

Medical Biophysics
MEDBIO 4467/BIOPHYS 9567: Radiation Biology with Biomedical Applications

Course Syllabus for Winter 2025



Western University is committed to a **thriving campus**; therefore, your health and wellness matter to us! The following link provides information about the resources available on and off campus to support students: <https://www.uwo.ca/health/> Your course coordinator can also **guide you** to resources and/or services should you need them.

1. **Technical Requirements (Only if needed):**



Stable internet connection



Laptop or computer



Working microphone



Working webcam

2. **Important Dates:**



| Classes Begin | Reading Week | Classes End | Study day(s) | Exam Period |
|---------------|----------------|-------------|--------------|-------------|
| January 6 | February 15-23 | April 4 | April 5-6 | April 7-30 |

* January 14, 2025: Last day to drop a course without penalty

3. **Contact Information**



| Course Coordinator | Contact Information |
|--------------------|---------------------|
| | |

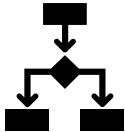
| Teaching Assistant | Contact Information |
|--------------------|---------------------|
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4. Course Description and Design

Delivery Mode: Online

This Web-based course consists of lecture slides with dubbed audio, 4 assignments, a mid-term exam of 2 hours, and a final exam of 3 hours. Opportunity for “live” interaction with the Instructor and Teaching Assistant will be provided through monthly scheduled tutorials. This course covers essential material for students in CAMPEP-accredited Medical Physics programs at the graduate or postgraduate levels. It is also required by medical postgraduate residency programs in radiation oncology and diagnostic imaging, including nuclear medicine.

The course describes the effects of ionizing radiation on living organisms, from cells to animals. The lectures begin with a brief physical description of the various types of ionizing radiation, the electromagnetic spectrum, and how radiation interacts with atoms. The early physical events produce ionizations and yield chemical radicals that can damage important biological molecules such as water and DNA, leading to either cellular repair or death. The course emphasizes radiation damage to cells and organs, with practical illustrations of applications to cancer radiotherapy. It also reviews the risk-benefit rationale used in government regulations for the controlled use of radiation in research and medicine.



Pre-or Corequisite(s): Medical Biophysics 3501F or the former Medical Biophysics 3302E; one of Medical Biophysics 3507G or Physics 2101A/B or 2102A/B, or the former Medical Biophysics 2128A/B and 2129A/B or the former Physics 2128A/B and 2129A/B; or permission of the instructor and Department.

All course material will be posted to [OWL Brightspace](#). Any changes will be indicated on the Brightspace site and discussed with the class.

If students need assistance, they can seek support on the [OWL Brightspace Help page](#). Alternatively, they can contact the [Western Technology Services Helpdesk](#). They can be contacted by phone at 519-661-3800 or ext. 83800.

[Google Chrome](#) or [Mozilla Firefox](#) are the preferred browsers to optimally use OWL Brightspace; update your browsers frequently. Students interested in evaluating their internet speed, please click [here](#).

5. Learning Outcomes

Upon successful completion of this course, students will be able to:



- Describe the various types of ionizing radiation.
- Define the radiation quantities (units) used in measurement/calculations of “dose”.
- Understand and sketch the interactions of radiation particles with atoms in tissue.
- Describe the physical-chemical events which follow an ionizing event, in terms of spatial distribution and time scale.
- Describe the biological impact on living cells and tissue at the DNA, cellular, organ, and whole animal levels.
- Predict the expected radiobiological outcome, when presented with the ambient conditions of irradiation (e.g. energy, dose, dose rate/fractionation, oxygen level, drugs).
- Describe applications of radiation in the research laboratory and to medicine, with emphasis on radiation oncology.
- Apply radiobiological principles and models to fractionated radiation therapy.
- Be aware of safety precautions when using radiation and be familiar with the government agencies related to the radiation exposure limits (in Canada) and the radiation protection philosophy (ALARA Principle).

6. Course Content and Schedule

Suggested Textbook: Radiobiology for the Radiologist, *E. Hall and A. Giaccia (7th edition matches slides)*



| Date(s) | Lecture | Topic | Textbook | Assessments |
|--------------------|---------|--|-------------------|-----------------------------------|
| | 1A, 1B | <p><u>Introduction and Learning Objectives</u></p> <ul style="list-style-type: none"> - Electromagnetic Spectrum - Ionizing Radiation - Basic Radiation Physics - Timing & Scale - Major Photon Interactions | 1 | |
| | 2A, 2B | <p><u>Particle Track Structure</u></p> <ul style="list-style-type: none"> - LET definition, RBE definition - Alternative Radiation Beams - Radiation Quantities and Units | 7 25,17 1 | |
| | 3A, 3B | <p><u>Radiation Chemistry</u></p> <ul style="list-style-type: none"> - Water Radiolysis - Radical Interactions - Oxygen Effect (OER) and Radiosensitizers - Radioprotectors (DMF) | 1 6 26 9 | ASSIGNMENT #1 RELEASED 4PM |
| TUTORIAL #1 | | | | |

| | | | | |
|-----------------------------------|-------------------|--|----------------------------------|-----------------------------------|
| | 4A, 4B | <u>DNA Damage and Repair</u> - Types of Radiation Damage - Chromosome Aberrations - Lethal and Non-Lethal Lesions - DSB and Lesion Yields - Basics of Carcinogenesis | 1 2 5 2,3 10,18 | |
| ASSIGNMENT #1 DEADLINE 4PM | | | | |
| | 5A, 5B | <u>Cell Survival Curves</u> - Experimental Technique - Dual Action Theory (Linear Quadratic) - Statistics of cellular "hits" - Mathematical Models | 3,19 | ASSIGNMENT #2 RELEASED 4PM |
| TUTORIAL #2 | | | | |
| | 6, 7A, 7B, 7C, 7D | <u>4R'S of Radiobiology</u> - Dose Rate Effects - Repair of Radiation Damage - Redistribution (cell cycle) - Repopulation of cells - Re-Oxygenation (OER) | 5 5 4 5,23 4,5,6 | |
| ASSIGNMENT #2 DEADLINE 4PM | | | | |
| Reading Week | | | | |
| MIDTERM EXAM | | | | |
| | 8 | <u>Radiation Therapy</u> - Early-Reacting Tissue (TCP) - Late-Reacting Tissue - Normal Tissue Response (NTCP) - Dose Fractionation/Rate (BED) | 23,19,21 23 19,20 22,23 | ASSIGNMENT #3 RELEASED 4PM |
| TUTORIAL #3 | | | | |
| | 9A, 9B | <u>Radiation Effects on Humans</u> - Acute Whole-Body Exposures - Stochastic and Non-Stochastic Effects - Carcinogenesis | 10,11 8,12,13 | |

| | | | | |
|--|-----------------------------------|---|----------------|-----------------------------------|
| | ASSIGNMENT #3 DEADLINE 4PM | | | |
| | 10 | <u>Radiation Protection</u> - Population Radiation Quantities - Background Radiation Levels - Diagnostic Imaging Risk and Benefit | 17 16 15 | ASSIGNMENT #4 RELEASED 4PM |
| | TUTORIAL #4 | | | |
| | 11, 12 | <u>Radiation Regulations</u> - Dose Limits and ALARA Principle | 16 17 | |
| | ASSIGNMENT #4 DEADLINE 4PM | | | |
| | CUMULATIVE FINAL EXAM | | | |

7. Participation and Engagement



- Students are expected to participate and engage with content as much as possible
- Students can also participate by interacting in the forums with their peers and instructors

8. Evaluation

Below is the evaluation breakdown for the course. Any deviations will be communicated.

| Assessment | Weighting (%) |
|-------------------|----------------------|
| Assignments (4) | 40 |
| Midterm Exam | 25 |
| Final Exam | 35 |



- All assignments are due at 4:00PM EST unless otherwise specified
- Students are responsible for ensuring that the correct file version is uploaded; incorrect submissions including corrupt files could be subject to late penalties (see below) or a 0
- Written assignments will be submitted to TAs via e-mail (statement in policies below)
- Rubrics will be used to evaluate assessments and will be posted with the instructions
- A student might not receive the same grade as their group members if it is determined that the distribution of work was not equal
- After an assessment is returned, students should wait 24 hours to digest feedback before contacting their evaluator; to ensure a timely response, reach out within 7 days
- Any grade appeals must be received within 3 weeks of the grade being posted.

Click [here](#) for a detailed and comprehensive set of policies and regulations concerning examinations and grading. The table below outlines the University-wide grade descriptors.

| | |
|----------|---|
| 90-100 | One could scarcely expect better from a student at this level |
| 80-89 | Superior work which is clearly above average |
| 70-79 | Good work, meeting all requirements, and eminently satisfactory |
| 60-69 | Competent work, meeting requirements |
| 50-59 | Fair work, minimally acceptable |
| below 50 | Fail |

Information about late or missed evaluations:

- Late assessments without accommodation will be subject to a late penalty 10%/day

INC (Incomplete Standing): If a student has been approved by the Academic Counselling Office (in consultation with the instructor/department) to complete term work at a later date, an INC will be assigned. Students with INC will have their course load in subsequent terms reduced to allow them to complete outstanding course work. Students may request permission from Academic Counselling to carry a full course load for the term the incomplete course work is scheduled.

9. Communication:



- Students should check the OWL Brightspace site every 24–48 hours
- Students should email their instructor(s) and teaching assistant(s) using email
- Emails will be monitored daily; students will receive a response in 48-72 hours
- This course will use class tutorial time for discussions

10. Office Hours:



- Office hours will be held in-person or remotely using Zoom
- Office hours will be booked
- Office hours will be individual or group (if needed)

11. Resources



- All resources will be posted in OWL Brightspace

12. Professionalism & Privacy:

Western students are expected to follow the [Student Code of Conduct](#). Additionally, the following expectations and professional conduct apply to this course:



- All course materials created by the instructor(s) are copyrighted and cannot be sold/shared (e.g., Must Knows Facebook group, Course Hero, Chegg, etc.)
- Recordings are not permitted (audio or video) without explicit permission
- Permitted recordings are not to be distributed
- Students will be expected to take an academic integrity pledge before some assessments

Western is committed to providing a learning and working environment that is free of harassment and discrimination. All **students**, staff, and faculty have a role in this commitment and have a responsibility to ensure and promote a safe and respectful learning and working environment. Relevant policies include Western's [Non-Discrimination/Harassment Policy](#) (M.A.P.P. 1.35) and [Non-Discrimination/Harassment Policy – Administrative Procedures](#) (M.A.P.P. 1.35).

Any **student**, staff, or faculty member who experiences or witnesses' behaviour that may be harassment or discrimination **must report the behaviour** to the Western's [Human Rights Office](#). Harassment and discrimination can be human rights-based, which is also known as EDI-based, (sexism, racism, transphobia, homophobia, islamophobia, xenophobia, antisemitism, and ableism) or non-human rights-based (personal harassment or workplace harassment).

13. How to Be Successful in this Class:

Students enrolled in this class should understand the level of autonomy and self-discipline required to be successful.



1. Invest in a planner or application to keep track of your courses. Populate all your deadlines at the start of the term and schedule your time throughout the course.
2. Make it a daily habit to log onto OWL Brightspace to ensure you have seen everything posted to help you succeed in this class.
3. Follow weekly checklists created on OWL Brightspace or create your own to help you stay on track.
4. Take notes as you go through the lesson material. Keeping handwritten notes or even notes on a regular Word document will help you learn more effectively than just reading or watching the videos.
5. Connect with others. Try forming an online study group and try meeting on a weekly basis for study and peer support.
6. Do not be afraid to ask questions. If you are struggling with a topic, check the online discussion boards or contact your instructor(s) and or teaching assistant(s).
7. Reward yourself for successes. It seems easier to motivate ourselves knowing that there is something waiting for us at the end of the task.

14. Western Academic Policies and Statements

Absence from Course Commitments

A. Absence for medical illness:

Students must familiarize themselves with the [Accommodation for Illness Policy](#).

A student seeking academic accommodation for any **work worth less than 10%** must contact the instructor or follow the appropriate Department or course specific instructions provided on the course outline. Instructors will use good judgment and ensure fair treatment for all students when considering these requests. You are not required to disclose details about your situation to your instructor; documentation is not required in this situation, and you should not send any pictures to your instructor.

If you are unable to meet a course requirement for any **work worth 10% or greater** due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Academic Counseling 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. Please note that the format of a make-up test, exam, or assignment is at the discretion of the course coordinator.

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

B. Absence for non-medical reasons:

Student absences might also be approved for non-medical reasons such as religious holidays and compassionate situations. Please review the policy on [Accommodation for Religious Holidays](#). All non-medical requests must be processed by Academic Counselling. Not all absences will be approved; pay attention to the academic calendar and final exam period when booking any trips.

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. To provide an opportunity for students to recover from the circumstances resulting in a Special Examination, the University has implemented Special Examinations dates. These dates as well as other important information about examinations and academic standing can be found [here](#).

Academic Offences

Scholastic offences are taken seriously, and students are directed [here](#) to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence.

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 Accessible Education (AE) at 661-2111 x 82147 for any specific question regarding an accommodation or review [The policy on Accommodation for Students with Disabilities](#)

Correspondence Statement

The centrally administered **e-mail account** provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at his/her official university address is attended to in a timely manner. You can read about the privacy and security of the UWO email accounts [here](#).

Discovery Credit Statement

Students are permitted to designate up to 1.0 Discovery Credit course (or equivalent) for pass/fail grading that can be counted toward the overall course credits required for their degree program. The details of this policy and the deadlines can be found [here](#).

15. BMSUE Academic Policies and Statements

Cell Phone and Electronic Device Policy (for in-person tests and exams)

The Schulich School of Medicine & Dentistry is committed to ensuring that testing and evaluation are undertaken fairly across all our departments and programs. For all tests and exams, it is the policy of the School that any electronic devices, i.e., cell phones, tablets, cameras, or iPod are strictly prohibited. These

devices **MUST** be left either at home or with the student's bag/jacket at the front of the room and **MUST NOT** be at the test/exam desk or in the individual's pocket. Any student found with one of these prohibited devices will receive a grade of zero on the test or exam. Non-programmable calculators are only allowed when indicated by the instructor. The program is not responsible for stolen/lost or broken devices.

Copyright and Audio/Video Recording 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. You must always ask permission to record another individual and you should never share or distribute recordings.

Rounding of Marks Statement

Across the Basic Medical Sciences Undergraduate Education programs, 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.

16. Support Services

The following links provide information about support services at Western University.

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at

https://www.uwo.ca/health/student_support/survivor_support/get-help.html.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

[Academic Counselling \(Science and Basic Medical Sciences\)](#)

[Appeal Procedures](#)

[Registrarial Services](#)

[Student Development Services](#)

[Student Health Services](#)