UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
DEPARTMENT OF PHYSICS AND ASTRONOMY
COURSE OUTLINE

1. **Course:** MDPH 639 **Term**: Winter 2018

Instructor: Dr. Esmaeel Ghasroddashti | 1-403-388-6878 | 1A 135 JACC | esmaeel.ghasroddashti@ahs.ca | Office Hours: Flexible with appointment

Lecture Sections: T 1300-1430 and F 0830-1000

Course Website: d2l.ucalgary.ca

Departmental Office: ABE88Y, 403 521-3752

2. **Prerequisites:** MDPH 625.

3. **Grading:** The University policy on grading and related matters is described in sections F.1 and F.2 of the online University Calendar. In determining the overall grade in the course the following weights will be used:

☐ Attendance/Participation	5%
Quizzes (weekly)	10%
Assignments	25%
Project	15%
Exam I (Midterm: Over Radiobiology Part)	40%
Exam II Final Examination-Over Radiation Safety Part	25%
In-class exercises	15%

Percentage to letter grade conversion scale:

> = 95 %	A +	> = 80 %	B +	> = 65 %	C +	> = 50 %	D
> = 90 %	A	> = 75 %	B	> = 60 %	C	< 50 %	F
> = 85 %	A -	> = 70 %	B -	> = 55 %	C -		

Projects are to be both handed in and presented.
Assignments are composed of two major ones (on questions selected from the CCPM question bank), and a few small ones on class discussions.
Project and assignments are due on time as announced. Late assignments/projects will be considered only in well-documented emergencies (e.g. a doctor's note should be provided in case of illness); or a penalty will be applied.

4. **Missed Components of Term Work:** The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in Section 3.6. It is the student's responsibility to familiarize himself/herself with these regulations. See also Section E.6 of the University Calendar

5. **Scheduled out-of-class activities:** There are no scheduled activities outside of class time.

6. **Course Materials:** Textbook: Radiobiology for the Radiologist, 7th edition, Eric J. Hall and Amato J. Giaccia

7. **Examination Policy**: Exams will be closed book. No aids allowed. Students should also read the Calendar, Section G, on Examinations.

8. **Course fees:** none

9. **Writing across the curriculum:** In this course, the quality of the student's writing will be a factor in the evaluation of the works. See also Section E.2 of the University Calendar.

10. **Human studies statement**: Students in this course are not expected to participate as subjects or researchers. See also Section E.5 of the University Calendar.

11. OTHER IMPORTANT INFORMATION FOR STUDENTS:

(a) **Academic Misconduct:** Academic misconduct (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under Section K. Student Misconduct to inform yourself of definitions, processes and penalties.

(b) **Assembly Points:** In case of emergency during class time, be sure to FAMILIARIZE YOURSELF with the information on Assembly points.

(c) **Student Accommodations:** Students needing an Accommodation because of a Disability or medical condition should contact Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities available at http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities_0.pdf. Students needing an Accommodation in relation to their coursework or to fulfill requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, preferably in writing, to the Associate Head of the Department of Physics and Astronomy, Dr. Ann-Lise Norman, by email (alnorman@ucalgary.ca) or by phone (403.220.5405).

(d) **Safewalk:** Campus Security will escort individuals day or night (http://www.ucalgary.ca/security/safewalk/). Call 220-5333 for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.

(e) **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). As one consequence, students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information see also http://www.ucalgary.ca/secretariat/privacy.

(f) **Student Union Information:** VP Academic Phone: 220-3911 Email: suvpaca@ucagary.ca.
SU Faculty Rep: Phone: 220-3913;
Email: science1@su.ucalgary.ca, science2@su.ucalgary.ca and science3@su.ucalgary.ca
Student Ombuds Office: 403 220-6420
Email: ombuds@ucalgary.ca; http://ucalgary.ca/provost/students/ombuds

(g) **Internet and Electronic Device Information:** You can assume that in all classes that you attend, your cell phone should be turned off unless instructed otherwise. Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.

(h) **U.S.R.I.:** At the University of Calgary, feedback provided by students through the Universal Student Ratings of Instruction (USRI) survey provides valuable information to help with evaluating instruction, enhancing learning

and teaching, and selecting courses (www.ucalgary.ca/usri). Your responses make a difference - please participate in USRI Surveys.

12. OTHER COURSE RELATED INFORMATION:

(a) Course Description

Aims to explain Cell Kinetics, Cell Survival Curves, Radiation Pathology, Fractionation, Radiation Safety, Shielding Calculations.

(b) Course Learning Outcomes

At the end of the course, students should will have a clear mental picture of the interaction of ionizing radiation with living cells.

(c) Course Learning Incomes

This course will require a high-school level understanding of the nature of ionizing radiation, and some basic understanding of cancer formation.

(d) Syllabus

A. Topics Recommendations of AAPM REPORT NO. 197 for Radiobiology

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
6. Cell Death: Concepts of Cell Death (Apoptosis and Reproductive Cell Death)
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. Histopathology
   (a) General morphology of radiation injury
   (b) Morphology of cell death
   (c) Morphologic changes in irradiated tumors
15. Tumor Radiobiology
   (a) Basic tumor structure and physiology
   (b) Importance of hypoxic cells in tumors and importance of reoxygenation
16. Time, Dose, and Fractionation
   (a) The 4 R's of radiobiology
   (b) Volume effects
   (c) The basis of fractionation
   (d) Dose-response relationships for early and late responding normal tissues
   (e) Hyperfractionation and accelerated treatments
   (f) α/β Model
17. Radiation Genetics: Radiation Effects of Fertility and Mutagenesis
   (a) Target cells for infertility
   (b) Doses to result in temporary and permanent sterility
   (c) "Reverse-fractionation effect"
   (d) Mechanisms of mutation induction
   (e) Relative risk vs. absolute risk
   (f) Time course and latency period/Risks of cancer induction in different sites
18. Molecular Mechanisms
   (a) Molecular cloning techniques
   (b) Gene analyses
   (c) Oncogenes and tumor suppressor genes
19. Drug Radiation Interactions

B. Additional Radiobiology Topics

1. Effect of radiation on Fetus & Embryo
2. Exotic Radiation Modalities

C. Radiation Safety Topic

1. Introduction to radiation safety, dose limits, background radiation, interactions
2. Regulations and licensing
3. Instrumentation, radiation safety program, brachytherapy sources
4. Shielding and room design
5. Radiation safety lab (survey, stuck source emergency, brachytherapy)
6. Review, internal exposure, non-ionizing radiation

MDPH 639 Winter Term 2018				**Radiobiology and Radiation Safety Class Schedule**	
Week	**Lecture No**	**Day**	**Date**	**Chapter**	**Quiz**
1	1	Tue	9-Jan	Introduction + Chapter 1	
	2	Fri	12-Jan	Chapter 2	Quiz 1
2	3	Tue	16-Jan	Chapter 3	
	4	Fri	19-Jan	Chapter 4	Quiz 2
3	5	Tue	23-Jan	Chapter 5	
	6	Fri	26-Jan	Chapter 6	Quiz 3
4	7	Tue	30-Jan	Chapter 7	
	8	Fri	2-Feb	Chapter 8, 9	Quiz 4
5	9	Tue	6-Feb	Chapter 10	
	10	Fri	9-Feb	Chapter 12,13	Quiz 5
6	11	Tue	13-Feb	Chapter 19	
	12	Fri	16-Feb	Chapter 20	Quiz 6
7	-	Tue	20-Feb	Mid-Term Break	No Classes
	-	Fri	23-Feb	Mid-Term Break	No Classes
8	-	Tue	27-Feb	Presentations	Projects Due
	13	Fri	2-Mar	Chapter 22	
9	14	Tue	6-Mar	Chapter 23	Quiz 7
	15	Fri	9-Mar	Chapter 25	Assig-1 Due
10	16	Tue	13-Mar	Chapter 27	Quiz 8
	17	Fri	16-Mar	Chapter 28	
11	-	Tue	20-Mar	Prepare for Exam I	No Classes
	-	Fri	23-Mar	Exam I on Radiobiology	Exam I
12	18	Tue	27-Mar	Radiation Safety-1	
	19	Fri	30-Mar	Good Friday	No Classes
13	20	Tue	3-Apr	Radiation Safety-2	Quiz 9
	21	Fri	6-Apr	Radiation Safety-3	Assig-2 Due
14	-	Tue	10-Apr	Radiation Safety-4	
		Fri	13-Apr	Radiation Safety-5: RS LAB	LAB
15	-	Tue	17-Apr	Radiation Safety-6	Quiz 10
	-	Fri	20-Apr	Exam II on Radiation Safety	Exam II