SYLLABUS FOR NUCLEAR MEDICINE TECHNOLOGY

SEMESTER I

SUBJECT-1: HUMAN ANATOMY & PHYSIOLOGY

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)

SEMESTER - I

SUBJECT 2 : BASIC PHYSICS & RADIATION PHYSICS

This syllabus should be augmented by as much of practical and demonstration classes as possible. Suggested number of minimum teaching hours: 120

1.Basic concepts: Units and measurements-Force, work, power and energy-Temperature and heat-SI units of above parameters. Atomic structure-atom model-Nucleus-electronic configuration-periodic table-Isotopes-Ionization-excitation-Binding energy-electron volt-Electro magnetic radiation-Quantum nature of radiation-mass energy equivalence-Fluorescence-electromagnetic spectrum

2.Electricity and magnetism: Electric charges, Coulomb's law-Unit of charge-Electric potential, unit of potential-Electric induction, capacitance and capacitors, series and parallel connection-electric current, unit, resistance, ohm's law, electric power, Joule's law

Magnetism: Magnetic induction-magnetic properties-Hysteresis-magnetic effect of current-Electrical instruments, Galvanometer, voltmeter, ammeter and multimeter.

3.Electromagnetic Induction: Induced electro motive force-Faradays experiments- laws of electro magnetic induction-Self and mutual induction-Alternating current- Ac generator-Peak and RMS values- AC circuits with resistance-capacitance and inductance- Choke coil- eddy current. Transformer-theory, design, losses- auto transformer- high voltage transformer- electric power transmission

4.X-rays: Discovery of x-rays- properties-production- x-ray spectrum- bremsstrahlung and characteristic x-rays- X-ray tube; Coolidge tube, tube design, line focus principle-space charge effect, tube cooling- Modern x-ray tubes-stationary anode, rotating anode, grid controlled x-ray tubes, heel effect, off focus radiation, tube insert and housing-Tube rating-Quality and intensity of x-rays-,factors influencing them.

5.X-ray generator circuits: Vacuum tube diodes-semi conductor diodes-transistor-rectification, half and full wave-self rectification – X-ray generator; filament circuit-kilo voltage circuit-single phase generator-three phase generator-constant potential generator Fuses, switches and interlocks-Exposure switching and timers-HT cables-earthing

6.Radioactivity: Discovery of radioactivity, natural radioactivity-activity units- radium, thorium and uranium series- alpha, beta decay and gamma rays - radioactive disintegration-exponential decay, half life period, decay constant. Artificial radioactivity –production of radioisotopes-cyclotron-neutron-fission and fusion-chain reaction-atom bomb-nuclear reactor

7.Interaction of X and gamma rays: Transmission through matter, law of exponential attenuation, half value layer, linear attenuation coefficient-coherent scattering-photoelectric effect- compton scattering-pair production-photonuclear disintegration-Particle interactions. Interactions of x and gamma rays in the body; fat-soft tissue-bone-contrast media-total attenuation coefficient-relative clinical importance

8.Radiation quantities and units: Radiation intensity-exposure, roentgen, its limitations-kerma and absorbed dose-electronic equilibrium-rad, gray, conversion factor for roentgen to rad-RBE-LET-quality factor-dose equivalent-rem, sievert.

9.Radiation detection and measurements: Principle of radiation detection-Ionization chamber-proportional counter-GM tubes-scintillation detectors-semiconductor detector-Gamma ray spectrometer. Measuring system: free ionization chamber-thimble ion chamber-condenser chamber-victoreen electrometer-secondary standard dosimeter-film dosimeter-chemical dosimeter-thermoluminecent dosimeter-Pocket dosimeter. Radiation survey meter-zone monitor-contamination monitor, their function use and maintenance.

BOOKS FOR STUDY

Text book

1.First year Physics for Radiographers - Hay & Hughes.

Reference books

1.Basic radiological physics-K. Thayalan, Jaypee bothers (P) Ltd, New Delhi(2001)
2.Fundamental of X-ray and Radium Physics - Joseph Selman
3.Basic Medical Radiation Physics - Stanton.
4.Chrtistensen's Physics of Diagnostic Radiology - Christensen.

Semester II

Subject : 3 : RADIOGRAPHIC PHOTOGRAPHY:

(Suggested number of teaching hours is 120, including tutorials and practical demonstration).

This Radiographic photography syllabus is intended as a guide to the theory and practical knowledge required by the students. Appreciation and application of all the factors listed below will enable the technologist to produce x-ray films of good quality and

diagnostic value. The lectures should be linked with practical demonstration to illustrate the importance of all that goes to make up correct exposure conditions.

1.X-ray film materials: Structure of film emulsion-Grain technology-Gelatin-Basic film types-Film formats and packing-Direct exposure duplitised films-Single coated emultions-Films for specialised use-manufacturing process.

Sensitometry :Photographic density—characteristic curve –information from the characteristic curve-speed Vs definition

Storage of x-ray film-unprocessed film-radiographs

2. Intensifying screens and cassettes: Intensifying screen- phosphor- Construction-Intensifying factor-speed and detail-crossover effect-resolution-mottle-reciprocity-screen asymmetry- screen-film contact- screen types and cleaning.

New phosphor technology-influence of kilo voltage. Photostimulable phosphor imaging

x-ray cassette-design-types- Identification of cassettes- General care of cassettes and storage.

3.Photochemistry: Film processing-latent image formation-Mechanism-theory-Developer-nature of development-pH scale-constitution of developer-development time-factors in the use of developer. Fixers-constitution of fixing solution-factors affecting the fixer-replenishment of fixer--silver conservation-Drying –developer and fixer for automatic film processor-rinsing-washing and drying.

4.processing equipment: Materials for processing equipment-manual processor-care of processing equipment-automatic processor-manual VS automatic-principles and typical equipment Microprocessor control-Cine processing-Daylight systems-Processing faults-maintenance

5.Processing room: Day light processing-location of the dark room-dark room illumination-equipment and layout-x-ray viewing room.

Daylight handling-daylight systems with cassettes-without cassettes.

6. Radiographic image-components of image quality-unsharpness in radiographic image-contrast of the radiographic image-distinctness of the radiographic image-size, shape and spatial relationships.

Presentation of radiographs-opaque letters and legents-perporating devices-actinic markers-Identification of dental films-preparation of stereo radiographs-viewing conditions

7.Monitor photography- Characteristics of the video image-television camera-imaging camera—imaging film-sensitometric characteristics-processing-final image.

Laser-light and laser-laser imaging-laser imagers—imaging plates-principle of photo stimulated luminescence

BOOKS FOR STUDY

Text book

1.Radiographic Imaging - Chesney & Chesney, Blakwell scientific publications, oxford (1981)

Reference books

1.Radiographic imaging-Derrick P. Roberts and Nigel L. Smith. Churchill Livingstone, Edinburgh (1994)
2.Radiographic Latent image processing - W.E.J. Mckinney
3.Photographic processing, quality control and evaluation of photographic material -J.E. Gray
4.Photographic processing Chemistry - L.F.A. Mason.
5.Physical and photography principles of Medical Radiography - Seeman & Herman.

SEMESTER II SUBJECT - 4

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

SEMESTER III SUBJECT 5
PHYSICS OF NUCLEAR MEDICINE AND EQUIPMENT

Total **Teaching hours 120** including tutorials and practical. This section is intended to educate the student technologists 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 - 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 - t 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 principles of operation Collimators - parallel multi hole, high resolution, high sensitivity pin hole, diverging hole, slant hole. Collimators Scintillation crystal, size Light guide - Photo multipliers pre amplifiers

Control panel- pulse shaping linear amplifiers Pulse height analyzer ,Timer, Data Processor and their function. Application of Cathode ray tube - persistence scope - Monitor scope - Camera scope. Resolving, time

characteristics - Analogue - Digital controls Uniformity and intrinsic resolution Sensitivity, Total-system resolution, Spatial volume resolution saturation.

6. Internal dosimetry: calculation of Radiation dose (absorbed fraction method) Basic procedure and practical problems, cumulated activity-equilibrium -absorbed dose constant- absorbed fraction.

Books for study

Text book

1.Physics Of Nuclear Medicine,-James A. Sorenson & Michael E.Phelps

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

SEMESTER III SUBJECT 6.
RADIOCHEMISTRY AND RADIOPHARMACY

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

SEMESTER IV SUBJECT 7.
NUCLEAR MEDICINE TECHNIQUES AND SPECIAL PROCEDURES.

Total number of **teaching Hours 120** including tutorials and demonstrations. This section is intended to 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 -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, 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 analague 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 - diskinesia 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. 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.

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

SEMESTER IV SUBJECT 8
PPATIENT CARE RELEVENT TO NUCLEAR MEDICINE

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 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 moniters should be available - emergency drugs should be available for the use in the time of need along with heparinized 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 glouse 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

SEMESTER V
SUBJECT 9-QUALITY ASSURANCE IN NUCLEAR MEDICINE

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 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.

SEMESTER-VI
SUBJECT: 10, RECENT ADVANCES IN NUCLEAR MEDICINE

Total number .of teaching hours: 100 including tutorials and demonstrations. This subject enables the student technologist to under stand the basics of computers and their applications in the Nuclear Medicine imaging as well as the processing of the results from them. This subject also emphasize the basics of the SPECT AND PET which are the recent advancement in the Nuclear medicine area.

1.Introduction to computer - Basic structures of software and Hardware. Keyboard skills, Hardware description, Software packages, Word processing, data base. Analog images, Digital Image processing, Digital Image representation. Picture, volume elements, gray scale - color scale

Image storage device Image processing: spatial, temporal, and contrast process. Image arithmetic image Analysis, System maintenance, Protocols, reconstruction Technique3 D Technique; Software low level and High level languages. Operating systems - user program ability.

2.Semi conductor counting systems: multi crystal imaging system, Fluorescence, whole body counting including neutron activation, Liquid scintillation counting system.

3. Positron emission tomography (PET): Basic principles,construction,production of positrons.Imaging Technique, Storage Reconstruction - Back projection

4.Single photon emission tomography (SPECT) :Basic principles - Image Acquisition, Image processing- Reconstruction, filters, SPECT acquisition in Central Nervous System, Cardiovascular, Bone, Hepatobiliary,Liver imaging, ,Renal-dynamic and cortical studies, Endocrine imaging

5.Radioimmuno scintigraphy - Principles, labeling and imaging methodology.

6. Radio receptor imaging- Principles, labeling and imaging methodology .

7.Magnetic resonance imaging (MRI)
Basic principles - Image storing - Image processing etc.

Books for study

Text book

1 .Physics Of Nuclear Medicine,-James A. Sorenson & Michael E. Phillips

Reference books

2.SPECT Robert. J & Susan E Brown**.**
3. Mathematical Techniques in Nuclear Medicine Report No. 73.-S T Chandler and W H Thomson
4**.** Nuclear Medicine Technology & Techniques,-Donald R. Bernier , Paul E. Christian & James K. Langan Mosby
5. Image Processing Architectures, Adrian Clark and Kirk Martinez
6. "Recent advances in Radiology and Medical Imaging"Lodge & Steiner Churchill Livingstone

SEMESTER VI
SUBJECT 11-RADIATION HAZARDS,CONTROL AND SAFETY

The total number of **teaching hours is 80** including tutorials. This subject emphasize the

students to under stand the effects of ionizing radiation and to educate them how to handle the unsealed radio isotopes in a safe way to minimize the radiation hazard to the patients, working staff as well as the public.

1.Radiation protection; principle, history& development-National & international agencies; AERB, BARC, ICRP,WHO,IAEA and their role. Equivalent dose-effective dose-sievert-rem. Sources of radiation-natural-man made & internal exposures.

2. Biological effects of radiation; effects on cell-stochastic & deterministic effects-radiation risk-tissues at risk-genetic, somatic & fetus risk-risk at other industries. Dose equivalent limits-philosophy-ICRP(60) concepts-AERB guidelines.

3.Planning of radiation installation-protection from primary, leakage and scattered radiation. Concepts of workload, use factor, occupancy factor & distance. Barrier design-barrier materials-concrete, brick& lead. Primary & secondary barrier design calculations. Design of doors. Control of radiation-effects of time, distance and shielding.

4.Personnel monitoring systems; principle and objective-film badge-guidelines for use-thermoluminecent dosimeter badge-pocket dosimeter. Area monitoring and radiation survey, practical use of survey meter, zone monitors and phantoms. Survey in rectilinear scanner ,gamma camera, and spect
Laboratory and clinical areas -contamination survey - Methods and Materials. Prevention of spread of contamination. Use of forceps, gloves etc.

5.AERB safety code and ethics; Built in safety specification for nuclear medicine equipments/installations. Specification for radiation protection devices-room layout. General classification of nuclear medicine labs- Operational safety-Radiation protection programme-Personnel requirements and responsibilities-regulatory controls.

6.Waste disposal: Handling of RIA materials - Procedure for handling spills Area monitoring, instruction to workers-Decontamination - personnel, equipment and work area ,decontamination kit Storage of radioactive materials Disposal of Radioactive Waste-disposal records-Maximum permissible concentration for airbone activity. Maximum permissible concentration for sewage disposal.-Record keeping. Requirements Periodical departmental survey and the maintenance of their records etc. Personnel dosimetry and their record keeping etc.

7. Patient protection; Safe work practice in Nuclear medicine-Radiation absorbed dose from diagnostic and therapeutic procedures. Investigations during pregnancy-examinations associated with illness, not associated with illness-medico-legal or insurance purpose examinations-medical research –avoidance of unnecessary radiation dose.

Radiation emergencies-situation preparedness, safety and prevention-legal requirements. Recent developments in radiation safety related topics.

Books for study

Text book

Radiation Protection in Hospitals. Richard F.Mould

Reference book

1.Basic radiological physics. Jaypee bothers pvt ltd, New delhi
2.An Introduction to Radiation Protection. Allen Martin & Samuel
3.Radiation safety in Medical practice. M.M. Rehani.
4.Radiation Protection. Ronald L. Kathren
5.AERB safety code and manuals,