MBIO4440 Systems Microbiology Winter Term 2021
Outline

Prerequisites
MBIO 3030 or MBIO2110 and MBIO/CHEM2370

Taught by

Lectures

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Laboratory

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Course Description
Systems microbiology focuses on complex interactions within microbial cells and microbial communities as the systems under study.
Genomics, large scale mutagenesis, and chemogenomics will be integrated to create models of functioning microbial cells with a focus on antimicrobial research

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

Sources of information
- 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

Course lecture notes

Lecture notes and additional course information can be found on the course UM Learn site. You will need your UMNet ID and password to login.

All course materials will be posted on UM Learn. It is your responsibility to get access to UM Learn. You are responsible for what is written in the prepared notes, what transpires in class, and the material assigned that corresponds to the lecture notes.

Lectures will be delivered by Zoom.

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 that is not posted it is your responsibility to get notes from a classmate, or to get the missing information from the textbook.
- Electronic devices are allowed during lectures (NOT EXAMS) as long as they do 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.

Lab section

The lab will meet "virtually" and consist of assignments relating to lab techniques, in silico exercises, and calculations using data collected in previous years. For a detailed schedule, see the "lab outline" file on Umlearn. It will be found in the content section in the "lab" subfolder. The first "lab meeting" will be Wed. Jan.27th (zoom links will be found on UMlearn).

Course Evaluation

Examination schedule:

One midterm test (open book online)	25 %
Quizzes (3)	3 %
Participation (chats, polls,breakout rooms)	2%
Laboratory	20%
Final exam (open book online)	50%

There will be no deferred midterm exams and no make-up assignments. Students with notes from a counselor, physician, or clergy will write the final exam for 70 to 80% of the total grade; students who did not write the midterm or failed to complete the assignments without official notes will receive 0% for their mark. There will be NO EXCEPTIONS.
Please note that specific assignment instructions will be provided as appropriate.
The grades for the midterm exam will be returned prior to the voluntary withdrawal date Mach 15st.
Exam format: Short answer. **The final exam will be cumulative**.
For this course, a grade of 45% in the final exam is required to pass the course. Letter grades are assigned taking into consideration the grade distribution in the class and the University of Manitoba's descriptors A^+ (Outstanding), A (Excellent), B^+ (Very Good), B (Good), C^+ (Satisfactory), C (Adequate), D (Marginal), F (Failure); The tentative grading scheme is: A+ (>90%), A (80-89.9 %), B+ (75-79.9%), B (70-74.9%), C+ (65-69.9%), C (55-64.9%), D (50-54.9%), F (<50%, or <45% in final exam).

Academic integrity and dishonesty

Guidelines are stated in your calendar regarding University policy with respect to academic dishonesty (particularly plagiarism, impersonation and cheating), as well as behavior and absence from final exams. All exams are to be written individually, without any discussion in person or electronically. Acceptable resources (notes, research papers) will be noted in class prior to the exam. If it isn't on the list, you cannot use it! In cases of cheating or collaboration during in-class examinations, the test(s) in question will be given a grade of 0% and the student will be reported to the appropriate authorities for disciplinary action. Dishonesty during final exams will be reported directly to the Faculty of Science.

The Faculty of Science web page has **detailed information**, with which you must become familiar.
(https://sci.umanitoba.ca/students/undergraduate-students/academic-resources/academic-integrity-2)
Please read and follow these guidelines and ask if you have any questions.

Watch the Faculty of Science video outlining issues regarding academic integrity in the context of on-line examinations, and the consequences of cheating: (7 min)
https://youtu.be/Ok-lilm4SeE

Course outline

UNITS
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 • Transcriptomics analysis of the cell cycle • Transcriptomics 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: o Chemogenomics applied to antimicrobial discoveries o Probiotics and microbiome

*Changes may be introduced according to course evaluation.

Tentative Schedule*

Unit	Date	Activity
Unit 1	January 19	Lecture 1: Microbial cells as systems: The *E. coli* cell cycle
	21	Lecture 2: Microbial cells as systems: Caulobacter cell cycle
	26	Lecture 3: Other microbial systems: bacteria exposed to antibiotics, microbial communities
	28	Lecture 4: Microbial Genomes: Shotgun Sequencing
Unit 2	February 2	Lecture 5: Microbial Genomes: next Generation sequencing (NGS). Library preparation
	4	Lecture 6: Next generation sequencing (NGS) platforms
	9	Lecture 7: NGS projects
	11	Assembly, annotation, and genomic databases **Quiz 1 opens**
	16-18	Winter Break
	23	Review of Quiz 1. Review for Midterm
Unit 3	25	Midterm Exam
	March 2	Lecture 8: Transcriptomics: Introduction, Microarrays, RNA-seq Chlp-seq
	4	Lecture 9: Transcriptomics: analysis of the cell cycle
	9	Lecture 10: Transcriptomic analysis of cells exposed to antibiotics **Quiz 2 opens**
	11	Lecture 11: Genome-wide mutagenesis: random vs. systematic; ordered vs. redundant
	16	Lecture 12: Genome-wide mutagenesis: high density transposon mutagenesis; Tn-seq and Bar-seq
	18	Lecture 13: Knockdown mutagenesis: delivery of inducible promoters
	23	Lecture 14: Knockdown mutagenesis: CRISPRi
	25	Lecture 15: Knockdown mutagenesis: CRISPRi **Quiz 3 opens**
Unit 4	30	Lecture 16: Knockdown mutagenesis: CRISPRi **VW Deadline March 31st**
	April 1st	Lecture 17: Antibiotic classic screens: target-based, whole-cell based
	6	Lecture 18: Antibiotic chemogenomic screens
	8	Lecture 19: Antibiotic chemogenomic screens
	13	Lecture 20: Microbiomes and probiotics
	15	Lecture 18: Review

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