JOHANNESBURG OFFICE
EXAMINATIONS & CREDENTIALS

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September 2022

R E G U L A T I O N S

FOR ADMISSION TO THE FELLOWSHIP OF

THE COLLEGE OF NUCLEAR PHYSICIANS OF SOUTH AFRICA

FCNP(SA)

The examination comprises Part I and Part II. Part II must be passed within six years of passing Part I

PURPOSE OF ASSESSMENT

This qualification forms part of a process to accredit medical practitioners, as specialists in Nuclear Medicine. The Health Professions Council of South Africa (HPCSA) stipulates training requirements, including a minimum period of experiential learning. It is usual for the examination to be taken and passed prior to the completion of the required period of supervised learning specified by the HPCSA. The aim of this qualification is to meet the needs for formal examination certification, as well as to set standards, nationally, for such a qualification.

PART I

1.0 ADMISSION TO THE PART I EXAMINATION

(to be read in conjunction with the Instructions)

1.1 **for admission to Part I of the examination**[1]

1.1.1 the candidate must have a qualification to practice medicine that is registered or registrable as a Medical Practitioner with the Health Professions Council of South Africa (HPCSA)

1.1.2 the candidate must prior to commencing his/her training under 1.1.1 have completed, after his/her internship, one year of acceptable clinical experience which may be family practice, of which six months may be in a recognised department of internal medicine, radiation oncology or diagnostic radiology

1.1.3 Applied Anatomy, Physiology and Pathology may be written prior to entering the registrar program, although it is recommended that this exam be written after at least 6 months of starting training.

1.1.4 Radiation Physics, Instrumentation and Statistics may be written after at least 12 months of starting their training.

1.1.5 Candidates need to pass both Part I examinations within 18 months of starting their training. If not the candidate will be required to rewrite both Part I subjects (depending on individual University rules candidates may also be excluded from further training at that institution).

1.2 **The CMSA Senate, through its Examinations and Credentials Committee, will review all applications for admission to the examination and may also review the ethical and professional standing of candidates**

2.0…/

[1] Updated admission to the Part I effective FS 2020

2.0 SYLLABUS OF THE PART I EXAMINATION

See Appendix A

3.0 CONDUCT OF THE PART I EXAMINATION

The examination comprises

3.1 **two three-hour papers, on**

3.1.1 Applied Anatomy, Physiology and Pathology

3.1.2 Radiation Physics, Instrumentation and Radiobiology

Both papers could include a number of long and/or shorter questions and multiple choice questions

3.2 Standard setting will be applied to all papers for FCNP I and FCNP II. The modified Angoff (Yes/No) method will be used.

3.3 Should a candidate fail one of the subjects, he/she will be exempted at the next sitting of the examination from writing any papers in which he/she obtained at least 50%[2]

3.4 [3]If candidates write only one paper in a semester, a reduced fee will be applied.

PART II

4.0 ADMISSION TO THE PART II OF THE EXAMINATION

(to be read in conjunction with the Instructions)

4.1 **For admission to Part II of the examination a candidate must**

4.1.1 have successfully completed FCNP Part I OR
have successfully completed the MMed (Nucl Med) Part 1 from a South African University
OR
after having been exempted by College of Nuclear Physicians from the primary examination

4.1.2 having successfully completed 36 months training in full-time training posts in a department of nuclear medicine recognised by the HPCSA for such purpose as evidenced by a completed declaration from the head of the academic department.

4.1.3 have successfully completed the Portfolio as proof of in service teaching and training as evidenced by a completed declaration from the head of the academic department. It is recommended that all candidates entering into their registrar training from 1 January 2019 use the LogBox online portfolio. This is a free service and the app is available in both Apple and Android format. Please register at www.logbox.co.za.[4]

5.0 SYLLABUS FOR THE PART II EXAMINATION

See Annexure B

6.0 CONDUCT OF THE PART II EXAMINATION[5]

6.1 **The examination comprises**

6.1.1 one three-hour paper with short questions on clinical nuclear medicine incorporating clinical medical practice as applied to nuclear medicine

6.1.2 one three-hour paper including single best answer (SBA) and extended matching questions on clinical nuclear medicine incorporating clinical medical practice as applied to nuclear medicine

6.1.3 A structured oral examination on clinical nuclear medicine incorporating clinical medical practice as applied to nuclear medicine. This will consist of a minimum of 12 cases that will include a combination of patient cases and OSCE questions as it relates to Radiopharmacy/ Radiation, Technical/Quality assurance, Clinical/ Patient management, Therapy and Radiobiology.

6.2 **The weighting for Part II is as follows:**

Standard setting (modified Angoff Yes/No) will be applied in order to determine the pass mark.

6.3 Candidates who achieved the required marks in the written examination but who fail the Structured oral/clinical component will be exempt from the written component of the next examination session. Such exemption applies to one sitting only and must be exercised in the following semester.

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[2] Change in exemption criteria effective FS 2019
[3] Fee structure effective FS 2020
[4] LogBox recommendation effective for new Registrars – 1 January 2019
[5] Change in conduct of the Part II examination effective FS 2020

7.0 ADMISSION AS A FELLOW

7.1 Only candidates who have completed training in a CMSA recognised registrar post may be awarded a fellowship if successful in the examination.

7.2 **Candidates who have written the examination as a prerequisite from the HPCSA for inclusion on the specialist register are not eligible to be awarded a Fellowship but will be sent a letter confirming their success in the examinations**

All other candidates will be asked to sign a declaration as below:

I, the undersigned, …… do solemnly and sincerely declare

that while a member of the CMSA I will at all times do all within my power to promote the objects of the CMSA and uphold the dignity of the CMSA and its members

that I will observe the provisions of the Memorandum and Articles of Association, By-laws, Regulations and Code of Ethics of the CMSA as in force from time to time

that I will obey every lawful summons issued by order of the Senate of the said CMSA, having no reasonable excuse to the contrary

and I make this solemn declaration faithfully promising to adhere to its terms

Signed at ……..……. this …… day of

…….. 20 ……..

Signature ……..……

Witness ……
(who must be a Founder, Associate Founder, Fellow, Member, Diplomate or Commissioner of Oaths)

7.3 A two-thirds majority of members of the Senate of the CMSA present at the relevant meeting shall be necessary for the award to any candidate of a Fellowship

7.4 A Fellow shall be entitled to the appropriate form of certificate under the seal of the CMSA

7.5 In the event of a candidate not being awarded the Fellowship (after having passed the examination) the examination fee shall be refunded in full excluding HPCSA candidates who are not entitled to a Fellowship.

7.6 The first annual subscription is due one year after registration (statements are rendered annually)

A P P E N D I X A

SYLLABUS FOR PART I OF THE FCNP(SA)

To provide the knowledge of the basic sciences required for the clinical practice of Nuclear Medicine. The syllabus therefore includes all aspects of physics, instrumentation, anatomy, physiology and pathology which provide the foundation for the clinical practice of Nuclear Medicine.

1.0 APPLIED ANATOMY, PHYSIOLOGY AND PATHOLOGY

1.1 The continuum from physiology of the normal state through to adaptation to environmental stress to pathophysiology is explicitly included.

Similarly with anatomy the impact of the anatomy on the consequences of pathology is included.

1.2 Cell structure and function; genetic control of protein synthesis; metabolism and energy use; kidney, water and electrolyte regulation; haematology, immunity and clotting; heart and circulation; lymph nodes and lymphatic system; lungs, respiration and gas exchange; liver, biliary excretion, gastro intestinal function; bone, calcium and phosphate metabolism; endocrinology, thyroid, parathyroid, adrenals; brain and cerebro-spinal system, cerebro-spinal fluid; biochemistry; amino acids, nuclear acids, hormones, enzymes, Vit B12, iron

1.3 General and special anatomy as applicable to the practise of nuclear medicine. Special attention should be given to systems such as the brain, thyroid, heart, lungs, liver, spleen, gastro-intestinal system, kidneys and bladder, genitalia. Normal tomographic and topographic anatomy, normal variations; embryology; normal appearance in the growing child

2.0 RADIATION PHYSICS, INSTRUMENTATION AND RADIOBIOLOGY[6]

SECTION A: BASIC PHYSICAL CONCEPTS

1. Basic atomic and nuclear physics
   Quantities and Units for radiation
   Atomic structure: Composition, structure, electron energy levels, atomic emissions, nucleus, stable and unstable nuclei
   Origin and general characteristics of radiation

2. Radioactive decay processes
   β− and (β−, γ) decay
   Isomeric transition and internal conversion
   Electron capture and (EC, γ) decay
   Positron (β+) AND (β+, γ) decay
   Decay by α emission and nuclear fission
   SOURCES OF INFORMATION ON RADIONUCLIDES

3. Kinetics of radioactive decay
   Decay equations, decay constant, half-life, average lifetime, effective half-life, units of radioactivity
   Determine decay factors, half-life of radionuclides used in NM, decay corrections
   Specific activity
   Successive decay: Secular vs Transient equilibrium

4. Radionuclide and Radiopharmaceutical Production
   Reactor-produced radionuclides
   Accelerator produced radionuclides
   Radionuclide generators: e.g. Mo-99/Tc-99m; Ge-68/Ga-68
   Radionuclides for nuclear medicine: consideration for diagnostic vs therapeutic
   Radiopharmaceuticals: practical considerations

5. Interaction of Radiation with Matter
   Excitation, ionization and radiative losses
   Interaction of charged particles with matter
   Interaction of x-rays and gamma rays with matter: Photoelectric Effect, Compton Scattering, Pair Production, Coherent (Rayleigh) Scattering
   Attenuation of x-rays and gamma rays: Attenuation Coefficients, narrow-beam vs broad-beam geometry

SECTION B…/

[6] Updated Syllabus effective FS 2020

SECTION B: INSTRUMENTATION

6. Radiation Detectors
   Gas-filled detectors: Ionization Chambers, Proportional Counters, Geiger-Müller Counters
   Semiconductor detectors
   Scintillation detectors: Photomultiplier Tubes, Photodiodes, Inorganic Scintillators, Organic Scintillators

7. Electronic Instrumentation for Radiation Detection Systems
   Preamplifiers, amplifiers, pulse-height analysers, single and multi-channel analysers, high voltage power supplies

8. Gamma ray Pulse-Height Spectrometry
   Spectrometry with NaI(Tl): pulse height spectrum, ideal vs actual spectrum, factors influencing spectrometry (effect of detector size, effect of counting rate, energy linearity, energy resolution)
   Spectrometry with other detectors: Semiconductor Detectors, Liquid Scintillation Detectors

9. Counting systems
   Characteristics: Energy resolution; Detection efficiency; Dead time
   Counting systems: Well counters, liquid scintillation counters, semi-conductor detector systems, in vivo counting systems (NaI(Tl) Probe Systems; Miniature γ-Ray and β Probes for Surgical Use; Whole-Body Counters)

10. Nuclear Counting Statistics
    Types of measurement error
    Nuclear counting statistics, error propagation
    Applications of statistical analysis: averaging, counting rates, significant difference between measurements, background effect, optimal counting time
    Statistical tests and indicators: $\chi 2$ Test, t-Test, Treatment of "Outliers, Linear Regression, Confidence intervals

11. The Gamma Camera
    Basic principles of operation, detector, collimator, PMTs, positioning circuits, PHA
    Digital cameras, Solid state cameras
    Gamma camera limitations: non-uniformity and non-linearity
    Gamma camera tuning
    Performance parameters of gamma cameras (planar): spatial resolution (intrinsic and extrinsic), spatial linearity, uniformity (intrinsic and extrinsic), counting rate performance, energy resolution, system sensitivity
    Image quality in NM: spatial resolution, contrast, noise, observer performance studies

12. Single Photon Emission Computed Tomography
    Tomographic imaging
    Image reconstruction: Filtered back-projection & iterative reconstruction techniques
    Frequency domain representation of an image
    SPECT SYSTEMS: Gamma Camera SPECT Systems; SPECT Systems for Brain Imaging; SPECT Systems for Cardiac Imaging; SPECT Systems for Small-Animal Imaging
    Attenuation Correction; Scatter Correction; Partial-Volume Effects, resolution recovery
    Performance characteristics of SPECT systems: Spatial Resolution; Volume Sensitivity; Quality Assurance in SPECT

13. Positron Emission Tomography
    Basic principles: annihilation coincidence detection; time of flight; spatial resolution, sensitivity; event types
    PET detector and scanner designs
    Data acquisition: 2D vs 3D
    Data corrections and quantitative aspects: Normalization, Correction for Random, scattered and attenuated events, dead time correction, quantification (SUV)
    Performance characteristics

14. X-Ray Computed tomography
    X-ray tube; X-ray detectors: Image formation; CT scanner
    Details of Acquisition; CT reconstruction
    Effect of Scatter; Image Quality
    Artefacts

15. MR Imaging
    Magnetization properties; Generation and detection of the MR signal
    Pulse sequences; Spin Echo; Inversion recovery; Gradient recall echo; Signal from flow
    Localisation of the MR signal
    "K-space" data acquisition and image reconstruction
    Image characteristics
    Instrumentation

16. Hybrid Imaging
    SPECT/CT and PET/CT systems
    Attenuation and scatter correction of SPECT and PET using CT
    Hybrid PET/MRI and SPECT/MRI

17. Digital Image Processing
    Basics of the computer, application of computers in NM
    Digital images: static, dynamic, gated
    Processing techniques: Image visualisation, ROI & VOI, Time activity curves, Image smoothing, Edge detection, segmentation, Co-registration of images, image reconstruction
    Image quantification: radioactive uptake in organs, MUGA, basic principles of integral and Rutland-Patlak
    File format compatibility (DICOM)

18. Non-imaging techniques and tracer kinetic modelling
    Basic concepts of tracers
    Basic concepts of compartmental models (??)
    Cardiac function and ejection fraction; Cardiac shunt analysis
    Non-imaging procedures: Blood volume, GFR

SECTION C: DOSIMETRY AND, RADIATION PROTECTION AND RADIOBIOLOGY

19. Internal Radiation Dosimetry
    Radiation dose and equivalent dose: quantities and units
    Calculation of radiation dose (MIRD method): Cumulated Activity, Equilibrium absorbed dose constant, absorbed fraction, mean dose per cumulated activity, whole body dose, effective dose, limitations of MIRD method
    Radiation doses in NM and Diagnostic radiology

20. Radiation Safety and Health Physics
    Quantities and units
    Principles of radiation protection: ALARA principle, time, distance, shielding
    Legal aspects of the medical use of radioactive materials and ionising equipment: South African act and regulations
    Safe handling of radioactive waste
    Disposal of radioactive waste
    Radiation accidents
    Radiation monitoring & limits

21. Radiobiology
    Biological effects of radiation
    Methods to minimise radiation dose to patients, staff and the environment
    Immunology; molecular biology and genetics
    Principles of therapeutic radiation biology

3.0 SUGGESTED READING MATERIAL[7]

- Saha GB. *Physics and Radiobiology of Nuclear Medicine.* 4th .ed Springer, 2013. ISBN 0-387-95021-4
- Cherry SR Sorenson JA, Phelps ME. *Physics in Nuclear Medicine.* 4th ed. Elsevier, 2012
- Bushberg JT, Seibert JA, Leidholdt EM, Boone, JM. *The Essential Physics of Medical Imaging*. 3rd ed. Lippincott Williams & Wilkins, Philadelphia, 2012. (specifically for MRI and CT, but also general NM)
- *Quality Control of Nuclear Medicine Instrumentation and Protocol standardisations, EANM 2017*
- *Performance Measurements of Scintillation Cameras.* NEMA Standards Publication July 2018

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[7] Updated suggested reading effective FS 2020

A P P E N D I X B

SYLLABUS FOR PART II OF THE FCNP(SA)

To provide the knowledge required for the clinical practice of Nuclear Medicine. The syllabus therefore includes application of all the knowledge obtained in part one and all aspects of medicine (eg Internal Medicine, Surgery, Paediatrics, Obstetrics and Gynaecology) relevant to the practice of Nuclear Medicine.

1.0 CLINICAL NUCLEAR MEDICINE INCORPORATING CLINICAL MEDICAL PRACTISE AND PATHOLOGY AS APPLIED TO NUCLEAR MEDICINE

1.1 **Radiopharmacology:**
General principles of radiopharmaceuticals; production of radionuclides by the reactor, cyclotron and other particle accelerators; generators; formulation of radiopharmaceuticals; biochemistry, physiology and pharmacokinetics of radiopharmaceuticals; preparation and dispensing of radiopharmaceuticals; physical, biological and effective half-lives; general principles of the use of radiopharmaceuticals with particular reference to organ and tumour imaging; calculation of absorbed dose, methods to reduce radiation dose

1.2 **Radiation biology and protection:**
The biological effect of radiation with emphasis on the effects of low dose radiation; methods to minimise radiation dose to patients, staff and the environment; immunology; molecular biology and genetics; principles of therapeutic radiation biology

1.3 **Diagnostic use of radionuclides in children and adults including imaging and non-imaging applications**[8]
General indications and limitations for the use of nuclear medicine techniques; clinical aspects of studies including preparation and management of patients before, during and after the examination. In vivo image and functional studies including those of the central nervous system, cerebro-spinal fluid, thyroid and other endocrine organs, salivary glands, lung, heart, blood vessels, gastro intestinal tract, biliary tract, liver, spleen, kidney, pancreas, bladder, musculoskeletal system, bone marrow, tumours and use of imaging equipment and external detectors. Use of physiological gating techniques; monitoring during intervention studies, exercise and pharmacological stress; electrocardiographic interpretation and cardiopulmonary resuscitation. Complimentary roles and comparisons between nuclear medicine examinations and other imaging techniques such as ultrasound, computer tomography and magnetic resonance imaging

1.4 **Therapeutic use of radionuclides:**
Selection of patients including diagnostic procedures required to determine the necessity of therapy with unsealed radionuclide sources. Indications and contra-indications for the use of therapeutic doses of radionuclides, including their efficacy relative to other therapeutic procedures. Doses administered including patient care post therapy, potential early and late adverse effects, expected clinical response including follow-up. Specific applications include radio-iodine for the treatment of hyperthyroidism and thyroid carcinoma, I-131-MIBG for neuro-endocrine tumours, peptide receptor radiotherapy (PRRT) for tumours expressing somatostatin receptor (SSR) or prostate-specific membrane antigen (PSMA), radiosynovectomy, selective internal radiation therapy (SIRT) and palliative bone therapy

2.0…/

[8] Updated syllabus for Part II examination effective FS 2020

2.0 SUGGESTED READING MATERIAL[9]

2.1 Nuclear Medicine

- Current nuclear medicine textbooks as recommended by individual teaching units
- Current Nuclear Medicine Guidelines (National and International, e.g. SASNM, SNMMI and EANM)
- Relevant current Clinical Guidelines
- Nuclear Medicine Journals (see below)

2.2 Radiopharmacy:

- Sampson's Textbook of Radiopharmacy: Theory and Practice. Fourth edition. A Theobald (ed), 2010
- Fundamentals of Nuclear Pharmacy, 6th or later edition. GB Saha, Springer
- Technetium-99m Radiopharmaceuticals: Preparation and Quality Control in Nuclear Medicine. I Zolle (ed), Springer, 2007
- Quality control in the production of radiopharmaceuticals. IAEA Tecdoc 1856. IAEA, 2018

2.3 Statistics:

- Kirkwood and Sterne. *Essential Medical Statistics*, 2nd ed. Blackwell Science Publishers, 2003.

2.4 Journals:

- Seminars in Nuclear Medicine
- Journal of Nuclear Medicine
- European Journal of Nuclear Medicine and Molecular Imaging
- American Journal of Nuclear Cardiology
- Quarterly Journal of Nuclear Medicine

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[9] Updated suggested reading effective FS 2020