C M S A

The Colleges of Medicine of South Africa NPC

Nonprofit Company (Reg No.1955/000003/08)
Nonprofit Organisation (Reg. No. 009-874 NPO)
Vat No. 4210273191

27 Rhodes Avenue, PARKTOWN WEST, 2193

Tel: +27 11 726 7037; Fax: +27 11 726 4036

Website: www.cmsa.co.za
General: Academic.Registrar@cmsa.co.za

JOHANNESBURG OFFICE
EXAMINATIONS & CREDENTIALS

A P P E N D I X A:*

Syllabus for Part I of the FC Rad Onc(SA) examination:

Physics curriculum

1.0 Atomic and nuclear structure

1.1 Structure of the atom

1.1.1 Nucleus, orbital shells, energy levels, binding energy
1.1.2 Particles - proton, electron, neutron, positron
1.1.3 Describe atomic number, atomic mass, isotopes

1.2 Wave and quantum models of radiation

1.2.1 Energy and wavelength, energy spectrum

1.3 Radioactivity

1.3.1 Decay processes
1.3.2 Activity, half life
1.3.3 Parent – daughter relationships and equilibrium
1.3.4 Nuclear reactions, bombardment and reactors

1.4 Production of photons and electrons

1.4.1 Physical concepts of beam production

- Bremsstrahlung
- X-ray tube design
- Energy spectrum
- Characteristic radiation

1.4.2 Generation of beams

- Filters
- Gamma sources
- Linear accelerator
- Beam geometry

1.4.3 Attenuation of beams

- Half value layer
- Attenuation, energy transfer, and absorption
- Attenuation co-efficients

1.5 Interaction of x-rays and gamma rays with matter

1.5.1 Absorption and scatter of x-rays in matter
1.5.2 Photoelectric effect
1.5.3 Compton effect
1.5.4 Pair production

1.6…/

1.6 **Interactions of particulate radiation**

1.6.1 Direct and indirect ionisation
1.6.2 Elastic and inelastic collisions
1.6.3 Linear energy transfer
1.6.4 Heavy particles interactions
1.6.5 Interactions of Neutrons
1.6.6 Interactions of Electrons

1.7 **Radiotherapy equipment**

1.7.1 Linear accelerator
- Construction of radiotherapy machines
- Principles of beam production
- Beam collimation and modifiers

1.7.2 Cobalt units
1.7.3 Simulators
- Operation
- Fluoroscopy and Intensifiers
- CT simulation

1.7.4 Other imagers
- Principles of ultrasound, CT, MRI, PET
- Applications and limitations of above imaging to radiotherapy

1.7.5 Brachytherapy
- Sources used
- Calibration of sources
- Radioprotection

1.7.6 Equipment selection and specifications

1.8 **Radiation beam quality and dose**

1.8.1 Mono energetic and heteroenergetic beams
1.8.2 Dose quantities and units
- Kerma
- Exposure
- Absorbed dose
- Dose equivalent
- RBE dose
- Calculation of absorbed dose from exposure
- Relationship between kerma, exposure and absorbed dose

1.9 **Radiation measurement and calibration**

1.9.1 Ionisation chambers
1.9.2 Principles of beam calibration
1.9.3 Other methods of measuring absorbed dose
- Calorimetry
- Chemical dosimetry
- Solid state detectors
- Film dosimetry

1.10…/

1.10 **Photon beam treatment**

1.10.1 External beam planning principles
- Inverse square law
- Backscatter factor
- Electron build up
- Percentage depth dose
- Equivalent squares
- Tissue-air ratio

1.10.2 Dose calculations
- Monitor unit calculations
  - Output factor
  - Field size correction factors
  - Collimator and phantom scatter factor
  - Beam modifier factors
  - Patient attenuation factors
- Calculations in practice
  - SSD technique
  - SAD technique

1.10.3 Translation of planning to calculations
- Beam parameters
- Beam weighting
- Arc rotation therapy
- Irregular fields

1.10.4 Dose calculations
- Monitor unit calculations
  - Output factor
  - Field size correction factors
  - Collimator and phantom scatter factor
  - Beam modifier factors
  - Patient attenuation factors
- Calculations in practice
  - SSD technique
  - SAD technique

1.10.5 Translation of planning to calculations
- Beam parameters
- Beam weighting
- Arc rotation therapy
- Irregular fields

1.10.6 Computerised treatment planning
- Isodose curves(beam characteristics)
- Surface dose
- Parallel opposed beams
- Wedge techniques, isodose curves, angles
- Beam combinations

1.10.7 Surface corrections and heterogeneities
- Surface obliquity
- Inhomogeneity correction

1.10.8 Adjoining fields and special dosimetry problems
- Two-fields
- Three-fields
- Craniospinal gapping
- Pacemaker
- Gonadal dose
- Pregnant patient

1.11…/

1.11 **Electron beam treatment**

1.11.1 Basic characteristics
- Depth-dose curves
- Interactions
- Obliquity

1.11.2 Treatment planning principles
- Selection of energy, field size
- Skin dose
- Bolus
- Field shaping
- Field-matching
- Inhomogeneities

1.12 **External beam quality assurance**

1.12.1 Goals
1.12.2 Roles and duties
1.12.3 Staffing
1.12.4 Linac QA
- Commissioning linear accelerators (principles)

1.12.5 Routine Quality assurance requirements
- Daily, monthly, annually

1.13 **Radiation protection and shielding**

1.13.1 Definitions and standards
1.13.2 Dose equivalent and effective dose equivalent
1.13.3 Types of radiation exposure
- Background
- Man-made
- National recommendations on exposure limits

1.13.4 Protection regulations
1.13.5 Administrative requirements
- Safety programme
- Staff monitoring

1.13.6 Radiation shielding principles
- Treatment room design
- Types of barriers
- Neutron shielding for high energy beams
- Sealed source storage
- Protection equipment and surveys
- Monitoring equipment

1.14 **Imaging in radiation oncology**

1.14.1 Routine diagnostic imaging principles
1.14.2 Port films
1.14.3 Processors
1.14.4 Other imaging
- Electronic portal imaging devices

1.15 **3D conformal therapy**

1.15.1 Concepts and goals vs traditional RT
- Technology and methods for planning
- Multiple volume images
- Image processing
- Virtual simulation
- DRR’s
- Multiple beams and non-coplanar beams

1.15.2…/

1.15.2 Optimisation methods
- Uniform vs non-uniform delivery
- Margins
- DVH's

1.15.3 Implications of treatment variabilities
- Set-up
- Patient factors
- ICRU 50 and 62 prescribing recording and reporting

1.16 **Assessment of patient setup and verification**

1.16.1 Immobilisation devices and methods
1.16.2 Positioning devices and methods
1.16.3 In-room treatment imaging
- Cone-beam CT
- Ultrasound
- Fiducials
- On-line correction of set-up errors
- Adaptive planning concepts

1.17 **Brachytherapy planning**

1.17.1 Calculation of dose distribution
- Calculation of dose from a point source/line source

1.17.2 Systems of implant dosimetry
1.17.3 Implantation techniques
- Surface
- Interstitial
- Intracavitary

1.17.4 Gynaecological implants
- Manchester system
- Bladder and rectal dose
- ICRU

1.18 **IMRT**

1.18.1 Delivery systems
1.18.2 Principles of dose prescription and inverse planning
1.18.3 QA

1.19 **Special procedures**

1.19.1 Stereotactic radiosurgery
- Delivery systems
- Principles of planning and delivery
- QA

1.19.2 Total body irradiation
- Principles of planning and delivery

1.20 **Particle therapy**

1.20.1 Protons
- Energy deposition
- Equipment
- Beam dosimetry
- Principles of production and delivery

1.20.2 Neutrons
- Basic interactions
- Principles of production and delivery

2.0 Radiobiology and Cancer Biology

2.1 Basic Principles of radiobiology

- 2.1.1 Interaction of radiation with matter
- 2.1.2 DNA damage by radiation
- 2.1.3 Cell survival curves
- 2.1.4 Cell radiosensitivity and radiocurability
- 2.1.5 Cell cycle
- 2.1.6 Lethal, potentially lethal, sublethal damage and repair
- 2.1.7 Dose rate effects
- 2.1.8 The basis of fractionation: 4 R's of radiobiology
- 2.1.9 Factors that modify clinical radiation response and methods to overcome limitations. The oxygen effect, radiosensitisers, radioprotectors, hypoxic cell sensitisers, hyperthermia, linear energy transfer.
- 2.1.10 Biological equivalent dose and linear quadratic equation (including practical clinical calculations)
- 2.1.11 Other radiation modalities (neutrons, protons), relative biological effectiveness
- 2.1.12 Tumour growth kinetics (Tpot, growth fraction, cell loss).

2.2 Effect of radiation on normal tissue

- 2.2.1 Normal tissue tolerance – organ and volume specific
- 2.2.2 Acute and late effects of radiation on normal tissues, including the eye and gonads (also hereditary effects, carcinogenesis)
- 2.2.3 Total body radiation
- 2.2.4 Effect of irradiation on the embryo and fetus

2.3 Cancer biology

- 2.3.1 Terminology of molecular biology of cancer
- 2.3.2 Carcinogenesis
- 2.3.3 Oncogenes
- 2.3.3 Tumour suppressor genes
- 2.3.4 Growth factors and signal transduction pathways
- 2.3.5 Apoptosis
- 2.3.6 Angiogenesis
- 2.3.7 Invasion and metastasis.

3.0 Applied Anatomy

3.1 Keeping the goal of treating the oncology patient in mind:

- 3.1.1 The structure, boundaries, vascular and lymphatic pathways, and neurological supply of: head and neck, the central nervous system, thoracic and abdominal organs and upper limbs proximal to mid humerus and lower limbs proximal to and including the femoral triangle
- 3.1.2 Landmark localisation:
  - On surface anatomy
  - Imaging
- 3.1.3 The relation of organs to one another and their movement
- 3.1.4 Radiological anatomy on relevant imaging techniques
- 3.1.5 Routes of potential cancer spread.