EEM300 Biological Effects of Ionizing Radiation

1st and 2nd quarters, Junior

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Style of Class	Lecture
Number of Credits	2
Day and Period	To be advised

Course Description

The Fukushima Daiichi nuclear disaster has heightened public interest in the effects of radiation and radioactive materials on humans. We have witnessed, however, many cases of people believing in wrong information or having excessive fears about radiation because they cannot correctly understand or evaluate various information on the biological effects of radiation, having had no opportunities for learning about radiation and radioactive materials.

Thus, in Fukui Prefecture where 10 nuclear reactors are situated, it is vital not only for the residents of communities hosting those nuclear power plants but also for people living in a broader area of the prefecture to have a correct understanding of the essential properties of radiation and radioactive materials as well as the effects of radiation on life.

In this course, students will learn about the effects of ionizing radiation and radioactive materials on life at molecular, cellular and individual levels, toward the final goal of comprehensively understanding the relations between radiation and life phenomena. They will understand in particular about how radiation damages DNA and how it is repaired, cell death and mutation, stochastic effects and deterministic effects, the target theory and epidemiological surveys. Further, from the perspective of radiation protection, they will learn about the properties of ionizing radiation and radioactive materials and risks associated with them, understand the basic ideas of radiation protection and foundations essential for building and operating radiation protection systems.

Course Objectives

- To understand the properties of radiation and ponder upon the essential nature of the effects of radiation and radioactive materials on living organisms
- To understand the idea of radiation protection and investigate on the operation of radiation protection systems

Prerequisites

Students should desirably have completed a course in biology or concerning life science, while classes will be understandable also to those students who have not.

Class Materials

Textbook: not specified

Reference book:

(1) Yamaguchi Hikoyuki, *Hoshasen seibutsugaku* (Radiation Biology), Shokabo, 2005.

(2) Tadashi Tsujimoto and Tomoko Kusama, *Hoshasen bogo no kiso* (Fundamentals of radiation protection), Nikkan Kogyo Shimbunsha, 2001.

(3) Shibata Tokushi, *Hoshasen gairon* (Introduction to radiation), 8th edition, Tsusho Sangyo Kenkyusha, 2013.

Course Method

Classes will be conducted in a lecture format, showing charts and tables with a projector. The print of the most important charts of the day will be handed out in class. Each class will start with a practice to check that students have understood the previous class.

Evaluation/Assessment

Evaluation will be based on performance in in-class practice quizzes, the mid-term examination, the term-end examination and paper. A minimum attendance of 2/3 of the classes is required.

Grading

20% In-class practice quizzes
30% Mid-term examination
30% Term-end examination
20% Term-end paper

Course Schedule

Week 1: Basics of radiation (Measurement unit & concept of radiation dose)
Learn fundamental issues such as measurement units of radiation, the concept of radiation dose and essential knowledge in biology.

Week 2: Effects of radiation 1 (physical and chemical processes)
In weeks 2 and 3, students will learn how radiation affects living things. This session will be dedicated primarily to physical and chemical processes.

Week 3: Effects of radiation 2 (physical, chemical and biological processes)
Concerning the effects of radiation on life, this session will focus mainly on the effects on chemical and biological processes.

Week 4: DNA damage and repair
Learn about DNA damage, which is an initiation reaction as an effect of radiation on a living organism, and DNA repair.

Week 5: Apoptosis and mutation
Learn about cell death induced by a failure in DNA repair and mutation with reference to sample cases.

Week 6: Direct effects, indirect effects and bystander effects
The processes in which radiation induces a biological effect will be classified and their characteristics will be shown.

Week 7: Stochastic and deterministic effects
Sample cases of biological effects of radiation will be shown with their causes, characteristics and dose ranges.

Week 8: Target theory
Modelling and analysis of the biological effects of radiation will be performed using data from the study of actual cells.

Week 9: Epidemiological survey
Symptoms observed in populations exposed to radiation and their frequencies are analyzed.

Week 10: Mid-term examination
Students' comprehension of classes from week 1 to 9 is checked. Model answers will be shown within the class for review.

Week 11: Basics of radiation protection (history, purpose of protection, target classification, radiation dose measurement units etc.)
Learn about the history of radiation protection, purpose of radiation protection, the classification of radiation target groups and the systems of dose measurement used for radiation protection.

Week 12: Radiation measurement technologies
Lean about personal dosemeters and the measurement of gamma ray, beta ray and internal exposure.

Week 13: Standards and regulations concerning radiation protection
Learn about the classification and types of radiation protection standards, recommendations of international organizations and dose limits given by Japanese regulations concerning radiation protection.

Week 14: Nuclear/radiation facility accidents and emergency responses
Learn about nuclear/radiation facility accidents, exposure in accidents and protection philosophy and interventions against large-scale radiation accidents and nuclear disaster prevention in Japan with case studies.

Week 15: Regulations concerning radiation protection
Learn about the Atomic Energy Basic Law and regulations related to it and make a summary of the study about radiation protection.

Preparation and Follow-up

Preparation: Read the relevant chapters of the reference books (about 1 hour).
Follow-up: Review the class so as to become able to answer practice quizzes (about 1 hour)