Expectations of Physics Knowledge for Certification

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Guiding Principles

- Test that a radiation oncology resident has the minimum basic physics knowledge to practice radiation oncology

Expectations

- A lot !
- Be a radiation oncologist
- Be a physicist
- Be an RSO: training and examination compliance

Guiding Principles

- Basic physics
- Based on identified needs
- Linked to scope of practice
- Multimodality imaging
- Physics/radiobiological: TCP, NCTP, dose constraints

Precision IMRT

Keep up with the advances

8. Dose image verification

7. Record and verify delivery system

Varis or compatible

6. Optically guided localization

Radio-camera & ultrasound localization

5. Organ motion & immobilization

Physical and software tools

4. Electronic data transfer

Network file sharing and transfer

3. Dynamic MLC defined field

Step& shoot and sliding window

2. Image based treatment planning & delivery

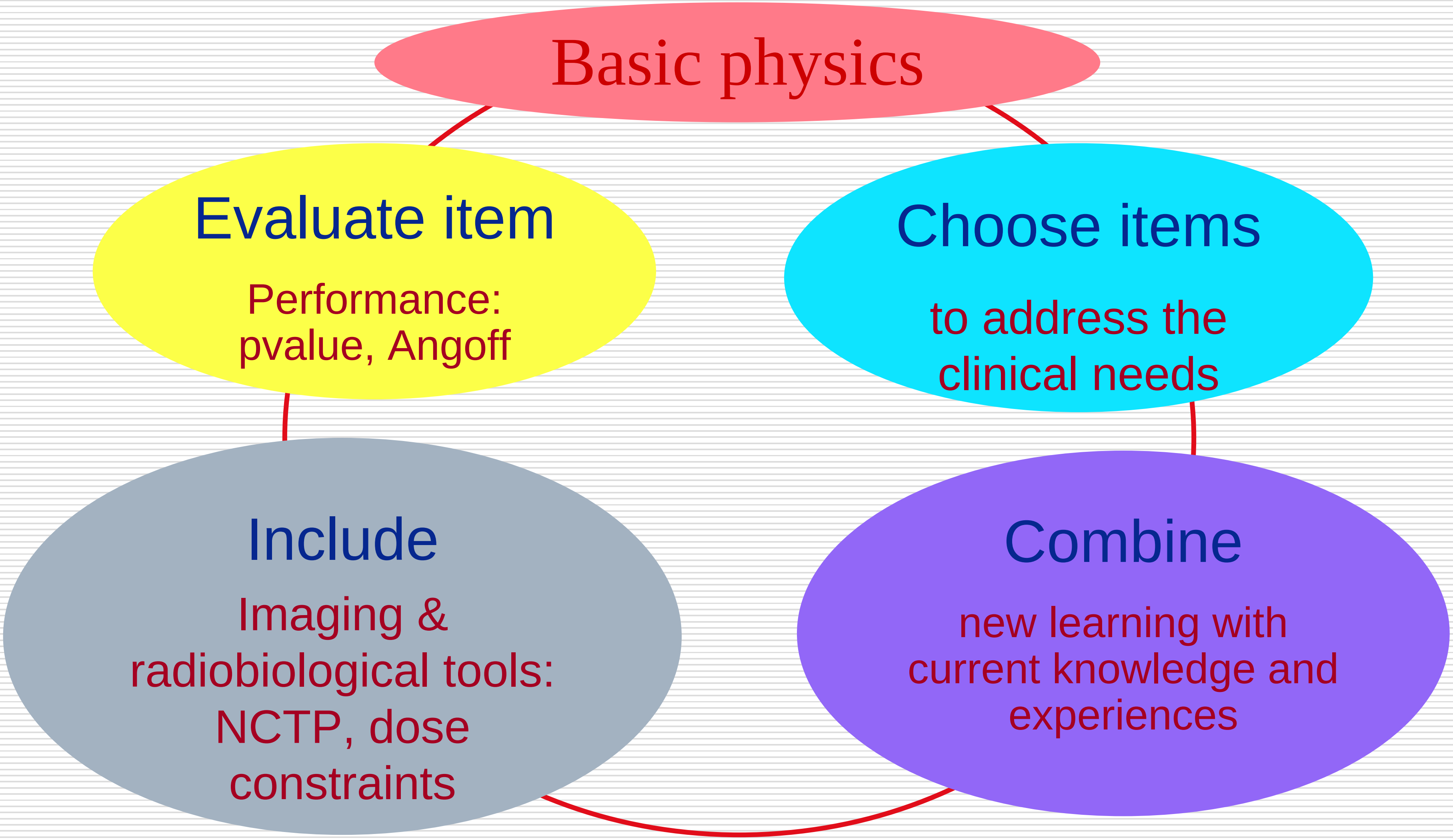
CT/MRI/PET & convolution Kernal based TP

1. Precision dosimetry

Compliance with RPC criteria

Radiotherapy

Guiding Principles



Typical Exam Booklet

- 150 items
- 13 major categories
- Differential weighting for each category
- Mix of old and new items
- New items incorporate advances

Major Categories (13)

- Atomic and nuclear structure
- Radioactive decay
- Properties and production of particulate and electromagnetic radiation
- Interactions of electromagnetic radiation with matter
- Interactions of particulate radiation with matter
- Quantification and measurement of dose (including SI units)
- Characteristics of photon beams
- Dosimetry of photon beams in a patient
- Brachytherapy
- Advanced treatment planning for EBRT
- Quality assurance
- Radiation protection
- Special topics

Atomic and nuclear structure

- Bohr model of the atom
- Coulomb force and electron binding energy
- Electron orbits (energy levels)
- Electron transitions absorption and emission of energy
- Characteristics radiation and the Auger effect
- Nuclear structure
- Nucleons - protons and neutrons
- Nuclear force
- E = MC2 and nuclear-binding energy
- Factors affecting nuclear stability
- Neutron-to-proton ratio
- Average binding energy per nucleon
- Pairing of similar nucleons in the nucleus
- Nuclear nomenclature
- The four isos (isotopes, isotones, isobars, isomers)
- Shorthand representation of isotopes

Radioactive decay

- Modes of radioactive decay
- Beta (β)
- β - (negative beta, negatron)
- β + (positive beta, positron)
- Electron capture
- Alpha (α)
- Other decay processes
- Gamma rays
- Internal conversion
- Decay schemes
- Construction and interpretation
- Examples for each decay mode
- Mathematics of radioactive decay
- Units (SI units)
- Exponential decay equation
- Half-life
- Decay constant
- Mean-life, ave-life, and effec half-life
- Simple dose calculation for implants
- Radioactive equilibrium
- Secular equilibrium
- Radium needles
- 90SR applicators
- Transient equilibrium
- Nuclear medicine generators
- Counting Statistics
- Naturally occurring radioisotopes
- Man-made radioisotopes
- Fission
- Category Description
- Nuclear bombardment
- Decay schemes for therapeutic isotopes

Properties and production of particulate and em radiation

- Particulate radiation
- Mass, charge
- Relativistic energy equation
- Electromagnetic radiation
- Wave-particle duality
- Wave equations
- Electromagnetic spectrum
- Production of radiation
- Principles
- Radioactive decay
- X-ray tube
- Linear accelerators
- Operational theory of wave guides
- Standing wave guides
- Traveling wave guides
- Bending magnet systems
- Flattening filters
- Electron scattering foils
- Electron cones
- Targets
- Factors affecting
- Beam energy
- Entrance dose
- Depth of maximum dose
- Beam uniformity
- Dose rate
- Monitor chamber
- Collimator systems
- Primary and secondary collimators
- Coupled and independent jaws
- Multileaf collimators
- Other collimation systems (e.g., stereo)
- Radiation and light fields (field size)
- Mechanical and operational features
- Cyclotron
- Betatron
- Microtron
- Van de Graaff accelerators
- Cobalt units
- Therapeutic x-ray (<300 kVp)

Interactions of electromagnetic radiation with matter

- Coherent scatter
- Photoelectric effect
- Compton effect
- Pair production
- Category Description
- Photonuclear disintegration
- Relative importance of interactions in human tissues
- Energy dependence
- Atomic number dependence
- Electron-density dependence

Interactions of particulate radiation with matter

- Formalism
- W value
- Specific ionization
- Linear energy transfer
- Range
- Stopping power
- Types of interactions
- Heavy vs light particles
- Charged vs uncharged
- Elastic collisions
- Inelastic collisions

- Heavy charged particles
- Inelastic collisions with electrons
- Depth dose characteristics (Bragg peak)
- Light charged particles
- Elastic and inelastic collisions with electrons
- Inelastic collisions with nuclei
- Neutrons
- Elastic collision with hydrogen nuclei
- Depth dose characteristics vs photons
- Biological implications of particle therapy

Quantification and measurement of dose (including SI units)

- Exposure (air kerma)
- Absorbed dose (kerma)
- Dose equivalent
- RBE dose
- Calculation of absorbed dose
- Bragg-Gray cavity theory
- Gas-filled detectors
- Principles of operation
- Uses
- Ion chambers
- Types
- Exposure measurement
- As a Bragg-Gray cavity
- Correction factors (e.g., temp and
- Calibration of beams (eg, TG 21 and TG 25
- Thermoluminescent dosimetry
- Calorimetry
- Film
- Chemical dosimetry
- Solid-state diodes
- Category Description
- Scintillation detectors
- Measurement techniques

Dosimetry of photon beams in a homogeneous water phantom

- Dose distributions
- Central axis percent depth dose
- Isodose curves
- Factors affecting dose distributions and penumbra
- Beam energy or quality (including patient dose from neutrons
- Source size
- SSD and SDD
- Mayneord F factor
- Inverse square law
- Field Size and shape
- Equivalent square
- Scatter effects
- Flattening filters
- Depth
- Surface dose

Dosimetry of photon…

- Dose distributions for multiple unshaped beams
- Open beams
- Wedged beams
- Tissue-air ratio and backscatter factor
- Tissue-maximum ratio
- Tissue-phantom ratio
- Relationships between PDD, TAR, TMR, TPR
- Point dose and treatment time calculation methods for single unshaped fields
- Machine output factors (e.g., absolute and relative output, head scatter…)
- Equivalent squares
- SSD vs SAD setups
- Wedge factors
- Dose calculation at the isocenter of a rotating beam
- Point dose and treatment time calculations for single-shaped fields
- Separation and recombination of primary and scatter radiation (e.g., Clarkson)
- Category Description
- Off-axis factors
- Dose under blocks
- Equivalent squares for shaped fields
- Isodose distributions for multiple fields, including arc therapy
- Measurement of photon dose distributions

Dosimetry of photon beams in a patient

- Dose specification (e.g., ICRU 50)
- Corrections for patient contour
- Effective SSD method
- TAR ratio method
- Isodose shift method
- Corrections for tissue inhomogeneities
- TAR ratio method
- Power law method
- Isodose shift method
- Equivalent TAR
- Dose within and around an inhomogeneity
- Matching of adjacent fields
- Using multiple wedged fields
- Parallel-opposed beams
- Point of maximum dose

Dosimetry of photon beams in a patient

- Uniformity, dependence upon
- Energy
- Separation
- SSD
- Entrance dose and exit dose, beam-modifiers
- Isodose distributions for multiple beams
- Compensation
- Missing tissue
- Dose compensation
- Bolus
- Off-axis factors
- Practical/Simple calculation of dose
- Practical/Simple 2D treatment planning
- Dose-delivery accuracy and precision

Dosimetry of electron beams

- Dose distributions
- Central axis percent depth dose
- Isodose curves
- Factors affecting dose distributions
- Beam quality
- Beam spreading systems
- SSD and SDD
- Effective SSD techniques
- Inverse square
- Field size and shape
- X-ray contamination
- Depth
- Surface dose
- Inhomogeneities (e.g., CET)
- Energy specification
- Most probable energy
- Mean energy
- Energy at depth
- Ranges (extrapolated, practical, R50)
- Choice of energy and field size
- Air gaps and oblique incidence
- Tissue inhomogeneities
- Bolus, absorbers, and spoilers
- Matching adjacent fields
- Point dose and treatment time calcs
- Electron arc
- Total skin electron therapy

Brachytherapy

- Historical review--role of radium
- Calculation of dose from a point source
- Calculation of dose from a line source
- Properties of sealed sources and applicators
- Implant instrumentation and techniques
- Low dose rate
- High dose rate (including PDR)
- Biological implications of dose, dose rate, and fractionation
- Calibration and specification of sources
- Disseminated (unsealed) sources
- Acceptance testing and quality assurance
- Dose specification, implantation, dosimetry/ systems
- Patterson-Parker
- Quimby
- Paris

Advanced treatment planning for EBRT

- Advanced treatment planning for EBRT
- Plane radiography and Fluoro simulation
- Portal imaging
- Film based
- Electronic
- Imaging for radiation therapy planning
- CT
- MRI
- Ultrasound
- Isotope imaging
- Image processing
- Image enhancement
- 2D and 3D visualization,rendering)
- Image registration
- Category Description
- Virtual simulation (BEV)
- Treatment planning systems
- 3D treatment planning
- Plan evaluation
- Dose optimization techniques
- Non-coplanar beams)
- Radiosurgery
- Patient setup and alignment

Quality assurance

- Equipment related
- Regulations and recommendations
- Measurement techniques
- Patient related
- Misadministration
- External beam
- Brachytherapy

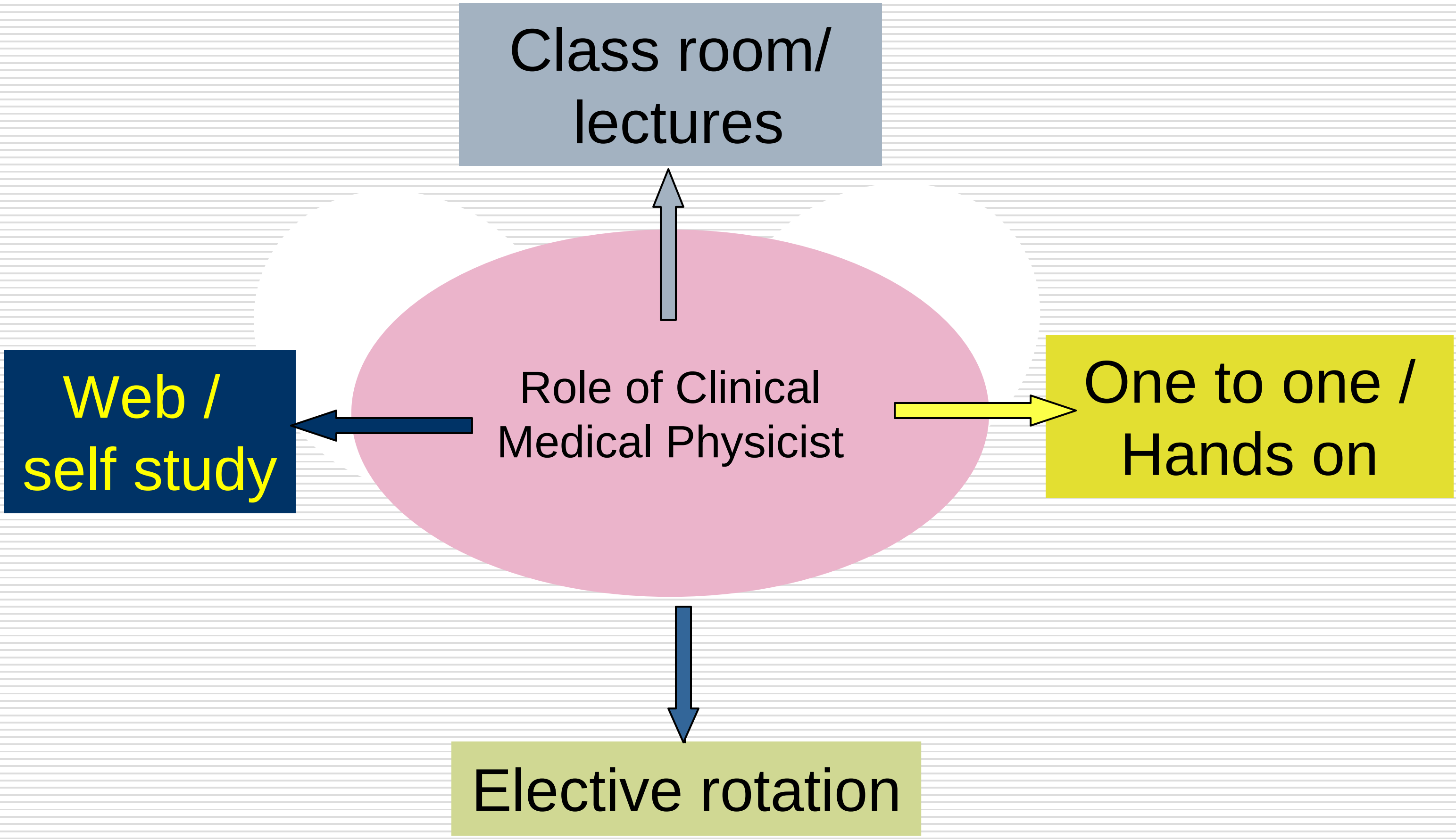
Radiation protection

- Principles, biological effect models, personnel dose limits, rules, and regulations
- Structural shielding design for external-beam therapy
- Primary barriers
- Secondary barriers
- Machine shielding (beam stoppers and head shielding)
- Neutrons
- Radiation protection for brachytherapy procedures
- Source storage and transport containers
- Patient room
- Special considerations for high dose-rate brachytherapy
- Special procedures and source preparation rooms
- Leak testing of sealed sources
- Routine radiation surveys
- Personnel monitoring
- Protection against non-ionizing radiation

Special topics

- Hyperthermia
- Computers

Expected Teaching / Learning Milieu



What is the optimum number of hours for each ?

Teaching / Learning Effort Allocations

What is the optimum number of hours for each ?

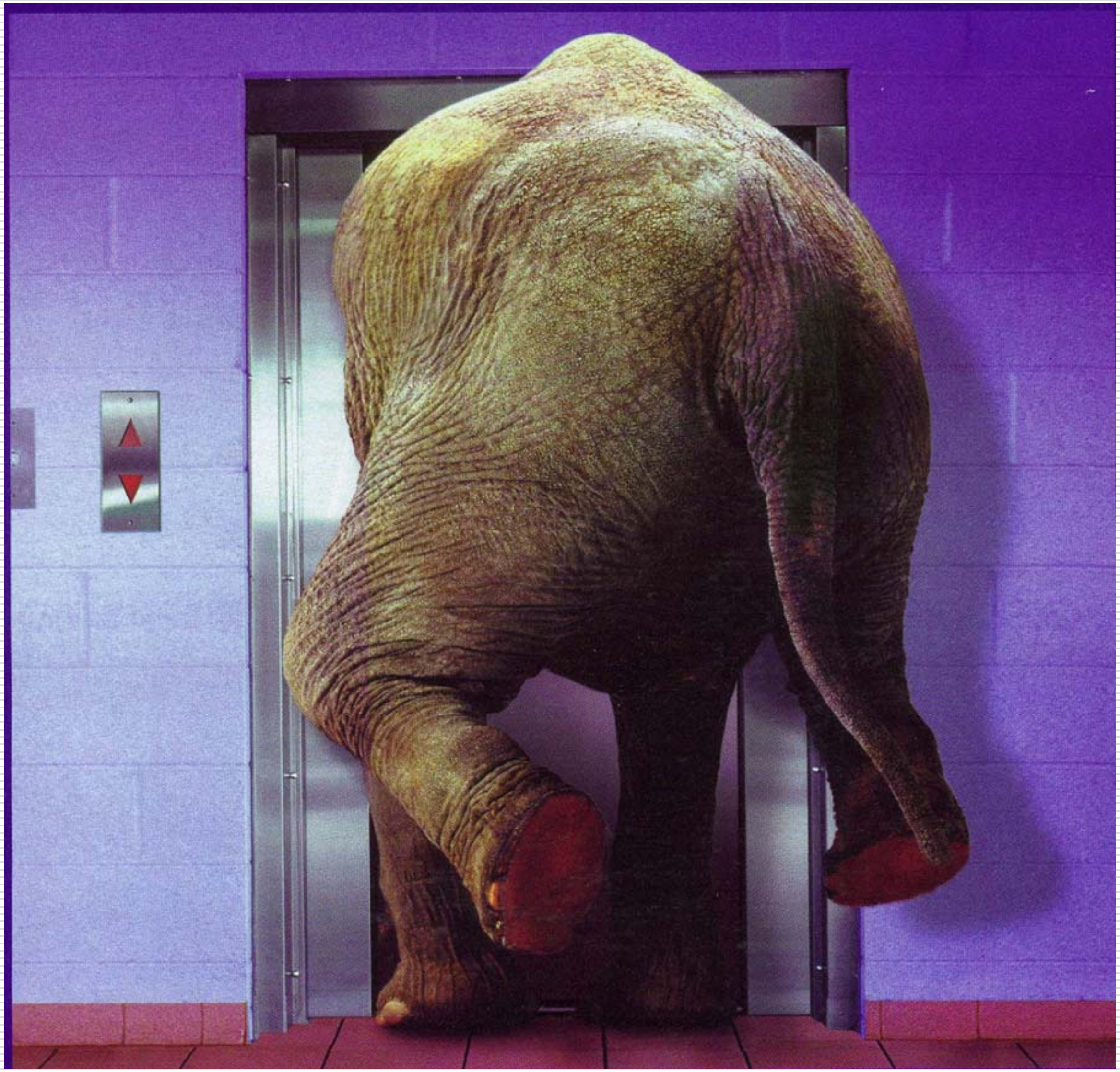
Milieu for teaching / learning	ASTRO syllabus hours	Bp hours
Web based self study	To be determined	25
Class room lectures	55	30
One to one / Hands on	16*	20**
Elective rotation	To be determined	175
Total	55	250

* Part of class room teaching ?

** could be part of elective rotation !

Are we all alike ?

Am I board certified ?



Thank You