MEDICAL BIOPHYSICS 3507G

1. Course Information

Course number: Medical Biophysics 3507G - Analysis of Oxygen Transport in Biological Systems

Year: Winter Term 2016

Biology is the study of all aspects of living organisms - their origin, history, physical characteristics, habits, etc. Obviously any biological study must begin with careful observations of the object or process under investigation. However biology does not consist solely of detailed descriptions of the results; once the measurements have been collected, one must interpret these results in an attempt to explain the biological process. Any good hypothesis must include the relevant basic physical laws, and, in many instances, a thorough understanding of these laws is needed to understand the biological process being studied.

The preface to a book entitled "The Pathways for Oxygen" by Ewald R. Weibel begins with the following statement:

"Unquestionably, most of the greatest advances in the understanding of living organisms have come through the thorough and imaginative work of investigators who acquired special skills with which to solve a problem at hand..."

In this course on Analysis of Oxygen Transport in Biological Systems we will draw upon skills you have already acquired in the disciplines of mathematics, chemistry, and physics in order to guide you towards solving problems involving oxygen diffusion and consumption in a variety of biological situations. These will include problems such as the challenge of supplying oxygen to the cornea when you wear contact lenses, how far oxygen can diffuse from capillaries into the surrounding tissue and how oxygen diffusion limits tumour growth. New concepts which may not be familiar to you will be developed gradually.

The appropriate analytical techniques (mainly, solving linear differential equations and graphical study of the solutions) will be taught and practice given. The course will also stress learning how to define the problem to be solved, how to develop an organized strategy for solving the problem, how to communicate to others the step by step processes you have used in reaching a solution and how to evaluate your solutions realistically in light of your practical knowledge of biology.

The course will have a special emphasis on teaching problem-solving skills. The course begins with in-class problem-solving tutorials and a problem solving team assignment. Since problem-solving is an important aspect of this course and these skills can only be learned by experience; attendance at these sessions is mandatory.

We look forward to having you with us in Medical Biophysics 3507G/Biophysics 9507.

Lectures:
Tuesday and Thursday 9:30 – 10:30 a.m. MSB 190

Laboratories:
Monday - 1:30 – 3:30 DSB 4006
Thursday - 2:30 – 4:30 DSB 4006
Requisites:
Prerequisite(s): One of Calculus 1000A/B or 1100A/B, plus one of Calculus 1301A/B or 1501A/B (or the former Calculus 050a/b plus one of 051a/b or 081a/b), or Applied Mathematics 1413 (or the former Applied Mathematics 026); 1.0 course from Physics 1020, 1024, 1028A/B, and 1029A/B, (or the former Physics 020, 022, 024, 025 or 028a/b and 029ab).

Open to second-year students with an overall average of at least 78% in first year.

Antirequisite(s): The former Medical Biophysics 3303E

“Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will 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.”

Extra information:
2 lecture hours, 2 tutorial hours, 0.5 course.

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.

Please contact the course instructor if you require material in an alternate format or if any other arrangements can 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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<thead>
<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. Christopher Ellis</td>
<td><a href="mailto:cgellis@uwo.ca">cgellis@uwo.ca</a></td>
<td>MSB 411</td>
<td>519-661-3100 or x83100</td>
<td>TBA</td>
</tr>
<tr>
<td>(Course Coordinator)</td>
<td></td>
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<tr>
<td>Dr. Dan Goldman</td>
<td><a href="mailto:dgoldma2@uwo.ca">dgoldma2@uwo.ca</a></td>
<td>NS 6</td>
<td>519-661-2111 x80213</td>
<td>TBA</td>
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<tr>
<td>Richard Sove (TA)</td>
<td><a href="mailto:rsove@uwo.ca">rsove@uwo.ca</a></td>
<td></td>
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<td>TBA</td>
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OWL:
Students with OWL issues should contact the ITS helpdesk
http://www.uwo.ca/its/helpdesk/index.html
3. Course Syllabus

**COURSE STRUCTURE:**
The course consists of 25 lectures and 8 problem assignments.
To assist you in grasping the course material we have formal laboratory/tutorial sessions, during which you can consult with the teaching assistant and with each other while working on the assignments or exercises. Some of the LAB sessions will involve the use of MATLAB to create basic computer models of oxygen transport. One section (002) is Mondays 1:30 to 3:30 pm, and the other (003) is Thursdays 2:30 to 4:30 which gives you protected time for consulting and doing much of the work, and you can count Biology 3507G as a laboratory course.

We have always encouraged students to study and work together, but you take total responsibility for ensuring that what you submit to be marked is your own work.

Note on Plagiarism: Students must write their essays, assignments and computer code on their own unless otherwise indicated by the instructor. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence” (see Scholastic Offence Policy in the Western Academic Calendar).

Your progress will be assessed chiefly by the assignments, a 50 minute in class Mid-Term Exam and the 3 hour April Term Exam. The format and style is similar for both exams. (Graduate students registered in Biophysics 9507 may be required to do different or extra assignments as appropriate to their strengths and special interests.)

**LECTURE OUTLINE 2014**

<table>
<thead>
<tr>
<th>Date</th>
<th>Section</th>
<th>Lecture Topic</th>
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<tbody>
<tr>
<td>Jan. 5</td>
<td>CGE</td>
<td>Introduction to Course and to Problem Solving</td>
</tr>
<tr>
<td>Jan. 7*</td>
<td>CGE</td>
<td>1st PS Tutorial: Solver/Listener: What is PS? Simple visual problem</td>
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<tr>
<td>Jan. 12</td>
<td>CGE</td>
<td>2nd PS Tutorial: Solver/Listener: Challenger Disaster</td>
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<tr>
<td>Jan. 14</td>
<td>CGE</td>
<td>Introduction to Oxygen Diffusion in Biology: Development of diffusion equations</td>
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<tr>
<td>Jan. 19</td>
<td>DG</td>
<td>Mass Balance and Geometry: Non-rigorous solution to specific cases</td>
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<tr>
<td>Jan. 21*</td>
<td>DG</td>
<td>Boundary Conditions: Solutions to specific cases</td>
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<tr>
<td>Jan. 26</td>
<td>DG</td>
<td>Boundary Conditions: Solutions to specific cases</td>
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<td>Jan. 28*</td>
<td>DG</td>
<td>Maximum Diffusion Distances in Different Geometries</td>
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<td>Feb. 2</td>
<td>DG</td>
<td>Diffusion through Multiple Layers: Cells in a culture dish</td>
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<tr>
<td>Feb. 4*</td>
<td>CGE</td>
<td>Cornea-Contact Lens: Physiology, how to develop a model</td>
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<tr>
<td>Feb. 9</td>
<td>CGE</td>
<td>Cornea-Contact Lens (cont’d): Solution to model and interpretation</td>
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12. Feb. 11  DG  Krogh Cylinder Model of Capillary: Physiology, how to develop a model

Reading Week February 15 – 19

13. Feb. 23*  DG  Krogh Cylinder Model (cont’d): Solution to model and interpretation

14. Feb. 25  DG  Mid-Term Review

15. Mar. 1  DG  In-Class Test (covering material up to and including Krogh Model)

16. Mar. 3  CGE  Multicellular Spheroid Tumor Model: Physiology, how to develop a model.

17. Mar. 8  CGE  Multicellular Spheroid Tumor Model (cont’d): Solution to model and interpretation

18. Mar. 10*  CGE  Mitochondria and Oxygen Sensors: comparison of models

19. Mar. 15  DG  Convective Transport of Oxygen, Oxygen carriers: hemoglobin and myoglobin

20. Mar. 11*  CGE  Unsteady State Problems - Analytic Solutions


23. Mar. 29  DG  Finite Difference Solution - How to Solve

24. Apr. 31  CGE  Problem Solving Specific to Course Material

DG

25. Apr. 5  Course Overview

WINTER TERM EXAMINATION PERIOD: April 9 - 28, 2016
The final examination is scheduled by the Registrar's Office.

4. Course Materials

There is no single text which suits us for most of the course. Course notes and lecture slides will be posted on OWL. On occasion material will be presented in class that does
not appear in the course notes or lecture slides; it is the student’s responsibility to be present in class to make notes on this material. There is one computer software package that you may wish to purchase: MATLAB student version. This software will be available on the student computers in the department.

5. Evaluation:

The final grade is made up of 20% for the problem assignments, 5% short quizzes, and 75% from the examinations. The final exam will cover all material taught in that term. Note: there will be an in-class test to prepare you for the final exam. If the mark from the in-class test is higher than the final exam mark, the examination mark will be weighted as 1/3 in-class test mark and 2/3 final exam mark. If the in-class test mark is less than the final exam mark, the examination mark will be the final exam mark. In the past students have been concerned that 75% of their course mark depends on the final exam. This is only the case where the final exam mark exceeds the in-class test mark and hence is to the student’s benefit. If the in-class test mark is higher, the final exam only counts towards 50% of the final mark.

6. Additional Information/Statements

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 .”

“Plagiarism: Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar).”

THE USE OF ELECTRONIC DEVICES
All cellular telephones and recording devices must be turned off during class time. In addition, while laptops are useful classroom tools, specifically for taking notes, using laptops and cellular telephones for personal enjoyment (i.e. Facebook, email, texting, twitter) during the class is unacceptable. Furthermore, usage of computers for purposes that are not related directly to class during class time (i.e. note taking) will result in restricting the use of computers in class. Finally, students are not permitted to record lectures using any electronic recording devices. Lectures are the intellectual property of the professor and unauthorized recording of lectures is considered an academic offence. Students who require assistance with note taking should consult the Student Development Centre.
Absence from course commitments

A. Absence for medical illness:

Information about “Accommodation for Medical Illness – Undergraduates: POLICY ON ACCOMMODATION FOR MEDICAL ILLNESS - UNDERGRADUATE STUDENTS” can be found in the Academic Handbook at http://www.uwo.ca/univsec/handbook/appeals/accommodation_medical.pdf

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

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

The Policy on Accommodation for Medical Illness is also available on the BMSUE secure site: www.uwo.ca/bmsc

B. Absence for non-medical reasons:

Non-medical absences from midterms, tutorials, laboratories, or late assignments, must be supported by appropriate documentation. Documentation must be submitted by the student directly to the appropriate Faculty Dean’s Office and not to the instructor. It will subsequently be the Dean’s Office that will determine if accommodation is warranted.

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://www3.registrar.uwo.ca/index.cfm

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

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

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