1. Course Information

Biochemistry 3382A: Biochemical Regulation

Fall Term 2017/18

An organism or cell must be able to regulate itself to coordinate numerous processes, respond to changes in its environment, and grow and differentiate in an orderly manner. One of the main objectives of this course is to introduce various biochemical mechanisms involved in cellular regulation. The first series of lectures deals with the structure, dynamics, replication and repair of DNA – essential cellular processes that ensure faithful transmission of genetic material from generation to generation. The second set of lectures introduces key concepts in protein-DNA interactions, and how these interactions are crucial for regulating transcription of genes in both prokaryotes and eukaryotes. The third set of lectures of the course delves into cellular mechanisms that regulate mRNA abundance and stability. The last set of lectures will integrate topics into a discussion of synthetic biology and biotechnology. Specific case studies addressing how synthetic biology can be used for biotechnology and to benefit human health will be discussed in class.

Lectures:

Tuesday and Thursday 10:30-11:30 am 3M Building Room 3250 (3M 3250)

Friday 2:30-3:30 pm Biological & Geological Sciences Room 0165 (B&GS 0165)

Tutorials:

Tuesday 5:30-6:30 pm

Natural Sciences Room 1 (NS 1) OR Medical Sciences Building Room 190 (MSB 190) (see schedule below)

Pre-requisite:

A minimum mark of 65% in either Biochemistry 2280A or 2288A; a minimum mark of 60% in either Chemistry 2213A/B or Chemistry 2273A; and a minimum mark of 60% in either Chemistry 2223B or 2283G.

Senate regulation regarding the student’s responsibility regarding requisites:

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.
Accessibility Statement

Please contact the course instructor if you require material in an alternate format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

2. Instructor Information

<table>
<thead>
<tr>
<th>Instructors</th>
<th>Email</th>
<th>Office</th>
<th>Phone</th>
<th>Office Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. David Edgell</td>
<td><a href="mailto:dedgell@uwo.ca">dedgell@uwo.ca</a></td>
<td>MBL C111</td>
<td>661-3133</td>
<td>Thu 1-3 pm</td>
</tr>
<tr>
<td>(Course Coordinator)</td>
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<tr>
<td>Dr. Ilka Heinemann</td>
<td><a href="mailto:ilka.heinemann@uwo.ca">ilka.heinemann@uwo.ca</a></td>
<td>MSB 358</td>
<td>850-2949</td>
<td>Fri 1-2 pm</td>
</tr>
<tr>
<td>Dr. Bogumil Karas</td>
<td><a href="mailto:bkaras@uwo.ca">bkaras@uwo.ca</a></td>
<td>MBL C1</td>
<td>661-4670</td>
<td>Thu 1-3 pm</td>
</tr>
<tr>
<td>Dr. Derek McLachlin</td>
<td><a href="mailto:derek.mclachlin@schulich.uwo.ca">derek.mclachlin@schulich.uwo.ca</a></td>
<td>MSB 349</td>
<td>661-3072</td>
<td>Thu 1-3 pm</td>
</tr>
<tr>
<td>Allison Dilliot (TA)</td>
<td><a href="mailto:adilliot@uwo.ca">adilliot@uwo.ca</a></td>
<td></td>
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<tr>
<td>Sander Roy (TA)</td>
<td><a href="mailto:aroy82@uwo.ca">aroy82@uwo.ca</a></td>
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OWL: Students with OWL issues should see: https://owl.uwo.ca/portal/site/owldocs

3. Course Content

Learning outcomes:

Upon completion of the course, students should be able to:

- describe the different types of structures formed by nucleic acids, and make predictions about how biochemical processes and changes in sequence and environment affect nucleic acid structure, stability, and supercoiling
- with reference to specific proteins, explain the biochemical mechanisms of DNA replication, recombination, and repair, and how these processes are regulated
- formulate general strategies using techniques of synthetic biology to accomplish defined biotechnological goals
- describe the different mechanisms that control mRNA turnover, stability and decay in eukaryotic cells, and be able to explain differences between cis- and trans-acting factors that control mRNA expression levels
- formulate general strategies for cloning and expressing genes based on the different types of restriction endonucleases used in recombinant DNA technologies
- describe the RNA-based mechanisms used for genome defence in both bacteria and eukaryotes, and how these mechanisms have been adapted for use as genome-editing tools
- describe how defects in DNA repair pathways can cause human diseases
- explain the key molecular components of transcription, including both DNA and proteins, and be able to formulate strategies to control gene expression with these components
- describe the concepts behind the RNA world, and the transition from RNA-based organisms to DNA-based organisms

SECTION 1 Dr. Derek McLachlin (September 7 – September 22)
Nucleic Acid Structure – DNA and RNA
DNA Supercoiling
Nucleotide metabolism
DNA replication (prokaryotic and eukaryotic)

SECTION 2 Dr. Ilka Heinemann (September 26 – October 31)
Recombination & DNA repair
RNA world
Prokaryotic transcription
Prokaryotic transcriptional regulation
Eukaryotic transcription
Eukaryotic gene expression
Protein-DNA interactions
RNA splicing

SECTION 3 Dr. David Edgell and Dr. Bogumil Karas (November 2 – December 5)
RNA turnover and mRNA stability
miRNA-mediated gene regulation
Mobile genetic elements
CRISPR systems
Recombinant DNA technology
Genome editing
Next generation sequencing and associated applications
Synthetic biology
Case studies in synthetic biology and synthetic genomes

4. Course Materials

Recommended Text:


It is recommended that Biochemistry Honors Specialization students taking both 3381A and 3382A buy the hardcopy or the e-book version of the textbook. This textbook will serve as a
reference for 4\textsuperscript{th} year Biochemistry courses. Students have the option of buying individual chapters online from the publisher. The cost per chapter is \$5. The hardcopy is available at the Campus Bookstore. The e-book and individual chapters can be purchased at:

https://login.cengage.com/cb/login.htm

5. Evaluation:

<table>
<thead>
<tr>
<th>Assessment</th>
<th>% of final grade</th>
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<tbody>
<tr>
<td>Midterm #1</td>
<td>20</td>
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<tr>
<td>Midterm #2</td>
<td>30</td>
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<tr>
<td>Final exam</td>
<td>35</td>
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<tr>
<td>Oral presentation</td>
<td>15</td>
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The midterm and final exams will consist primarily of short answer and problems based on materials from lectures, assigned textbook readings and other assigned reading. There are no multiple choice questions.

(1) Midterms

Midterm #1 will be 7:00 – 9:00 pm on Thursday, September 28 in EC 2168A/B. It will cover Dr. McLachlin’s section.

Midterm #2 will be 7:00 – 9:00 pm on Thursday, November 9 in EC 2168A/B. It will cover Dr. Heinemann’s section.

(2) Final exam

The final exam will be scheduled by the Registrar’s Office during the December exam period. It will cover Dr. Edgell’s and Dr. Karas’ section. The final exam will not be cumulative.

(3) Oral presentation

Detailed instructions, including a marking rubric, are provided in a supplementary document. Briefly, after the Add deadline the instructors will divide the class into groups of 4 students, and each group will choose a paper to present from a list provided. Presentations will occur during the Tuesday tutorial sessions. Not all tutorial sessions will be used for presentations, as those sessions close to the midterms will be set aside for review (see schedule below). Each group will give an 8- to 10-minute presentation (plus 2 mins of questions) describing a paper related to the material taught in the course. Each student in the group is expected to participate in all aspects of the project, including the oral presentation. Grading of the presentations will be done by the instructor who chose the paper and a course TA. Presentation grades will be multiplied by a factor representing the peer evaluation given by other members of the group. Students are required to attend all presentations on their presentation day, but otherwise attendance at tutorial sessions is optional.
Tutorial schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Room</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Sep 12</td>
<td>NS 1</td>
<td>Example presentations – Edgell and McLachlin</td>
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<td>Sep 19</td>
<td>—</td>
<td>Free tutorial for group work</td>
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<tr>
<td>Sep 26</td>
<td>NS 1</td>
<td>Review tutorial for McLachlin midterm</td>
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<tr>
<td>Oct 3</td>
<td>MSB 190</td>
<td>McLachlin presentations #1</td>
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<td>Oct 10</td>
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<td>Study week – no tutorial</td>
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<td>Oct 17</td>
<td>MSB 190</td>
<td>Heinemann presentations #1</td>
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<tr>
<td>Oct 24</td>
<td>MSB 190</td>
<td>Heinemann presentations #2</td>
</tr>
<tr>
<td>Oct 31</td>
<td>MSB 190</td>
<td>McLachlin presentations #2</td>
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<tr>
<td>Nov 7</td>
<td>NS 1</td>
<td>Review tutorial for Heinemann midterm</td>
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<tr>
<td>Nov 14</td>
<td>MSB 190</td>
<td>Heinemann presentations #3</td>
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<tr>
<td>Nov 21</td>
<td>MSB 190</td>
<td>Edgell/Karas presentations #1</td>
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<tr>
<td>Nov 28</td>
<td>MSB 190</td>
<td>Edgell/Karas presentations #2</td>
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<tr>
<td>Dec 5</td>
<td>MSB 190</td>
<td>Edgell/Karas presentations #3</td>
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Rounding of marks

Final grades in this course, irrespective of the number of decimal places used in marking individual assignments and tests, will be calculated to one decimal place and rounded to the nearest integer (e.g., 74.4 becomes 74, while 74.5 becomes 75). Marks WILL NOT be bumped to the next grade or GPA level (e.g., an 84 will NOT be bumped up to an 85). The mark attained is the mark you achieved and the mark assigned; requests for mark bumping will be denied, in accordance with Bachelor of Medical Science Undergraduate Education policy.

6. Additional Information/Statements

Unless otherwise indicated, the use of electronic devices will not be permitted for the midterm tests and final exam.
Statement on Academic 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 website: http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf.”

A. Absence for medical illness:

Students must familiarize themselves with the Policy on Accommodation for Medical Illness: https://studentservices.uwo.ca/secure/index.cfm

Students who miss their group’s oral presentation without approved academic accommodation will receive a mark of 0 for the presentation. Students who miss their group’s presentation with approved academic accommodation must give a solo presentation at a later date.

Statement from the Dean’s Office, Faculty of Science

If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Dean's office as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Dean's Office immediately. For further information please see: http://www.uwo.ca/univsec/handbook/appeals/medical.pdf

A student requiring academic accommodation due to illness, should use the Student Medical Certificate when visiting an off-campus medical facility or request a Record's Release Form (located in the Dean's Office) for visits to Student Health Services.

The form can be found at: https://studentservices.uwo.ca/secure/medical_document.pdf

B. Absence for non-medical reasons:

If you have course timetable conflicts with the examination times, contact the course coordinator at least two weeks before the examination.

In these circumstances, special arrangements will be made to write midterms tests or exams in advance of the regularly scheduled midterm test or exam.

C. Special Examinations

A Special Examination is any examination other than the regular examination, and it may be offered only with the permission of the Dean of the Faculty in which the student is registered, in consultation with the instructor and Department Chair. Permission to write a Special Examination may be given on the basis of compassionate or medical grounds with appropriate supporting documents.
A Special Examination must be written at the University or an Affiliated University College no later than 30 days after the end of the examination period involved. To accommodate unusual circumstances, a date later than this may be arranged at the time permission is first given by the Dean of the Faculty. The Dean will consult with the instructor and Department Chair and, if a later date is arranged, will communicate this to Registrarial Services. If a student fails to write a scheduled Special Examination, permission to write another Special Examination will be granted only with the permission of the Dean in exceptional circumstances and with appropriate supporting documents. In such a case, the date of this Special Examination normally will be the scheduled date for the final exam the next time the course is offered.

**Support Services:**

Registrarial Services: http://www.registrar.uwo.ca

Academic Counselling (Science and Basic Medical Sciences): http://www.uwo.ca/sci/counselling/index.html

USC Student Support Services: http://westernusc.ca/service

Student Development Services: http://www.sdc.uwo.ca

Student Health Services: http://www.shs.uwo.ca/

Students who are in emotional/mental distress should refer to Mental Health@Western http://www.uwo.ca/uwocom/mentalhealth/ for a complete list of options about how to obtain help.