RAD-540: RADIOBIOLOGY

Effective Term
Fall 2024

BOT Approval Date
12/14/2023

Discipline
RAD - Radiologic Technology

Course Number
540

Course Title
Radiobiology

Short Title
Radiobiology

Credit Status (CB 04)
D - Credit - Degree applicable

Units

Lecture Units
2.00

Total Units
2.00

Hours

Lecture Contact Hours
32-36

Out of Class Hours Lecture
64-72

Total Contact Hours
32 - 36

Total Out of Class Hours
64 - 72

Total Student Learning Hours
96 - 108

Distance Education
No

Catalog Description
This course is designed to provide the principles of radiation interaction with cells, tissues, and the body as a whole. Factors affecting biological responses are presented, including early and late effects of radiation exposure. The principles of radiation protection along with the responsibilities of the radiographer for patients, personnel, and the public is included.

Attach Supporting Documents
ASRT 2022 radiography curriculum guide.pdf
JRCERT 2021 Radiography Standards pg 28.pdf

Attach Supporting Documents
LMI.pdf

Requisites

Pre or corequisite(s)

Prerequisite or corequisite(s) (must be taken simultaneously if not taken before)
RAD-510 (with a grade of C or better)
and RAD-515 (with a grade of C or better).

Codes

TOP Code (CB 03)
1225.00* - *Radiologic Technology

CIP Code
51.0911 - Radiologic Technology/Science - Radiographer.

Student Accountability Model (SAM) Priority Code (CB 09)
C - Clearly Occupational

Noncredit Category (CB 22)
Y - Credit Course

Repeatability Code
No

Grading Option
Letter grade OR P/NP

Minimum Qualifications

Minimum Qualifications	And/Or
Radiological Technology	End

CSU Area(s)

IGETC Area(s)

Learning Objectives

Learning Objectives

Learning Objective
1. Analyze the human cell in terms of function, proliferation, mitosis, and meiosis.
2. Evaluate the radiosensitivity of tissues and organs.
3. Compare the physical and biological factors that affect radiation response.
4. Differentiate how the radiation dose-response relationships affect patient exposure.
5. State the Law of Bergonie and Tribondeau.
6. Compare the effects of in vitro and in vivo irradiation of macromolecules.
7. Examine the principles of target theory.
8. Compare and contrast the acute and late effects of radiation exposure.
9. Formulate the dose limits for radiation workers and the public.
10. Inspect the radiation protection features of the radiographic and fluoroscopic imaging systems.

11. Examine the various factors influencing patient radiation dose and strategies for addressing the concerns of a diverse patient population regarding exposure, considering differences in race, culture, gender, and disabilities..
12. Understand the principles of radiation exposure to the fetus.

Learning Outcome Information

Course Learning Outcomes

Learning Outcome
1. Students will analyze biological responses after exposure to radiation and formulate the most appropriate methods to protect the patient and radiographer.
2. Students will identify the radiation dose needed to produce stochastic effects.
3. Students will list the risks of low-dose radiation on fertility and pregnancy.

Program Learning Outcomes

Learning Outcome
Apply positioning skills in all required radiographic examinations.
Select appropriate technical factors for radiographic examinations.
Practice radiation protection for all radiographic examinations.
Employ proper patient care techniques and effectively provide care for patients from diverse groups/populations.
Demonstrate oral and written communication skills.
Relate to and anticipate the needs of the doctors and technologists.
Adjust to changes, situations, patient conditions, updated evidence-based practice, and deviation from the normal routine.
Demonstrate knowledge of ethical requirements for an entry level radiographer along with ethical practices in a healthcare setting.
Understand professional obligations upon gaining the ARRT status.

Institutional Learning Outcomes

Aesthetic Awareness: The student will identify and evaluate how aesthetic expression leads to an appreciation of social and cultural context as well as the values of art and nature.
Communication: The student will effectively express and exchange ideas through listening, speaking, reading, writing, visual works, and other modes of interpersonal expression.
Critical Thinking: The student will analyze problems, gather and synthesize relevant information, evaluate ideas, information, and evaluate alternative points of view to create, innovate and implement effective solutions.
Cultural Awareness and Humility: The student will demonstrate knowledge of and sensitivity toward individuals of diverse ethnicity, age, gender, sexual orientation, and religious affiliations, as well as toward those individuals with diverse abilities and socio-economic classes to respectfully interact with individuals of diverse perspectives, beliefs and values while being mindful of the limitation of their own cultural frameworks.
Information and Technology Literacy: The student will access, interpret, evaluate, and apply relevant information sources and digital media effectively, and in an ethical and legal manner.
Scientific Awareness: The student will apply the scientific method of inquiry to assess potential solutions for real-life challenges by employing science-based knowledge and methodologies in daily life.
Social Awareness: The student will recognize and analyze the interconnectedness of global, national, and local concerns, analyzing cultural, political, social, and environmental issues from multiple perspectives and appreciate similarities and differences among cultures.
Civic
Personal
and Professional Responsibility

Content

Course Lecture Content

1. Human biology
   a. Human radiation response
   b. Composition of the body
   c. Cell theory
   d. The human cell
   e. Tissues and organs

2. Fundamental principles of radiobiology
    a. Law of Bergonie and Tribondeau
    b. Physical factors that affect radiosensitivity
    c. Biologic factors that affect radiosensitivity
    d. Radiation dose-response relationships
3. Molecular and cellular radiobiology
    a. Irradiation of macromolecules
    b. Direct and indirect effects
    c. Target theory
    d. Cell survival kinetics
    e. Cell cycle effects
    f. Linear energy transfer, relative biologic effectiveness, oxygen enhancement ratio
4. Early effect of radiation
    a. Acute radiation lethality
    b. Local tissue damage
    c. Hematologic effects
    d. Cytogenetic effects
5. Late effects of radiation
    a. Local tissue effects
    b. Life span shortening
    c. Risk estimates
    d. Radiation induced malignancy
    e. Radiation and pregnancy
6. Health Physics
    a. Radiation and health
    b. Cardinal principles of radiation protection
    c. Effective dose
    d. Radiologic terrorism
7. Designing for radiation protection
    a. Radiographic protection features
    b. Fluoroscopic protection features
    c. Design of protective barriers
    d. Radiation detection and measurement
8. Patient radiation dose management
    a. Patient dose descriptions
    b. Reduction of unnecessary patient dose
    c. Pregnant patients
    d. Patient dose trends
    e. Patient communication and addressing fears
        i. Gender considerations
        ii. Race, culture considerations
        iii. Patients with disabilities considerations
9. Occupation radiation dose management
    a. Occupational radiation exposure
    b. Radiation dose limits
    c. Reduction of occupational radiation exposure
    d. Pregnant radiographers

Methods of Instruction

Method

Lecture

Integration

The lecture will serve as an informative session on the impact of radiation on the human body and the establishment of dose limits for radiation protection. It will encompass both stochastic and deterministic effects, providing students with a comprehensive understanding of radiation health physics. This knowledge will be conveyed through a well-structured PowerPoint presentations.

Method

Reading

Integration

Students are expected to independently complete the assigned reading materials. These readings will be supplemented with classroom discussions aimed at fostering the essential critical thinking abilities that radiographers require to ensure the safety of both themselves and their patients by minimizing unnecessary radiation exposure. The course will cover material from Chapters 29 to 40 of the S. Bushong textbook. Topics within these chapters encompass molecular and cellular radiobiology, deterministic and stochastic radiation effects, health physics, and the management of radiation doses for patients and occupational workers.

Method

Discussion

Integration

Classroom discussions play a pivotal role in nurturing the essential critical thinking skills required for radiographers to safeguard both themselves and their patients from avoidable radiation exposure. These discussions will delve into the crucial concept of radiological protection known as "as low as reasonably achievable" (ALARA), enlightening students about the potential harm radiation can inflict on the human body. Additionally, these conversations will facilitate a deeper understanding of the impact of radiation on biological tissues, further solidifying the students' grasp of the fundamental principles of radiation protection.

Method

In-class Exercises

Integration

In-class exercises provide an opportunity for students to determine their understanding of the lectre material. An example of in-class exercises would include the topic of exploring radiation effects on biological tissues. Students can conduct a brief research on the different types of radiation that affect biological tissue using the internet, textbook, and class notes. The students can discuss and anayze the effects of radiation exposure on a human body focusing on acute and long-term symptoms. Students may also have an in-class exercise exploring the effects of ionizing radiation and discuss preventive measures. In-class exercises not only allows students to gauge their understanding of radiation's impact on biological tissues bt also promotes research skills, collaborative learning, and critical thinking. It encourages active participation and facilitates a comprehensive understanding of the topic.

Method

Film/video Viewing and Discussion

Integration

To enhance the lecture material, students will have access to a selection of YouTube videos. One such video, titled "Basic Radiation Protection and Radiobiology" and presented by Christy Foster, will be recommended for viewing. Following this, students will engage in a discussion led by the instructor. During this discussion, the instructor will use verbal questions to stimulate active participation and exploration of the topic. Specifically, the focus will be on understanding how radiographers can minimize radiation exposure to patients by adjusting various exposure factors, thereby influencing the types of radiation interactions that occur.

Methods of Evaluation

Method

Exams/Tests

Integration

Examinations and tests will be utilized as assessment tools to measure students' understanding of various aspects related to radiation, including its impact on different cell types within the body, strategies to mitigate radiation exposure during imaging procedures, prescribed dose limits for different anatomical regions, and the various types of interactions that occur with X-rays.

Additionally, these assessments will evaluate students' proficiency in safeguarding both pregnant patients and pregnant individuals employed in the radiologic field.

These examinations will primarily consist of multiple-choice questions, aiming to effectively prepare students for the American Registry of Radiologic Technologists exam, which also employs a multiple-choice format for assessment. Grading will be determined based on the accuracy and correctness of the responses provided by students.

Method

Homework

Integration

Homework questions serve as a valuable tool for reinforcing the content covered during lectures and gauging students' comprehension of radiobiology concepts. It offers an opportunity to assess whether students have grasped the subject matter effectively.

Instructors can craft review questions based on the lecture material, such as identifying the prescribed dose limits for various body parts, to evaluate the students' ability to recall these limits accurately. Additionally, questions related to radiation interactions and patient exposure can be provided by the instructor to serve as study guides, aiding students in their learning process.

To facilitate this, students can take these questions home, allowing them ample time to contemplate and formulate their responses. Alternatively, as an interactive option, homework can be completed in class within small groups, promoting discussion and interaction among students. This collaborative approach not only enhances understanding but also encourages peer-to-peer learning and engagement with the material.
Homework assignments can be assessed based on their accuracy and completeness.

Method

Papers

Integration

Written papers offer students the chance to develop strategies and techniques aimed at minimizing radiation exposure for both healthcare workers and patients during radiography procedures. The three fundamental principles of radiation protection—time, distance, and shielding—will be adapted based on the specific radiological procedure and the patient's level of cooperation.
Papers will be 3-4 pages in length and will be assessed based on the inclusion of pertinent sources, accuracy of the information, quality of content, and grammar.

Assignments

Assignment Type

Reading

In-class and/or outside of class

Outside of class

Formative or Summative

Formative

Assignment

In preparation for our upcoming class discussion, read Chapter 39 titled "Patient Radiation Dose Management" in the required textbook. Your active participation in our forthcoming classroom conversations is highly encouraged, as we will be exploring a diverse array of topics.

During our discussion, we will delve into several areas, including:

Methods of Patient Radiation Dose Reporting: We will explore various ways in which patient radiation dose can be reported, emphasizing the importance of accurate measurement and communication.

As Low As Reasonably Achievable (ALARA) Principles: We will discuss how ALARA principles can be applied to minimize radiation exposure for patients, considering both the benefits and risks of diagnostic and therapeutic procedures.

Factors Influencing Radiation Dose: We will analyze the factors that affect radiation dose, considering variables such as patient characteristics, equipment settings, and procedural variations.

Management Protocols for Pregnant Patients: We will review procedures and guidelines for managing radiation exposure in pregnant patients, prioritizing their safety and that of their unborn children.

Utilization of Gonadal Shielding: We will explore the appropriate use of gonadal shielding and its effectiveness in reducing radiation exposure in specific scenarios.

In addition to these topics, we will also address the crucial matter of addressing a diverse patient population's concerns regarding radiation exposure. This includes considerations related to gender identities, race, culture, and patients with disabilities. We will engage in an inclusive dialogue on how to effectively communicate with and accommodate the unique needs and concerns of various patient groups.

While reading Chapter 39, please make diligent notes on key concepts, any questions that arise, or any areas of confusion. These notes will serve as valuable reference points during our in-class discussions.

If you encounter challenging or unclear content while reading, compile a list of questions or topics that you would like to explore further during our next class session. Your active engagement and understanding of these topics will greatly enrich our classroom experience, fostering a productive and engaging learning environment for all. Your participation in the discussion and accuracy of information will be used to determine the grade for this assignment.

Assignment Type

Writing

In-class and/or outside of class

Outside of class

Formative or Summative

Summative

Assignment

Write a comprehensive analysis of the biological effects of ionizing radiation, encompassing deterministic and stochastic effects, while highlighting the short-term and long-term consequences of radiation exposure. Include in this analysis the difference between deterministic and stochastic effects with examples of each, cell recovery and the dose-rate effect, radiation levels for short and long term effects with examples of each, and how ALARA (As Low As Reasonably Achievable) impacts radiographic imaging of patients.

The paper should be a minimum of 4 pages, not including the title page and references.
Use clear and concise language. Avoid unnecessary jargon.
Proofread for clarity and grammar.
Utilize diagrams, charts, or relevant images to enhance explanations. Label them appropriately and refer to them in the text.
Follow a consistent citation style (e.g., APA, MLA) for in-text citations and the References section.
Include a title page with the paper's title, your name, date, and course information.
Use section headings and subheadings to organize your paper logically.
Ensure a logical flow of ideas from one section to another.
Cite credible sources such as peer-reviewed journals, books, and government reports to support your information.
The grade for this assignment will be determined on following the instructions for this paper along with the accuracy of the information presented.

Assignment Type

Writing

In-class and/or outside of class

In-class

Formative or Summative

Summative

Assignment

Working in small groups, assess your understanding of occupational dose management for female radiographers. This assignment aims to enhance your knowledge of radiation safety measures specific to female radiographers and their importance in the workplace.
In your groups, discuss and list factors that contribute to the occupational radiation dose for female radiographers. Consider physical differences, work environments, and the types of procedures they perform. Each group should identify and describe at least three specific radiation protection measures that can be taken by female radiographers to minimize their exposure. Discuss about the importance of proper lead shielding and maintaining a safe distance from the radiation source. Indicate the dose limits for the fetus during pregnancy and explain the dose monitoring and tracking for the radiographer.

Summarize the key takeaways from your discussion, emphasizing the importance of radiation safety for female radiographers in the workplace. Each student will write a brief reflection on what they have learned from this discussion and how they can apply these principles to their future careers in radiography.

Be prepared to answer questions and engage in a class-wide discussion on the topic.
Your understanding of occupational dose management for female radiographers will be assessed based on the quality of your group's discussion and the clarity of your individual reflections. Active participation in the group discussion and the ability to apply concepts to real-life scenarios will also be considered in the assessment.

Course Materials

Textbooks

Bushong, S., (2021) Radiologic Science for Technologists: Physics, Biology, and Protection, 12th Ed., Elsevier. ISBN#: 978-0323661348

Class Size Information

Class Size

40

Class Size Category

A - Lecture/discussion 40

Diversity and Inclusion

Explain how diversity and inclusion(e.g., gender, culture/race, sexuality, etc.) is infused into the course.

The content of this course highlights and analyzes the effect of x-ray interaction on the human body. Students are required to protect their patients from unnecessary radiation when performing imaging procedures. Understanding that some patients may have a fear of radiation, it is the role of the radiographer to alleviate these fears so the patient may receive a proper care based on the radiographic diagnosis. Students will learn how to communicate effectively with a patient population that is diverse in race, culture, and ethnicity, and disabilities along with patients who may have preconceived ideas and fears of the effects of radiation from their procedure.

Describe how assignments, instruction, evaluation, course content, and interactions are contextualized for diverse learners promoting an equitable course.

Lecture material is presented in various formats including direct instruction, group discussions, in-class assignments, and audio visual recordings that addresses various learning styles. Students will work in small groups to complete assignments. This methodology is aimed at allowing students to interact and to connect personally and culturally with the material presented in the course.

Interactions

Explain how the course will incorporate student-to-student interaction.

In-class assignments related to the biological effects of ionizing radiation and radiation protection practices will be completed by students in small groups. These assignments will foster discussions on topics such as how radiographers safeguard themselves and their patients against undue radiation exposure, the radiological protection principle of "as low as reasonably achievable," and the examination of radiation's impact on biological tissues. These discussions will enhance student interaction with one another.

Explain how the course will incorporate instructor-to-student interaction.

The instructor actively participates in classroom discussions, providing insights and facilitating conversations on the research paper topic related to radiobiology and radiation protection. Instructors also engage in face-to-face lectures, where students can ask questions and seek clarification. Real-life experience stories are incorporated into these lectures to enhance student learning.

Explain how the course will incorporate student-to-content interaction.

This course has a detailed textbook which supports the lecture material. Students are encouraged to engage with the course material by reading the textbook, watching instructional videos on radiation interactions, and actively participating in assignments and discussions.

Explain how the course will incorporate student-to-self interaction (metacognitive).

This course empowers students to contemplate their role in producing high quality radiographic images with minimal radiation exposure, prioritizing both their own well-being and that of the patient, in order to facilitate diagnostic interpretations by radiologists. Throughout the course, students will gain insights into the impact of radiation on biological tissue and acquire strategies to minimize radiation dosage for both themselves and their patients. Additionally, they will grasp the significance of their contributions to the overall recovery and health of the diverse population of patients they image.

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