1. Course Information

Biochemistry 3381A: Biological Macromolecules
Fall Term 2018

Overview: Our goal in delivering Biochemistry 3381A is to ‘NOT BORE YOU’ with disjointed facts that will likely be memorized and then quickly forgotten soon after examination periods. Instead we want to get you TURNED ON to the amazing world of proteins and for you to walk away from this course with a set of KEY CONCEPTS that govern a true understanding and appreciation of why it is that PROTEINS RULE! In addition, these concepts will serve you well for your future courses and research within Biochemistry and Biomedical Sciences. Students will be exposed to these concepts in both traditional lecture and small group inquiry environments. Some of the key concepts we want you to take away, include: 1) understanding basic protein structure and the forces that govern its formation, 2) methods for protein structure prediction and analysis, 3) protein folding, 4) enzyme mediated chemical reactions and their associated kinetic parameters, and 5) how proteins govern regulator networks.

Lectures: MWF 12:30 - 1:20 pm, Natural Science Centre (NS) Rm1

Tutorials: W 5:30 - 6:20 pm, Natural Science Centre (NS) Rm 1

Requisites: A minimum mark of 65% in either Biochemistry 2280A or 2288A; a minimum mark of 60% in either Chemistry 2213A/B or 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

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<tr>
<th>Instructors</th>
<th>Email</th>
<th>Office</th>
<th>Phone</th>
<th>Office Hours*</th>
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<tbody>
<tr>
<td>Dr. M. Junop</td>
<td><a href="mailto:mjunop@uwo.ca">mjunop@uwo.ca</a></td>
<td>M364 MSB</td>
<td>519-661-2017</td>
<td>M 2:30 – 3:30</td>
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<tr>
<td>(Coordinator)</td>
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<td>Th 1:30 – 2:30</td>
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<tr>
<td>Dr. J. Choy</td>
<td><a href="mailto:jchoy4@uwo.ca">jchoy4@uwo.ca</a></td>
<td>M302 MSB</td>
<td>519-661-2111</td>
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<td>x83161</td>
<td>Th 1:30 – 2:30</td>
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<tr>
<td>Dr. B. Shilton</td>
<td><a href="mailto:bshilton@uwo.ca">bshilton@uwo.ca</a></td>
<td>M332 MSB</td>
<td>519-661-4124</td>
<td>M 2:30 – 3:30</td>
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*or by appointment
### Teaching Assistants

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<th>Email</th>
<th>Inquiry Group</th>
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<tr>
<td><a href="mailto:rgrainge@uwo.ca">rgrainge@uwo.ca</a></td>
<td>Group A 1-6</td>
<td>Thursday: 4:30 – 5:30 in M340 MSB</td>
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<tr>
<td><a href="mailto:rcocha3@uwo.ca">rcocha3@uwo.ca</a></td>
<td>Group B 1-6</td>
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<tr>
<td><a href="mailto:sslatte2@uwo.ca">sslatte2@uwo.ca</a></td>
<td>Group C 1-6</td>
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**OWL:** This course will use OWL for communication and distribution of teaching materials including lecture notes. Students with OWL issues should see: https://owl.uwo.ca/portal/site/owldocs

### 3. Course Syllabus

Biochemistry 3381A covers three major areas: Protein Structure (“Proteins”), Enzyme Function and Regulation (“Enzymes”), and Protein Regulatory Networks (“Networks”). Each area will be taught by a different professor. Lecture material will be taken from the text, but will be largely supplemented by other sources as determined by instructors. The text is required and assigned readings are mandatory. Readings are intended to help better understand material covered during lectures. Lecture slides will be placed on OWL and should be downloaded prior to class. The information on these slides is meant to aid, but not replace, taking of notes during lectures.

Tutorial sessions will be conducted by the Teaching Assistants and will be used for three major purposes: 1) to provide guidance into the use of web- or personal computer-based programs for the analysis of protein sequences and the viewing/analysis of macromolecular structures, 2) clarification of issues arising from lectures, and 3) guidance and instruction in the solution of problems similar to those on assignments.

**Course Objectives**

The objectives of the **Proteins** section are to develop an in-depth understanding of protein structure, of how protein conformation and stability depend on the environment. The relationship of amino acid sequence and function to the extraordinary diversity of protein structures will be explored. A large number of tools are available for analysis and comparison of protein sequences, and application of such tools is often useful in inferring the properties or functions of a polypeptide, just from its sequence. However, analysis of protein structure by instrumental techniques in the laboratory remains essential to the discovery of protein structure and function. Newly synthesized proteins must fold to achieve their functional conformations, while misfolding of some proteins causes disease states.

The objective of the **Enzymes** section is to provide an understanding of how proteins behave as both individual molecules and ensembles, and how enzymatic (and by extension, biological) systems are governed by the laws of thermodynamics. Enzymes interact with other molecules to effect chemical change, but this process is essentially a series of binding events. To highlight this, a detailed analysis of the individual steps in selected enzymatic reactions will be covered. This will include the chemical mechanisms involved which will be related to the energies of the individual steps and the relationship of these energetic changes to the rate of the reaction. The nature of “energy” in biochemical systems, and the roles that energetic changes play in determining the rate and direction of biochemical reactions will be a major theme of this section. The lectures end with a discussion of allosteric systems using hemoglobin as an
example. The idea here is that the mechanistic and energetic principles governing single enzyme
catalysis can be scaled and used to understand intermolecular interactions in larger systems.

The Regulatory Protein Networks section will build on concepts covered in the other
sections of the course to reveal how protein networks are responsible for the execution of
complex biological processes and how these processes are regulated. The section will begin with
a review of metabolic pathways with emphasis on the chemical logic or principles that govern
the regulation of metabolic reactions and integration of pathways into regulatory protein
networks. Application of chemical logic or principles will also be employed to understand how
regulatory signals are transmitted within cells to orchestrate cellular events both in healthy and
diseased states.

**Learning Outcomes**
At the conclusion of Biochemistry 3381A students should be able to:

1. Demonstrate knowledge of the structures and functions of proteins, methods used in the
   purification and characterization of proteins, and the physical forces that determine stabilities of
   the folded and unfolded states

2. Demonstrate knowledge of the chemical mechanisms, thermodynamics, kinetics, and
   regulation of enzymatic catalysis

3. Demonstrate knowledge of the chemical logic or principles that govern regulation of
   metabolic reactions and the integration of pathways into regulatory protein networks

4. Relate the folded structures, functions, and regulatory features of protein molecules to their
   amino acid sequences, and make plausible predictions of the effects of mutations

5. Formulate experimental approaches for the purification of proteins, and for the analysis of
   their structures and regulatory/catalytic functions

6. Critically evaluate and interpret data from primary research papers relating to enzyme kinetics
   and the regulation/integration of metabolic and cellular pathways

**Lecture Schedule**
Introduction (Sep 07) will provide an overview of the course – this will be a very important
lecture!

**Protein Structure** —Dr. M. Junop (Sept 7 – 28: weeks 1-3)
Most material will be covered during lectures; however, relevant sections from the textbook and
some supplemental information will be provided as needed. In this section, you will learn about
the forces that govern protein folding, secondary/tertiary/quaternary structure and prediction, and
techniques (computational methods) used to analyse protein structure/function.

**Enzyme Function and Regulation**—Dr. B. Shilton (October 15 – November 2: weeks 5-7)
This section of the course will deal with protein-ligand interactions, enzyme
kinetics/catalysis/regulation and a more in-depth treatment of the driving forces governing
protein function (energy, entropy, thermodynamics). Students are encouraged to read Chapters
3, 12, 13, and 14 for further understanding in this section. Supplemental information will be provided during lectures.

**Regulatory Protein Networks – Dr. J. Choy (November 12 – November 23: weeks 9-10)**

This section will bring concepts from prior sections together through consideration of some examples of how proteins function to regulate biochemical networks (eg. signal transduction). Some Chapters in Nelson Biochemistry to have a look at include: 11, 16, 17, 21, 32, 33.

### 4. Course Materials


**Supplemental Information:** Additional information including lecture notes may be posted on OWL by individual instructors.

**Copyright Statement:**
Course material produced by faculty is copyrighted and to reproduce this material for any purposes other than your own educational use contravenes Canadian Copyright Laws.

**Electronic Devices:** please feel free to use them as much as possible to help with your learning. We will be doing weekly quizzes using OWL, and therefore access to OWL will be required (ie. laptop, etc) on those Friday classes when quizzes will be administered. You will most likely want to bring a non-programmable calculator to class for quizzes.

### 5. Evaluation:

8 weeks (weeks 1-3, 5-7, and 9-10) will be lecture format. Weeks 4, 8, 11 (ie. weeks starting Oct 1, Nov 5, Nov 26) are being made available for students to undertake more self-directed learning. During these three weeks, students will work in small groups based on common interest and be given the opportunity to ask and answer questions regarding aspects of proteins that have or have not been already touched on during lectures. Inquiry courses emphasize both process and content, and therefore a secondary objective of this course is to develop your inquiry skill set. Throughout this course, with guidance from your TA and the course instructors, you will refine your verbal and written communication skills, your ability to find and critically evaluate information, and your ability to work effectively as a member of a group. Week 12 (Starting Dec 3rd and including the tutorial session on Dec 5th) will be dedicated to each group presenting the findings of their inquiry project to the class.

I. **Quizzes (35%)** Each Friday of a lecture week starting **Sept 14th** and ending **November 23rd**, you will have a quiz to complete that is worth 5% of your final mark. Since the lowest mark will be dropped, the final mark will be the result of 7 weeks x 5% per test = 35% of final mark. The one test which will be dropped is to cover **emergencies etc.** that prevent a student
from being present; therefore, no excuses for missing more than one Friday quiz will be accepted. All marks will be posted on OWL.

II. Assignment 1 (20%) Due Friday October 5th – hard copy in class, worth 20% of final.

III. Assignment 2 (15%) Due Monday November 12 on owl by 12 pm, worth 15% of final.

IV. Inquiry (30%)
   * Final Group Presentation: week 12 (5% of final mark).
   * Final Written Report: due Friday December 7th (hard copy in class) (20% final mark).
   * Peer Evaluations: individual contribution to your group (5% of final mark).

**Important Details:**

I. Weekly Quizzes: Each Friday starting Sept 14th, we will be having a short, 10 minute, in-class quiz. Students will complete the quiz using OWL in class. During the last 10 minutes of class, you will have 5 multiple-choice questions to answer. Marks will be posted on OWL and answers will be taken up during the following class. Please note that material covered in each test will be cumulative throughout the entire course, meaning that you will be responsible for all material covered from the start of the course up to and including the class preceding the Friday quiz. There will be a total of 8 quizzes, the last being Nov 23rd. Only the results from the best 7 quizzes will count toward your final mark (ie. 7 x 5% per test = 35% of final mark). Since one test will be dropped, no excuses will be accepted for missed tests.

II. Assignments: Assignment 1 and 2 will be worth 20% and 15% of your final mark, respectively. The first assignment is due on Oct 5th in class. The second assignment is due on Monday Nov 12th (completed on OWL) by 12 pm.

III. Inquiry: During the 8 weeks of lecture, students will be exposed to different fundamental aspects of proteins. In order to make this course as interesting and useful to students as possible, students will be allowed to choose a preferred area of interest in keeping with the content of the course in which they would like to carry out a more in-depth, small group, inquiry based study. **Students are encouraged to self-assemble into groups of 11 people.** Each group should email Dr. Junop (mjunop@uwo.ca) with their list of students (including Name, email contact and student number) by Sept 14th. **One email per group only please.** Students who have not been included in a group by Sept 14th will be randomly placed into groups. Final group assignments will be posted on OWL Monday Sept 17th. Although designated inquiry will not begin until the week of Oct 1st, it is strongly suggested that you use the intervening time to orient yourselves with your other group members and start considering a common question for your group to explore. Each group will be assigned a TA and will be expected to meet with their TA once a week for 20 minutes in class during weeks 4, 8 and 11 (see details for individual group schedules below). There will be 18 groups, assigned A1-6, B1-6 and C1-6. Students will be given the opportunity to choose their own inquiry topic.

**Progress Meetings with TA:** During weeks 4, 8 and 11, groups will be scheduled to meet with their TA for 20 minutes to report on their recent work, review progress and set/refine direction.
Exact meeting times are provided below. To ensure that TAs have enough time to help students during those 3 short meetings, each group is **REQUIRED** to email a one page summary of their progress, questions etc, to their assigned TA one day prior to their designated meeting. Reports should be one-page, double-spaced, typewritten. You should come prepared to show any evidence of your research and learning, ie. you may bring a copy of key papers or review articles that have guided you. The report and any key articles will be placed in your group’s file to track your progress. Meetings will be informal. Because the success of the group depends on the full participation of all members, **attendance at all meetings is mandatory**. Failure to provide documentation for absence will result in an automatic zero for group peer evaluation (worth 5% of final). Course instructors will attend at least one of your group’s three meetings.

**Final Group Presentations:** Starting Monday **December 3rd**, each group will deliver a final presentation. One person from the group will be chosen at random to deliver the presentation. It is therefore very important to make sure every member in the group is ready! Following the presentation, all members of the group will be responsible to answer questions from the audience and course instructors. The presentation **CANNOT** exceed 8 minutes total, leaving 2 to 5 minutes for questions. Roughly 1/3 of the presentation should focus on the background you must communicate to your audience, and roughly 2/3 on answering the ‘Question’ your group decided to pursue. Be sure to use references appropriately. Any information (including figures) or ideas that are not your own, must be referenced to the primary source (not a general textbook). **Should you choose to give a PowerPoint presentation, you must send your presentation file by email to Dr. Junop by 9:00 am on December 3rd.** All PowerPoint presentations will be loaded onto a single laptop being used that day (MacBook Pro running OSX Yosemite), as time will not allow for each group to use individual computers. The order of the presentations is indicated in the schedule near the end of the course outline. Marks will be given based on the following criteria:

**CONTENT**
- Was the background material appropriate, not excessive, and helped the audience’s comprehension of the topic?
- Did the group demonstrate creativity in their approach to the question?
- Did the group use adequate results from original research to support their contention?
- Did the group demonstrate an understanding of basic biochemical principles?
- Did the group critically evaluate the literature, integrate and reconstruct the new knowledge?

**ORGANIZATION AND FORMAT**
- Was the format of the presentation well organized and presented in a logical, easy-to-follow sequence?
- **Was the presentation indicative of a clearly defined set of objectives?**
- Was the use of visuals appropriate and legible?

**CLARITY AND DELIVERY**
- Clear, appropriate use of scientific language, terminology
• Was the speaker clear and audible?
• Did the speaker remain attentive and enthusiastic throughout the presentation to make it rewarding for the audience and sustain interest?
• Was the delivery practiced and smooth?

POST-PRESENTATION
• Ability to answer questions
• Demonstrated knowledge of Biochemistry

**Final Written Report:** Each individual will write a final report on their group inquiry project. The report should demonstrate a logical progression from the question, through to the conclusion. Roughly 2/3 of the report should focus on the biochemical background you must communicate to your audience, and roughly 1/3 on ‘What’s next’. Any information or ideas that are not your own, must be referenced to the primary source (not a general textbook). **Figures must be your original work, unless copyright permission is obtained from the original source (ie. Journal).** Do not provide a bibliography, but a proper reference section (see journals like the Journal of Biological Chemistry, etc... [www.asbmb.org](http://www.asbmb.org)). The final report should be a maximum of 5 pages, double-spaced. Figures and tables may be included within the main text, or included as appendices, and do not count toward the final page count. All hard copies should be stapled, 12-point Times New Roman font, with one-inch margins and handed in at the end of class on **Friday December 7th**.

Marks will be assigned as follows:
• Overall Structure (2 marks): organization and logical flow
• Figures and Tables (3 marks): good use of
• Background (4 marks): description and background of relevant material for setting up the question
• Analysis (6 marks): level of depth and analysis in addressing question
• Summary (3 marks): clear and concise, including future directions
• Referencing (2 marks): proper use of

**Peer Evaluations:** You will be asked to reflect on each member’s participation and preparation, knowledge acquisition, group dynamics and overall contribution to the group. Keep these important aspects in mind throughout the term as you work within your group. At the conclusion of the term, each student will be required to assess contributions made by individual group members, including themselves. Each student will need to provide a **hard copy Dec 7th in class** that lists all members (names and student numbers) of their group and a mark out of 5. Your evaluation of each member’s level of contribution to group work should be indicated as a mark from 0 to 5, with 0 indicating absolutely no contribution and 5 indicating a fair and equitable contribution.

**IMPORTANT:** Questions regarding the marking or addition of tests and assignments must be brought to the attention of the TA within **ONE** week of their return to you.
Quizzes:
To be held on:
• September 14, 21, 28; October 19, 26; and November 2, 16 and 23

Assignments:
Assignment 1 – Deadline: **Friday October 5th in class**
Assignment 2 – Deadline: **Monday November 12th on OWL**

Student Group Preferences:
Friday September 14th – by email to Dr. Junop. **NOTE: one email only per group!!!**

Assigned Group Posting:
Posted on OWL Sept 17th

Progress Meetings with TA’s: (See schedule at end of course outline)

Final Group Presentations (to be held during regular class and tutorial time):
• Groups A1-4 – Monday December 3rd during class time
• Groups A5-6 and B1-2 – Wednesday December 5th during class time
• Groups B3-6 and C1 – Wednesday December 5th during tutorial time
• Groups C2-6 – Friday December 7th during class time

Final Written Inquiry Report and Peer Evaluations:
Deadline: **Friday December 7th – hard copy due in class.**

A detailed and comprehensive set of regulations concerning the scheduling of tests, assignments, etc. is available at: [http://www.uwo.ca/univsec/academic_policies/examinations.html](http://www.uwo.ca/univsec/academic_policies/examinations.html)

15% Assessment Rule:
At least three days prior to the deadline for withdrawal from a course without academic penalty, students will receive assessment of work accounting for at least 15% of their final grade. For more details, refer to the link below:
http://www.uwo.ca/univsec/pdf/academic_policies/exam/evaluation_undergrad.pdf

Rounding of marks:
Across the Basic Medical Sciences Undergraduate Education programs and within the department of Biochemistry we strive to maintain high standards that reflect the effort that both students and faculty put into the teaching and learning experience during this course. All students will be treated equally and evaluated based only on their actual achievement. **Final grades** on 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, and 74.5 becomes 75. Marks WILL NOT be bumped to the next grade or GPA, e.g. a 79 will NOT be bumped up to an 80, an 84 WILL NOT be bumped up to an 85, etc. The mark
attained is the mark you achieved and the mark assigned; requests for mark “bumping” will be denied.

6. Additional Information/Statements

Copyright statement:
Course material produced by faculty is copyrighted and to reproduce this material for any purposes other than your own educational use contravenes Canadian Copyright Laws.

Statement on Student Conduct
Western’s Code of Student Conduct (see https://www.uwo.ca/univsec/pdf/board/code.pdf) prohibits assault, harassment, intimidation, threats, or coercion, as well as discrimination based on grounds including race, ethnic origin, sex, sexual orientation, gender identity, and disability. Students in this course are expected to speak and act in ways that maintain an environment in which all people feel safe and respected.

Statement on Use of Electronic Devices
Students may bring a laptop and simple calculator that lacks programmable memory to quizzes.

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/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf”

Absence from course commitments

Statement on Student Conduct
Western’s Code of Student Conduct (see https://www.uwo.ca/univsec/pdf/board/code.pdf) prohibits assault, harassment, intimidation, threats, or coercion, as well as discrimination based on grounds including race, ethnic origin, sex, sexual orientation, gender identity, and disability. Students in this course are expected to speak and act in ways that maintain an environment in which all people feel safe and respected.

A. Absence for medical illness:
Students must familiarize themselves with the Policy on Accommodation for Medical Illness for Undergraduate Students, located at: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf

Statement from the Academic Counselling Office, Faculty of Science (for Science and BMSc students)
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 Academic Counselling Office as soon as possible and contact your instructor (and Dr. M. Junop) immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved by the Academic Counselling Office and the instructor has
been informed. In the event of a missed test, a student with medical documentation will be allowed to write a makeup test. In the event of a missed assignment, a student with medical documentation will receive a mark based on their performance in the relevant unit test. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Academic Counselling Office immediately. For further information please see: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_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: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf

Both the academic counselor and Dr. Junop, the course co-ordinator, should be contacted regarding absence from class for an extended period due to illness or injury.

**B. Absence for non-medical reasons:**
A student who misses a unit test for non-medical reasons must provide documentation to the Dean’s Academic Counselling Office for determination of whether accommodation is warranted.

Late assignments will not be accepted.

If you have course timetable conflicts or other non-medical conflicts for class quizzes, contact Dr. M. Junop (mjunop@uwo.ca) at least two weeks before the scheduled quiz.

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.

**C. Special Examinations**
A Special Examination is any examination other than the regular final examination, and it may be offered only with the permission of the Dean/Academic Counselling Office 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/Academic Counselling Office of the Faculty. The Dean/Academic Counselling Office will consult with the instructor and Department Chair and, if a later date is arranged, will communicate this to the Office of the Registrar.

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/Academic Counselling Office 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.
When a grade of Special (SPC) or Incomplete (INC) appears on a student's record, the notations will be removed and replaced by a substantive grade as soon as the grade is available.

Dr. M. Junop will co-ordinate the scheduling of make-up quizzes.

**D. Support Services:**
RegISTRARIAL SERVICES: http://www.registrar.uwo.ca

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

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

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.

**RECORDING OF LECTURES**
Some students like to record lectures—the instructors do not object to this, but if you intend to do so you must:

1) *Email to Dr. Junop stating that you would like to record lectures and that you accept points 2 and 3 below:
2) Recordings **may not be distributed** in any way without permission of the instructor.
3) At the request of the instructor, you are obliged to share the recording with a student who is missing a number of classes due to extended illness or injury
### September 2018

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<td><strong>Oct 1 Progress Mtgs Groups A-C (1-2)</strong></td>
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### November 2018

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# TA Progress Meeting Schedule

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