Course Outlines for Biophysics of Therapeutic Methods (Phys 395)

Course description

Here is the UW official calendar description:

The effect of radiation of various kinds on cells and tissues; elements of radiobiology and photobiology; molecular mechanisms of radiation-induced DNA damage and cell death, repair of radiation damage, dose-response relationships; tumor radiobiology and therapies, radiotherapy, photodynamic therapy, combination therapies; radiosensitizers and photosensitizers for cancer therapies; transdisciplinary advances in physical methods (ultrafast laser and ultrasound techniques) for biomedical applications. [Prereq: One of PHYS 112, 122, 125, ECE 106, (NE 122 and one of PHYS 112, 122, ECE 106); One of BIOL 112, 130, 139/239, CHEM 123, PHARM 141, PHYS 280/BIOL 280, PHYS 380; Level at least 3A Science, Mathematics or Engineering students ].

Here is an enhanced version:

This course is an introduction to biophysics of therapeutic methods and is intended to stimulate and educate students about the use of physical science methods (such as ionizing radiation and lasers) in biology and medicine. The course has been designed to follow the basic curriculum of a Medical Biophysics training program, including three major parts. Part I represents introductory radiation physics and radiation chemistry, including the types of radiation, fundamental interactions of radiation with matter, photochemistry and radiation chemistry. Part II is focused on radiation biology, including photochemistry and radiation chemistry of DNA, mechanisms of radiation-induced DNA damage; repair pathways of radiation damage to DNA, mechanisms of cell killing, and cell survival curves. Part III is devoted to radiation oncology, including radiobiology in radiation therapy, phototherapy, photodynamic therapy and photothermal therapy, combination therapies, and transdisciplinary advances in physical methods for biomedical applications, including femtomedicine and new frontiers in cancer research and cancer therapy.

The course will be delivered by lectures with chalkboard, PowerPoint, and group discussions (special topic seminars).

Lectures begin: January 7th, 2014 (last lecture April 3rd, 2014)
When: Tuesdays and Thursdays, 2:30-3:50 pm
Where: Physics 308

Course learning objectives

Students will gain insight to the importance of physical science methods in biology and medicine and issues associated with therapeutic methods. The course is intended to stimulate students who will be pursuing graduate studies and possibly future careers in radiology, nuclear medicine, oncology,
biophysics, and medical physicists. The students may also learn some materials suitable for the written examination for residents in diagnostic radiology and nuclear medicine and in radiation oncology.

Contact information

**Instructor:** Qing-Bin Lu  **Office:** Phys 376  **Ext:** 33503  **Email:** qblu@uwaterloo.ca

Office hours: 4:00-5:00 pm Tuesday, or by appointment.

Resources

Course Text (recommended):


Other Useful Texts:

- *Biomolecular Action of Ionizing Radiation* by S Lehnert (Taylor & Francis Ltd. 2007)

*Student assessment*

**Assignments:**

*Independent* work. Use (8.5 x11” paper), single-sided, stapled together with a cover sheet. The due date for submission of assignments is **one week**.

**Mid-term & Final Exam:**

Closed book midterm test and final exam, based on materials **covered in class** and problems related to assignments.

Date and Place: (check the appropriate UW websites).

Aids allowed: pocket calculator

**Marking Scheme:**

Assignments 20 marks; Midterm 20 marks; Group discussion 10 marks; Term paper (Essay) 10 marks, and final term 40 marks.

Course topics (week-by-week, approximately only)
Part 1: Radiation Physics and Chemistry (Week 1-4)

Week 1  Introduction; Types of Radiation: Nature and Properties; Radiation sources
Week 2  Radioactivity; Radiation terms and units; Interaction Processes of Radiation with matter (Absorption)
Week 3  Interaction Processes of Radiation with matter (Ionization); Deposition of Radiation Energy
Week 4  Photochemistry and Radiation Chemistry

Part II: Radiation Biology: Biological effects of radiation (Week 5-8)

Week 5  Photochemistry of DNA; Radiation Chemistry of DNA
Week 6  Mechanisms of DNA Damage; Repair of Radiation Damage to DNA
Week 7  Study Break (Feb 17-21)
Week 8  Midterm (Feb 25th); Mechanisms of cell killing; Cell survival curves

Part III: Radiation Oncology (Radiotherapy, Combination therapy & Femtomedicine) (Week 9-13)

Week 9  Radiobiology in radiation therapy
Week 10  Time, dose and fractionation in radiotherapy
Week 11  Phototherapy, Photodynamic therapy (PDT) and photothermal therapy
Week 12  The oxygen effects in Radiotherapy & PDT; Combination therapy
Week 13  Femtomedicine; New frontiers in cancer research and cancer therapy

Expectation of Academic Integrity

“To create and promote a culture of academic integrity, the behaviour of all members of the University of Waterloo should be based on honesty, trust, fairness, respect and responsibility.”

Avoidance of Academic Offenses. Students are expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for their actions. Students who are unsure whether an action constitutes an offense, or who need help in learning how to avoid offenses (e.g., plagiarism, cheating) or about “rules” for group work/collaboration should seek guidance from the course professor, TA, academic advisor, or the Undergraduate Associate Dean. For information on categories of offenses and types of penalties, students should refer to Policy #71, Student Academic Discipline, http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm . Students who believe that they have been wrongly or unjustly penalized have the right to grieve; refer to Policy #70, Student Grievance, http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm .”

Student Grievances

“Students who believe that they have been wrongfully or unjustly penalized have the right to grieve; refer to Policy #70, Student Grievance, http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm .”