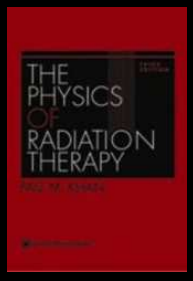
Medical Physics I: Radiation Therapy Physics N.E. 567

Chester R. Ramsey, Ph.D
Thompson Cancer Survival Center
Knoxville, Tennessee

Textbooks

“Required” Textbooks for NE 567

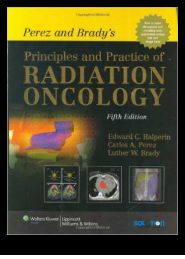
“*The Physics of Radiation Therapy*” by Fiaz Khan



Recommended Textbooks for NE 567

“*Principles and Practices of Radiation Oncology*” by Carlos Perez

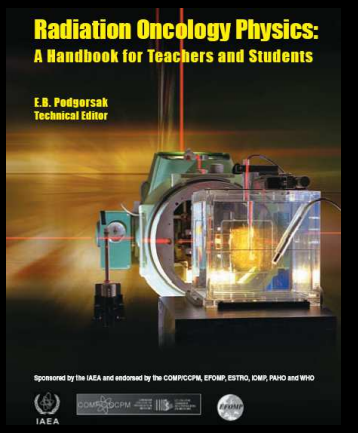
“*Radiobiology for the Radiologist*” by Eric Hall (Optional)



Other Resources

Radiation Oncology Physics Handbook

- In 2005 the IAEA published "Radiation Oncology Physics: a handbook for teachers and students" aiming at providing the basis for an education in radiotherapy physics
- As a complement to the publication, a set of slides following closely the material in the book has been developed and posted on the internet



www-naweb.iaea.org/nahu/dmrp/syllabus.shtm

Other Resources

- Medical Physics Professional Societies
  - American Association of Physicists in Medicine
  - American College of Medical Physics
- Sister-Professional Societies
  - American Society of Therapeutic Radiology & Oncology
  - Radiological Society of North America
  - American College of Radiology
  - Society of Nuclear Medicine
  - International Society for Magnetic Resonance in Medicine
  - American Brachytherapy Society
  - Health Physics Society
  - …

What is a Medical Physicist?

- A Medical Physicist is a professional who specializes in the application of the concepts and methods of physics to the diagnosis and treatment of human disease
- Medical Physicists work with their physician peers to contribute to the well-being of patients

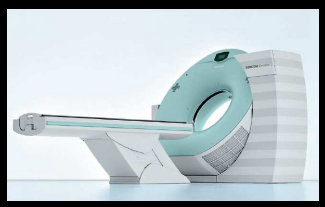
What is a Medical Physicist?

Therapy

- Physician (Radiation Oncologist, Surgeon, …)
- Medical Physicist
- Medical Dosimetrist
- Physics Assistant
- Radiation Therapist

Imaging

- Physician (Radiologist, Cardiologist, …)
- Medical Physicist
- Physics Assistant
- Radiological Technologist



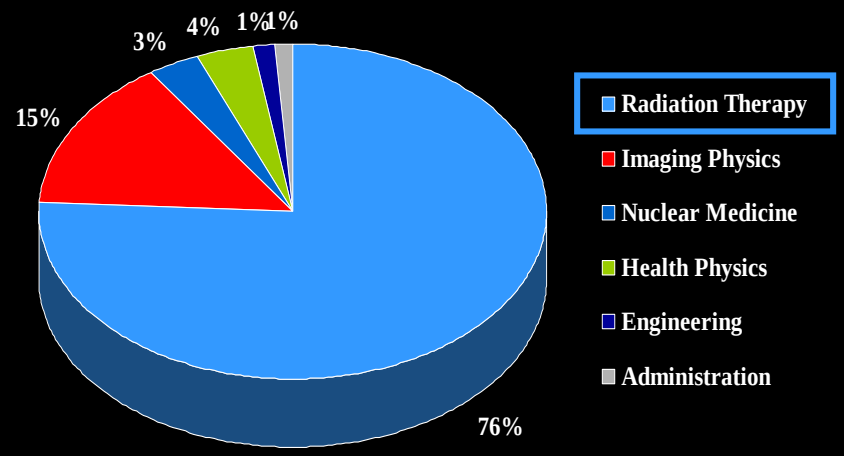
Qualified Medical Physicist?

- An individual who is competent to practice independently in one or more of the subfields in medical physics.
  - Certification and continuing education (to demonstrate competence)
  - Trained to be familiar with the principles of physics used in the equipment and instruments
  - Familiar with government regulations and laws
  - Familiar with performance specifications of equipment
  - Familiar with physical limitations of instruments, calibration procedures, and computer algorithms

Medical Physics Subfields

- Therapeutic Radiological Physics
- Diagnostic Imaging Physics
- Medical Nuclear Physics
- Medical Health Physics

Medical Physics Subfields



Diagnostic Radiological Physics

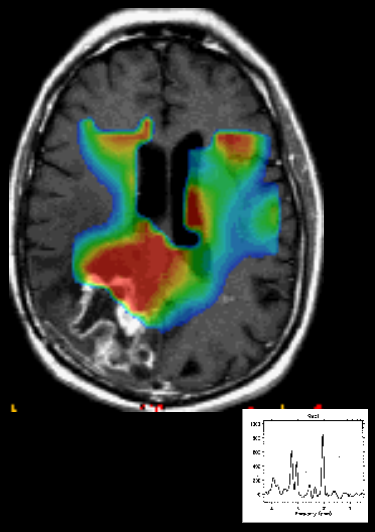
- The diagnostic applications of x-rays, gamma rays from sealed sources, ultrasonic radiation, and radio frequency radiation and magnetic fields
- The equipment association with their production, use, measurement and evaluation
- The quality of images resulting from their production and use
- Medical health physics associated with this subfield

MR Spectroscopy

Functional MR: Measures Neuronal activity by looking at localized changes in blood flow, cerebral blood flow, and oxygen delivery

MR Spectroscopy: Measures the differences in resonant frequencies among nuclei that occupy different positions in molecules

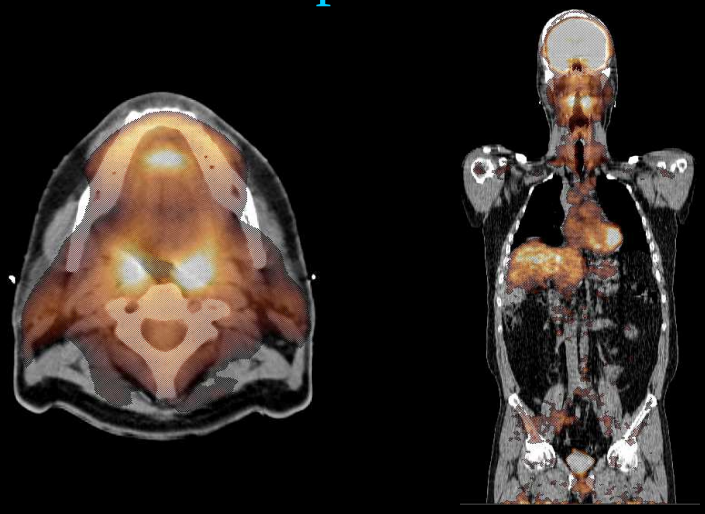
Proton MR spectra can be used to observe metabolites such as lactate and glucose



Medical Nuclear Physics

- The therapeutic and diagnostic applications of radionuclides in unsealed sources
- The equipment association with their production, use, measurement, and evaluation
- The quality of images resulting from their production and use
- Medical health physics associated with this subfield

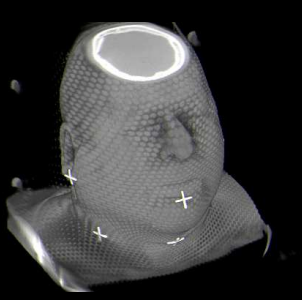
PET Detector and Tracer Development

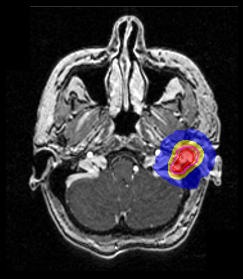


Therapeutic Radiological Physics

- The therapeutic applications of x-ray, gamma ray, neutron, electron, and charged-particle beams, and radiation from sealed radionuclide sources.
- The equipment associated with their production, use, measurement, and evaluation.
- The quality of images resulting from their production and use.
- Medical health physics associated with this subfield.

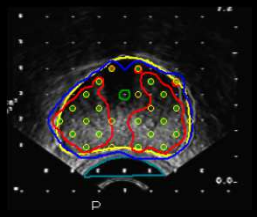
External-Beam Radiation Therapy





Imaging	Planning	Delivery
■ CT	■ Pencil Beam	■ Photons (6-20 MV)
■ MRI	■ Convolution	■ Electrons (4-24 MeV)
■ PET/CT	■ Monte Carlo	■ Protons (50-300 MeV)

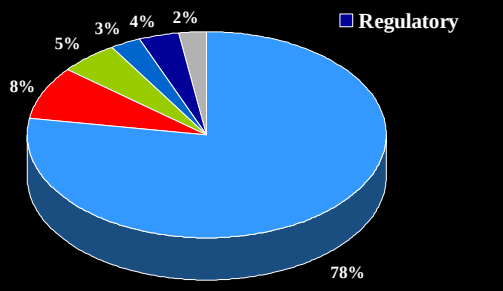
Brachytherapy



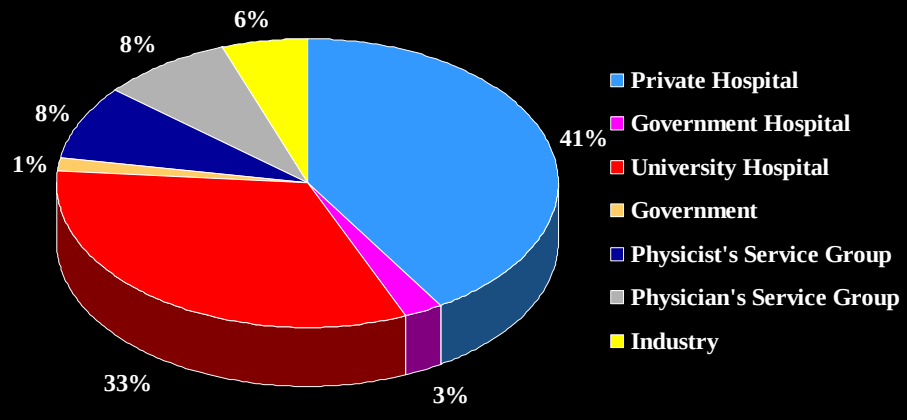
Isotopes	Planning	Implanting
■ Iodine	■ Pre-Operative	■ Temporary
■ Iridium	■ Intra-Operative	■ Permanent
■ Palladium		

Responsibilities of the Medical Physicist

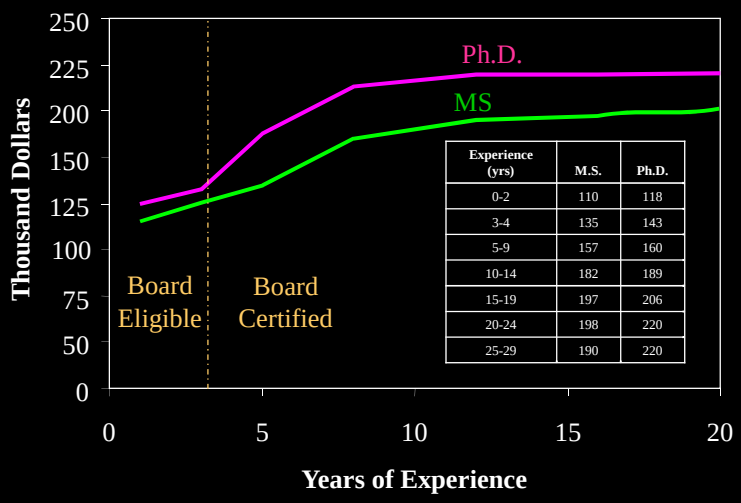
- Daily clinical support
- Quality assurance
- Accelerator calibrations
- Equipment acquisitions
- Dose calculations
- Site planning
- Teaching
- Research
- Regulatory



Where are Medical Physicists Primarily Employed?



Average Income



Experience (yrs)	M.S.	Ph.D.
0-2	110	118
3-4	135	143
5-9	157	160
10-14	182	189
15-19	197	206
20-24	198	220
25-29	190	220

Medical Physics Background

Of all employed medical physicists residing in the United States

- 60% reported that they graduated from a medical physics graduate program. 63% said that the program was CAMPEP approved
- Only 24% reported that they graduated from a medical physics residency program. 66% said that the program was CAMPEP approved
- 57 respondents began full-time employment during 2016. Of them, 33% reported that the position they took was advertised.

Credentials for the Medical Physicist

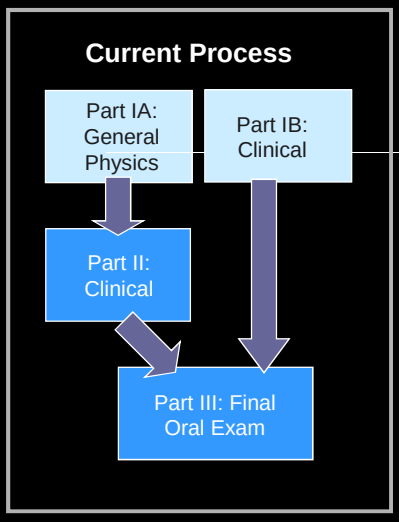
Board Certification

- Medical Physicists are certified by the American Board of Radiology, which is part of the American Board of Medical Specialties (*ABMS*)
- The ABMS provides standardization between 24 approved medical specialty boards in the development and ongoing evaluation and certification of physicians
- ABMS is recognized as the "gold standard" in physician certification in the United States

American Board of Medical Specialties
Higher standards. Better care.®

1. Allergy and Immunology (1971)
2. Anesthesiology (1941)
3. Colon and Rectal Surgery (1949)
4. Dermatology (1933)
5. Emergency Medicine (1979)
6. Family Medicine (1969)
7. Internal Medicine (1936)
8. Medical Genetics (1991)
9. Neurological Surgery (1940)
10. Nuclear Medicine (1971)
11. Obstetrics and Gynecology (1933)
12. Ophthalmology (1933)
13. Orthopaedic Surgery (1935)
14. Otolaryngology (1933)
15. Pathology (1936)
16. Pediatrics (1935)
17. Physical Medicine and Rehabilitation (1947)
18. Plastic Surgery (1941)
19. Preventive Medicine (1949)
20. Psychiatry and Neurology (1935)
21. **Radiology (1935)**
22. Surgery (1937)
23. Thoracic Surgery (1971)
24. Urology (1935)

Board Certification



Must have completed a CAMPEP degree (or a CAMPEP certificate program) Plus a Two Year CAMPEP Residency

Or

Must have completed a 4 year DMP (Doctor of Medical Physics) program

Post 2014 Certification Process

Radiation Oncologist (M.D.)

College	Medical School		Residency	
Undergraduate	Pre-Clinical	Clinical	Internal Medicine	Radiation Oncology
4 yrs	2 yrs	2 yrs	1 yr	4 yrs

Public In-State: $94,324
Public Out-of-State: $174,348
Private School: $170,076

Doctorate of Medical Physics (DMP)

College	Medical School	
Undergraduate	Pre-Clinical	Clinical Physics
4 yrs	2 yrs	2 yrs

Must be CAMPEP Approved

Post 2014 Certification Process

Medical Physicist (M.S.)

College	Grad.	Residency
Undergraduate	M.S.	Radiation Physics
4 yrs	2 yrs	2 yrs

→ ABR The American Board of Radiology

Must be CAMPEP Approved

Salary = $45,000 / yr

Medical Physicist (Ph.D.)

College	Grad School	**Residency**
Undergraduate	Ph.D.	Radiation Physics
4 yrs	3-4 yrs	2 yrs

→ ABR The American Board of Radiology

Must be CAMPEP Approved

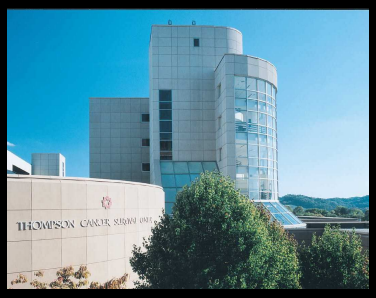
Salary = $45,000 / yr

Medical Physics Background

- 51% have Masters Degrees, while 49% have PhDs
- Nearly all (97%) are employed full-time
- Only 3.3% of members who were full-time employed have been identified as being primarily a self employed consultant
- 20% of medical physicists also report consulting income
- Women currently comprise 23% of the medical physicists

Medical Physicist Rewards

- Challenge of applying the principles of physics to medicine
- Satisfaction of developing new technology for medical use that can save lives
- Contributing to the well-being of patients
- Receiving competitive compensation



Questions?