study and research, and must not be distributed in any format without permission. Do not upload copyrighted works to a learning management system (such as UM Learn) or any website (e.g., Course Hero, Chegg, etc.), unless an exception to the Copyright Act applies or written permission has been confirmed. For more information, see the University's Copyright Office website (http://umanitoba.ca/copyright/) or contact um_copyright@umanitoba.ca.