MBG*3080 Bacterial Genetics

Fall 2017

Sections(s): C01

College of Biological Science

Credit Weight: 0.50

Version 1.00 - September 06, 2017

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1 Course Details

1.1 Calendar Description

This course focuses on the genetics of prokaryotic microorganisms and their viruses. Some major topics covered are: regulation of gene expression, analysis of bacterial and phage genomes, plasmids, transposable elements, and mutation studies.

Pre-Requisite(s): MBG*2040, MICR*2420

1.2 Timetable

Lectures**:** MCKN 120

Mondays, Wednesdays and Fridays, 9:30 - 10:20 am

1.3 Final Exam

Final Exam time and location is subject to change. Please see WebAdvisor for the latest information.

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2 Instructional Support

2.1 Instructor(s)

Dr. Stephen Seah

Email:	sseah@uoguelph.ca
Telephone:	+1-519-824-4120 x56750
Office:	SSC 4250
Office Hours:	Appointments to meet instructor outside normal class hours can be made by e-mail.

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3 Learning Resources

3.1 Required Resources(s)

Molecular Genetics of Bacteria (Textbook)

The primary textbook for the course is Molecular Genetics of Bacteria, 4th Edition 2012. Authors: Larry Snyder; Joseph E. Peters; Tina M. Henkin; Wendy Champness. This is available for purchase in the bookstore and there is one copy in the Library's reserve desk.

"Microbiology an evolving Science 3rd edition by Slonczewski and Foster" Chps 7, 8, 9, 10, 11 and 12 can be used as a reference if you need a basic understanding of the topic before reading the primary textbook.

Courselink (Website)

https://courselink.uoguelph.ca
You are responsible for all information posted on the University of Guelph's Course link page for MBG*3080. Lecture quizzes will be administered through courselink. Most of the slides used in lectures will be available on Courselink. Note that the slides are lecture aids that help me teach the material. They are not comprehensive course notes. You are expected to read the textbook and other readings supplied through courselink and attend lectures to supplement the material presented in the slides. Self-study questions will also be posted on CourseLink.

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4 Learning Outcomes

4.1 Course Learning Outcomes

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

1. **NUCLEIC ACID STRUCTURE** ***By the end of the semester, the student will be able to:***

    - Describe the molecular structure of DNA, including base pairing, 5'→ 3'orientation, major/minor grooves
    - Describe the roles of plasmids in bacterial cells and the various genetic elements in a natural and synthetic plasmid.
    - Describe the structures of different types of RNA, how they are synthesized/processed and their functions in the bacterial cell.
    - Understand the types of molecular interactions between proteins and nucleic acids and how specific interactions can be achieved.
    - Describe template and coding strands and relate how genes are organized on both DNA strands of a chromosome

2. **DNA REPLICATION** ***By the end of the semester, the student will be able to:***

    - Describe the process of DNA replication (plasmids and chromosome) in a bacterial cell.

- Understand how initiation of chromosome replication is accomplished, and how this is coordinated with cell division
- Understand the molecular basis of plasmid incompatibility and how plasmid copy number is regulated in a bacterial cell.
- Identify the major DNA polymerases in *E. coli* and their molecular properties/functions
- Explain how proofreading and repair occurs during DNA synthesis.
- Understand the principle behind the polymerase chain reaction and how this differs from DNA synthesis in a cell.
- Explain techniques of DNA sequencing

3. **EVOLUTION AND THE FLOW OF GENETIC INFORMATION** ***By the end of the semester, the student will be able to:***

- Understand the relationship between genotype and phenotype
- Describe the molecular mechanisms of gene transfer by conjugation (including Hfr strains), transformation and transduction
- Understand the concept of lysogenic conversion of bacterial pathogens
- Describe pathogenicity islands and their evolution
- Understand the concept of a minimal genome and how this can be tested experimentally
- Understand the fluidity and evolution of bacterial genomes
- Understand the concept and rationale behind comparative genomics
- Recognize the convention and symbols used to describe bacteria genotype and phenotype

4. **GENE EXPRESSION** ***By the end of the semester, the student will be able to:***

- Describe at the biochemical level the events that occur from genes to phenotype
- Identify different types of promoter sequences and the different sigma factors that recognize each type of promoter.
- Understand the concept of promoter “strength”
- Understand the concept of *cis*- and *trans*-acting factors in gene expression
- Describe the process of transcription at the molecular level including transcription termination
- Describe the process of translation at the molecular level in monocistronic and polycistronic mRNAs.
- Explain the various molecular mechanisms of transcription regulation in bacteria.
- Explain how the *lac, trp and ara* operons are regulated.
- Understand the difference between negative and positive transcriptional regulation and induction vs derepression
- Understand how transcription and translation are coupled in bacteria
- Understand and describe some examples of gene regulation by attenuation
- Understand the difference between specific gene regulation and global gene regulation
- Understand how the phenotype of specific mutants can be used to determine the mechanism of gene expression and regulation in bacteria.
- Describe some examples of how bacteria sense environmental conditions and

respond by controlling gene expression**.**
- Identify the characteristics of a gene from a DNA sequence

5. **GENE MUTATIONS** ***By the end of the semester, the student will be able to:***

- Understand the difference between DNA lesions and mutation
- Describe the various mechanisms of how mutations can arise spontaneously within a cell or can be induced.
- Identify the various kinds of DNA mutations (point mutation, insertion, deletion, nonsense, nonsense suppressor, frameshift and reversion) and how these might affect the resultant mRNA transcript or protein product as well as the phenotype.
- Understand the relationship between nonsense and frameshift mutations and polarity
- Understand how gene complementation can be used to identify if a specific gene mutation is dominant or recessive
- Explain how creating mutants and merodiploids in genetic model systems can help us infer the function of genes
- Be able to predict the effects of mutations in specific genes of systems covered in the course and identify, based on mutant phenotype, the affected gene(s)
- Describe the various mechanisms of DNA repair and the hierarchy of induction of systems of the SOS regulo

6. **Transposons** ***By the end of the semester, the student will be able to:***

- Identify the key characteristics of various types of transposons
- Describe how transposition occurs at the molecular level
- Understand transposon mutagenesis *in vivo* as an evolutionary force and *in vitro,* as a tool in bacterial genetics
- Understand how transposon activity is assayed in the lab and how to identify the site of transposon integration from a DNA sequence
- Understand the underlying molecular events and roles of site-specific recombination in bacteria and bacteriophages

7. **Phage genetics** ***By the end of the semester, the student will be able to:***

- Understand, through comparing and contrasting, the temporal regulation of gene expression in phage T4 and lambda.
- Understand the molecular basis for transcriptional antitermination (λ)
- Describe the molecular events that occur in the lysogenic and lytic phases of lambda
- Describe the process of induction of a phage lysogen and its relationship with the SOS response
- Understand the differences between generalized and specialized transduction and the applications of each in bacterial genetics
- Understand the role of lysogenic conversion in bacterial pathogenesis

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5 Teaching and Learning Activities

5.1 Course Content

The following is a list of lecture topics: the relative amount of time spent on a given topic and the order of topics may be subject to minor modifications. ***Not all topics within the indicated textbook readings will necessarily be covered and some readings in addition to those in the textbook may be assigned.***

Lecture	Topic	Textbook Chapter
1	Course information. Bacterial genetics history and relevance	1
2, 3, 4	Chromosome structure and organization. DNA replication	1
5	Plasmids. Replication and copy number control	4
6,7	*Transcription*	2
8,9	*Translation, and Protein Folding*	2
10, 11	Regulation of gene expression I – the *lac* operon	12
12, 13	Regulation of gene expression II – the *trp* and *ara* operons	12
14, 15,16	DNA Repair and Mutagenesis	11
17	Mid-term exam	
18, 19	Global regulatory mechanisms and signal transduction I	13
20,21, 22, 23	The Bacterial genome. Bacterial gene pool and evolution of bacterial genetic diversity. CRISPR-Cas, Minimal genome and synthetic life	Articles in D2L
24, 25	Conjugation and gene mapping	5
26	Transformation	6

27, 28, 29	Transposition and Site-Specific Recombination	9
30	Transposon mutagenesis	Articles in D2L
31, 32	Bacteriophages: Lytic Development,Genetics, and Transduction	7
33, 34, 35,	Lysogeny: the λ Paradigm and the Role of Lysogenic Conversion in Bacterial Pathogenesis	8
36	Revision	

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6 Assessments

6.1 Methods of Assessment

Activity	*Dates & Notes*	*Final course grade = highest of A or B*	
		A	*B*
Lecture Quizzes	Best 3 of 4 quizzes. Quizzes are to be taken on courselink. ***Dates****: Quiz 1: Sept 19 , Quiz 2 :Oct 3, Quiz 3: Nov.2; Quiz 4: Nov. 23*	**10%**	**10%**
Midterm exam	During lecture time. **Oct 18**. **Writing the Exam is *highly recommended* but not compulsory. No penalties if missed.**	**35%**	
Assignment	See Courselink for instructions. Due on **Nov 1** during lecture time.	**10%**	**10%**
Final exam	Dec 8 (Check webadvisor)	**45%**	**80%**

6.2 Midterm Examination

The midterm exam is held during a regular lecture hour at the date shown in the table below.

The midterm is worth a maximum of 35% of the final course grade. No alternate date or time will be set for any reason. Students who miss the midterm will write an 80% final exam. Students who DO write the midterm, but perform better on the final, will have their midterm grade dropped and the grade weight transferred to the final exam (80%). Students are strongly encouraged to write the midterm rather than gamble on performing well on the final exam. Re-grading of midterms exams- Exam papers must be handed back to the instructor within 5 class days of the return of the graded exam. Exam papers written in pencil cannot be re-graded.

6.3 Assignment

One assignment worth 10% of the final mark. The assignment must be handed in by Nov 1 during lecture time. Assignment must be submitted on paper and not electronically. Late submissions will be assigned grades of zero unless extenuating circumstances are adequately documented within one week of the requirement date. Details and instructions for the report will be provided in D2L. Note you may also be tested on independent assignment materials for the final exam.

6.4 Online Quizes

On line quizzes worth 10% of final mark. There will be 4 quizzes (equal weighting). Quizzes are based on the lecture materials and are to be taken online via D2L. Each quiz will cover material starting from the date of the preceding quiz. You will have a 12 hr window (9:30 am to 9:30 pm) to sign on. Every student will have 30 min to complete the quiz – no extra time allowed for any reason. The best 3 out of 4 quiz marks will be used towards 10% of the final mark.

6.5 Final Exam

The Final examination is compulsory and will be comprehensive, i.e. the exam will cover all lecture materials and readings (including independent assignment) BEFORE & AFTER the midterm

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7 Course Statements

7.1 Absence & Illness

Students who miss lectures are expected to obtain the materials through reading or discussion with colleagues. Where requested, Academic consideration can only be given providing appropriate supporting / written (and signed) documentation is submitted as soon as possible following the event/circumstance for which consideration is requested. If a student is unable to write the final exam or miss the final exam for any reason, they must fill out a "request for academic consideration" form, available in the BSc academic advising office. That request is then considered by the Academic Review Subcommittee, and they make decisions on granting deferred final exams (or deferred conditions).

8 College of Biological Science Statements

8.1 Academic Advisors

If you are concerned about any aspect of your academic program:

- Make an appointment with a program counsellor in your degree program. B.Sc. Academic Advising or Program Counsellors

8.2 Academic Support

If you are struggling to succeed academically:

- Learning Commons: There are numerous academic resources offered by the Learning Commons including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills. You can also set up individualized appointments with a learning specialist.
- Science Commons: Located in the library, the Science Commons provides support for physics, mathematic/statistics, and chemistry. Details on their hours of operations can be found at: Chemistry & Physics Help and Math & Stats Help

8.3 Wellness

If you are struggling with personal or health issues:

- Counselling Services offers individualized appointments to help students work through personal struggles that may be impacting their academic performance.
- Student Health Services is located on campus and is available to provide medical attention.
- For support related to stress and anxiety, besides Health Services and Counselling Services, Kathy Somers runs training workshops and one-on-one sessions related to stress management and high performance situations.

9 University Statements

9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The regulations and procedures for Academic Consideration are detailed in the Undergraduate Calendar.

9.3 Drop Date

Courses that are one semester long must be dropped by the end of the fortieth class day; two-semester courses must be dropped by the last day of the add period in the second semester. The regulations and procedures for Dropping Courses are available in the Undergraduate Calendar.

9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required, however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance, and not later than the 40th Class Day.

More information: www.uoguelph.ca/sas

9.6 Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy is detailed in the Undergraduate Calendar.

9.7 Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.