Radiobiology and Radiation Safety: PHYS 565  
Fall 2015  
Schedule Number 22630  
COURSE INFORMATION

Class Days: Mondays and Wednesdays  
Class Times: 2:00 pm  
Class Location: P-245

Professor: M. Tambasco, Ph.D., MCCPM  
Contact Information: mtambasco@mail.sdsu.edu  
Office Hours Days: Mondays and Wednesdays  
Office Hours Times (and by appointment): 3:15-4:30  
Office Hours Location: P-139

Course Overview

Description from the Official Course Catalog:
Effects of ionizing radiation on physical and biological systems in medical imaging and radiation therapy, to include associated radiation safety precautions.

Description of the Purpose and Course Content:
This course covers the effects of ionizing radiation on physical and biological systems in the context of medical imaging and radiation therapy. Associated radiation safety precautions are also covered. The course will explore the biological impact of ionizing radiation on living tissue at the molecular, cellular, organ, and organism level. Hence, this course will provide you with the fundamental foundation for understanding the biological impact of radiation in radiotherapy and diagnostic x-ray imaging. It will also provide you with a means to assess the risk versus benefit of radiation use in medical procedures. The following course topics will be covered:

1. Review of Interaction of Radiation with Matter  
   (a) Types of radiation  
   (b) Mechanisms of radiation absorption  
   (c) Ionization density

2. Radiation Injury to DNA  
   (a) Radiation chemistry of water  
   (b) Structure of DNA and radiation-induced lesions

3. Repair of DNA Damage  
   (a) Excision repair  
   (b) Repair of double-strand breaks

4. Radiation-Induced Chromosome Damage and Repair  
   (a) Chromosome biology and aberrations  
   (b) Linear-quadratic model

5. Survival Curve Theory  
   (a) Target theory  
   (b) Survival curve models  
      i. Single-hit multitarget  
      ii. Linear-quadratic  
   (c) Cellular sensitivity  
      i. Single-hit multitarget  
      ii. Mechanisms of cell killing


7. Cellular Recovery Processes
(a) Types of radiation damage
(b) Potentially lethal and sublethal damage
(c) Fractionation effort
(d) Dose rate effects

8. Cell Cycle
   (a) Cell kinetics and cycle phases
   (b) Radiosensitivity and cell cycle position
   (c) Radiation effects on cell cycle

9. Modifiers of Radiation Response – Sensitizers and Protectors
   (a) Oxygen effect and other radiosensitizers
   (b) Radioprotection

10. RBE, OER, and LET
    (a) Linear energy transfer (LET)
    (b) Relative biological effectiveness (RBE)
    (c) Oxygen enhancement ratio (OER)

11. Cell Kinetics
    (a) The cell cycle and quantitation of its constituent parts
    (b) The growth fraction and cell loss from tumors
    (c) Autoradiography and flow cytometry
    (d) The growth kinetics of human tumors

12. Radiation Injury to Tissues
    (a) Tissue and organ anatomy
    (b) Expression and measurement of damage

13. Radiation Pathology – Acute and Late Effects
    (a) Acute and late responding normal tissues
    (b) Pathogenesis of acute and late effects
    (c) Different kinds of late responses
    (d) Residual damage/Radiation Syndromes/Clinical TBI (total body irradiation)

14. Radiation Protection

15. Doses & Risks

16. Shielding

**Student Learning Outcomes:**
Upon completion of this course the student should be able to:
- Describe the different types of radiation
- List the applications of radiation in research and medicine
- Define radiation quantities and units
- Describe and sketch interactions of x-rays with matter
- Describe the physical and chemical processes in terms of spatial and time scales involved following ionization
- Describe the biological impact of ionizing radiation on living tissue at the molecular, cellular, organ, and organism level
- Estimate the effects of energy, dose, dose rate, temperature, oxygenation, and certain drugs on radiobiological outcome
- List some government agencies and regulations related to radiation exposure limits and the radiation protection philosophy of ALARA
- Describe radiation safety precautions in research laboratories and hospitals
- Discuss the relative risk versus benefit of medical procedures involving radiation (e.g., x-ray imaging and radiotherapy)
Real Life Relevance:
The prevalence of radiation exposure from medical procedures (i.e., diagnostic imaging, radiation therapy, and nuclear medicine) and environmental sources (i.e., terrestrial and cosmic background) gives this course real life relevance.

Relation to Other Courses:
This course should be taken concurrently with Radiological Physics (PHYS 560). It is a core requirement for the CAMPEP Accredited M.S. Medical Physics Graduate Program, and complements other courses in the program that relate to medical uses of ionizing radiation.

Enrollment Information

Prerequisites:
Concurrent registration in Radiological Physics (PHYS 560), or consent from the instructor.

Adding/Dropping Procedures:
The course must be added before the end of the second week of the semester. Dropping procedures will follow the Physics Department guidelines.

Course Materials

Required Materials:

Recommended Materials:
http://www-pub.iaea.org/mtcd/publications/PubDetails.asp?pubId=8219

Lectures:
PDF versions of the PowerPoint lectures presented in class will be made available to the students on Blackboard.

Practice Multiple Choice Questions:
http://www.hep.lu.se/staff/c.jarlskog/hall/

Course Structure and Conduct

Style of the Course:
- Classes will take the form of a lecture and discussion of the material with the focus on understanding
- Students are expected to have reviewed all material before class and be capable of answering questions in class
- Technology Utilized in the Course: Blackboard

Course Assessment and Grading

Approximate Due Dates for Midterm and Final Exam:
- Midterm: 2nd week of October
- Final Exam: 2nd or 3rd week of December

Scored activities and weighting by percentage of total score:
- Attendance and Participation: 10%
- Midterm: 40%
- Final Examination: 50%

Grading Scale:
Students will be evaluated based on attendance and participation (10%), midterm (40%) and final examination (50%). The following grading scheme will be used:

- **A**: 90 – 100%
- **A-**: 80 – 89%
- **B+**: 76 – 79%
- **B**: 74 – 75%
- **B-**: 70 – 73%
- **C+**: 66 – 69%
- **C**: 64 – 65%
- **C-**: 60 – 63%
- **D+**: 56 – 59%
- **D**: 54 – 55%
- **D-**: 50 – 53%

**Excused Absence Make-up Policies:**
Students should have an extraordinary reason (e.g., illness, death in the family, etc.), with proof, to miss the midterm or final exam. A make-up for such a case will be arranged with the Professor.

**Other Course Policies**

- Students are expected to attend and participate in all classes, unless there is a valid reason to be absent. Assignments are due at the beginning of class on the due date. The use of electronic devices (e.g., cell phones, laptops, etc.) is not permitted during class time.

- If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact Student Disability Services at (619) 594-6473. To avoid any delay in the receipt of your accommodations, you should contact Student Disability Services as soon as possible. Please note that accommodations are not retroactive, and that I cannot provide accommodations based upon disability until I have received an accommodation letter from Student Disability Services. Your cooperation is appreciated.