



தமிழ்நாடு டாக்டர் எம்.ஜி.ஆர். மருத்துவப் பல்கலைக்கழகம்
The Tamilnadu Dr. M.G.R. Medical University
69, Anna Salai, Guindy, Chennai, Tamilnadu, India

Allied Health Science

B.Sc. Nuclear Medicine Technology

Regulation, Curriculum and Syllabus
(2011-2012)

B.Sc in Nuclear Medicine Technology
Course Guidelines & Framework

Eligibility	12 th Std School Passed and 17years of age.
Duration	3 Years
Number of Beds	50 Beds
Gamma Camera	1
Gamma Counter	1
Tie Up	SPECT – CT, PET-CT - Optional
Maximum Student Intake	5
Medical College	Medical Colleges affiliated to Tamil Nadu Dr.MGR Medical University can start this course with maximum student intake of 10.
Common Room	1
Class Rooms (25x10sq ft)	2
Multimedia	LCD projector.
Library	Minimum 100sq ft With Computers & Internet facility Minimum of 100books
Teaching Responsibility	Designated Course Director should be a Nuclear Medicine Specialist -1
Faculty	Part time Lecturers to be named- Medical physicist (RSO),Radiologist, Cardiologist, Neurologist, Nephrologist Ortho specialist,Gastroenterologist, OB&G and other specialities.
Training Modality	
1 st Year	Theory on 1 st year subjects.
2 nd Year	Theory on 2 nd year subjects + Practicals and Log Book.
3 rd Year	Theory on 3 rd year subjects + Practicals and Log book
Examinations	
1 st Year	Theory Examination + Practical
2 nd Year	Theory Examination + Practical +Viva
3 rd Year	Theory Examination + Practical + Viva
Fee	
University Affiliation Fee	Rs.1lakh - one time fee.
Security Deposit	Rs.1lakh - refund as per university norms
Inspection Fee	Rs.15000
Inspection Duration	Yearly for first two consecutive year. Thereafter once in three years.
Student Registration - University Fee	Rs.500 per student.

BRIEF SUBJECT TITLE TO BE COVERED

Main Subjects		Supportive Subjects
Ist Year		
1	Human Anatomy & Physiology.	English
2	Basics of Computer and Image hard copies production in NM, including X-ray Film / Image processing Techniques	Medical Ethics
3	Basic physics & Nuclear Physics.	General principles of Hospital practice and care of patient.
IIInd Year		
4	Physics of Nuclear Medicine instrumentation	Patient care relevant to Nuclear Medicine practice.
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.

Syllabus for B.Sc in Nuclear Medicine Technology.**FIRST YEAR**

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- 1. ENGLISH (50hrs)**
 - 2. MEDICAL ETHICS (50hrs)**
 - 3. GENERAL PRINCIPLES OF HOSPITAL PRACTICE AND CARE OF PATIENT (50HRS)**

GENERAL PRINCIPLES OF HOSPITAL PRACTICE AND CARE OF PATIENT

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 asepsis: 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 Houghton Pub: Bacilliere
4. "First Aid' By : Haugher & Gardner Pub: Hamlyn.
5. "Practical nursing and first- aid" By: Ross and Wilson.Pub: Livingstone.

4. 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, epididymis, 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. Johnston.

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).

5. BASICS OF COMPUTER AND IMAGE HARD COPIES PRODUCTION (100hrs) IN NUCLEAR MEDICINE, INCLUDING X-RAY FILM IMAGE PROCESSING TECHNIQUES.

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.

6. 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- simple ideas of quantum mechanics - Mass energy equivalence – Fluorescence – Phosphorescence – luminescence - electromagnetic spectrum.

Physics in Nuclear Medicine – Simon Cherry, James Sorenson & Michael Phelps. 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.

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-rays & γ -rays 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	Identification of computer parts, Image hard copies & equipments.
PAPER-III	Basic physics & Nuclear Physics.	Models, Charts & Graphs Demo

MARK SHEDULE

SCHEME OF EXAMINATION FIRST YEAR (250 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

Theory (20)	Practical (20)	Log Book/Project/Record(10)
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- Wherever there is no Log Book/Project/ Record work the 10 mark be added to the Practical of the respective subject.

Practical Subject Title
Identification of Bones, Joints & Organs
Identification of computer parts, Image hard copies, processing equipments. Cassette screen, Film Sizes, Development
Charts, Models, & Graphs Demo.

SYLLABUS FOR B.SC IN NUCLEAR MEDICINE TECHNOLOGY.

SECOND YEAR:

7. Physics of Nuclear Medicine instrumentation

(100hr)

Total Teaching hours 120 including tutorials and practical. This section is intended to educate the student technologist about the basics of radioactivity and their applications in the field of Nuclear Medicine along with the constructions and working principles of Nuclear Medicine equipments.

1. Radiation detectors: Construction and Principles of Operation – Ionization Chamber – 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

Scintillation detector: Thallium activated Sodium Iodide 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.

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 I131, Tc99, Cr51, Cs137. Problems in radiation measurements with worked examples

3. Statistics of counting: Types of measurement error, Precision and Accuracy – Nuclear counts statistics – Poisson, 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.

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

8. RADIOCHEMISTRY AND RADIOPHARMACY

(120hrs)

Total number of **teaching Hours 120** including practical demonstrations. This section is intended to emphasize the students to acquire adequate knowledge about the basic principles involving the radio chemical reactions regarding the binding efficiencies and the working principles of various isotope generators used in Nuclear Medicine department.

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 phramachuticals: 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, 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)

7.Dispensing of radio pharmaceuticals - Specific activity Tracer dose preparation - 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)

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

9. NUCLEAR MEDICINE TECHNIQUES AND SPECIAL PROCEDURES (100hrs)

Total number of **teaching Hours 120** including tutorials and demonstrations. This section is intended to educate the students about the physiology of different system in human body in brief and also about the different pathological conditions occur in various systems and their indications for the need of Nuclear Medicine Procedures in an elaborate manner to the best of the ability.

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. (b) General Principles of scintigraphy: Introduction, imaging modalities, documentation of images, analog\digital images, hard copy, formatter, intensity settings, image resolution and contrast, gray scale, color scale. (c) Clinical Nuclear Medicines - Diagnostic studies.

3. ENDOCRINE SYSTEM: Thyroid: anatomy, physiology and different pathology - Iodine metabolism -Radiopharmaceuticals, the rationale, dosimetry & precautions- Indications for Thyroid Imaging -¹³¹I 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, epileptic patients ,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 -Radio pharmaceutical preparation - dosages & Administration, patient preparation, renogram using probes, 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 including analogue imaging-indication and comparison, of different studies as per the pathology-renal cortical 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- Radio pharmaceutical dosimetry, technique & analysis. Gastro esophageal reflux- Radio pharmaceutical dosimetry, technique & analysis. Gastric emptying- radio pharmaceutical dosimetry, technique & analysis. Gastrointestinal bleed scintigraphy: Radio pharmaceutical, dosimetry, methodology including RBC tagging procedures, Meckels' scintigraphy- Radio pharmaceutical, patient preparation. Pancreatic imaging: Radio pharmaceutical, dosimetry, methodology

9.Heptobiliary scintigraphy: Anatomy and pathology . Radio pharmaceutical, patient preparation ,dosimetry, dynamic flow- static imaging procedures, applications. Hepatic artery perfusion scintigraphy.

10.Liver,spleen scintigraphy: Pathology ,basis of scintigraphic localization - Patient-Dosage-Procedures-Patient. Preparation,applications.99mTc Heat damaged - RBCs - basics of - Tagging procedure 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 cardiac output, Ejection Fraction - Pulmonary Transit time, Hypokinesia - akinesia - dyskinesia etc. Dynamic study-first pass study: Purpose - radio nuclide - dosage - Bolus Injection - computer settings - 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, physical stress study - MUGA repeated after stress. Myocardial perfusion imaging - Radionuclide & Radio pharmaceuticals used, dosage administration, dosimetry. Imaging procedures -stress and rest.

Infarct avid imaging: Radio pharmaceuticals, Technique.

Shunt evaluation: Radio pharmaceuticals, Technique & analysis. 24

12.Haematological studies: Hematological disorders total blood volume., Estimation of RBC volume, 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 software for survival curves.

13.Infection and inflammation: Radio pharmaceuticals, dosimetry, comparison of the radio pharmaceuticals used, leukocyte labeled studies- leukocyte labeling procedures, imaging techniques 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. Protein loss 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 I131 - Indications - Dosage - Administration - Precaution to be taken during administration. Palliative treatment for bone metastasis : ³²P and ⁸⁹Strontium Dosage - Administration - Precaution to be followed during administration. Intracavitary 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.

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 Livingstone, 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

10. PATIENT CARE RELEVANT TO NUCLEAR MEDICINE

(50hrs)

Total number of **teaching Hours 100** including tutorial This section will emphasise the students to learn the special and necessary care to be taken while handling and managing the sick patients coming to the Nuclear Medicine Department ,especially Cardiac patients ,post renal transplant patients ,neuro patients with epileptic convulsions and patients coming for lung perfusion

1.Ordering nuclear medicine procedure- checking relevant data 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 witheparinized 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 the ghouse and over coats during the 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 extra vesisation 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 ,central venous pressure line-colonostomy care management of seizure patients-application of cardio pulmonary resuscitation for cardiac arrest patients.

9.Speciman 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

Reference books

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

(250 WORKING DAYS)

Sl. No.	Subject Title	I A		Theory		Practical		Viva Voce	
		Max	Min	Max	Min	Max	Min	Max	Min
1.	Physics of Nuclear Medicine instrumentation	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

Practical Subject Title
Identification of Equipment parts.
Radiopharmaceutical preparation formulae for Scanning
Charts on scans work-up.

SYLLABUS FOR B.SC IN NUCLEAR MEDICINE TECHNOLOGY.

THIRD YEAR

11. Recent advances in Nuclear Medicine Techniques (100hrs)

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

Recent advances in equipments- SPECT, PET including hybrid systems.

Recent advances in radiopharmaceuticals- FDG - Sodium fluoride for bone imaging –Neuro & cardiac radiopharmaceuticals-

Newer Computer applications in Nuclear Medicine - Medical Data Communications and Computer Networks.

In subject material remove para-1 on Introduction to computer which is included in 1st year subject-3: Basics of Computers and Image hard copy production in Nuclear Medicine.

12. 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.

13. Quality Assurance in Nuclear Medicine (100hrs)

Total number of **teaching hours 100** including tutorials. The major aim of this subject is to educate the students to attain high quality of health care in the goal of medical service. Nuclear Medicine procedures are more valid in the evaluation of functional status of any organ. So it is very essential in maintaining the high caliber of quality both in the equipment maintenance accuracy in the test rocedures. Efficient utilization of the technology can be assured only through planned systematic and well organized quality assurance

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 patients 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 machineries 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.Assesment 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.

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 Tortoise,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
(250 WORKING DAYS)

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

Practical Subject Title
Nuclear Medicine Procedures-Demo
Planning & Radiation Survey –Demo
Charts discussion

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

Biological assessment of Radiation Damage – Thomas.L, Walden.Jr and Nushin K

Radiobiology for the Radiologist – Eric J Hall, and Amato J Giaccia.& add in Reference books:

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.
