MDPH 609 Syllabus
(Winter 2021)

Course description: The course provides theoretical and practical understanding of the biological and physiological effects of ionizing radiation on human tissues from molecular and microscopic interactions, through sub-cellular and cellular levels of organization, to macroscopic response of tissues, organs and the whole body. It also covers topics related to the application of radiation biology to oncology radiology and resulting therapy regimens and safety policies.

Instructors: Dr. Piotr Pater, Dr. Norma Ybarra
Coordinator: Norma Ybarra

Class time: 9:30 to 12:00 AM Tuesdays (DS1.5034). Starting January 5th, 2021.

Evaluation:

Quizzes	30%
Topic presentation	20%
Final exam	50%

Syllabus (2 CR):

Week	*Topic*	*Instructor*
1 January 5th, 2021	- Review of basic cell biology (nucleus, membrane, cytoplasm, organelle). - Molecular genetics (DNA, RNA, proteins). - Genes, chromatin, chromosomes. - Cell cycle, cell kinetics, and cycle phases. - Radiosensitivity and cell cycle position - Radiation effects on cell cycle	Dr. Ybarra
2 January 12th, 2021	- Physico-chemical aspects of interaction of RT with cell (Direct and indirect effects, LET, RBE). - Free radical generation, oxidative stress, Radiation damage to biologically important macromolecules sp. DNA and cell membrane lipids. - Modes of DNA damage: Base damage, SSB, DSB, multiply damaged sites.	Dr. Ybarra
3 January 19th, 2021	- DNA damage response: DNA repair, cell cycle delay, apoptosis. - Modes of DNA repair: Base excision repair (BER), Homologous recombination (HR), Non-homologous endjoining (NHEJ. Chemical, biological and physical modifiers of radiation effect. - Oxygen effect and reoxygenation	Dr. Ybarra
4 January 26th, 2021	- Radiation-induced gene expression- molecular basis of normal tissue damage. Relation of chromosome damage to radiation-induced cell death. - Modes of Cell Death: Apoptosis, mitotic catastrophe, Cell cycle arrest (reproductive cell death) - Bystander effects	Dr. Ybarra

5 February 2nd, 2021.	- Tumour biology. Oncogenes and tumor-suppressor genes. - Tumor-specific architecture and metabolism in relation to radiation response and targeting for radiosensitization. - Radiation Carcinogenesis.	Dr. Ybarra
6 February 9th, 2021	- Tumour Radiobiology - Microenvironment (acute and chronic hypoxia, re-oxygenation, OER) - 4 Rs (repair, redistribution, repopulation, reoxygenation). Lethal and sublethal damage. - Molecular basis of tumour-specific radiosensitivity/resistance - Solid tumor assays - Cell and Tissue kinetics	Dr. Ybarra
7 February 16th, 2021	- Total body irradiation - Normal tissue radiobiology (cell death, acute and late responses). - Tissue tolerances and architecture. - Expression and measurement of damage - Acute and late responding normal tissues - Pathogenesis of acute and late effects - Different kinds of late responses - Residual damage/radiation syndromes/ clinical total body irradiation - General morphology of radiation injury - Morphology of cell death - Morphologic changes in irradiated tumors - Target cells for infertility - Doses to result in temporary and permanent sterility - Reverse fractionation effect - Mechanisms of mutation induction - Relative risk vs absolute risk - Time course and latency period/risks of cancer induction in different sites	Dr. Ybarra
8 February 23rd, 2021	- Cell and tissue kinetics - Cell and Tissue Survival Assays - Introduction to cell cultures (cell lines, media, incubation, passaging). - Cell cycle and quantitation of its constituent parts - Autoradiography and flow cytometry - General laboratory techniques of molecular biology (Gels, PCR, IHC). - Demonstration of radiation damage using fluorescent microscopy. Lab - Experimental RT models (mammalian and non-mammalian cell lines, small animals).	Dr. Ybarra
9 March 9th, 2021	- Drug radiation Interactions (chemo-radiation).	Dr. Ybarra

10 March 16th, 2021	- Models of cell survival - Survival curve theory (Target theory, Survival curve models, standard LQ). - α/β model - Volume effects - The basis of fractionation	Dr. Pater
11 March 23th, 2021	- Radiobiology of Brachytherapy	Dr Serban
12 March 30th, 2021	- Dose-response relationship for early and later responding normal tissues - Hyperfractionation and accelerated treatments - Time, Dose, Dose rate and Fractionation (standard, hyper-fractionation, hypo-fractionation, accelerated). - Therapeutic ratio - Dose-response relationship (TCP/NTCP). Fractionation design (BED, NTD, scheduling)	Dr. Pater
13 April 6th, 2021	- Student presentations	Dr. Ybarra
14 TBD	Final exam	Dr. Ybarra

List of presentation topics:

1. Radiosensitizers, radioprotectors
2. Targeted therapies and monoclonal antibodies
3. Radiation carcinogenesis and radiation protection
4. Heritable effects of radiation and radiation effects in the developing embryo and fetus
5. Molecular imaging
6. Photodynamic therapy
7. Hyperthermia
8. High-intensity focused ultrasound HIFU
9. Particle therapy

Definition:

- Ultrasound theory review
- HIFU Mechanism of Action
- Applications
- Advantages
- Disadvantages