AAPM Diagnostic Radiology Curriculum and RSNA/AAPM Web Modules

Kalpana Kanal, Ph.D.
Philip Heintz, Ph.D.
William Hendee, Ph.D.

AAPM Diagnostic Radiology Curriculum

- AAPM Subcommittee of the Medical Physics Education of Physicians Committee developed the curriculum and published in May 2009
- Endorsed by: AAPM Education Council and the Academic Council of the Association of University Radiologists
- Where can it be found?
  - ✓ http://www.aapm.org/education/documents/Curriculum.pdf

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AAPM Diagnostic Radiology Curriculum

- Purpose
  - ✓ Outline the breadth and depth of scientific knowledge underlying the practice of diagnostic radiology that will aid a practicing radiologist in understanding the strengths and limitations of the tools in practice
- Describes the core physics knowledge related to medical imaging that a radiologist should know when graduating from an accredited radiology residency program

AAPM Diagnostic Radiology Curriculum

- **The curriculum contains 17 modules covering imaging physics:**
  - ✓ **First 9 modules cover basic radiation physics and biology**
  - ✓ **Last 8 modules utilize this base information to examine clinical applications of physics to each modality**

Structure of Atom	Electromagnetic radiation	Particulate radiation	Interactions with matter	Radiation units
X-ray production	Basic imaging science & technology	Biologic effects of ionizing radiation	Radiation protection & assoc. regs	
X-ray projection & detectors	General radiography	Mammography	Fluoroscopy & IR	CT
US	MRI	Nuc. Med		

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AAPM Diagnostic Radiology Curriculum Example of a Module

Module 8: Biological Effects of Ionizing Radiation

After completing this module, the resident should be able to apply the "Fundamental Knowledge" and "Clinical Applications" learned from the module to example tasks, such as those found in "Clinical Problem-Solving.".

Fundamental Knowledge:

1. Describe the cell cycle, and discuss the radiosensitivity of each phase.
2. Discuss the probability of cell survival for low-LET radiations.
3. Compare the radiosensitivities of different organs in the body.
4. Explain the effects of massive whole body irradiation and how it is managed.
5. Understand the threshold for deterministic effects, including cutaneous radiation injury, cataracts and sterility.
6. Explain the risk of carcinogenesis due to radiation.
7. Understand the latencies for different cancers.
8. Explain the effects of common drugs on radiation sensitivity.
9. Describe the effect of radiation on mutagenesis and teratogenesis.
10. List the most probable *in utero* radiation effects at different stages of gestation.
11. Define the principles of how radiation deposits energy that can cause biological effects.
12. Explain the difference between direct and indirect effects, how radiation affects DNA and how radiation damage can be repaired.
13. Recognize the risk vs. benefit in radiation uses, and recognize the information sources that can be used to assist in assessing these risks.
14. Describe the different dose response models for radiation effects.

1. Learning Objectives

AAPM Diagnostic Radiology Curriculum Example of a Module

Clinical Application:

1. Understand the risks to patients from high-dose fluoroscopy regarding deterministic effects, such as cutaneous radiation injury and cataractogenesis, and the importance of applying radiation protection principles in clinical protocols to avoid damage.
2. Understand the risks to the female breast, especially in girls, from repeated imaging for scoliosis, from mobile chest radiography and CT scans; and the importance of applying radiation protection principles in clinical protocols to minimize future harm.
3. Explain radiation risks to pregnant technologists assisting in fluoroscopic procedures.
4. Explain radiation risks to pregnant nurses who are incidentally exposed in mobile radiography ("portables").
5. Understand the best use of gonad shielding and breast shields.

Clinical Problem-Solving:

1. Plan an interventional procedure to minimize the risk of deterministic effects.
2. Select the most appropriate radiological exam for a pregnant patient.
3. Determine the risk vs. benefit for a new procedure shown at a conference.

1. Learning Objectives

AAPM Diagnostic Radiology Curriculum Example of a Module

Concise Syllabus:

- 8.1. Principles of Radiation Biology
- 8.2. Molecular Effects of Radiation
- 8.3. Cellular Effects of Radiation
  - 8.3.1. Law of Bergonié and Tribondeau
  - 8.3.2. Radiosensitivities of Different Cell Types
  - 8.3.3. Radiosensitivities of Phases of the Cell Cycle
  - 8.3.4. Cell Damage
  - 8.3.5. Cell Survival Curves

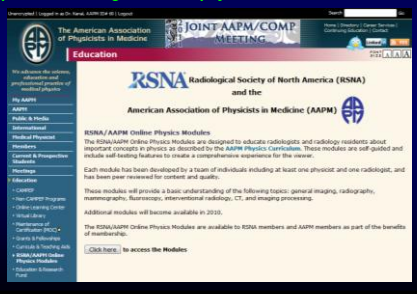
Detailed Syllabus:

8. Radiation Biology
   - 8.1. Principles
     - 8.1.1. Linear Energy Transfer
     - 8.1.2. Relative Biological Effectiveness
     - 8.1.3. Weighting Factors
   - 8.2. Molecular Effects of Radiation
     - 8.2.1. Direct Effects
     - 8.2.2. Indirect Effects
     - 8.2.3. Effects of Radiation on DNA
   - 8.3. Cellular Effects of Radiation
     - 8.3.1. Law of Bergonié and Tribondeau
     - 8.3.2. Radiosensitivity of Different Cell Types
     - 8.3.3. Cell Cycle Radiosensitivity
     - 8.3.4. Cell Damage
       - 8.3.4.1. Division Delay
       - 8.3.4.2. Mitotic Death
       - 8.3.4.3. Apoptosis
     - 8.3.5. Cell Survival Curves
     - 8.3.6. Repair

2. Concise Syllabus and 3. Detailed Syllabus

RSNA/AAPM Online Physics Modules

- **Where can it be found?**
  - ✓ **http://www.aapm.org/education/webbasedmodules.asp**
  - ✓ **http://www.rsna.org/Education/physics.cfm**



RSNA/AAPM Online Physics Modules Task Force Members

William Hendee PhD (Chair)
Medical College of Wisconsin

George Bisset MD
Duke University

Robert Dixon MD
University of North Carolina

Philip Heintz, PhD
University of New Mexico

Mitchell Goodsitt, PhD
University of Michigan

Mahadevappa Mahesh PhD
Johns Hopkins University

Mary Moore MS
Philadelphia VA

Mark Rzeszotarski PhD
Case-Western University

Ehsan Samei PhD
Duke University

RSNA/AAPM Online Physics Modules

- **Purpose**
  - ✓ The RSNA/AAPM Online Physics Modules are designed to educate radiologists and radiology residents about important concepts in physics as identified in the AAPM Physics Curriculum
- These modules are self-guided and include self-testing features to create a comprehensive experience for the viewer
- Each module has been developed by a team of individuals including at least one physicist and one radiologist, and has been peer reviewed for content and quality

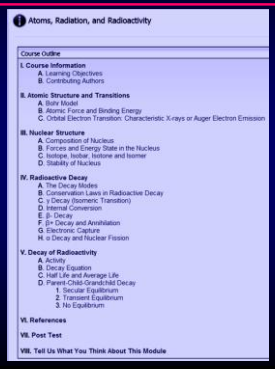
RSNA/AAPM Online Physics Modules

- **The curriculum contains 44 modules covering imaging physics:**

Fundamentals (3)	Basic imaging science & technology (5)	Radiation Biology (2)
Radiation Protection (3)	Projection x-ray Imaging (6)	Fluoroscopy (2)
CT (3)	US (4)	MRI (10)
Nuc. Med (5)	X-ray production (1)	

- **30 Phase I modules are currently being revised**

RSNA/AAPM Online Physics Modules Example of a Module



Atoms, Radiation, and Radioactivity

Course Outline

I. Course Information
- A. Learning Objectives
- B. Contributing Authors

II. Atomic Structure and Transitions
- A. Bohr Model
- B. Atomic Force and Binding Energy
- C. Orbital Electron Transition: Characteristic X-rays or Auger Electron Emission

III. Nuclear Structure
- A. Composition of Nucleus
- B. Forces and Energy State in the Nucleus
- C. Isotope, Isobar, Isotone and Isomer
- D. Stability of Nucleus

IV. Radioactive Decay
- A. The Decay Modes
- B. Conservation Laws in Radioactive Decay
- C. γ Decay (Isomeric Transition)
- D. Internal Conversion
- E. β- Decay
- F. β+ Decay and Annihilation
- G. Electronic Capture
- H. α Decay and Nuclear Fission

V. Decay of Radioactivity
- A. Activity
- B. Decay Equation
- C. Half Life and Average Life
- D. Parent-Child-Grandchild Decay
  - 1. Secular Equilibrium
  - 2. Transient Equilibrium
  - 3. No Equilibrium

VI. References

VII. Post Test

VIII. Tell Us What You Think About This Module

Properties of Modules

- No charge for RSNA/AAPM members (students and residents)
- Approximately 1 hour each
- Always available
- Contain special features (animations, pop-ups, video, etc.)
- Self-paced learning
- Can be repeated
- Pop-up questions and self test
- Certificate of successful completion

Using the Curriculum and Modules together

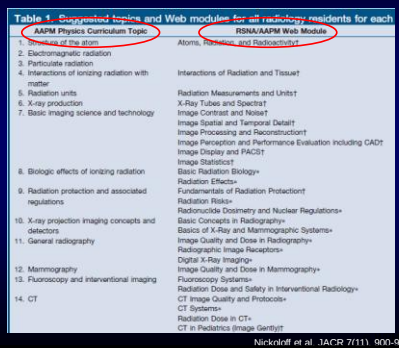


Table 1. Suggested topics and Web modules for all radiology residents for each

AAPM Physics Curriculum Topic	RSNA/AAPM Web Module
1. Structure of the atom	Atoms, Radiation, and Radioactivity†
2. Electromagnetic radiation	
3. Particulate radiation	
4. Interactions of ionizing radiation with matter	Interactions of Radiation and Tissue†
5. Radiation units	Radiation Measurements and Units†
6. X-ray production	X-Ray Tubes and Spectra†
7. Basic imaging science and technology	Image Contrast and Noise†
	Image Spatial and Temporal Detail†
	Image Processing and Reconstruction†
	Image Perception and Performance Evaluation including CAD†
	Image Display and PACS†
	Image Statistics†
8. Biologic effects of ionizing radiation	Basic Radiation Biology*
	Radiation Effects*
9. Radiation protection and associated regulations	Fundamentals of Radiation Protection†
	Radiation Risks*
	Radionuclide Dosimetry and Nuclear Regulations*
10. X-ray projection imaging concepts and detectors	Basic Concepts in Radiography*
	Basics of X-Ray and Mammographic Systems*
11. General radiography	Image Quality and Dose in Radiography*
	Radiographic Image Receptors*
	Digital X-Ray Imaging*
12. Mammography	Image Quality and Dose in Mammography*
13. Fluoroscopy and interventional imaging	Fluoroscopy Systems*
	Radiation Dose and Safety in Interventional Radiology*
14. CT	CT Image Quality and Protocols*
	CT Systems*
	Radiation Dose in CT*
	CT in Pediatrics (Image Gently)†

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Modules Statistics

Title	Enrolled Users	Completed Course	
Fluoroscopy Systems	354	137	
Radiographic Image Receptors	463	124	
Gamma Cameras / Image Quality	480	208	
MRI: Image Characteristics	579	122	
MRI: Image Formation	422	73	
SPECT/SPECT-CT/Image Quality	306	86	
Basic Concepts In Radiography	966	239	
Image Quality and Dose in Mammography	396	141	
Radiation Effects	1017	395	
Radiation Risks	810	268	
MRI: Siting and Environmental Protection	211	64	
PET / PET-CT / Image Quality	368	83	
Basics of X-ray and Mammographic Systems	458	93	
MRI: Special Acquisition Methods	336	84	
Ultrasound – Concepts and Transducers	351	89	
Nuclear Medicine: Principles and Radiopharmaceuticals	608	226	
MRI: Pulse Sequences	560	115	
CT Systems	560	172	
Image Quality-Artifacts-Doppler	310	109	
MRI: Tissue Properties, Contrast Agents and Reactions	271	61	
Basic Ultrasound Imaging and Display	642	153	
Radionuclide Dosimetry and Nuclear Regulations	492	119	
Basic Radiation Biology	1519	428	
Image Quality and Dose in Radiography	555	156	
MRI: Instrumentation	281	45	
Basic Principles of Nuclear Magnetic Resonance	745	251	
MRI: Quality/Bioeffects/Safety	335	103	
CT Image Quality and Protocols	816	155	
Radiation Detection Instrumentation in Nuclear Medicine Practice			
Radiation Dose and Safety in Interventional Radiology	395	115	
Radiation Dose in CT	659	160	
Totals	16465	4574	28%


Thank You