THE TAMIL NADU DR. M.G.R.
MEDICAL UNIVERSITY, CHENNAI.

Allied Health Science
B.Sc. Nuclear Medicine Technology
2018-2019

BRIEF SUBJECT TITLE TO BE COVERED

Syllabus for B.Sc in Nuclear Medicine Technology

Main Subjects

1st Year

1 Human Anatomy & Physiology.

2 Basics of Computer and Image hard copies production in NM, including X-ray Film / Image processing Techniques

3 Basic physics & Nuclear Physics.

IInd Year

4 Physics of Nuclear Medicine instrumentation

5 Radiochemistry & Radio pharmacy

6 Nuclear Medicine Techniques & Special Procedures

IIIrd Year

7 Recent advances in Nuclear Medicine Techniques

9 Radiation Biology & Radiation safety in Nuclear Medicine.

8 Quality Assurance in Nuclear Medicine.

NOTE: For the supportive subjects Internal Examination to be conducted by the institute conducting the course and marks should be submitted to the University.

FIRST YEAR (INTERNAL PAPERS)

1. ENGLISH (50hrs)

2. MEDICAL ETHICS (50hrs)

3.GENERAL PRINCIPLES OF HOSPITAL PRACTICE AND CARE OF PATIENT (50HRS)

SECOND YEAR (INTERNAL PAPERS)

PATIENT CARE RELEVANT TO NUCLEAR MEDICINE PRACTICE. (50hrs)

1. ENGLISH (INTERAL PAPER)

Communication

Role of communication Defining
Communication Classification of
communication

Purpose of communication

Major difficulties in
communication Barriers
to communication
Characteristics of successful communication – The
seven Cs Communication at the work place
Human needs and communication “Mind

mapping” Information communication

Comprehension passage:

Reading purposefully Understanding what is read Drawing

conclusion Finding and analysis

Explaining:-

How to explain clearly Defining and giving reasons Explaining
differences Explaining procedures Giving directions

Writing business letters:-

How to construct correctly Formal language

Address Salutation
Body Conclusion

Report writing: Reporting an accident

Reporting what happened at a session

Reporting what happened at a meeting

2. **MEDICAL ETHICS (INTERNAL PAPER)**

1. Medical ethics - Definition - Goal - Scope

2. Code of conduct - Introduction –Basic principles of medical ethics – Confidentiality

3. Malpractice and negligence - Rational and irrational drug therapy

4. Autonomy and informed consent - Right of patients

5. Care of the terminally ill- Euthanasia

6. Organ transplantation

7. Medico legal aspects of medical records – Medicolegal case and type- Records and document related to MLC - ownership of medical records - Confidentiality Privilege communication - Release of medical information - Unauthorized disclosure - rentention of medical records - other various aspects

3. GENERAL PRINCIPLES OF HOSPITAL PRACTICE AND CARE OF PATIENT (INTERAL PAPER)

Suggested number of teaching hours 100 including tutorials and demonstrations. This section is intended to emphasize to the student technologist the importance of patient welfare. Many of the points included in this section may be considered during the teaching of other subjects also; but it is strongly urged that specific teaching and as much practical demonstration and instruction as possible should be given in this section. Modern hospital treatment is based on team work, it is essential that the student should appreciate the technologists role and that the importance of co-operation with wards and other departments. The students should be attached to wards or the accident and emergency department for a definite training period, the length of time being suited to the individual hospital.

1.Hospital procedure: Hospital staffing and organization; records relating to patients and departmental statistics; professional attitude of the technologist to patients and other members of the staff; medico-legal aspects; accidents in the departments appointments organization; minimizing waiting time; out-patient and follow-up clinics; stock-taking and stock keeping.

2.Care of the patient: FIRST contact with patients in the department; management of chair and stretcher patients and aids for this, management of the unconscious patient; elementary hygiene; personal cleanliness; hygiene in relation to patients (for example clean linen and receptacles , nursing care; temperature pulse and respiration; essential care of the patient who has a tracheostomy; essential care of the patient who has a colostomy; bedpans and urinals; simple application of a sterile dressing.

3. First aid: Aims and objectives of first aid; wounds and bleeding, dressing and bandages; pressure and splints, supports etc. Shock; insensibility; asphyxia; convulsions; resuscitation, use of suction apparatus, drug reactions; prophylactic measures; administration of oxygen; electric shock; burns; scalds; haemorrhage; pressure points; compression band. Fractures; splints, bandaging; dressing, foreign bodies ; poisons.

4 Infection : Bacteria, their nature and appearance ; spread of infections; auto-infection or cross-infection; the inflammatory process; local tissue reaction, general body reaction; ulceration; asepsis and antisepsis

5.Principles of a sepsis: Sterilization -methods of sterilization; use of central sterile supply department; care of identification of instruments, surgical dressings in common use, including filamented swabs, elementary operating theatre procedure; setting of trays and trolleys in the radiotherapy department (for study by radiotherapy students only)

6.Departmental procedures: Department staffing and organization; records relating to patients and departmental statistics; professional attitudes of the technologist to

patients and other members of the staff, medico-legal aspects accidents in the department; appointments; organization; minimizing waiting time; out-patient and follow-up clinics; stock taking and stock keeping.

7.Drugs in the department : Storage : classification; labeling and checking, regulations regarding dangerous and other drugs; units of measurement, special drugs, anti-depressive, anti-hypertensive etc.

Books for study

Text book

1." Care of patient in diagnostic Radiography" By: Chesney & Chesney.
Pub: Blackwell Scientific.

Reference book :

2. " Chesney's Care of the patient in Diagnostic Radiography"By: Pauline J . Culmer. Pub:Blackwell Scientific.
3. " Aid to Tray and Trolley Setting" By: Marjorie Hougton Pub: Bacilliere
4. "First Aid' By : Haugher & Gardner Pub: Hamlyn..
5. "Practical nursing and first- aid" By: Ross and Wilson.Pub: Livingstone.

Paper - 1. HUMAN ANATOMY & PHYSIOLOGY (150 hrs)

Suggested number of teaching hours 120 including tutorials A knowledge of the normal structure and function of the different parts of the body must be coupled with some idea of the way in which disease arises and extends, so that the technologist can assist in the various procedures used in diagnosis and treatment.

The syllabus gives under the main headings the names of organs and systems to indicate the scope of teaching required. Both in diagnosis and treatment. Knowledge of the size and position of an organ is of paramount importance. The level to be aimed at here is difficult to define, but books on surface anatomy are available and only rarely will it be necessary to refer to major works on anatomy, such as Gray and Cunningham.

Under the repeating headings common terms used in connections with diseases of this system, no detailed list of diseases is required, but an explanation of those terms which the technologist may encounter in daily work is necessary.

1 **General Anatomical Terms**

2 **Regions of the body**

3 **Description of a typical animal cell:** Cell mitosis; genes; sex cell; ova and spermatozoa. Fertilization of the ovum. Broad lines of embryonic development. Cell function and differentiation of tissues.

4 **Structure of General Tissues :** Epithelium; simple and complex epithelia; glands; skin. Connective tissue; fibrous tissue; cartilage; bone; Haversian systems; blood; numbers and types of cells in blood; clotting of blood. Muscle tissue; involuntary, voluntary and cardiac muscle. Nerve tissue.

5 **Nature of neoplasm's:** Common benign tumors. Malignant tumors and their dissemination.

6 **Bones, joints and locomotors system:** General description of bones, their main processes and attachments, 'including the skull with emphasis on the skull as a whole. Development of bones, Primary and secondary bone centers; diaphyses and epiphyses. Position and function of main joints. Some common diseases and injuries of bones and joints; Healing of fractures.

7 **Thorax and Abdomen :** Structure of thoracic cage, abdominal cavity; diaphragm and mediastinum.

8 **Heart and Blood Vessels**: Structure and function of the heart, pericardium, peripheral vascular system; names of main arteries and veins, circulation. Common terms used in connection with diseases of this system.

9 **Respiratory system :** Nasal passages and accessory nasal sinuses, pharynx and larynx, trachea, bronchi and lungs; pleura, nature and function of respiration. Common terms used in connection with diseases of this system.

10 **Lymph node Groups:** Lymph and tissue fluid, main lymphatic gland groups and drainage areas, lymphoid tissue and tonsil.

11 **Reticule-Endothelial system :** Spleen and liver, bone marrow, extent and nature, physiology of the red and white blood corpuscle's.

12 **Alimentary system :**Mouth, tongue and teeth, salivary glands, pharynx and esophagus, stomach, small and large bowel, liver and biliary tract, pancreas, motility of the alimentary tract; digestion, absorption and metabolism, nutrition and dietetics, Common terms used in connection with diseases of this system.

13 **Urinary tract :** Kidneys, ureters, bladder and urethra; urine formation & excretion, common terms used in connection with diseases of the system.

14 **Reproductive system :** Male genital tract; testes, epidedymis, seminal vesicle and prostate; female genital tract; uterine tubes, ovaries, uterus, vagina and vulva, the mammary glands; menstruation, pregnancy and lactation; common terms used in connection with diseases of this system.

15 **Endocrine glands;** Anatomy and function of pituitary, thyroid, para thyroids, adrenal, thymus, pancreas and gonads as endocrine organs; common terms used in connection with diseases of this system.

16 **Nervous system:** Brain; main subdivisions and lobes; ventricular system, spinal cord, concept of motor, sensory and reflex pathways; meninges and cerebrospinal fluid; its circulation; autonomic nervous system; common terms used in connection with diseases of this system.

17 **Special sensory organs:** Structure and function of the eye; structure and function of the ear; structure and function of the skin.

18 **Surface markings** and topographical relations; radiographic anatomy.

BOOKS FOR STUDY

Text book

1.Anatomy and Physiology for Radiographers - C.A. Warrick Reference books
2.Gray's anatomy Descriptive and applied - T.B. Johnstor.
3.Foundation of Anatomy and Physiology - Ross and Wilson.
4.An Atlas of Normal Radiographic Anatomy - Richard & Alvin
5.Essentials of Human Anatomy – Russell
6.Best and Taylor : The Human Body – its anatomy and physiology (Chapman and Hall)
7.Blewett and Rackow : Anatomy and Physiology for Radiographers (Butterworth)
8.Dean : Basic Anatomy and Physiology for Radiographers (Blackwell)
9.Fitzgerald : Anatomy 1600 multiple choice question (Butterworth)
10.Hamilton et al : Surface and Radiological Anatomy (Heffer).

Paper – 2. COMPUTERS AND IMAGE PROCESSING TECHNIQUES IN NUCLEAR MEDICINE.

Computer Applications related to Nuclear Medicine -Introduction to computer: Characteristics of computers -Computer basics -Word processing -data base -analog images – digital image -image processing -picture, volume elements-gray scale & color scale -software – hard ware – keyboard skills-hard ware description-software packages –Computer limitations. Storage devices. Basics on Nuclear Medicine image hard copies in films, glossy prints, paper prints etc -how to produce the best image quality.

X-Ray films – types – basic film structure & quality-choosing films for different studies –dry and wet processing -manual –automatic-Conventional & modern image processing rooms -Image processing equipments – types –day light systems advantages & disadvantages-processing faults-maintenance -Components of Image quality-image sharpness-spatial relationships-use of radioactive markers – optimum image viewing options.

Paper - 3. BASIC PHYSICS & NUCLEAR MEDICINE PHYSICS (150hrs)

Basics: Elementary introduction to structure of matter-elements-compounds and mixtures -molecules and atoms-Atomic & Nuclear structures-Atomic models – Periodic table -Mass energy equivalence – Fluorescence – Phosphorescence – luminescence - electromagnetic spectrum.
Electricity, Magnetism and Electro magnetic induction: Electricity in ionized gases-electric charges-electric induction-Coloumb law-unit of charge-resistance-ohms law-electric power-Joules law. Magnetism-magnetic properties-electromagnetic effect-electrical instruments like Voltmeter, Ammeter & Multimeter.

Radiation Units & Quantities.

Radioactivity & Interaction of Radiation: Radioactivity -Discovery– Natural & Artificial Radioactivity-Isotopes and nuclides – binding forces between nuclear particles –alpha & beta particles – gamma radiation -mechanisms of radioactive decay – half life -Interaction of electrons, X-Ray production, X-rays & ɣ-rays interaction with matter -Radiation intensity & exposure -radiation dose -Radiation quality – law of exponential attenuation – half value layer – linear attenuation coefficient – Scattering – photoelectric effect – Compton-scattering – pair production – particle interactions – total attenuation coefficient- relative clinical importance.

BOOKS FOR STUDY

1 Physics in Nuclear Medicine – Simon Cherry, James Sorenson & Michael Phelps.
2 Basic Medical Radiation physics: Stanton
3 Medical Radiation Physics – William R. Hendee.
4 Basics of Computers and Image hard copy production in Nuclear Medicine.
5 Computers in Nuclear Medicine –A practical Approach – Kai.H.Lee
6 Computer Fundamentals-concepts, systems & Applications – D.P Nagpal
7 Effective use of computers in Nuclear Medicine: Michael J.Gelf and Stephen.RThomas.
8 Radiographic Latent Image Processing – W.E.J. Mckinney
9 General principles of Hospital practice and care of patient

EXAMINATION SCHEDULES:

1st YEAR

THEORY	PRACTICALS & VIVA
PAPER-I Human Anatomy & Physiology.	Identification of Bones
PAPER-II Image processing Techniques	
PAPER-III Basic physics & Nuclear Physics.	

Identification of computer parts, Image hard copies & equipments. Models, Charts & Graphs Demo

SCHEME OF EXAMINATION

FIRST YEAR **(240 WORKING DAYS)**

Sl. No	Subject Title	I A		Theory		Practical		Viva Voce	
		Max	Min	Max	Min	Max	Min	Max	Min
1.	Human Anatomy & Physiology.	50	25	100	50	100	50	50	25
2	Image processing Techniques.	50	25	100	50	100	50	50	25
3.	Basic physics & Nuclear Physics	50	25	100	50	100	50	50	25

Internal Assessment

• Wherever there is no Log Book/Project/ Record work, 10 mark be added to the Practical of the respective subject.

Practical List

First Year

Human Anatomy & Physiology

BP Measurement
Recording Pulse

Basic Imaging Techniques, Computers, X ray films

Adjusting gray/colour scales for a given image
Drawing a graph for the given data in Excel (Eg.Time activity cure)

Basic Physics & Nuclear Physics

Half valve layer of Beta and Gamma Emitters
Determination of Half-life of given radionuclide
Effect of Distance and Shielding on Intensity of Radiation from the given source.

SYLLABUS FOR B.SC IN NUCLEAR MEDICINE TECHNOLOGY.

SECOND YEAR:

Paper - 1. Physics of Nuclear Medicine instrumentation (100hr) mber – Isotope calibrator – Proportional Counter – Geiger muller counter – Voltage calibration of a Geiger Mueller tube, optimum operating condition – Dead time correction – Uses of Gas – filled detectors – Semiconductor detectors

1. **Radiation detectors:** Construction and Principles of Operation – lonization Cha Scintillation detector: Thallium activated Sodium lodide crystal – Photo multiplier tube, electron multiplication, high voltage supply, Shielding, collimators, field of view. Well counter – construction, design of shielding. Signal output, Pre-amplifier – reasons for use – Voltage amplifier – liquid scintillation detector- Beta counter – Gamma probes.

2. **Spectrometer:** Basic principles of Pulse – height analyzer single channel and Multi – channel analyzers. Optimum operating conditions, window settings –

Determination of gamma energy spectrum, Integral and differential counting. Spectra of commonly used radio nuclides
e.g l-131, Tc99m, Cr51, Cs137. Problems in radiation measurements with worked examples

3. **Statistics of counting:** Types of measurement error, Precision and Accuracy – Nuclear counts statistics – Poison, Normal (Gaussian) distribution – Standard deviation, Probable error, confidence limits, Percent standard deviation – Efficient distribution of counting time. Statistical tests. – Chi – square test – Figure of Merit – test – Precision of Rate meter Measurements.

4. **Rectilinear scanner:** Construction and Principles of Operation. Collimation, collimator focus, collimator focal length septa thickness, high resolution, high sensitivity, Iso-response curves collimator resolution with – Scintillation crystal size and its effect on photo and dot scans. Rate meters – time constant – effect on counting Cathode ray tube – Photo recording display, cathode ray tube, film density, gray curve, effect of contrast enhancement Information density, scan speed, line space Dot factor Minified images – application in Bone scan – multi crystal scanners, fluorescent scanning.

5. **Gamma camera:** Camera head construction and principle of operation Collimators – parallel multi hole, high resolution, high sensitivity pin hole, diverging hole, slant hole. Collimators Scintillation crystal, size Light guide – Photo multipliers per amplifiers.

Control panel – pulse shaping linear amplifiers Pulse height analyzer Timer, Data Processor and their function. Application of Cathode ray tube – persistence scope – Camera scope. Resolving, time characteristics – Analogue – Digital controls Uniformity and intrinsic resolution Sensitivity, Total – system resolution, Spatial volume resolution saturation.

Frame mode & List mode acquistion - Static, Dynamic, Tomo and Gated acquisition

– Image perception & Analysis -Background correction methods -ROI analysis- Time Activity curves – Filters and normalization methods.

BOOKS FOR STUDY

Text book

1. Physics of Nuclear Medicine, - James A. Sorenson & Michael

Reference books

2. Nuclear Radiation Detection – William J. Price, McGraw – Hill Book Company
3. Principles of Nuclear Medicine – Henry N. Wagner, W.B. Saunders company, London

4. Principles and practice of Nuclear Medicine, Paul J. Early, D. Bruce Sodes. C.V. Mosby company Princeton
5. Instrumentation in Nuclear Medicine – Gerald J. Hine

Paper - 2. RADIOCHEMISTRY AND RADIOPHARMACY (120hrs)

1.Basic Laboratory Techniques (i) use of glasswares (ii) Washing and autoclaving glasswares for the use in Radiopharmacy areas (iii) Correct use of Pipettes, Balance, Centrifuge, Syringes etc.
Receipt -storage -disposal of radioactive materials (iii) International symbols of radioactivity labels

2.Basics of radiation chemistry:(a)Atomic and molecular structure (b) Bonding (Electrovalent, covalent, Dative bond and hydrogen bonds) (c) Valency, Atomic wt., -Molecular wt -Normality and molarity of solution, (d)Acids and Bases - Hydrogen Ion concentration - pH value - The play of pH in the preparations of radio pharmaceuticals -(e) chemical reaction -solute -Solvents -Solubility -crystallization -
(f) The chemical elements which are necessary for life (carbon -Hydrogen, oxygen and nitrogen, Phosphorous, Iron etc.). (g) Fundamental chemistry of carbohydrates and carbonyl groups (h) -Oxidation and Reduction (i) proteins and amino acids. Lipids and profiles. Enzymes - vitamins, Hormones.

3.Isotope generators: Production of radio nuclides by artificial methods (b) cyclotron Produced radio nuclide (c) Nuclear reactor produced radio nuclides Principles of generator systems -Ion Exchange system -Solvent extraction system - Parent -daughter relationship-growth of daughter product equilibrium with parent elements etc.

Chemistry of Tc99m, Mo99-Tc99m generators -Assay -Mo99 contamination check Aluminum break through test etc (f) Sterilization

4. **Radio pharmaceuticals:** Lyophilisation, Preparation of cold kits. -DTPA, GHA, DMSA, MDP, Phytate. Tin pyrophosphate, -Albumin microspheres, S. Colloid etc. (c) Labeling of cold kits with required radio isotopes and their Quality control tests like RC purity, RN purity, sterility check, Chromatography (Various methods) pyrogen test, Methods of radiopharmaceutical localization and bio distribution studies.

5.Radio iodination: basic principles, Iodination of MIBG-131, Purification -Resin column -Ion exchange reaction, radiochemical purity etc.
6.Tracer methods -Behavior of radioactive tracers in biological process -characteristics of radio pharmaceuticals - Half life - (Physical and Biological) – Tracer kinetics – Compartmental models.

7.Dispensing of radio pharmaceuticals - Specific activity Tracer dose preparation – Radiopharmaceutical dossage calculations - Tracer dose administration etc. Preparation of standard (References) 100%, 50%, 10%, etc.
8. Preparation of the required reagents for the kit formulations and other labeling procedures.
9.Introduction to Molecular biology, biochemistry (carbohydrates-,proteins-enzymes-lipids-hormones-vitamins and nucleic acids) and immunology (humeral immune response-cell mediated immune response- antigen-antibody reaction-monoclonal antibody)

10. Radiolabeled Blood Cells
Individual Radiopharmaceuticals: Clearance and uptake. Method of Localisation (Not included in NM Techniques paper too).

11. Elution of 99mTc from 99Mo-99m Tc Generator & Check the radio Chemical purity
Calculate the number of particles Tc99m MAA preparation
Prepare Tc99mMDP]
Prepare Tc99mDTPA]
Prepare Tc99mDMSA] Check Purity, pH etc.,
Prepare Tc99mMIBI]

Books for study

Text book

1. The handbook of Radio pharmaceutical -Mohan Patel & Samij Sadack, Chapman & Hall Medicals, London.

Reference books

2 Fundamentals of Nuclear Pharmacy-Gopal B. Sah,eSpringer-Verlag, New York.
3 Nuclear Medicine Technology & Techniques-Donald R. Bernier , Paul E. Christian & James K. Langan Mosby

Paper - 3. NUCLEAR MEDICINE TECHNIQUES AND SPECIAL PROCEDURES (100hrs)

I Diagnostic – In vitro techniques: Principles of Radio immunoassays (RIA) standard curve, data analysis, Quality Control(QC) and applications, Methods of receptor assays, hormones , drugs.
IRMA Immunoradiometric assay, ELISA, RIA, estimation, T3, T4, TSH, thyroid antibodies, and current applications using similar techniques.
2. **In vivo techniques -** (Imaging & non imaging Procedures) a) General Principles of non-imaging techniques, Tracer dose, uptake studies, compartmental analysis in radio nuclide studies, volume dilution studies. Clinical Nuclear Medicine - Diagnostic studies.

3. **Endocrine System:** *An*atomy, physiology and different pathology -Iodine metabolism -Radiopharmaceuticals, the rationale, dosimetry & precautions-Indications for Thyroid Imaging -131 I Uptake studies -Scintigraphic technique -regular study as well as Thyroid Cancer-Thyroid whole body survey . Per chlorate discharge Test, T3/T4 suppression test, TSH stimulation test. RIA invitro Procedures: T3, T4 Estimation using Radio Immuno Assay methods-estimation of TSH levels, Thyroid Antibodies levels.

Adrenal scintigraphy: Cortical scintigraphy-radio pharmaceuticals, technique, applications. Medullary scintigraphy - radio pharmaceuticals, technique, applications Parathyroid scintigraphy: radiopharmaceuticals, technique

4. **Skeletal system:** Bone: Pathology of bone diseases, indications for scintigraphy -patient preparation -Radio active tracer doses and their administrations, Imaging techniques- whole body sweep, spot views, isocount and isotime studies, three phase & four phase bone scans - care to be taken while handling patients with bone fractures-applications Bone marrow scintigraphy: Radio pharmaceutical used, technique Measurement of bone mineral mineral: technique & applications.

5. **Respiratory system:** Pathology of respiratory diseases-Indication for scintigraphy.-Perfusion studies -Patients preparation -radio pharmaceuticals and dose administration-precautions to be followed and drugs to be kept for any anaphylactic reactions- contraindication for the procedure. Ventilation studies --Radio pharmaceuticals -Aerosols -inhalation procedures -Imaging procedures -precautions to be followed during inhalation of Aerosols.

6. **Central nervous system:** Brain: Anatomy and brief physiology, different pathology and indications for scintigraphy.Conventional brain scintigraphy-radio pharmaceuticals , dose &dosimetry, patients preparation, precaution to be taken with post operative patients, epilepticpatients ,brain secondaries. Cerebral perfusion imaging: radio pharmaceuticals, dose &dosimetry, patients preparation Cisternography:radiopharmaceuticalsdose&dosimetry,methodology.Scintigraphy for CSF leak.

7. **Urinary tract:** Anatomy and physiology in brief, Pathology, Indications -Radiopharmaceutical preparation -dosages & Administration, patient preparation, renogram usingprobes, quantitative studies GFR, ERPF, split function, parameters for function evaluation. Acquisition techniques-Dynamic study:-renal perfusion study -dynamic mode -purpose -dosage and technique in normal & renal transplants.

Static renal imaging: procedure includinganalague imaging-indication and comparison, of different studies as per the pathology-renalcortical imaging techniques. Evaluation of Reno vascular hypertension, Transplant

scintigraphy.Radionuclide cystography-Radio pharmaceutical & imaging techniques. Scrotal scintigraphy:Radio pharmaceutical, dosimetry, methodology.

8. **Gastrointestinal tract:** Anatomy and pathology, Esophageal transit study-Radiopharmaceutical dosimetry, technique & analysis. Gastro esophageal reflux-Radiopharmaceutical dosimetry, technique & analysis. Gastric emptying-radio pharmaceuticaldosimetry, technique & analysis. Gastrointestinal bleed scintigraphy: Radio pharmaceutical,dosimetry, methodology including RBC tagging procedures, Meckels' scintigraphy-Radiopharmaceutical, patient preparation. Pancreatic imaging: Radio pharmaceutical, dosimetry,methodology

9. ***Heptobiliary scintigraphy:*** Anatomy and pathology . Radio pharmaceutical, patientpreparation ,dosimetry, dynamic flow-static imaging procedures, applications. Hepatic arteryperfusion scintigraphy.

10. ***Liver,spleen scintigraphy:*** Pathology ,basis of scintigraphic localization -Patient-Dosage-Procedures-Patient. Preparation,applications.99mTc Heat damaged -RBCs -basics of -Taggingprocedure dose administration - Imaging procedure.

11.*Cardio vascular system* :Anatomy and pathological conditions, Indications for studies. ECG-Terminology of cardiac cycle - diastole -systole -diastolic volume -stroke volume cardiacoutput, Ejection Fraction - Pulmonary Transit time, Hypokinesia - akinesia - diskinesia etc.Dynamic study-first pass study: Purpose -radio nuclide -dosage -Bolus Injection -computersettings - Image acquisition - processing etc.

Multigated Blood Pool Acquisition (MUGA) Radionuclide, indication,administration dosage,Imaging procedures, Processing -E.F. calculation -Global and Regional stroke volume -Histogram phase angle etc. Stress study -Different medicines used for stress -dosage, physicalstress study -MUGA repeated after stress. Myocardial perfusion imaging -Radionuclide &Radio pharmaceuticals used, dosage administration, dosimetry. Imaging procedures -stress andrest. Infarct avid imaging: Radio pharmaceuticals, Technique.Shunt evaluation: Radio pharmaceuticals, Technique & analysis. 24

12. **Haematological studies:** Hematological disorders total blood volume., Estimation of RBCvolume, Blood volume -using 51Cr as well as 99mc -Red cell survival studies with 51Cr.,platelet survival studies, ICSH recommendations in data presentation, use of computer softwarefor survival curves.

13.Infection and inflammation: Radio pharmaceuticals, dosimetry, comparison of the radiopharmaceuticals used, leukocyte labeled studies-leukocyte labeling procedures, imagingtechniques and applications.

14.Tumor imaging: Radio pharmaceuticals, dosimetry, comparison of the radio pharmaceuticals used, imaging techniques, applications.

15. ***Special procedures:*** Lymphoscintigraphy: Radio pharmaceuticals, dosimetry, imaging techniques. Venography: Radio pharmaceuticals, dosimetry, imaging techniques. Proteinloss studies: Radio pharmaceuticals, dosimetry, imaging

techniques, precautions prior to imaging. Salivary gland imaging: Radio nuclide -dosage -Imaging procedures. Vitamin B12 absorption study: Folic acids study etc. Schilling test.

16. ***Therapeutic application of radio nuclides:*** General precaution regarding contamination and radiation dosage. Radio iodine therapy for Thyrotoxicosis : Dosage Administration -Precaution to be followed. Radio iodine therapy for Thyroid malignancy :Dosage. Administration -Precaution and care of patient during administration. mIBG I13l -Indications -Dosage -Administration -Precaution to be taken during administration. Palliative treatment for bone metastasis : 32 P- and 89 Strontium Dosage -Administration -Precaution to be followed during administration. Intracavitory use of radioactive colloid: Au 198 Dosage - Administration -Precaution to be followed during administration. Intravascular particulate radio nuclide Therapy-Administration -Precaution to be followed during administration. Intra articular Therapy : Administration -Precaution to be followed during administration. Labeled Monoclonal antibodies (Radioimmunotherapy). Labeled receptor therapy.

17. Perfom Diuretic Renogram, Perform Triphase Bone Scan, Perform thyroid scan, Perform a thyroid uptake study, Perform renal cortical scan, Perform radionuclide Ventriculography, Perform GI Bleed scan, Perform Hepatobiliary scan

18.Instrumentation in Nuclear Medicine

GM tube experiments – Plateau, Operating Voltage and Dead time
Resolution of Half-lives from a mixture of radionuclides
Gamma Ray Spectrometer calibration
Identification of Unknown radiotracer
Isotope Dilution Principle
Chisquare Test
Accuracy & Constancy test

Books for study

Text book

1. Principles and practice of Nuclear Medicine ,Bruce Sodee, Paul J.Early & Sharon Wikepry

Reference book

2 Mosbeys manual of Nuclear Medicine Procedures Bruce Sodee, Paul J.Early & Sharon Wikepry, Mosbey company, London
3 Essentials of Nuclear Medicine, M.V.Merrick
4 Basic Science of Nuclear Medicine,Roy P Parker, Peter A S Smith & David Churchill Livingston, New York 35

5 Essentials of Nuclear Medicine Imaging ,Fred A Metter, Milton J W B Saunders company, London
6 Principles of Nuclear Medicine Henry N Wagner:W B Saunders company, London
7. Clinical Nuclear Medicine M N Masey, K E Britton & D L Gilday Chapman and Hall
medicals
8. Nuclear Medicine Technology & Techniques -Donald R. Bernier , Paul E. Christian & James K. Langan Mosby

PATIENT CARE RELEVANT TO NUCLEAR MEDICINE
(INTERNAL PAPER)

1.Ordering nuclear medicine procedure-checking relevent datas in the request-scheduling the procedures by giving appointments-giving proper instructions regarding the studies and pre preparation for the procedures to the out patients as well as the in patients through the written appointments

2.Preparation of the patients before the procedure-check the correct patient by checking the Name ID No and the Referral unit etc before take the patients for the nuclear medicine procedure.

3.Check the patients about their previous medications especially for thyroid studies and renal studies for patients with RAS problem. Patients (female) should be checked for early pregnancies before starting any radio active procedure. Patients also should be checked for the sensitivity for any particular medicine or dye or any contra indication for the particular study. Eg. Pulmonary hypertension is contra indication for Lung perfusion studies.

4.Care of Patients During the Nuclear Medicine Procedure: regarding the care to be taken while Transferring the patients from the wheel chair or stretcher to the treatment couch especially the bone scan patients with spine secondaries and lung scan patients connected with oxygen cylinders, Post renal Tx patients with IV line and drain tubes. etc neuro patients under coma stage or with epileptic convulsions or children care regarding using the immobilizing devices etc. Micturition of the patients before starting the NM procedures.

5. **Care to be taken during the cardiac studies in the NM department-**ECG monitors should be available -emergency drugs should be available for the use in the time of need along with eparinized IV line and fluids for the parental use.

6. **Preparation of the radio active tracer for the study-**selecting the appropriate tracer for the particular study should be assayed before use and to be properly labeled and to be kept with in the lead shielded container. Usage of gloves and over coats during dispensing of the radio active tracer. Proper tray should be used during the transporting the tracer from the hot room to the injection room. And should be administered carefully and properly in the vein or required spot with

out causing any extravessation and the management of the local haemorrhage and swelling.

7. **Special care** regarding the patients who are coming from SICU and MICU and paediatric patients.

8. **Keeping special equipment** namely Gastric suction, Chest suction, T-tube, Urinary retention catheters., surgical dressing trays, Cardiac monitors,bcentral venous pressure line-colonostomy care management of seizure patients-application of cardio pulmonary resuscitation for cardiac arrest patients.

9. **Specimen collection** in a safe manner and properly label them and store in a proper place for counting or sampling -safety precautions to be followed during the sampling of radio active specimen and precautions to be followed while disposing the same. Care regarding the disposal of contaminated swabs syringes and needles etc.

Books for study

Text book

1. Nuclear Medicine Technology & Techniques, -Donald R. Bernier , Paul E. Christian & James K. Langan Mosby

2. Care of the patient in diagnostic radiology, Chesney & Chesney Blackwell
3. Notes on radiological emergencies Ansell, Churchill
4. A guide to Oncological nursing Deeley Livingstone
5. First aid (Hamlyn) Haugher & Gardner, Hamlyn
6. Care of the injured, Ring Livingstone
7. Practical Nursing and first aid -Ross & Wilson, Livingstone

BOOKS FOR STUDY Add Books to be read

1 Hand book of Nuclear Medicine – Frederick L Datz and

2 Essentials of Nuclear Medicine Imaging – Fred A Mettler , Milton J Guiberteau.

SECOND YEAR

(240 WORKING DAYS)

S.No.	Subject Title	IA		Theory		Practical		Vivavoce	
		Max	Min	Max	Min	Max	Min	Max	Min
1.	Physics of Nuclear Medicine	50	25	100	50	100	50	50	25
2.	Radiochemistry & Radiopharmacy	50	25	100	50	100	50	50	25
3.	Nuclear Medicine Techniques & Special Procedures	50	25	100	50	100	50	50	25

SYLLABUS FOR B.SC IN NUCLEAR MEDICINE TECHNOLOGY. THIRD YEAR

Paper - 1. Recent advances in Nuclear Medicine Techniques (100hrs)

Recent advances in imaging techniques & image processing including fusion techniques-imageguiding for radiotherapy & stereotactic surgeries.

Recent advances in equipments- SPECT, PET including hybrid systems and PET-CT & PET-MRI

Recent advances in radiopharmaceuticals - PET Tracers, production ; Cyclotron-principle, configration and operation - FDG -Sodium fluoride for bone imaging – Neuro & Cardiac radiopharmaceuticals - Newer Computer applications in Nuclear

Medicine -Medical Data Communications and Computer Networks – DICOM – PACS – RIS – HIS -Telemedicine.

Acquire and process Bone SPECT
Acquire and process Myocardial Perfusion SPECT
Acquire and process Brain SPECT
Acquire SPECT CT and register it (Optional)
PETCT Procedures (Optional) – 18FDG PETCT, Naf18 Bone Scan etc.,

1.2 Radiation Biology & Radiation safety in Nuclear Medicine. (100hrs)

Biological effects of Radiation - induction of Radiation injury – somatic and hereditary effects of radiation – effects of radiation on embryo – normal and abnormal human exposure to radiation – maximum permissible levels – Choice of Radiopharmaceutical for the clinical situation and the equipments in hand -Dosimetry – absorbed dose – calculation of absorbed dose – dosimetry of individuals
– absorbed dose from diagnostic & therapeutic nuclear medicine procedures – personnel monitoring – instruments used in radiation survey & monitoring.

Radiation Protection of Staff, Patients & Environment –Transport & Handling of Radioisotopes – Safety and Security of Radioactive sources - Safe administration of diagnostic therapeutic tracers. Inventory maintenance of records - Radioactive waste
& its disposal -Decontamination procedures in Nuclear Medicine Dept. Radiation Accidents and Medical management.

AERB Safety directive - Regulatory Consent -ICRP - Responsibilities of the NM technologist for implementation of basic safety standards- Layout and Planning of Nuclear Medicine facility.
Radiation Safety – Area Monitoring and Contamination swipe test
Decontamination of an Injection table
Calculate the dose received to a patient attendant during a High Dose Therapy
Draw a layout design for Nuclear Medicine Laboratory with PET & SPECT facility.

1.3. Quality Assurance in Nuclear Medicine:-

1.Quality Assurance: In General -quality assurance for attaining the high standards of efficiency reliability in the practice of Nuclear Medicine procedures -efforts to be taken in order to get closeness of standard procedures with which the accurate out-come proper way of submitting the request for the procedure -The preparation and dispensing of radio pharmaceuticals -The routine quality control studies -The protection of patients -staff and general public by following standard procedures -scheduling of patients study patients preparation etc -setting up patient vs correctly for the procedure -maintaining the electronic equipment -in

the correct manner -methodology of the procedure -The analysis and interpretation of results or
data - and finally keeping their records.

2.Quality Assurance of Equipments mainly involves -Acceptance test during installation -Routine daily check -checking the power line -Air conditioning efficiency -dust free atmosphere -Making the availability of service then and there -Routine quality control study of different equipment periodically without delay.
Flood check -linearity-uniformity, dead time, resolution check for gamma camera-Field of view and chi square test for Thyroid uptake unit -Focal distance calibration -Density calibration for scanner. Precision and Energy response study for isotope calibrator-Routine departmental survey for keeping the working area at a lower level of background radiation level etc.

3.Organization of department: How to set up a Lab. -Psychology and social behavior -Group behaviors -individual relationship with colleagues -Senior staff and patients -How people learn memory and forgetting -motivation and emotion -stress and adjustment -Social influence and the individual -evidence of satisfactory progress reflected in the reports of the clinical supervisors –

4. **Assessment procedures:** Presentation of a Technical paper -Literature searching Library resource utilization - Personnel management, punctuality in duties. Professional ethics etc.

5. **Record keeping:** test procedure – maintenance-provisional appointment -Registration of the patients in the department, Register with proper ID number -Isotope Radio pharmaceuticals administration -dosage -Date -Time -mode of Administration etc. Details of Test done -storing of results -Hard copies like Films, Report forms etc. -Despatch of the results to the respective departments -maintaining the records -maintaining original report copy in the department safely etc.

6.Equipment maintenance: Date of installation - Defects raised service done on date and time -done by whom -service record. Periodical quality control study on equipment and their record keeping -Preventive maintenance service on periodical interval either by the engineers in the institution or engineers from the company. stocking of important spares and PC boards for the rectification of the defects during the time of repair.
Dose Calibrator – Accuracy, Precision and Linearity.
QC of Imaging Equipment – Gamma Camera /SPECT CT – Uniformity, Sensitivity, Spatial Resolution, Energy Resolution, COR, Total Performance SPECT, Registration of SPECT & CT – NEMA Procedures.
QC of Imaging Equipment (Optional) – Cross Calibration of PET scanner, Normalization, Registration of PET & CT.

Books for study

Text book

1.Quality Control of Nuclear Medicine Instruments, International Atomic Energy Agency

Reference books

2. Quality Control of Gamma Cameras and Associated Computer Systems, The Institute of Physical Sciences in Medicine
3. Quality Control of Nuclear Medicine Instrumentation, The Institute of Physical Sciences in Medicine
4. "Quality Control in diagnostic imaging"-J.E. GRAY, University Park Press.
5. "Processing and Quality Control"William, E.J. Mckinney.J.B. Lippincott Company.
6. "Concepts in Medical Radiographic imaging"Marianne Tortoice,W.B. Saunders Company.
7. "Quality assurance Management"G.E. Hayes Charger production.
8. Diagnostic Imaging: Quality Assurance M.M. Rehani ,Jaypee Bros Medical Publishers.

THIRD YEAR
(240 WORKING DAYS)

Sl. No.	Subject Title	I A		Theory		Practical		Viva Voce	
	Recent advances	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**
1.	in Nuclear Medicine Techniques Radiation	50	25	100	50	100	50	50	25
2.	Biology & Radiation safety in Nuclear Medicine.	50	25	100	50	100	50	50	25
3.	Quality Assurance Nuclear Medicine	50	25	100	50	100	50	50	25

Practical Subject Title

Nuclear Medicine Procedures – Demo
Planning & Radiation Survey – Demo
Charts discussion.

Log Book
Each candidate should be required to maintain a log book in which following details will be entered.

Investigations performed by him (Under Supervision)
Presentation in Journal clubs along with Title & Journal & Issue with title
Presentation in Departmental Seminars.
Cases worked up for radionuclide therapy.
Department visit logs.

BOOKS FOR STUDY

Text Books:

Radiation Biology and Physics Paul F Wilson and Joel S.Bedford Radiation safety in Nuclear Medicine – Max.H.Lombardi

Reference books:

An introduction to Radiobiology – A.H.W.Nias
Introduction to Health Physics – Herman Cember.
Biological assessment of Radiation Damage – Thomas.L, Walden.Jr and Nushin K
Radiobiology for the Radiologist – Eric J Hall, and Amato J Giaccia.
PET: Physics, Instrumentation, and Scanners – Michael Phelps.
PET and PET-CT A clinical Guide – Eugene Lin and Abass Alavi
Nuclear Medicine and PET/CT Technology and Techniques – Paul Christian and Kristin Waterstram.

Postings during one year Internship

First 2 Months

Nuclear Oncology Posting

Posting in Radiotherapy CT-Stimulator, Work Station and Linear Accelerator

3rd and 4 Months

Nuclear Cardiology Posting

Posting in ECG & Treadmill in Cardiology, Angiogram/Angioplasty,
Myocardial Perfusion SPECt (MIBI/13NH3) Myocardial viability FDG, PET Cardiac MR Posting in Radiology.

5th and 6th Month

Nuclear Neurology Posting

Posting in EEG, In Neurology for Seizure recordings.

7th & 8th Month

Radio immunoassay, other immunological investigation (eg. ELISA, CLIA etc)
Rapid Diagnostic tests in Microbiology & Immunology.

9th & 10th month

Cyclotron, Hotcell, Cyclotron module.

11th & 12th Month

All Radio nucleotide therapy procedures and safe disposal of biological waste from therapy ward.

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