

MEDICAL BIOPHYSICS 3507G

1. Course Information

Course number: Medical Biophysics 3507G - Analysis of Oxygen Transport
Year: Winter Term 2016/2017

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..."

Learning Outcomes

Knowledge

In this course we will draw upon skills you have already acquired in the disciplines of biology, mathematics and physics in order to guide you towards solving problems involving oxygen diffusion and consumption in a variety of novel 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. With this knowledge of how to apply fundamental biophysical principles to model and understand complex biological problems *graduates of this course* will be prepared to imagine and generate novel solutions new unanswered questions in the future.

Literacies and Interdisciplinarity

By design, this is an interdisciplinary course that applies appropriate analytical and modelling techniques (mainly, solving linear differential equations and graphical analysis of solutions) to solve problems in biology. *Graduates of this course* will be able to apply appropriate terminology from these diverse disciplines.

Resilience and Life-long Learning

Graduates of this course will have a deep appreciation of how to apply problem solving skills in a real world setting which will contribute to the life-long learning in both academic and non-academic settings.

Critical Inquiry and Creative Thinking

Graduates of this course will know how to extract and define solvable problems from a mass of poorly structured information, and how to develop an organized strategy for exploring, planning and solving the problem while looking back to review whether the solution achieves the original goals.

Communication

Graduates of the course will recognize the importance of effective communication and be able to communicate to others in an effective way the step by step processes they used in reaching a solution and demonstrate how they evaluate their solutions realistically in light of their practical knowledge of biology.

Professionalism and Ethical Conduct

Graduates of the course will be to identify underlying assumptions and how those assumptions may impact the resulting solution to a problem. Through the team problem solving assignments, the graduates will develop critical aspects of professionalism and ethical conduct of shared responsibility and respective group interactions.

Lectures:

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

Laboratories:

Monday - 1:30 – 3:30 SH 1310

Thursday - 2:30 – 4:30 SH 1310

Requisites:

Prerequisite(s): One of [Calculus 1000A/B](#) or [1100A/B](#) plus one of [Calculus 1301A/B](#) or [1501A/B](#), or Applied Mathematics 1413; 1.0 course from Physics [1028A/B](#), [1301A/B](#), [1401A/B](#), [1501A/B](#) and 1029A/B, 1302A/B, 1402A/B, 1502A/B.

Open to second-year students with an overall average of at least 70% 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:

Per week 2 lecture hours, 2 tutorial hours.

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

Instructors	Email	Office	Phone	Office Hours
Dr. Christopher Ellis (Course Coordinator)	cgellis@uwo.ca	MSB 412	519-661-3100 or x83100	By appointment
Richard Sove (TA)	rsove@uwo.ca	MSB 411		By appointment

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 6 problem assignments (* denotes when assignments are posted).

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.

LECTURE OUTLINE 2017

1. Jan. 5 CE **Introduction to Course and to Problem Solving**
2. Jan. 10 CE **1st PS Tutorial: Solver/Listener: What is PS? Simple visual problem**
3. Jan. 12 CE **2nd PS Tutorial: Solver/Listener: Challenger Disaster**

4. Jan. 17* CE **Introduction to Oxygen Diffusion in Biology:** *Development of diffusion equations*
5. Jan. 19 CE **Introduction to Oxygen Carriers and Convective Transport of Oxygen**
6. Jan. 24 RS **Mass Balance and Geometry:** *Non-rigorous solution to specific cases*
7. Jan. 26 RS **Boundary Conditions:** *Solutions to specific cases*
8. Jan. 31 CE **Maximum Diffusion Distances in Different Geometries**
9. Feb. 2* RS **Interface Boundary Conditions**
10. Feb. 7 CE **Diffusion through Multiple Layers:** *Cells in a culture dish*
11. Feb. 9 CE **Cornea-Contact Lens:** *Physiology, how to develop a model*
12. Feb. 14* CE **Cornea-Contact Lens (cont'd):** *Solution to model and interpretation*
13. Feb. 16 CE **Mitochondria and Oxygen Sensors:** *comparison of models*

Reading Week February 20 – 24

14. Feb. 28 CE/RS **Mid-Term Review**
15. Mar. 2 CE **In-Class Test** *(covering material up to and including Krogh Model)*
16. Mar. 7 CE **Multicellular Spheroid Tumor Model:** *Physiology, how to develop a model.*
17. Mar. 9* CE **Multicellular Spheroid Tumor Model (cont'd):** *Solution to model and interpretation*
18. Mar. 14 CE **Krogh Cylinder Model:** *diffusion from capillary*
19. Mar 16 CE **Krogh Cylinder Model (cont'd):** *Solution to model and interpretation*
20. Mar. 21* RS **Two Dimensional Krogh Model with Convective Transport**
21. Mar. 23 RS **Unsteady State Problems - Analytic Solutions**
22. Mar. 28 RS **Unsteady State Problems - Analytic Solutions:** *Measuring Diffusion Coefficients*

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| 23. | Mar. 30* | RS | Computational Modeling - Finite Difference Approach |
| 24. | Apr. 4 | RS | Computational Modeling – Sample Problem |
| 25. | Apr. 6 | CE | Course Overview |

*WINTER TERM EXAMINATION PERIOD: April 9 - 30, 2017
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.

Late assignments will be deducted 10% per day.

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 instructor and unauthorized recording of lectures is considered an academic offence. Students who require assistance with note taking should consult the Student Development Centre.

Lecture notes and slides are the intellectual property of the course instructor who developed them and unauthorized submission of these documents to online learning platforms is prohibited.

EMAIL CORRESPONDENCE

For security reasons, emails will only be answered when they come from your official UWO email account. Please keep all correspondence professional and concise.

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:

Registrar 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/>