IRAN UNIVERSITY OF MEDICAL SCIENCES

School of Pharmacy

Department of Medicinal Chemistry

Course title: **Radiopharmaceuticals**

Credit (Theory or Practical): 2 Credits (Theory)

Prerequisite: ---

Responsible Lecturer: Dr.Golsanamlu

Course Lecturers: Dr. Golsanamlu, Dr. Mokhtari, Dr. Mirfazli, Dr. Azizian

Field of Study: Master of Pharmacy (M.Pharm)

Course Instructor Information

Academic Rank: **Assistant Professor**

Field of Specialization: Medicinal Chemistry

Workplace: Faculty of Pharmacy

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Course Description:

- Course objectives (Competency):

This course provides a comprehensive overview of the principles, production, quality control, and clinical applications of radiopharmaceuticals. Satisfactory completion of this course will provide students with a basic understanding of the core concepts and foundations of radioactivity, such as atomic structure, nuclear forces, and types of radionuclide decay (including alpha decay, neutron decay, positron emission, gamma emission, X-ray emission, etc.). It integrates fundamental concepts in nuclear physics, radiation biology, radiochemistry, and nuclear medicine imaging. Emphasis is placed on both diagnostic and therapeutic radiopharmaceuticals, radiation safety, and contrast agents. Upon completion, students will be able to understand and evaluate the use of radioactive materials in biological and medical settings.

-Specific Objectives (Core Competency):

- Explain the fundamentals of nuclear physics, including atomic structure, nuclear forces, stability, models, and the classification of nuclides.

- Describe the different modes of radioactive decay (alpha, beta, gamma, electron capture, isomeric transition), the associated phenomenon of internal conversion, and apply the decay law to calculate half-life and activity.

- Analyze the principles and methods of radionuclide production, including the concepts of activity, activity concentration, and specific activity.

- Explain the production and unique characteristics of positron emitters, including the annihilation phenomenon, and contrast the effects of Compton scattering and pair production.

- Describe the structure, design, and diagnostic applications of radiopharmaceuticals, highlighting the key differences between radiopharmaceuticals and conventional drugs.

- Compare and contrast the imaging techniques of Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT) in the context of radiopharmaceuticals.

- Evaluate the methods for controlling the physicochemical and biological properties of radiopharmaceuticals, with a focus on identifying radiochemical impurities.

- Explain the general methods for radiolabeling, with a specific focus on the process of radiolabeling with Technetium-99m and Iodine radioisotopes.

- Apply the principles of radiation safety, including calculations for intensity, exposure, equivalent dose, and effective dose, and summarize the biological effects of radiation.

- Introduce the purpose, types, and characteristics of contrast media pharmaceuticals, with a detailed look at iodinated contrast media. Describe the principles and applications of contrast agents used in ultrasound and Magnetic Resonance Imaging (MRI).

Educational Approach:

Virtual approach □ In-person approach ■ Blended approach □

Teaching-Learning Methods (according to the chosen educational approach):

-Interactive Lecture (Q&A, Quizzes, Group Discussion, etc.)
-Problem-Based Learning (PBL)

Radiopharmaceuticals Course Plan (M-Pharm) - 2026

Wednesday – 8-10

	Subject	Teaching-Learning method	Lecturer	Date
1	**Fundamentals of nuclear physics** -Atomic structure, nuclear forces, nuclear stability, and models, isotopes, ….	Interactive Lecture	Dr. Golsanamlu	**Feb 25** (Esfand 6)
2	**Modes of decay** -Alpha decay, Beta decay, Gamma decay -Electrone-capture, isomeric transition, internal conversion electrons	Interactive Lecture Problem-Based Learning	Dr. Golsanamlu	**March 4** (Esfand 13)
3	**Production of radionuclide (1)** -Basic equations in radionuclide production -Radionuclide production methods	Interactive Lecture Problem-Based Learning	Dr. Golsanamlu	**March 18** (Esfand 27)
4	**Production of radionuclide (2)** -Thermal neutron capture and fission reactions -Generator systems, Ionizing radiations	Interactive Lecture Problem-Based Learning	Dr. Golsanamlu	**April 8** (Farvardin 19)
5	**Positron Emitters** -Annihilation phenomenon -positron-emitting radionuclides -Compton and pair production effects	Interactive Lecture	Dr. Golsanamlu	**April 15** (Farvardin 26)
Midterm Exam				**April 22** (Ordibehesht 2)
6	**Radiopharmaceutical (1)** -Structure and design, the difference between radiopharmaceuticals and conventional drugs	Interactive Lecture	Dr. Mokhtari	**April 22** (Ordibehesht 2)
7	**Radiopharmaceutical (2)** -Imaging: PET, SPECT	Interactive Lecture	Dr. Mokhtari	**April 29** (Ordibehesht 9)
8	**Control of physicochemical and biological properties** -Quality control of radiopharmaceuticals -Radiochemical impurities	Interactive Lecture	Dr. Mirfazli	**May 6** (Ordibehesht 16)
9	**Labeling** -Labeling methods -Radiolabeling with Technetium-99m	Interactive Lecture	Dr. Mirfazli	**May 13** (Ordibehesht 23)
10	**Labeling** -Radiolabeling with Iodine radioisotopes	Interactive Lecture	Dr. Mirfazli	**May 20** (Ordibehesht 30)
11	**Radiation safety** -Radiation Protection, intensity, exposure, rate, equivalent dose, effective dose -Biological effects of radiation	Interactive Lecture Problem-Based Learning	Dr. Mokhtari	**May 27** (Khordad 6)
12	**Contrast media pharmaceuticals (1)** -Introduction of contrast media -Iodinated contrast media	Interactive Lecture	Dr. Azizian	**June 10** (Khordad 20)
13	**Contrast media pharmaceuticals (2)** -Ultrasound contrast agents - MRI contrast agents	Interactive Lecture	Dr. Azizian	**June 17** (Khordad 27)

Student responsibilities:

-The set of activities that the student is obligated to complete in this course are as follows:

Regular class attendance

Participating in class discussions

Submit the assigned project by the specified date

Participating in teaching and problem-solving

Taking the midterm exams

Taking the final exam

Note: Attendance is mandatory for all students. The absence hours of a student should not exceed 4/17 in theoretical, 2/17 in practical, and laboratorial. Otherwise, the score for that course or section will be considered as zero. Allowed absences are accepted, provided that students bring in the documents for that and the relevant professor approves them. Acting against absences (either excused or not) will be the decision of the professor and the agreement of the college.

Note: All students in the course must submit the assignments specified by the instructors (project, report preparation, exercise solutions, etc.) by the stipulated deadline.

Student Assessment Method:

Type of assessment mentioned: Formative and summative assessment (question and answer each session, class quizzes, midterm exam, and final exam).

Grading contribution of the course instructors:

Professors	Class Activity	Midterm Exam	Final Exam	Sum
Dr Golsanamlu	0.8	7	-	7.8
Dr. Mirfazli	0.6	-	4	4.6
Dr Mokhtari	0.6	-	4	4.6
Dr. Azizian	0.3	-	2.7	3

References:

- Sampson's Textbook of Radio Pharmacy, The last edition
- Essentials of Nuclear Medicine Imaging. Mettler JRFA, The last edition
- Principle of Nuclear Radiation Detection. Eichhola GG, The last edition

- Radiopharmaceuticals in Nuclear Pharmacy and Nuclear Medicine, Kowalsky RJ, The last edition
- Radiochemistry, Keller C, The last edition
- Introductory Nuclear Physics. Krane KS, The last edition