JEFFERSON COLLEGE

COURSE SYLLABUS

RAD155

Radiographic Biology

3 Credit Hours

Revised by: Janet E. Akers BS RT (R)(M)
Date: September 30, 2013

Kenny Wilson, Director, Health Occupation Programs
Dena McCaffrey, Dean, Career & Technical Education
RAD155 Radiographic Biology

I. CATALOGUE DESCRIPTION

A. Prerequisites: Acceptance to Radiologic Technology Program, Reading Proficiency

B. Credit hour award: 3

C. Description: This course will provide an overview of the principles of the interaction of radiation on the human body. Radiation effects on molecules, organisms, and factors affecting biological response, and acute and chronic effects of radiation are discussed. This course will also review radiation protection measures. (F)

II. EXPECTED LEARNING OUTCOMES/CORRESPONDING ASSESSMENT MEASURES

<table>
<thead>
<tr>
<th>Expected Learning Outcomes</th>
<th>Assessment Measures</th>
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<tbody>
<tr>
<td>Distinguish the fundamental principles of radiobiology on the human body.</td>
<td>Class Discussion/Activity</td>
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<td>Written Examinations</td>
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<td>Written Assignments</td>
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<tr>
<td>Specify the natural sources of radiation exposure and the means for protection.</td>
<td>Class Discussion/Activity</td>
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<td>Written Examinations</td>
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<td>Evaluate the radiation effects on DNA.</td>
<td>Class Discussion/Activity</td>
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<td>Written Examinations</td>
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<td>Written Assignments</td>
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<tr>
<td>Correlate the Law of Bergonie and Tribondeau and the physical and biological factors.</td>
<td>Class Discussion/Activity</td>
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<td>Written Examinations</td>
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<td>Written Assignments</td>
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<td>Determine the fetal, early and late systemic effects of radiation sensitivity.</td>
<td>Class Discussion/Activity</td>
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<td>Written Examinations</td>
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<td>Written Assignments</td>
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III. OUTLINE OF TOPICS

A. Introduction to Radiobiology
   1. Definition of radiobiology
   2. Importance of and necessity for medical radiobiology in today’s world
B. Radiation Protection Review
1. Radiation Units
   i. Roentgen – Coulomb/kilogram
   ii. Rad – Gray
   iii. Rem – Sievert
   iv. Curie – Bacquerel
2. Radiation Sources
   i. Natural Background
      1. Radon
      2. Cosmic
      3. Terrestrial
      4. Internal
   ii. Man Made
      1. Medical x-rays
      2. Nuclear Medicine
      3. Other
3. Absorbed Dose Equivalent and MPD (maximum permissible dose)
4. NCRP Report #91 (1987)
5. Organ Dose Limits
6. Review of Radiation Protection Methods
   i. Time
   ii. Distance
   iii. Shielding
   iv. 10 Day Rule
C. Human Biology
1. Seven Structural Levels
   i. Atomic/Molecular
   ii. Organelle
   iii. Cellular
   iv. Tissue
   v. Organ
   vi. Organ System
   vii. Organism
2. Molecular Composition
3. Macromolecular Composition
   i. Proteins
   ii. Lipids
   iii. Carbohydrates
   iv. Nucleic Acids
      1. DNA
      2. Messenger RNA
      3. Transfer RNA
      4. Ribosomal RNA
4. Cellular Structure
   i. Nucleus and Cytoplasm
   ii. Cell and Nuclear Membrane
iii. Mitochondria
iv. Endoplasmic Reticulum
   1. Rough
   2. Smooth
v. Ribosomes
   1. Attached
   2. Free Floating
vi. Lysosomes

5. Cell Growth
   i. Cell Cycle
   ii. Protein Synthesis
   iii. DNA Synthesis
   iv. Mitosis
   v. Meiosis

6. Tissue & Organ Radiosensitivity

D. Fundamental Principles of Radiobiology
   1. Law of Bergonie and Tribondeau
   2. Physical Factors Effecting Radiosensitivity
      i. Linear Energy Transfer (LET)
      ii. Relative Biological Effect (RBE)
      iii. Fractionation & Protraction
   3. Biological Factors Effecting Radiosensitivity
      i. Oxygen Enhancement Ratio (OER)
      ii. Age
      iii. Gender
      iv. Recovery of Cell
      v. Chemical Agents
         1. Radiosensitizer
         2. Radioprotectant

4. Dose-Response Relationship Curves

E. Molecular and Cellular Radiobiology
   1. Irradiation of Macromolecules
      i. In Vivo
      ii. In Vitro
      iii. Solution
      iv. Effects of Macromolecular Irradiation
         1. Main-Chain Scission
         2. Cross-Linking
         3. Point Lesions/Point Mutations
   2. Radiation Effects on DNA
      i. Main-Chain Scission
         1. 1 side rail severed
         2. 2 side rails severed
      ii. Cross-Linking
      iii. Base Separation
      iv. Change/Loss of a Base/Point Lesion/Point Mutation
3. Radiolysis of Water
   i. No Damage/No Effect
   ii. Damage
      1. Hydrogen Peroxide
      2. Hydrogen Peroxyl
      3. Free Radicals
4. Direct and Indirect Effects
5. Target Theory
6. Cell Survival Kinetics
   i. Single Target, Single Hit
      1. D37 – Radiosensitivity of the Cell
   ii. Multitarget, Single Hit
      1. D0 – Mean Lethal Dose
      2. DQ – Threshold Dose
   iii. Recovery
   iv. Cell Cycle Effects
   v. LET, RBE, OER revisited
F. Early Effects of Radiation
   1. Acute Radiation Lethality
      i. Acute Radiation Syndromes
         1. Prodromal Syndrome
         2. Latent Period
         3. Manifest Illness Stage
         4. Hemotologic Syndrome
         5. Gastrointestinal (GI Syndrome)
         6. Central Nervous System (CNS) Syndrome
      ii. LD 50/30
      iii. Mean Survival Time (MST)
2. Local Tissue Damage
   i. Skin
      1. Erythemia
      2. Desquamation
      3. Epilation
      4. Carcinoma
      5. Non-Malignant Changes
   ii. Gonads
      1. Ovaries
      2. Testies
3. Hemotologic Effect
   i. Hemopoietic System
      1. Lymphocytes
      2. Granulocytes
      3. Thrombocytes/Platelets
      4. Erythrocytes
   ii. Hemopoietic Cell Survival
4. Cytogenetic Effects
i. Karyotype
   1. Single & Double Hit Aberrations
   2. Reciprocal Translocation
   3. Point Mutations

ii. Chromosomal Aberrations
   1. Chromatid Deletion
   2. Acentric Fragment
   3. Dicentric Fragment
   4. Isochromatid
   5. Ring Formation
   6. Reciprocal Translocation

G. Late Effect of Radiation
   1. Local Tissue Effects
      i. Skin
      ii. Chromosomes
      iii. Cataracts
   2. Life Span Shortening
   3. Risk Estimates
      i. Relative Risk
      ii. Excessive Risk
      iii. Absolute Risk
   4. Radiation – Induced Malignancies
      i. Leukemia
      ii. Cancer
         1. Thyroid
         2. Bone
         3. Skin
         4. Breast
         5. Lung
         6. Liver
   5. Radiation and Pregnancy
      i. Effects on Fertility
      ii. Irradiation in Utero
      iii. Genetic Effects
         1. Double Dose

IV. METHOD(S) OF INSTRUCTION

This course is taught using a variety of instructional methods, which include but are not limited to interactive lectures, computer presentations, group activities and exercises, videos, supplemental handouts and student presentations. Students are expected to be ACTIVE participants in the learning process. Students are expected to read the assigned readings prior to scheduled class meetings and come to class prepared to actively participate in all activities.

V. REQUIRED TEXTBOOK(S)
VI. REQUIRED MATERIALS

A. A computer with internet access and basic software to include Word and Power Point (available through Jefferson College labs)
B. Course homepage available through Blackboard
C. Binder, paper, pens, pencils with erasers, highlighters

VII. SUPPLEMENTAL REFERENCES

A. Class Handouts
B. Library Resources
   1. Textbooks
   2. Periodicals
   3. Films On Demand Videos
C. Internet Resources
   1. On-line references
   2. Textbook companion website

VIII. METHOD OF EVALUATION (basis for determining course grade)

GRADES–Grades will be based on the percentage of total points earned out of total points possible for this semester. The assignments will vary in the number of possible points based upon amount of work involved and complexity of material. The student should be aware that proofreading and revision are extremely important when preparing homework. A final semester grade of 80% or above must be achieved in this course to successfully complete this course.

EXAMS–All exams with scores less than 75% must be retaken until a score of 75% or above is achieved to complete course requirements. The original score will be used to figure the semester grade. The student will be allowed to retake an exam a maximum of two times. If the student has not passed an exam within the three designated attempts, the student will present to the review board and may be dismissed from the program. The student must contact the instructor prior to any absence to make arrangements for retesting. Until course requirements are met the final grade will be an incomplete.

If an exam is not taken at the scheduled time and arrangements for a make-up exam have not been made prior to the designated exam time, the grade for that exam will be zero. No make-up exam will be considered unless the instructor is personally notified prior to the absence. If a student arranges to take the exam at other than the scheduled time, 5% will be deducted from the grade on that exam. Make-up exams are scheduled at the convenience of the instructor.

Student’s grade will also be based on participation in class and attendance.
ASSIGNMENTS – In order to be prepared for each class meeting, the student should complete each homework assignment prior to the following class meeting. Assignments will consist of worksheets, textbook reading, review questions and other activities to enhance the learning experience.

Evaluation tools will include research projects, written and oral communication projects, class attendance/participation, homework assignments, and exams.

All assignments must be typewritten and are due at the beginning of class on the assigned due dates. Late assignments will not be accepted. In-class quizzes and assignments cannot be made up.

Grading Scale: *(Jefferson College Radiologic Technology Program’s)*

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<tr>
<th>Grade</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>A</td>
<td>100-92%</td>
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<tr>
<td>B</td>
<td>91.9-86%</td>
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<tr>
<td>C</td>
<td>85.9-80%</td>
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<tr>
<td>D</td>
<td>79.9-70%</td>
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<tr>
<td>F</td>
<td>69.9 and below</td>
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<tr>
<td>I</td>
<td>Incomplete</td>
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<tr>
<td>W</td>
<td>Excused withdrawal from course</td>
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IX. ADA AA STATEMENT

Any student requiring special accommodations should inform the instructor and the Coordinator of Disability Support Services (Library; phone 636-481-3169).

X. ACADEMIC HONESTY STATEMENT

All students are responsible for complying with campus policies as stated in the Student Handbook (see College website, [http://www.jeffco.edu](http://www.jeffco.edu)).

XI. ATTENDANCE STATEMENT

Students earn their financial aid by regularly attending and actively participating in their coursework. If a student does not actively participate, he/she may have to return financial aid funds. Consult the College Catalog or a Student Financial Services representative for more details. Student’s grade will also be based on participation in class and attendance.

XII. OUTSIDE OF CLASS ACADEMICALLY-RELATED ACTIVITIES

The US Department of Education mandates that students be made aware of expectations regarding coursework to be completed outside the classroom. Students are expected to spend substantial time outside of class meetings engaging in academically-related activities such as reading, studying, and completing assignments. Specifically, time spent on academically-related activities outside of class combined with time spent in class meetings is expected to be a minimum of
37.5 hours over the duration of the term for each credit hour.