

## MDPH 609 RADIATION BIOLOGY (2 credits) – Winter 2023

### Course description:

This course deals with the effects and mode of action of ionizing radiation on biological material from molecular interactions, through sub-cellular and cellular levels of organization, to the response of tissues, organs and the whole body. Includes the application of radiation biology to oncology and the biological aspects of environmental radiation exposure.

**Course Pre-Requisites:** Open to graduate students registered in Medical Physics or Biological & Biomedical Engineering at McGill. Instructor approval of the instructor is required for students not registered in these programs

**Instructor:** Prof. Norma Ybarra, PhD  
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**Location:** MUHC Glen Site, 1001 Decarie Boulevard (métro Vendôme)  
Room DS1.1427

**Course Schedule:** Tuesdays, 9:30 AM to 12:00 PM  
Starting January 10<sup>th</sup>, 2023.

### Reference texts:

1. Biomolecular Action of Ionizing Radiation, By Shirley Lehnert, Taylor and Francis Group.
2. Radiobiology for the Radiologist by Eric J Hall; Amato J Giaccia Wolters Kluwer Health/Lippincott Williams & Wilkins, [2012] ©2012.
3. Basic Clinical Radiobiology, 5th Edition, By M. Joiner and A. Van der Kogel.
4. Handbook of radiobiology, 2<sup>nd</sup> edition, by Kedar N Prasad, Boca Raton : CRC Press, [2020]

### Assessment:

Quizzes (weekly)	20%
Perusall (Material to read before class posted on my courses)	20%
Topic presentation (See page 3 for list of topics and instructions)	20%
Final exam	40%

**Health and Wellness Resources at McGill:** Student well-being is a priority for the University. All of our health and wellness resources have been integrated into a single Student Wellness Hub, your one-stop shop for everything related to your physical and mental health. If you need to access services or get more information, visit the Virtual Hub at [mcgill.ca/wellness-hub](http://mcgill.ca/wellness-hub) or drop by the Brown Student Services Building (downtown) or Centennial Centre (Macdonald Campus). Within your faculty, you can also connect with your Local Wellness Advisor (to make an appointment, visit [mcgill.ca/lwa](http://mcgill.ca/lwa)).

### Learning objectives:

By the end of this course, the student should be able to:

1. Explain basic concepts and principles of radiation biology
2. Understand the effects of ionizing radiation on DNA and the associated DNA damage response, with respect to their effects on cell survival.

3. Understand the biological effects of ionizing radiation at the cell, tissue, organ level as well as the whole body.
4. Understand basic concepts and principles of radiation therapy
5. Understand the relationship between the characteristics of the tumour microenvironment and the response of that tumour to irradiation.

**Expectations:**

- Students are responsible for their learning in this class.
- All course materials and key dates will be posted to MyCourses.
- I will provide some lectures to be read ahead of the sessions, and I will also provide the notes that will help you to prepare for the final exam. I will also give you a quiz before each class with questions from the previous class, the quizzes will be part of your final grade.
- Sessions will be held in-person and if need on Zoom (depending on the public health situation).

**Proposed outline of classes:**

<i>Week</i>	<i>Topic</i>	<i>Instructor</i>
1 January 10 <sup>th</sup> , 2023	- Review of basic cell biology (nucleus, membrane, cytoplasm, organelle) (Perusal). - History of radiation injuries in humans - Radiation interactions	Dr. Ybarra
2 January 17 <sup>th</sup> , 2023	- Indirect effects of radiation - Free radical formation	Dr. Ybarra
3 January 24 <sup>th</sup> , 2023	- Radiation injury to DNA - Repair of DNA damage - Chromosomal damage and repair	Dr. Ybarra
4 January 31 <sup>st</sup> , 2023	- Target theory and cell survival curves - History of linear no-threshold theory	Dr. Ybarra
5 February 7 <sup>th</sup> , 2023.	- Apoptosis, reproductive cell death - Cell kinetics - Cell recovery processes - Cell cycle sensitivity	Dr. Ybarra
6 February 14 <sup>th</sup> , 2023	- RBE, OER - Radioprotectors, radiosensitizers	Dr. Ybarra
7 February 21 <sup>st</sup> , 2023	- Tissue injuries - Acute effects of radiation - Delayed effects of radiation - Radiation carcinogenesis	Dr. Ybarra
8 March 7 <sup>th</sup> , 2023	- Radiation mutagenesis - Radiation teratogenesis - Other embryo/fetal effects	Dr. Ybarra
9 March 14 <sup>th</sup> , 2023	- Risk estimates of radiation - Predictions of cancers in populations - Radiation epidemiology - Evidence of cancers in populations	Dr. Ybarra
10 March 21 <sup>st</sup> ,	- Concept of radiation hormesis - Time, dose, fractionation	Dr. Ybarra

2023	- BED/EQD2 calculations, calculating the effects of treatment delays (Tpot, Tdelay)	
11 March 28 <sup>th</sup> , 2023	- Tumor Biology - Tumor radiobiology	Dr. Ybarra
12 April 4 <sup>th</sup> , 2023	- Molecular mechanisms - Drug/radiation interactions	Dr. Ybarra
13 April 11 <sup>th</sup> , 2023	- Student presentations	Dr. Ybarra
14 April 18 <sup>th</sup> , 2023 Proposed dated but TBD	Final exam	Dr. Ybarra

#### List of presentation topics:

1. Fetal exposure
2. Photodynamic therapy
3. Hyperthermia
4. High-intensity focused ultrasound HIFU
5. Particle therapy and High LET
6. Molecular imaging pre-clinical and clinical
7. Total body irradiation, clinical and not clinical, and acute and chronic radiation syndromes
8. Targeted therapies (small molecules and monoclonal antibodies)

The presentations will take place on the last class of this semester (April 12<sup>th</sup>), the time for each presentation will be 15-17 minutes. The presentations can be structures as follows:

- Definition (if applicable)
- Background
- Mechanism of action
- Applications
- Advantages
- Disadvantages

#### McGill Policies:

**1)** *"In accord with McGill University's [Charter of Student Rights](#), students in this course have the right to submit in English or in French any written work that is to be graded. This does not apply to courses in which acquiring proficiency in a language is one of the objectives." (Approved by Senate on 21 January 2009)*

*« Conformément à [la Charte des droits de l'étudiant](#) de l'Université McGill, chaque étudiant a le droit de soumettre en français ou en anglais tout travail écrit devant être noté, sauf dans le cas des cours dont l'un des objets est la maîtrise d'une langue. »*

**2)** *McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see [www.mcgill.ca/students/srr/honest/](http://www.mcgill.ca/students/srr/honest/)) for more information).*

## NOTES

- *Under extreme circumstances, the contents of this document can be modified at any time by the instructor to allow for adjustments in the course.*
- *Students are responsible for being aware of key dates and deadlines for the class and for the university, including deadlines for registration, course Add/Drop, and course withdrawal. Accommodations outside of these policies will only be supported in circumstances beyond the student's control.*