BIO-2200: RADIOBIOLOGY

Cuyahoga Community College

Viewing:BIO-2200 : Radiobiology
Board of Trustees:
2014-05-29

Academic Term:
2014-08-25

Subject Code
BIO - Biology

Course Number:
2200

Title:
Radiobiology

Catalog Description:
Theories of the biological effects of ionizing radiation, quantities and units of measurement, proper protective measures for patient and personnel, effective dose equivalents radiation absorption processes and shielding, exposure monitoring devices.

Credit Hour(s):
2

Lecture Hour(s):
2

Lab Hour(s):
0

Other Hour(s):
0

Requisites
Prerequisite and Corequisite
BIO-1221 Anatomy and Physiology for Diagnostic Medical Imaging, and departmental approval: admission to Radiography Program.

I. ACADEMIC CREDIT

Academic Credit According to the Ohio Department of Higher Education, one (1) semester hour of college credit will be awarded for each lecture hour. Students will be expected to work on out-of-class assignments on a regular basis which, over the length of the course, would normally average two hours of out-of-class study for each hour of formal class activity. For laboratory hours, one (1) credit shall be awarded for a minimum of three laboratory hours in a standard week for which little or no out-of-class study is required since three hours will be in the lab (i.e. Laboratory 03 hours). Whereas, one (1) credit shall be awarded for a minimum of two laboratory hours in a standard week, if supplemented by out-of-class assignments which would normally average one hour of out-of-class study preparing for or following up the laboratory experience (i.e. Laboratory 02 hours). Credit is also awarded for other hours such as directed practice, practicum, cooperative work experience, and field experience. The number of hours required to receive credit is listed under Other Hours on the syllabus. The number of credit hours for lecture, lab and other hours are listed at the beginning of the syllabus. Make sure you can prioritize your time accordingly. Proper planning, prioritization and dedication will enhance your success in this course.

The standard expectation for an online course is that you will spend 3 hours per week for each credit hour.

II. ACCESSIBILITY STATEMENT

If you need any special course adaptations or accommodations because of a documented disability, please notify your instructor within a reasonable length of time, preferably the first week of the term with formal notice of that need (i.e. an official letter from the Student Accessibility Services (SAS) office). Accommodations will not be made retroactively.
For specific information pertaining to ADA accommodation, please contact your campus SAS office or visit online at http://www.tri-c.edu/accessprograms/. Blackboard accessibility information is available at http://access.blackboard.com.

III. ATTENDANCE TRACKING

Regular class attendance is expected. Tri-C is required by law to verify the enrollment of students who participate in federal Title IV student aid programs and/or who receive educational benefits through other funding sources. Eligibility for federal student financial aid is based in part on enrollment status.

Students who do not attend classes for the entire term are required to withdraw from the course(s). Additionally, students who withdraw from a course or stop attending class without officially withdrawing may be required to return all or a portion of their financial aid based on the date of last attendance. Students who do not attend the full session are responsible for withdrawing from the course(s).

Tri-C is responsible for identifying students who have not attended a course before financial aid funds can be applied to students’ accounts.

Therefore, attendance is recorded in the following ways:

• For in-person and blended-learning courses, students are required to attend the course by the 15th day of the semester (or equivalent for terms shorter than five weeks) to be considered attending. Students who have not met all attendance requirements for in-person and blended courses, as described herein, within the first two weeks or equivalent, will be considered not attending.

• For online courses, students are required to login at least two times per week and submit one assignment per week for the first two weeks of the semester, or equivalent to the 15th day of the term. Students who have not met all attendance requirements for online courses, as described herein, within the first two weeks or equivalent, will be considered not attending.

At the conclusion of the first two weeks of a semester or equivalent, instructors report any registered students who have “Never Attended” a course. Those students will be administratively withdrawn from that course. However, after the time period in the previous paragraphs, if a student stops attending a class or wants or needs to withdraw, for any reason, it is the student’s responsibility to take action to withdraw from the course. Students must complete and submit the appropriate Tri-C form by the established withdrawal deadline.

Tri-C is required to ensure that students receive financial aid only for courses that they attend and complete. Students reported for not attending at least one of their registered courses will have all financial aid funds held until confirmation of attendance in registered courses has been verified. Students who fail to complete at least one course may be required to repay all or a portion of their federal financial aid funds and may be ineligible to receive future federal financial aid awards. Students who withdraw from classes prior to completing more than 60 percent of their enrolled class time may be subject to the required federal refund policy.

If illness or emergency should necessitate a brief absence from class, students should confer with instructors upon their return.

Students having problems with coursework due to a prolonged absence should confer with the instructor or a counselor.

IV. LEARNING OUTCOMES ASSESSMENT

Occasionally, in addition to submitting assignments to their instructors for evaluation and a grade, students will also be asked to submit completed assignments, called ‘artifacts,’ for assessment of course and program outcomes and the College’s Essential Learning Outcomes (ELOs). The artifacts will be submitted in Blackboard or a similar technology. The level of mastery of the outcome demonstrated by the artifact DOES NOT affect the student’s grade or academic record in any way. However, some instructors require that students submit their artifact before receiving their final grade. Some artifacts will be randomly selected for assessment, which will help determine improvements and support needed to further student success. If you have any questions, please feel free to speak with your instructor or contact the Learning Outcomes Assessment office.

V. CONCEALED CARRY STATEMENT

College policy prohibits the possession of weapons on college property by students, faculty and staff, unless specifically approved in advance as a job-related requirement (i.e., Tri-C campus police officers) or, in accordance with Ohio law, secured in a parked vehicle in a designated parking area only by an individual in possession of a valid conceal carry permit.

As a Tri-C student, your behavior on campus must comply with the student code of conduct which is available on page 29 within the Tri-C student handbook, available at http://www.tri-c.edu/student-resources/documents/studenthandbook.pdf. You must also comply with the College’s Zero Tolerance for Violence on College Property available at http://www.tri-c.edu/policies-and-procedures/documents/3354-1-20-10-zero-tolerance-for-violence-policy.pdf

Outcomes
Course Outcome(s):
Apply knowledge of the units, detection and measurement of all forms of ionizing radiation.
Objective(s):
1. Comprehend the need for radiation protection.
2. Relate radiation exposure to quantities and units.
3. Identify methods of detection and detection devices.

Course Outcome(s):
Apply knowledge of the interaction of radiation with living systems from molecules, cells, tissues and the body as a whole.

Objective(s):
1. Compare the different types of photon interactions.
2. Compare the different types of radiation.
3. Evaluate the biophysical events and relate them to the causes of biologic damage.
4. Analyze radiosensitivity and radioresistancy.
5. Describe the somatic and genetic effects.
6. Explain the effects of irradiation on human tissues.

Course Outcome(s):
Understand the operation and principles of equipment used with radiation.

Objective(s):
1. Identify and display the appropriate use of image receptors.
2. Apply grid methodology.
3. Differentiate between digital, conventional and fluoroscopic radiation events or effects and relate them to the cause of biologic damage.

Course Outcome(s):
Apply knowledge of the principles of radiation protection, including the responsibilities of the radiographer, radiation safety officer and radiation health agencies.

Essential Learning Outcome Mapping:
Civic Responsibility: Analyze the results of actions and inactions with the likely effects on the larger local and/or global communities.

Objective(s):
1. Describe the operation and principles of personnel monitoring and personnel monitoring devices.
2. Describe the regulatory/advisory agencies and their recommendations and regulations regarding radiation exposures.
3. Apply the as low as reasonably achievable (ALARA) concept for radiation workers and the general public.

Methods of Evaluation:
1. Examinations
2. Quizzes
3. Essay papers
4. Oral presentations
5. Workbook assignments
6. Weekly discussion presentations

Course Content Outline:
1. Cell biology
   a. Cellular structure
   b. Cellular function
   c. Cell proliferation
2. Radiation production and characteristics
   a. Types of ionizing radiation
      i. Electromagnetic radiation
         1. X-rays
         2. Gamma rays
      ii. Particulate radiation
         1. Alpha
         2. Beta
a. Negatron
b. Positron
3. Neutrons
4. Protons

iii. Radioactivity
1. Radioactive decay
   a. Alpha emission
   b. Beta emission
   c. Gamma emission
2. Half-life \( (T_{1/2}) \)

iv. Sources of medical radiation exposure
1. Diagnostic radiology
2. Dental radiology
3. Cardiovascular-interventional radiology
4. Nuclear medicine
5. Radiation oncology

v. Transmission of photons
1. Attenuated radiation
2. Exit/remnant radiation

vi. Unmodified scattering (coherent, classical, Rayleigh, Thompson)

vii. Photoelectric effect
1. Description of interaction
2. Relation to atomic number
3. Energy of incident photon and resulting product
4. Probability of occurrence
   a. Atomic number
   b. Photon energy
   c. Part density
5. Application

viii. Modified scattering (Compton’s)
1. Description of interaction
2. Relation of electron density
3. Energy
4. Probability of occurrence

ix. Pair production

x. Photodisintegration

3. Attenuation by various tissues
   a. Thickness by body part (density)
   b. Type of tissue (atomic number)

4. Biological aspects of radiation
   a. Radiosensitivity and response
      i. Molecular effects of radiation
         1. Direct effect
            i. Target theory
               i. Target molecules
               ii. Cell death
         2. Indirect effect
            a. Radiolysis of water
      ii. Factors affecting energy transfer
         1. Linear energy transfer (LET)
         2. Relative biological effectiveness (RBE)
         3. Factors influencing RBE
            a. LET
               b. Oxygen effect
      iii. Law of Bergonie and Tribondeau
         1. Differentiation
         2. Mitotic rate
         3. Metabolic rate
      iv. Cell survival and recovery
1. Factors affecting survival
   a. Linear energy transfer (LET)
   b. Oxygen enhancement ratio (OER)
   c. Fractionation
   d. Protraction
2. Lethal dose (100/60, 10/30, 50/30, 50/60)
3. Radiation dose response relationships/curves
   1. Linear, nonthreshold
   2. Nonlinear, nonthreshold
   3. Linear, threshold
   4. Nonlinear, threshold
b. Somatic effects
   i. Short-term
   ii. Long-term effects
   iii. Stochastic (probabilistic) effects
   iv. Nonstochastic (deterministic) effects
   v. Carcinogenesis
c. Systemic response to radiation
   i. Hemopoietic
   ii. Integumentary
   iii. Digestive
   iv. Urinary
   v. Respiratory
   vi. Reproductive
   vii. Muscle
   viii. Nervous
   ix. Other
d. Total body irradiation
   i. Acute Radiation Syndromes
      1. Central Nervous System
      2. Hemopoietic
      3. Gastrointestinal
      4. Cutaneous
   ii. Stages of response and dose levels
   iii. Factors that influence response
e. Embryonic and fetal effects
f. Genetic effects
   i. Genetic significant dose
   ii. Mutagenesis
   iii. Goals of gonadal shielding
5. Minimizing exposure
a. Exposure factors
   i. Kilovoltage peak (KVp)
   ii. Milliamp seconds (mAs)
b. Shielding
   i. Rationale for use
   ii. Types
   iii. Placement
c. Beam-limiting devices
   i. Purpose of primary beam limitation
   ii. Types (e.g. collimators)
d. Filtration
   i. Effect on skin and organ exposure
   ii. Effect on average beam energy
   iii. National Council on Radiation Protections & Measurements (NCRP) recommendations (NCRP #102, minimum filtration in useful beam)
e. Exposure reduction
   i. Patient positioning
   ii. Automatic exposure control (AEC)
iii. Patient communication
iv. Image receptor system/digital imaging
v. Pediatric dose reduction
vi. As low as reasonably achievable (ALARA)
  1. Time-distance-shielding
f. Image receptors (e.g. types, relative speed, digital versus film)
g. Grids
h. Fluoroscopy
  i. Pulsed
  ii. Exposure factors
  iii. Grids
iv. Positioning
  v. Fluoroscopy time
vi. Automatic brightness control (ABC)
vii. Image intensifier positioning
viii. Magnification mode
ix. Kerma display
x. Last image hold

6. Personnel protection
a. Sources of radiation
  i. Natural
  ii. Man-made (artificial)
b. Sources of radiation exposure
  i. Primary x-ray beam
  ii. Secondary radiation
    1. Scatter
    2. Leakage
  iii. Patient as source
c. Cardinal principles of radiation protection
  i. Time
  ii. Distance
  iii. Shielding
d. Radiation detectors
  i. Area monitors
  ii. Personal detectors
e. Requirements for personnel monitoring
  i. Deep dose equivalents (DDE)
  ii. Shallow dose equivalents (SDE)
  iii. Eye dose equivalents (EDE)
  iv. Total effective dose equivalents (TEDE)
f. Protective devices
  i. Types
  ii. Attenuation properties
  iii. Minimum lead equivalent (NCRP #102)
g. Regulatory agencies
  i. Nuclear Regulatory Commission (NRC)
  ii. Food and Drug Administration (FDA)
  iii. Environmental Protection Agency (EPA)
iv. Occupational Safety and Health Administration (OSHA)
v. State agencies
h. Advisory agencies
  i. International Council on Radiation Protection and Measurement (ICRP)
  ii. National Council on Radiation Protection and Measurement (NCRP)
  iii. Biologic Effects on Ionizing Radiation (BEIR)
i. Regulations and recommendations
  i. Current NRC recommendations and/or regulations
  ii. Current NCRP recommendations and/or regulations
  iii. Applicable state regulations
v. CARE
vi. Public awareness
   1. Background equivalent radiation time (BERT)
   2. Social marketing (Image Gently, Image Wisely)

j. Radiation safety officer
   i. Requirements
   ii. Responsibilities

k. Special considerations
   i. Portable (mobile) units
   ii. Fluoroscopy
      1. Protective drapes
      2. Protective bucky slot cover
      3. Cumulative timer
   iii. CT immobilization devices
      1. Straps
      2. Head holders
      3. IV arm boards

iv. Design of a radiologic facility
   1. Materials
   2. Primary barrier
   3. Secondary barrier
   4. Half-value layer (HVL) and tenth-value layer (TVL)
   5. Factors
      a. Use (U) controlled and uncontrolled
      b. Workload (W)
      c. Occupancy (T)
      d. Distance (D)
   6. X-ray and ancillary equipment
      a. Beam-limiting devices
      b. Exposure control devices
      c. On and off switches
      d. Interlocks
      e. Visual/audio monitors
      f. Emergency controls
      g. Quality control
         i. Calibration
         ii. Standards

v. Guidelines for fluoroscopy and portable units (NCRP #102-21 CFR)
   1. Fluoroscopy exposure rates
   2. Exposure switch guidelines

vi. Emergency procedures

7. Radiation exposure and monitoring
   a. Objectives of a radiation protection program
      i. Documentation
      ii. Occupational and nonoccupational dose limits
      iii. ALARA concept (optimization)
      iv. Comparable risk
      v. Negligible individual dose (NID)
   b. Legal and ethical responsibilities
   c. Units of measurement
      i. Absorbed Dose
         1. Gray (Gy) (Rad)
      ii. Dose Equivalent
         1. Sievert (Sv) (Rem)
      iii. Exposure
         1. Coulomb/kilogram (C/kg) Roentgen (R)
   iv. Kerma
1. Kinetic energy release in matter
2. Measurement unit in the gray
3. Dose Area Product (DAP) meter

v. Measurement units in CT
1. CT dose index (CTDI)
2. Multiple scan average dose (MSAD)
3. Dose length product (DLP)

vi. Radioactivity
1. Becquerel (Bq)
2. Curie (Ci)

d. Methods and types of personnel monitors
i. Film badge
ii. Thermoluminescent dosimeter (TLD)
   1. Body badge
   2. Ring badge
iii. Optically stimulated luminescent dosimeter (OSLD)

e. NCRP recommendations for personnel monitoring (NRP #116)
   i. Occupational exposure
   ii. Public exposure
   iii. Embryo/fetus exposure
   iv. ALARA and dose equivalent limits
   v. Evaluation and maintenance of personnel dosimetry records

f. Dose reporting
   i. NCR Regulations (10 Code of Federal Regulations [CFR]) Part 20 Standards for Radiation Protection
   ii. NCRP guidelines
      1. Dose quantities
         a. Effective dose (E)
         b. Collective effective dose (S)
         c. Average effective dose to an individual in a group exposed to a specific source (EExp)
         d. Effective dose per individual in the U.S. population whether exposed to the specific source or not (EUS)

g. Medical exposure of patients (NCRP #160)
   i. Typical effective dose per exam
   ii. Comparison of typical doses by modality

Resources


Resources Other
2. University of Michigan Radiation and Health Physics http://www.umich.edu/~radinfo/