



# BROWARD COMMUNITY COLLEGE COURSE OUTLINE

**LAST REVIEW:** 2008-2009      **NEXT REVIEW:** 2013-2014      **STATUS:** A  
*(i.e. 2003-2004)*      *(i.e. 2008-2009)*      *(A, I, D)*

**COURSE TITLE:** Nuclear Medicine Methodology

**COMMON COURSE NUMBER:** NMT 2485

**CREDIT HOURS:** 3

**CONTACT HOUR BREAKDOWN**  
*(per 16 week term)*

**CLOCK HOURS:**  
*(Voc. Course ONLY)*

Lecture: 48      Lab: 0

Clinic: 0      Other: 0

**PREREQUISITE(S):**

**COREQUISITE(S):**

**PRE/COREQUISITE(S):** NMT 2130; NMT 2705L and NMT 2834

## COURSE DESCRIPTION

Study of biological effects associated with exposure to ionizing radiation through cellular, tissue and the total biological response patterns. Introduction to the fundamentals of physics to include radiation sources, radiation/matter interaction modes. Overview to diagnosis of procedures done in Nuclear Medicine.

## UNIT TITLES

1. Review of Cell Biology
2. Radiation & Matter Interaction
3. Radiation Genetics
4. Radiosensitivity and Cell Response
5. Cellular Response to Radiation
6. Systemic Radiation Effects
7. In Utero Radiation Effects
8. Late Effects of Radiation Exposure
9. Critical Organ and Dose Effects
10. Review of the Atom
11. Structure of the Atom
12. Radiation and the Atom
13. Particulate Interaction with Matter
14. Gamma and X-Ray with Matter
15. Discussion of Diagnosis of Nuclear Medicine Procedures



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### ASSESSMENT:

Please provide a brief description (250 characters maximum) that details how students will be assessed on the course outcomes.

1. Announced and unannounced quizzes and Unit examinations;
2. Mid term and/or Final Exam (cumulative/comprehensive);
3. Assessment of reading and online assignments via submission of homework projects.

*\*\*\* Complete the following only if course is seeking general education status \*\*\**

### GENERAL EDUCATION Competencies and Skills \*:

Please highlight in green font all Competencies/Skills from the list below that apply to this course. In the box to the right of the Competency/Skill, enter all specific learning outcome numbers (i.e. 1.1, 2.7, 5.12) that apply.

1. Read with critical comprehension	
2. Speak and listen effectively	
3. Speak and listen effectively	
4. Think creatively, logically, critically, and reflectively (analyze, synthesize, apply, and evaluate)	
5. Demonstrate and apply literacy in its various forms:	
6. Apply problem solving techniques to real-world experiences	
7. Apply methods of scientific inquiry	
8. Demonstrate an understanding of the physical and biological environment and how it is impacted by human beings	
9. Demonstrate an understanding of and appreciation for human diversities and commonalities	
10. Collaborate with others to achieve common goals.	
11. Research, synthesize and produce original work	
12. Practice ethical behavior	
13. Demonstrate self-direction and self motivation	
14. Assume responsibility for and understand the impact of personal behaviors on self and society	
15. Contribute to the welfare of the community	

*\* General Education Competencies and Skills endorsed by '05-'06 General Education Task Force*



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**Common Course Number: NMT 2485**

## **Unit 1 Review of Cell Biology**

### **General Outcome:**

**1.0 The student shall be able to demonstrate an understanding of cell biology.**

### **Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 1.1** Identify and describe the function of each major unit of a typical human cell.
- 1.2** Differentiate between the process that take place in mitosis and meiosis.
- 1.3** Describe the interaction of various types of radiation with matter.



**Common Course Number: NMT 2485**

**Unit 2 Radiation & Matter Interaction**

**General Outcome:**

**2.0 The student shall be able to demonstrate an understanding of radiation and matter.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 2.1** Define linear energy transfer in relationship to the differences in cellular damage from various types of radiation.
- 2.2** Describe and compare direct and indirect action of ionizing radiation on the cell.
- 2.3** Describe the way in which free radicals are formed and state how they produce damage in molecular structures.



**Common Course Number: NMT 2485**

**Unit 3 Radiation Genetics**

**General Outcome:**

**3.0 The student shall be able to demonstrate an understanding of radiation genetics.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 3.1** Discuss the concept of the "target theory" and define a "hit".
- 3.2** Discuss the effects of ionization on DNA, Chromosomes, proteins, lipids, carbohydrates, and enzymes.
- 3.3** Describe the arrangement of genetic code on DNA molecules.



**Common Course Number: NMT 2485**

**Unit 4 Radiosensitivity and Cell Population**

**General Outcome:**

**4.0 The student shall be able to demonstrate an understanding of radiosensitivity and cell population.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 4.1** Discuss the concept of genetic mutation as applied to the effects of ionizing radiation.
- 4.2** Describe and compare point mutations and chromosomal aberrations.
- 4.3** List factors that determine the relative radiosensitivities of tissues in terms of the law of Bergonie and Tribondeau.
- 4.4** Compare the radiosensitivity of cells during the four stages of cell division.
- 4.5** Discuss the influences of hydration and dehydration on radiosensitivity.
- 4.6** List the five categories of radiosensitive cells in decreasing order of radiosensitivity, and discuss factors that influence cell radiosensitivity, according to Ruin and Casaret's classification theme.
- 4.7** Differentiate between interphase death and reproductive death.
- 4.8** Define RBE.



**Common Course Number: NMT 2485**

**Unit 5 Cellular Response to Radiation**

**General Outcome:**

**5.0 The student shall be able to demonstrate an understanding of cellular response to radiation.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 5.1** Describe the effect of oxygen on cell death and repair.
- 5.2** Define LD-50/30.
- 5.3** Given a survival curve, be able to extract significant data.
- 5.4** List and discuss several factors influencing the effects of irradiation on cell death/survival.



**Common Course Number: NMT 2485**

**Unit 6 Systemic Radiation Effects**

**General Outcome:**

**6.0 The student shall be able to demonstrate an understanding of the effects of systemic radiation.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 6.1** Distinguish between the acute and late effects of irradiation, including types of effects, dose levels, cell and tissue sensitivity, and stage cell development at the time of exposure.
- 6.2** Define "syndrome" and list the major radiation symbols.
- 6.3** Discuss the clinical stages of a radiation syndrome along the associated time sequence..



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**Unit 7 In utero Radiation Effects**

**General Outcome:**

**7.0 The student shall be able to demonstrate an understanding of In utero radiation effects.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 7.1** Discuss the irradiation of the hemopoietic system.
- 7.2** List the components of the blood in the order of their Radiosensitivity.
- 7.3** Discuss the effects of whole body irradiation on the gastrointestinal system.
- 7.4** Identify the most sensitive portion of gastrointestinal system.



**Common Course Number: NMT 2485**

**Unit 8 Late Effects of Radiation Exposure**

**General Outcome:**

**8.0 The student shall be able to demonstrate an understanding of Late effects of radiation.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 8.1** Discuss the effects of irradiation on the following body systems or tissue:
- a. Vascular system
  - b. reproductive system
  - c. Skeletal system
  - d. Nervous system
  - e. Respiratory, Urinary
  - f. embryo in utero and muscular system
- 8.2** List and discuss chronic somatic effects of radiation exposure.
- 8.3** Compare the normal aging process with radiological aging.



**Common Course Number: NMT 2485**

**Unit 9 Critical Organ and Dose Calculation**

**General Outcome:**

**9.0 The student shall be able to demonstrate an understanding of dose calculation.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 9.1** Discuss life shortening as associated with radiation exposure.
- 9.2** Describe the relationship between radiation exposure and incidence of cancer.
- 9.3** Describe the relationship between radiation exposure and genetic mutations.
- 9.4** Given a list of commonly used radiopharmaceuticals and/or nuclear radiology procedures list the critical organ and target organ.
- 9.5** Compare and describe classical and MIRD methods of calculating absorbed dose.
- 9.6** Discuss the risk-to-benefit ratio of radiation exposure in terms of diagnostic and therapeutic procedures.



**Common Course Number: NMT 2485**

**Unit 10 Historical Review of the Atom**

**General Outcome:**

**10.0 The student shall be able to demonstrate an understanding of discovery of the atom.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 10.1** Describe the significance of historical contributions to the development of the current concept of the atom.
- 10.2** Describe the general atomic structure, based on the Bohr model, with reference to other models that have been proposed.
- 10.3** Discuss the concepts of orbital shells and quantum numbers as they relate to both the shell designation and the periodic table.
- 10.4** Write appropriate s, p, d, and f numbers for a given atom.
- 10.5** Diagram an atom, placing electrons in the proper shells.
- 10.6** Relate the Pauli Exclusion principle to the organization of atom.
- 10.7** Explain the structure of the periodic table, discussing the various symbols and abbreviations used in the table.
- 10.8** Explain the structure of the trilinear chart of the nuclides, discussing the various symbols and abbreviations used in the chart.



**Common Course Number: NMT 2485**

**Unit 11 Structure of the Atom**

**General Outcome:**

**11.0 The student shall be able to demonstrate an understanding of the structure of the atom.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 11.1** Describe the process of ionization.
- 11.2** Define and differentiate between anions and cations.
- 11.3** Using the A, Z, X notations, write any element given.
- 11.4** Given the A, Z numbers, determine the number of neutrons.
- 11.5** Use and explain nuclear shorthand.
- 11.6** Define terminology associated with nuclear physics.
- 11.7** Discuss the concepts of binding energy, energy states, and orbital energy levels of electrons.
- 11.8** Discuss nuclear structure and the forces associated with nuclear structure and content.
- 11.9** Describe mass defect and nuclear binding energy.
- 11.10** Given appropriate information, calculate wavelength or energy.
- 11.11** Define atomic mass units and energy equivalents and derive the value of one, given the other by mathematical conversion.
- 11.12** Describe the electron volt as a measure of energy.
- 11.13** Discuss the concepts and characteristics of wave motion.



**Common Course Number: NMT 2485**

**Unit 12 Radiation and the Atom**

**General Outcome:**

**12.0 The student shall be able to demonstrate an understanding of radiation and the atom.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 12.1** Discuss the quantum theory of electromagnetic radiation.
- 12.2** Identify, compare, and contrast corpuscular and secondary electromagnetic radiation.
- 12.3** Explain the various modes of electromagnetic radiation production.
- 12.4** Differentiate between natural and artificial radioactivity.
- 12.5** Define "radiation".
- 12.6** List and describe the various types of nuclear transformations.
- 12.7** Define and discuss the Curie and Becquerel as units of measurement of radioactivity.
- 12.8** Convert and/or calculate sub-multiple values of the Curie and Becquerel.
- 12.9** Differentiate between Bremsstrahlung and characteristic x-ray production.



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**Unit 13 Particulate Interaction with Matter**

**General Outcome:**

**13.0 The student shall be able to demonstrate an understanding of the particulate interaction of matter.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 13.1** Describe the use of N to P ratios in predicting the modes of decay of radionuclides.
- 13.2** From a decay scheme, name the parent radionuclide, daughter half-lives of parent and daughters, types of emissions, energy of emissions, and abundance of emissions.
- 13.3** Define and calculate the decay constant of a radionuclide.
- 13.4** Explain "radioactive decay" and explain how nuclear transformation occur.
- 13.5** Define the terms associated with radioactive decay: physical, biologic, and effective half-life, average life, specific activity and activity concentration.
- 13.6** List the characteristics of alpha decay, beta decay, and gamma decay.
- 13.7** Using both formulas and decay schemes, explain the events associated with alpha, beta, and gamma decay.
- 13.8** Using both formulas and decay schemes, explain the events associated with internal conversion, characteristic x-rays, and Auger electrons.
- 13.9** Describe the process of absorption of alpha & beta particles.



**Common Course Number: NMT 2485**

**Unit 14 Gamma and X-ray Interaction with Matter**

**General Outcome:**

**14.0 The student shall be able to demonstrate an understanding of gamma and x-ray interaction with matter.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 14.1** Describe the transformation process for isomeric and isobaric transitions.
- 14.2** Differentiate between elastic and inelastic interaction as applicable to alpha and beta interaction with matter.
- 14.3** State the radioactive decay formula, identify each component and discuss the relationship between various components.
- 14.4** Given a physical half-life calculate the decay constant.
- 14.5** Given a source and quantity of radioactivity, use decay factors and/or the decay equation to determine the quantity at a prior or subsequent time.
- 14.6** Discuss the importance of parent/daughter relationship in the radioactive equilibrium process.
- 14.7** State the requirements for secular and transient equilibrium relationships in generator systems.
- 14.8** Describe the various methods for production of radioactive materials.
- 14.9** Differentiate between the process of production with reactors linear accelerators, and cyclotrons, and describe the general characteristics of the products obtained by each method.
- 14.10** Describe the mechanisms of a typical radionuclide generator system, including components, construction, and chemical processes that lead to production of the daughter nuclide.
- 14.11** Given appropriate data, calculate specific activity and activity concentrations.
- 14.12** Explain the term "carrier" and "carrier free" radionuclides.



**Common Course Number: NMT 2485**

**Unit 14 Gamma and X-ray Interaction with Matter continued**

- 14.13** Express mathematically, the growth of a radionuclide in a neutron flux, and calculate the time and flux required to produce a specific radionuclide.
- 14.14** Define nuclear fission, and relate this process to the production of radionuclides by writing the typical reactions for commonly used radionuclides.
- 14.15** Describe the characteristics of electromagnetic radiation.
- 14.16** Explain the similarities and differences between x-rays and gamma photons.
- 14.17** Describe and diagram photoelectric, Compton, and pair production interaction of radiation with matter.



**Common Course Number: NMT 2485**

**Unit 15 Interaction Relationships**

**General Outcome:**

**15.0 The student shall be able to demonstrate an understanding of the interaction relationships.**

**Specific Measurable Learning Outcomes:**

**Upon successful completion of this unit, the student shall be able to:**

- 15.1** Discuss the relationship of electricity and magnetism to radioactivity.
- 15.2** Describe the characteristics of incident energy and absorber material most likely to result in pair production.
- 15.3** Describe and diagram the interactions that take place during annihilation radiation.
- 15.4** Discuss the concepts of half-value layer and demonstrate use of equation in shielding materials for radionuclides.