Christian Institute of Health Sciences and Research

(A NABH Pre-Accreditation Entry Level Hospital)

(Regular Membership with CAHO)

NAGALAND UNIVERSITY

Regulation and Syllabus for

Bachelor of Science in Nuclear Medicine Technology (B.Sc. NMT)

(3+1 years) Degree course

2025

Regulations for the Allied Health Sciences Bachelor Programs of the Nagaland University

The Regulations & syllabus are subject to modifications by the University from time to time.

1. Eligibility for Admission:

(i) The candidate should have passed the Higher Secondary (10+2) from CBSE or State Education Board or any Govt. recognized Board with at least 50% marks for general candidates (UR) and 45% for SC/ST/OBC/NCL candidates in Physics, Chemistry, and Biology.

(ii) For B.Sc. (Health Information Management) course, candidates with Physics, Chemistry, and Mathematics in 10+2 may also be considered

(iii) The candidate should have attained the minimum age of 17 years during the admission.

(iv) **Lateral Entry:**

Candidates who have completed a two-year diploma programme in the concerned subject from Boards recognized by Central / State Government(s) / State / Central University with at least 50% marks in aggregate for (UR) candidates and 45% marks in aggregate for SC / ST / OBC / NCL candidates shall be eligible for Lateral Entry to the second year (3rd Semester) of Bachelor Programme in Allied Health Sciences.

2. Duration of the Course:

(i) Group A: 4 years, i.e., 3 years or 6 semesters of academic studies and one year of internship (B.Sc.HIM, B.Sc.DTT, B.Sc.AOTT, BSc RTT, B.Sc MRIT, B.Sc. NMT).
Group B: 4 and a half years, i.e., 4 years or 8 semesters of academic studies and six months of internship (BPT, BOT courses).
Group C: 4 years, i.e., 3 and a half year or 7 Semesters of academic studies and six months of internship (BMLS) during the 8th semester.

(ii) The maximum duration of the Bachelor Programme for Group A, B & C above shall be N+2 where N is the normal duration of the programme. No student shall be allowed to continue beyond the maximum duration.

3. Medium of Instruction:

The medium of instruction for all the Allied Health Sciences courses shall be English.

4. Working Days Per Semester:

Each Semester consists of 90 working days, with eight hours of work per day and 40 hours per week, totaling 720 hours per Semester.

5. Internship Hours:

One-year Internship programs will include 1440 hours of practical training and Six Months Internship will include 720 hours of practical training.

6. Attendance:

(i) A candidate must secure a minimum of 80% attendance in theory classes. Students who fail to meet the requirement due to illness may be eligible for a 5% condonation, provided they submit a medical certificate from a registered medical practitioner.

(ii) 100% in skills training (practical/internship) to qualify for the award of degree. In case of insufficient attendance, the candidate's internship period will be extended accordingly. There are no other exceptions to these rules under any circumstances.

7. Submission of Log Books:

a. At the time of the practical examination, each candidate shall submit to the examiners his / her Log book duly certified by the Head of the Department as a bonafide record of the work done by the candidate.

b. The practical record shall be evaluated by the concerned Head of the Department (Internal Evaluator) and the practical record marks shall be submitted to the University 15 days prior to the commencement of the theory Examinations.

c. In respect of failed candidates, the marks awarded for record at previous examination will be carried over for the subsequent examination. The candidates have the option to improve his performance by submission of fresh records.

8. Revaluation / Scrutiny of Answer Papers:

(i) There is no provision for candidates to request for revaluation of the answer papers of failed candidates in any examination. However, the failed candidates can apply for scrutiny.

(ii) Nagaland University shall constitute a Result Moderation Committee of 3 members.

9. Pattern of Question Paper for University Examination:

Descriptive type Questions	=30%
Descriptive Short Notes	=30%
Short Answer questions	=20%
MCQ Type	=20%

10. Assessment:

(i) Assessment for theory and practical examinations: - Students must attain at least 50% marks in each theory and practical component, both in internal assessments and in the final University examinations to pass the course. The final marks will be 75% from the University examination and 25% will be from the internal assessment.

(ii) The distribution of marks between theory and practical shall be provided in the **Curriculum and Syllabi** of each course.

(iii) Assessment for internship: - During the internship, students gain clinical experience and learn to document patient care effectively. Each student must maintain a logbook and a portfolio.

Activity	Marks %	Assessor
Log book	20	Supervisor
Portfolio*	20	Supervisor
Practical	40	Examiners
Viva voce	20	Examiners

*The portfolio provides one with an opportunity to demonstrate the breadth and depth of your knowledge on certain topics

The portfolio incorporates the follow documents:

- Curriculum vitae
- Progress reports
- "Summary of Competency Achievement" demonstrating the level of competency achieved in each sub-module.
- Samples of work prepared by the intern from at least 5 of the modules of internship training guide.

A presentation delivered covering key aspects of the module

The clinical supervisor will examine the portfolio at regular (at least once in three months) intervals and provide feedback to the Intern.

(iv) Mode of Evaluation: -

Evaluation for Theory papers during Odd End Semester Examination shall be internally done by the colleges and Theory papers during Even End Semester Examinations shall be externally evaluated or as notified by the University.

11. Internship Project:

As part of the internship, students are required to choose a relevant subject and prepare an in-depth project report, which should include the objective, scope of the project, and a detailed report.

12. Advancement to the Next Semester:

Advancement to the next semester is contingent upon meeting the following conditions and clearing any backlogs as described: -

A student may not fail in more than two papers in the preceding semester to be eligible to advance to the next semester.

13. Repeat examination for failed candidates:

Failed papers in odd semesters can be repeated during the exams of the subsequent odd semester. Similarly, failed papers in even semesters exams can be repeated during the subsequent even semester exams.

14. Vacation:

Maximum of 15 days including Saturdays and Sundays

15. Re-Admission after Break of Study:

Students shall be allowed to continue after a break in study provided the maximum duration as given in Clause- 2 (ii) is not exceeded.

16. Award of the Degree:

a. Candidates who have passed all written examinations and successfully completed the compulsory internship as per the university's requirements will be awarded the degree.
b. Final Consolidated Mark sheet shall be issued by the Nagaland University to the candidate after submission of his/her Internship Completion Certificate by the College.

17. Academic Calendar:

a. Odd semester shall be from July to December, and Even semester shall be from January to June.
b. The odd semester and even semester university (end) examinations shall be conducted in the months of December and June respectively.

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Bachelor of Science in Nuclear Medicine Technology

(BSc. NMT)

Semester Wise Distribution of Subjects

Total Credits=132; Total Marks=3800.

Semester	Code	Subject	Credits		Total	MARKS					Total Hours	
						Internal		Semester		Total		
			Theory	Practical		Theory	Practical	Theory	Practical		Theory	Practical
1st Semester	BSC. NMT-101	Human Anatomy & Physiology	4	1	5	30	20	100	50	**200**	72	36
	BSC. NMT-102	Basic Sciences (Biochemistry, Microbiology, Pathology, Pharmacology)	4	1	5	30	20	100	50	200	72	36
	BSC. NMT-103	English, Computer, Ethics and Medical terminology	4	1	5	30	20	100	50	200	72	36
	BSC. NMT-104	Biostatistics & Sociology	2	3	5	30	20	100	50	200	36	108
			Total		**20**					**800**	**252**	**216**
2nd Semester	BSC. NMT - 201	Basic radiological physics	4	3	7	30	20	100	50	200	72	108
	BSC. NMT - 202	Physics of Radiographic equipment	4	3	7	30	20	100	50	200	72	108
	BSC. NMT - 203	Hospital practice and patient care	4	2	6	30	20	100	50	200	72	72
		Total			**20**					**600**	**216**	**288**
3rd Semester	BSC. NMT - 301	Computers and image processing techniques in Nuclear medicine	4	2	6	30	20	100	50	200	72	72
	BSC. NMT - 302	Physics of Nuclear Medicine instrumentation	4	3	7	30	20	100	50	200	72	108
	BSC. NMT - 303	Radiochemistry and radiopharmacy	4	3	7	30	20	100	50	200	72	108
		Total			**20**					**600**	**216**	**288**

Semester	Code	Subject	Credits		Total	MARKS					Total Hours	
						Internal		Semester		Total		
			Theory	Practical		Theory	Practical	Theory	Practical		Theory	Practical
4th Semester	BSC. NMT - 401	Patient care relevant to nuclear medicine	4	3	7	30	20	100	50	200	72	108
	BSC. NMT - 402	Nuclear medicine techniques and special procedures - part 1	4	3	7	30	20	100	50	200	72	108

	BSC. NMT - 403	Recent advances in nuclear medicine techniques	4	2	6	30	20	100		200	72	72
		Total			**20**					**600**	**216**	**288**
5th Semester	BSC. NMT - 501	Nuclear medicine techniques and special procedures - part 2	4	4	8	30	20	100	50	200	72	144
	BSC. NMT - 502	Research Methodology	4	-	4	25	-	75	-	100	72	-
	BSC. NMT - 503	Quality control in nuclear medicine	4	4	8	30	20	100	50	200	72	144
		Total			**20**					**500**	**216**	**288**
6th Semester	BSC. NMT- 601	Radiobiology	4	3	7	30	20	100	50	200	72	108
	BSC. NMT - 602	Planning and Regulatory requirement in Nuclear Medicine Facility	4	3	7	30	20	100	50	200	72	108
	BSC. NMT - 603	Radiation protection	4	2	6	30	20	100	50	200	72	72
			Total		**20**					**600**	**216**	**288**
4th Year	Internship	12-month compulsory rotational clinical posting Project submission Mid-term assessment Final Practical & Viva			12					**100**		**1440**

Course Titles	Hours			Weekly class hours
	Theory	Practical	Total	
Internships		1440 (minimum)	1440	NA
Total			1440	

INTERNSHIP – Minimum 1440 hours (calculated based on 8 hours per day, if 180 working days in one-year span)

Contents

Bachelor of Science in Nuclear Medicine Technology
(BSC. NMT)

SEMESTER-1:20 CREDITS

BSC. NMT-101: HUMAN ANATOMY AND PHYSIOLOGY

SUBJECT DESCRIPTION: Human anatomy and physiology is designed to provide students with the working knowledge of the structure and the functions of the human body which is essential foundation for their clinical studies.

Anatomy:

Unit I: BASIC CONCEPTS OF ANATOMY:

Subdivisions of anatomy, anatomical position and anatomical terms: - Regions, cavities and systems of the body. General Tissues:- Definition of tissues, Classification, location and function of different types of tissues. General features of cartilage - Types of cartilage and their location. General features and classification of bones and joints: Parts of developing long bone, Classify bones with example, Synovial joint with diagram. General features of muscles, vessels and nerves: Classify the types of muscle, their location and functions, Parts of a muscle – belly and tendon, Differentiate artery and vein, Layers of blood vessel.

Unit II: SKELETAL SYSTEMS:

Describe the features of bones and joints of the skull, upper limb, lower limb, vertebral column, ribs, sternum - Parts of a long bone , Describe briefly the salient features of clavicle, scapula, humerus, radius, ulna, phalanges, hip bone, femur, fibula, tibia, sternum - Parts of a typical rib and the vertebra , Names of skull bone, carpal bones and tarsal bones , Description of major joints like shoulder, elbow, hip and knee joint.

RADIOLOGICAL ANATOMY**:** Introduction: Standard view of radiographs, Types of Radiographs, X-ray appearance of normal skeleton. Radiographic appearance of shoulder, elbow, wrist and hand, hip, knee, ankle foot

PATHOLOGICAL CONSIDERATION**:** Fracture, dislocation, arthritis, tumors of bone, healing of fractures, Kyphosis, scoliosis.

Unit III: MUSCULAR SYSTEMS:

Name the muscles and know the attachments, nerve supply and actions of important muscles of head & neck, trunk, upper limb and lower limb. Describe the location and nerve supply of: Deltoid, Pectoralis major, Intercostal muscles, Diaphragm, Gluteus maximus, Gluteus medius, Gluteus minimus, sternocleidomastoid

UNIT IV: CIRCULATORY SYSTEMS:

The heart – covering, chambers, and external features, Blood supply, Great vessels of the heart , Pericardium and pericardial cavity, Surface marking of apex of heart, Chambers of heart, Valves of heart, Coronary vessels supplying the heart , Branches of Aorta.

Blood vessels - position and distribution of major arteries and their branches, Position and the tributaries of superficial and deep veins, dural venous sinuses – Position and branches of brachial artery, radial artery, ulnar artery, palmar arches, femoral artery, popliteal artery, anterior and posterior tibial artery, dorsalis pedis artery – Position of cephalic, basilic and median cubital vein of the upper limb - Position of long and short saphenous vein of lower limb - Location of superior sagittal sinus, inferior sagittal sinus, straight sinus, transverse sinus and sigmoid sinus in the cranial cavity

RADIOLOGICAL ANATOMY**:** Chest – PA view, oblique view

PATHOLOGICAL CONSIDERATIONS**:** Congenital heart diseases, acquired heart diseases, infarction, collateral circulation

UNIT V: LYMPHATIC SYSTEM:

General and regional arrangements of the lymphatic system, the lymphatic organs, lymph nodes of axilla, inguinal region, thorax, abdomen and neck, Location and drainage areas of different groups of lymph nodes in the body, Location and functions of thymus, spleen, lymph nodes and tonsils

UNIT VI: RESPIRATORY SYSTEM:

The nasal cavity, larynx, trachea, lungs and pleura, the paranasal air sinuses - Describe briefly the conducting and respiratory part, Types and location of paranasal sinuses. Larynx - Extend and

relation of trachea with the esophagus, Pleura and pleural cavity, Lobes of lung and difference between the right and left lung.

RADIOLOGICAL ANATOMY**:** Plain X-ray chest, Bronchogram

PATHOLOGICAL CONSIDERATION**:** Tracheostomy, pleural effusion, pneumothorax, bronchoscopy

UNIT VII: DIGESTIVE SYSTEM:

Mouth, salivary glands, pharynx, esophagus, stomach, small and large intestine, the liver and biliary system, and the pancreas. Types of major salivary gland, their location and functions, Parts of pharynx, Location and the parts of stomach. Parts of large and small intestine and their location, Lobes of liver and portal triad. Location and parts of gall bladder - Parts of pancreas, its secretion and functions. Blood supply of the stomach and intestine, Portal vein formation

RADIOLOGICAL ANATOMY**:** Barium swallow, barium meal, barium enema, cholecystogram

PATHOLOGICAL CONSIDERATION**:** Hypertrophic congenital pyloric stenosis, peptic ulcers, carcinoma, cholecystitis, cholelithiasis, oesophagoscopy, gastroscopy, sigmoidoscopy gastrostomy, ileostomy, colostomy, gastrectomy, colectomy, cholecystectomy

Unit VIII: URINARY SYSTEM:

Kidneys, ureter, urinary bladder, urethra - Location and internal structure of kidney - Microscopic structure of a nephron - Extend of ureter and the constrictions - Position of urinary bladder and its relation in males and females.

RADIOLOGICAL ANATOMY**:** X-ray KUB, IVP

PATHOLOGICAL CONSIDERATION**:** Dysuria, cystitis, pyelonephritis, calculus kidney

Unit IX: REPRODUCTIVE SYSTEM:

Male reproductive organs – testes, epididymis, seminal vesicle and prostate - relation of prostate with the neck of urinary bladder.

Female reproductive organs - uterus, ovary, fallopian tube, cervix, vagina and mammary gland - Uterus – location, parts and layers - Parts of fallopian tube - Location of ovary and ovulation

RADIOLOGICAL ANATOMY**:** Hysterosalpingogram

PATHOLOGICAL CONSIDERATION**:** Abnormalities of uterus, polycystic ovary, cancer cervix, benign prostatic hypertrophy, cancer prostate.

Unit X: NERVOUS SYSTEM:

Central nervous system – Brain – lobes, sulci and gyri, ventricular system, blood supply, circle of Willis and spinal cord. Parts of brain, Lobes of brain, Major sulci - central sulcus, lateral sulcus, parietooccipital and calcarine sulcus, Major gyri - pre and postcentral gyrus. Important functional areas - Motor, sensory, visual and auditory areas - Ventricles of brain and Flow of Cerebrospinal fluid - Circle of Willis and significance - External features of spinal cord - Meninges

Unit XI: PERIPHERAL NERVOUS SYSTEM:

Cranial nerves and somatic nerves; Formation and branches of brachial, lumbar and sacral plexus. The basic organization of the autonomic nervous system - Spinal nerves - Cranial nerves in order, Major branches of brachial plexus - ulnar nerve, radial nerve, musculocutaneous nerve, axillary nerve and median nerve in the upper limb, Major nerves from the lumbosacral plexus - femoral nerve and sciatic nerve

RADIOLOGICAL ANATOMY**:** X-ray skull

PATHOLOGICAL CONSIDERATION**:** Hemiplegia, quadriplegia, paraplegia, hydrocephalus, Erb's paralysis, claw hand, wrist drop, foot drop

Unit XII: ENDOCRINE SYSTEM:

The location of pituitary, thyroid, parathyroid, pancreas, adrenal, testis and ovary Pathological consideration: Pituitary tumors, gigantism, acromegaly, thyrotoxicosis, goiter, hyperthyroidism, hypothyroidism, diabetes mellitus

Unit X III: SENSORY ORGANS

Basic structure and function of eye, ear and skin

Physiology:

Unit I: BLOOD:

Composition, properties and functions of blood, Blood groups, Blood indices - MCV, MHC, MCHC, ESR, PCV, Lymph – Formation, circulation, composition and functions of lymph.

Unit II: MUSCULAR SYSTEM:

Neuromuscular junction Muscle tone

Unit III: CARDIOVASCULAR SYSTEM:

Function of heart – systole, diastole, heart sound, cardiac output, conducting system of heart, blood pressure, circulation of blood

Unit IV: RESPIRATORY SYSTEM:

Mechanism of Respiration, Gaseous exchange in lungs and tissues, lung volume and capacities

Unit V: DIGESTIVE SYSTEM:

Deglutition, peristalsis, movements of the stomach, small intestine & large intestine, defecation, Functions of the liver, gall bladder, bile, pancreas

Unit VI: EXCRETORY SYSTEM:

Functions of kidneys, formation of urine, micturation

Unit VII: REPRODUCTIVE SYSTEM:

Oogenesis, Menstrual cycle, ovarian cycle, Spermatogenesis, maturation of sperm

Unit VIII: NERVOUS SYSTEM:

Reflex action, Sensory pathway, Motor pathway, CSF formation, circulation properties and composition, lumbar puncture

Unit IX: ENDOCRINE SYSTEM:

Functions of pituitary, thyroid, parathyroid, adrenals, pancreas, gonads

Unit X: SENSE ORGANS:

Visual and accommodation pathway, Mechanism of hearing

References:

1. Textbook of Physiology by A.K. Jain

2. Textbook of Physiology by Chaudhuri Sujit K

3. Ghai's textbook of practical physiology by VP Varshney & Mona Bedi

4. Anatomy and Physiology for Radiographers C.A. Warrick Reference books

5. .Foundation of Anatomy and Physiology Ross and Wilson.
6. An Atlas of Normal Radiographic Anatomy Richard & Alvin
7. Essentials of Human Anatomy – Russell
8. Best and Taylor : The Human Body – its anatomy and physiology (Chapman and Hall)
9. Blewett and Rackow : Anatomy and Physiology for Radiographers (Butterworth)
10. .Dean : Basic Anatomy and Physiology for Radiographers (Blackwell)
11. Fitzgerald : Anatomy 1600 multiple choice question (Butterworth)
12. Hamilton et al : Surface and Radiological Anatomy (Heffer).

BSC. NMT-102: BASIC SCIENCES

SUBJECT DESCRIPTION: This subject on Basic Sciences is designed to provide the students introduction to Biochemistry, Pharmacology, Pathology and Microbiology,

Unit I: Biochemistry:

Basics of carbohydrates, Amino acids, Protein and Non-protein, Lipids, Enzymes, Minerals- Iron, Calcium & Magnesium, Normal value ranges

Unit II: Pharmacology:

General definitions- Pharmacology, Drugs, Medical pharmacology, Toxicology, Pharmacodynamic properties, Pharmacokinetic properties

- Introduction to pharmacology, Basic pharmacology terminology and concepts
- Introduction to pharmacodynamics
- Introduction to pharmacokinetics- absorption, distribution, elimination
- Mechanism of drug action, dosage forms, routes of administration
- Common generic and trade names
- Medication errors, Legal aspects in pharmacology

UNIT III: Pathology

General Pathology Adaptations, Cell Injury and Repair: Hyperplasia, atrophy, metaplasia, necrosis and apoptosis - Differences between apoptosis and necrosis.

Acute and Chronic inflammation: Five cardinal signs of inflammation- Outcomes of acute inflammation- Chronic inflammation -Granulomatous inflammation -Acute phase proteins

Tissue repair, regeneration and hemodynamic disorders: Cutaneous wound healing-Pathologic aspects of repair-Hyperaemia and congestion-Thrombosis and Virchow triad-Embolism-Infarction-Shock; Bronchial asthma, COPD - Tumors

Diseases of immune system: Hypersensitivity reaction -Type I, II, III, and IV hypersensitivity reactions

Neoplasia: Definition of neoplasia. Differences between benign and malignant tumors; Metastasis; Carcinogenesis – Causes; Carcinoma of oral cavity – Causes; Etiology of Carcinoma cervix – type of virus implicated, high risk sero-types, Screening investigations; Breast carcinoma – Risk factors.

UNIT IV: Microbiology

Introduction and historical background of Microbiology, classification special characteristics of organisms, cultivation (Different types of Media) and identification of organisms, Sterilization techniques; Basics of Immunology- Ag Ab reaction & Basics in Immune response & Hypersensitivity, Parasites and Fungi

References:

1. Textbook of Biochemistry for Medical Students 6th Edition, DM Vasudevan, Sreekumari S , KannanVaidyanathan.
2. Textbook of Microbiology 9th Edition, Ananthanarayan, Paniker.
3. Text book of pathology & Genetics by Purnima S. Rao

BSC. NMT-103: ENGLISH, COMPUTER, ETHICS AND MEDICAL TERMINOLOGY

SUBJECT DESCRIPTION: The subject is on communicative English, learning word processing, other basic computer application such as excel, power point, medical ethics and medical terminology for technologists.

ENGLISH:

Unit I: STUDY TECHNIQUES: Organization of effective note taking and logical processes of analysis and synthesis Use of the dictionary. Enlargement of vocabulary Effective diction

Unit II: APPLIED GRAMMAR**:** Correct usage the structure of sentences, the structure of paragraphs Enlargements of Vocabulary

Unit III: WRITTEN COMPOSITION**:** Precise writing and summarizing Writing of bibliography Enlargement of Vocabulary

Unit IV: READING AND COMPREHENSION**:** Review of selected materials and express oneself in one's words. Enlargement of Vocabulary.

Unit V: THE STUDY OF THE VARIOUS FORMS OF COMPOSITION**:**

Paragraph, Essay, Letter, Summary, Practice in writing

Unit VI: VERBAL COMMUNICATION**:** Discussions and summarization, Debates, Oral reports, use in teaching

Unit VII: LANGUAGE AND COMMUNICATION SKILLS**:** Basic concepts in English communication - Grammar and Usage - Pronunciation. Communication Skills: Formal conversation, Informal conversation, Telephone conversation - Case Presentation - Interviews. Writing Skills: Writing paragraphs, formal letters, reports - Case study - E-mails. Study Skills: How to take notes – preparing assignments - listening to lectures – summary writing - exam preparation

MEDICAL ETHICS

Unit VIII: Medical ethics – Definition, Goal, Scope**,** Basic principles of medical ethics - Confidentiality, Malpractice and negligence, Autonomy and informed consent, Right of patients, Medico legal aspects of medical records, Medico legal case and type ,Records and documentation , Development of standardized protocol to avoid near miss or sentinel events - Obtaining an informed consent. Introduction to NABH guidelines

COMPUTER

Unit IX: Introduction to computer - Input & output devices, CPU, Memory, Storage devices. Introduction of Windows OS - MS-Word: Creating, opening, inserting, formatting, saving, and printing the document, Spell check, Creating and editing table , Mail merge.

Unit X: MS Office: MS-Excel: Creating, data entry, formatting, saving, and printing the worksheet - Creating graphs. MS-Power point: Creating and formatting presentations, enhancing text, slides with graphs and tables.

Unit XI: Computer networks: Types of network - LAN, WAN, Intranet. The Internet and its Applications, Application of Computers in clinical settings.

Unit XII: Introduction to - PACS-Picture Archiving in Communication in Medicine - DICOM – Digital Imaging for Communication in Medicine

- **Medical Terminology**

References:

1. Manipal Academy of higher education; English book for Nurse by Selva Rose, 3rd Edition
2. Selva Rose. 1997, Career English for Nurses. Published by: Orient Blackswan Ltd
3. Quirk Randolph and Greenbaum Sidney, 1987. A University Grammar of English, Hong Kong: Longman group (FE) Ltd/ Pearson.
4. Thomson A.J. and Maituiet A.V. 1987, A Practical English Grammar, Delhi: Oxford University Press.
5. Gimson A.C.1989, An Introduction to pronunciation of English. Hodder Arnold; 4th Revised edition (1 May 1989).
6. O'Connor J.D, 1986. Better English pronunciation
7. Quirk Randolph and Greenbaum Sidney, 1987. A University Grammar of English, Hong Kong: Longman group (FE) Ltd/ Pearson.
8. Computer Fundamentals: Pearl Software
9. Fundamentals of Computers: E.Balagurusamy
10. Principles of Bioethics: Tom Beauchamp & Childress

BSC. NMT-104: BIOSTATISTICS/SOCIOLOGY

SUBJECT DESCRIPTION: The subject is on biostatistics and sociology where students learn about different types of data and presentation of data and about sociology.

a) Biostatistics

Unit I : Biostatistics General Statistics

Unit II : Definition and importance of biostatistics

Unit III : Types of data, rates and ratio

Unit IV : Methods of collection of data-primary and secondary data Sampling of data

Unit VI : Measures of central tendency (Mean, median, mode) , Measures of Dispersion (Mean deviation, standard deviation, Range)

Unit VII : Presentation of data (Bar diagram, Pie diagram, Histogram, Frequency, Polygon,

Unit VIII : Frequency curve, Cumulative frequency curve, Line diagram) Correlation and Regression analysis, Basic concept of probability

b) Sociology and Environment Health: Practical including field work Sociology and health:

UNIT I: Difference between community health and clinical medicine

UNIT II: Concepts in sociology which influence health and disease.

Unit III: Social structure, social behavior, social institutions, socialization, culture, custom, acculturation. Standard of living, social problems, social stress and social surveys

Unit IV: Types of family, functions of family, family and health, broken family.

Unit V: Demography and health. Influence of social factors on health

References:

1. Croxton – elementary statistic
2. Biostatistics: Basic Concepts and Methodology for the Health Sciences- Wayne W. Daniel , Chad L. Cross
3. Introduction to Biostatistics and Research Methods Fifth Edition- P.S.S. Sundar Rao, J. Richard
4. Mahajan's Methods in Biostatistics for Medical Students and Research Workers-Bratati Banerjee.
5. Sociology of Health and Medicine-Nagla madhu
6. Sociology: Principles of Sociology with an Introduction to Social Thoughts-C N Shankar Rao

7. Handbook Of Medical Sociology For Nursing,Physiotherapy And Paramedical Students-Varun Malhotra

SEMESTER-2: 20 CREDITS

BSC. NMT-201: BASIC RADIOLOGICAL PHYSICS

SUBJECT DESCRIPTION –This subject will introduce student to the basic physics concepts, principles necessary to learn the physics related to radiology.

Unit I: STRUCTURE OF MATTER:

Constituents of atoms, atomic and mass, energy units, electron shells, atomic energy levels, nuclear forces, Nuclear energy levels. Atomic structure Nucleus, Electromagnetic spectrum, Energy quantization, Relationship between wavelengths, Frequency, Energy.

Unit II: PHYSICS UNITS AND MEASUREMENTS

Force, Work, Power, energy temperature and heat SI units of above parameters. Atomic Number, Mass No., electron orbit and energy levels Periodic table, Isotopes, Isobars, Ionization and excitation. Electromagnetic radiation.

Unit III: 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.

Unit IV: RECTIFICATION AND TRANSFORMERS: Principle of rectification, wave form of half wave and full wave current/voltage wave form; Rectifiers: Introduction, energy bands in solids, the semiconductor, p-type and n-type semiconductors, density of charge carriers and conductivity, p-n junction, p-n junction diode, p-n junction diode as rectifier (half- wave and full-wave rectifier), rectifiers relative merits and demerits; silicon, germanium diodes. Principles of transformer, Electromagnetic induction, transformer design, efficiency of transformer, source of power loss

UNIT V: ELECTROMAGNETIC RADIATION: Electromagnetic radiation spectrum, common properties of electromagnetic radiation; relationship between energy, frequency, wavelength and velocity e.g. X-rays and gamma rays. Properties of X-rays and gamma rays; General properties of X-rays, velocity, frequency etc., photographic effect, photochemical effect – discolouration of salts, heating effect, biological effect; ionization of gases e.g., air.

UNIT VI : RADIOACTIVITY

Natural and artificial radioactivity, Isotope, isobar and isotone, alpha decay beta decay and spectra, gamma emission, positron decay, electron capture and internal conversion, , exponential decay. Half-life. activity, Curie, Becquerel specific activity

Radiation sources Natural and artificial production of radio isotopes Nuclear fission, nuclear reactor, reactor produced isotopes, fission products Gamma ray source for medical uses.

UNIT VII: RADIATION QUANTITIES AND UNITS:

Photons, Fluence, Exposure – Roentgen, absorbed dose, rad, Gray, Roentgen to rad conversion, , equivalent dose, effective dose and their units., Flux-Fluence-absorbed dose and KERMA, exposure rate constant, gamma ray constant, Measurement of exposure, Free air chamber, Thimble chamber,

UNIT VIII INTERACTION OF RADIATION WITH MATTER

Attenuation of X-ray or Gamma rays, absorption and scattering, half value layer, Coherent scattering, Photoelectric absorption, Compton scattering, Pair production and photo electric disintegration. X-ray transmission of through Medium, Linear, and mass attenuation coefficients, total attenuation coefficient, HVT, TVT and interaction of charged particle and neutrons with matter. LET, Interaction of X and Gamma rays with fat, soft tissue, and bone. Relative importance of different types of interactions.

References:

1. The physics of radiation therapy, Faiz M. Khan, 5th edition (2014), Lippincott, Williams and Wilkins, USA.
2. Christensen's Physics of Diagnostic Radiology – Christensen & Christense
3. Fundamental of Xray Fundamental of Xray and Radium Physics Joseph
4. Basic Medical Radiation Physics – Stanton
5. Physics for Radiography - Hay and Hughs
6. Ball and mores essential physics radiographers, IV edition, Blackwell publishing.
7. Basic Medical Radiation physics – Stanton.

BSC. NMT- 202: PHYSICS OF RADIOGRAPHIC EQIPMENT

SUBJECT DESCRIPTION: The students will be able to understand and appreciate the construction, essential parts and functioning of radiographic equipment used for imaging.

Unit I: X-ray Tube : X-ray tube design: History, early tube design (Coolidge tube), X-ray tube design requirements: cathode assembly, anode assembly, anode configurations – stationary, rotating anode x-ray tubes, filament current, tube current, thermionic emission, space charge effect, anode heel effect, line focus principle, tube housing, efficiency of x-ray production, modern x-ray tubes, grid controlled x ray tube, heat dissipation methods, tube rating charts, anode cooling curves, tube overloading, operating conditions. Filtration and scatter radiation.

X-ray production: Characteristic and Bremsstrahlung radiation, X-ray spectrum, quantity and quality of x-ray beam.

Unit II: X-Ray generators and circuits : Types of generators – single phase, three phase, high tension generator, falling load generator, capacitor discharge generator. High tension circuits- autotransformer, filament circuit, operating console (kV, mA, timer circuits), timers- synchronous timer, electronic timer, mAs timer, automatic exposure control (AEC), X-ray tube circuit, – Rectification - half wave & full wave rectification -three phase circuits- 6 and 12 pulse rectifier circuits, voltage ripple.

Unit III: X-Ray Grids /Bucky

Scattered Radiation -Significance of scatter – Beam limiting devices.-Grid principle and structure – Types of Grids - vertical bucky- versatile bucky -Stationary grid, parallel grid, focused grid – crossed grid, moving grid – Potter Bucky Diaphragm- Control of scattered radiation and grids/Bucky - Methods of minimizing formation of scatter radiation, types of grids and grid ratio- use of cones – diaphragm/ light beam devices - effectiveness of collimation - limitations of the primary beam/the light beam diaphragm -Effects of scatter radiation on radiograph image quality,

patient dose and occupational exposure.

Unit IV: X-Ray Cassettes & Intensifying screens: Fluorescence – constituents of intensifying screens – types of screens-intensification factors-speed of screen – screen unharness. Cassette-construction-types of cassettes- use of fluorescent screen in radiology, effect of screen in reduction of patient dose.

Unit V - Computed radiography: its principle, physics & equipment. Digital Radiography. CR Cassettes, CR Reader, principle of image formation, advantages and disadvantages.

- **Unit VI: FLUOROSCOPY:**

Fluoroscopy imaging technique, history, fluoroscopy imaging components, image intensifiers – construction, principles, brightness gain, automatic brightness control (ABC), optical coupling, television camera – vidicon, plumbicon, picture tube, cine fluorography. Digital Radiography Flat panel detectors: construction, principle, pixel binning, digital subtraction angiography, road mapping. Direct and indirect digital radiography and fluoroscopy systems. Digital radiography and Computed radiography its advantages, disadvantages, and applications.

Unit VII: TOMOGRAPHY:

Theory of tomography – multi section radiography, tomographic equipment Computed tomography, scanning principle, Generations of CT, Reconstruction of image, storing the image, viewing theimage, evaluation of the image. Equipment for computed tomography, Table, scanning gantry X-ray generator, image quality. Dual energy x-ray absorptiom etry (DEXA)

Unit VIII: Picture archiving and communication system (PACS)

References:

1. Christensen's Physics of Diagnostic Radiology – Christensen & Christensen
2. Physics for Radiography Hay and Hughes
3. Handbook of Physics in Diagnostic Imaging - Roshan S. Livingstone
4. The Essential Physics of Medical Imaging - Jerrold T. Bushberg
5. Physics of Radiology and Imaging by Thayalan

BSC. NMT-203: HOSPITAL PRACTICE AND PATIENT CARE

SUBJECT DESCRIPTION: The students will be able to learn and appreciate the role of technologists in patient care, hospital practice, their principles, and procedures such as first aid, managing infections and departmental procedures.

Unit I: GENERAL PRINCIPLE OF HOSPITAL PRACTICES:

Modern hospital treatment is based on teamwork; 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.

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.

Unit II: 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 tracheotomy; essential care of the patient who has a colostomy; bedpans and urinals; simple application of a sterile dressing. Care of patients with infectious/ contagious diseases

Unit III: 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; hemorrhage; pressure points; compression band. Fractures; splints, bandaging; dressing, foreign bodies; poisons; Basic life support, CPR

Unit IV: INFECTIO N:

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.

Unit V: 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 radiology departme nt.

Unit VI: 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 stockkeeping.

Unit VII: DRUGS IN THE DEPARTMENT:

Storage: classification; labelling and checking, regulations regarding dangerous and other drugs; units of measurement, special drugs, anti-depressive, anti-hypertensive etc.

References:

1. Principles of Hospital Practice and Patient Care by P Srinivasulu Reddy, Paras Medical Books Pvt Ltd
2. Textbook of nursing foundation-I Clement
3. Principles and practice of nursing –Sr Nancy.Vol 1 & 2
4. Care of patient in diagnostic Radiography" Chesney & Chesney (Blackwell Scientific)
5. Chesney's Care of the patient in Diagnostic Radiography" Pauline J . Culmer. (Blackwell Scientific)
6. Aid to Tray and Trolley Setting" Marjorie Hougton (Bacilliere)
7. First Aid' Haugher & Gardner (Hamlyn.)
8. Practical nursing and first- aid" Ross and Wilson (Livingstone

SEMESTER-3: 20 CREDITS

BSC. NMT- 301: COMPUTERS AND IMAGE PROCESSING TECHNIQUES IN NUCLEAR MEDICINE

SUBJECT DESCRIPTION: The students will learn about computers and will know about different image processing techniques in nuclear medicine.

Unit I: 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.

Unit II: Image processing in nuclear Medicine : 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.

References:

1. Basics of Computers and Image hard copy production in Nuclear Medicine.
2. Computers in Nuclear Medicine –A practical Approach – Kai.H.Lee
3. Computer Fundamentals-concepts, systems & Applications – D.P Nagpal
4. Effective use of computers in Nuclear Medicine: Michael J.Gelf and Stephen.RThomas.
5. Radiographic Latent Image Processing – W.E.J. Mckinney

BSC. NMT -302: PHYSICS OF NUCLEAR MEDICINEINSTRUMENTATION

SUBJECT DESCRIPTION – In this paper the students will be able to learn and understand the physics principles behind the different nuclear medicine devices.

Unit I: 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

Unit II: Radiation detectors: Construction and Principles of Operation – lonization Chamber 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.

Unit III: Spectrometer: Basic principles of Pulse – height analyzer single channel and Multi – channel analyzers. Optimum operating conditions, window setting

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

Unit IV: 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.

Unit V: 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.

Unit VI: 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 acquisition - Static, Dynamic, Tomo and Gated acquisition
– Image perception & Analysis -Background correction methods -ROI analysis- Time Activity

Reference books

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

BSC. NMT -303: RADIOCHEMISTRY AND RADIOPHARMACY

SUBJECT DESCRIPTION: The students should learn and appreciate about Radiochemistry and Radiopharmacy

Unit I - 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

Unit II - 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.

Unit III - 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

Unit IV - 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.

Unit IV - Radio iodination: basic principles, Iodination of MIBG-131, Purification -Resin column -Ion exchange reaction, radiochemical purity etc. Orthography, Discography

Unit V: Tracer methods

Behavior of radioactive tracers in biological process -characteristics of radio pharmaceuticals - Half life - (Physical and Biological) – Tracer kinetics – Compartmental models.

Unit VI - Dispensing of radio pharmaceuticals

Specific activity Tracer dose preparation – Radiopharmaceutical dossage calculations - Tracer dose administration etc. Preparation of standard (References) 100%, 50%, 10%, etc.

Preparation of the required reagents for the kit formulations and other labeling procedures.

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)

Unit VII - Radiolabeled Blood Cells

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

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]

Reference Books:

1. The handbook of Radio pharmaceutical -Mohan Patel & Samij Sadack, Chapman & Hall Medicals, London.
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-4: 20 CREDITS

BSC. NMT- 401: PATIENT CARE RELEVANT TO NUCLEAR MEDICINE

SUBJECT DESCRIPTION: The students should learn how to take patient care in different nuclear medicine procedure.

Unit I - 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

Unit – II 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.

Unit -III 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.

Unit IV - 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.

Unit – V 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.

Unit-VI- 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 without causing any extravessation and the management of the local haemorrhage and swelling.

Unit VII- 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.

UnitVIII- 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.

Reference books:

1. Nuclear Medicine Technology & Techniques, - Donald R. Bernier , Paul E. Christian & James K. Langan Mosby
2. Notes on Radiological Emergencies – Ansell and Churchill
3. Care of patient in diagnostic Radiography – Chesney & Chesney.
4. First Aid – Haugher and Gardner.
5. Practical Nursing and First Aid – Ross and Wilson.
6. Hand book of Nuclear Medicine – Frederick L Datz
7. Essentials of Nuclear Medicine Imaging – Fred A Mettler , Milton J Guiberteau.
8. A guide to Oncological nursing Deeley Livingstone
9. Care of the injured, Ring Livingstone

BSC. NMT-402: NUCLEAR MEDICINE TECHNIQUES AND SPECIAL PROCEDURES - PART 1

SUBJECT DESCRIPTION – In this paper the students are expected to learn about different nuclear medicine techniques and special procedure related to nuclear medicine.

Unit – 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.

Unit II - 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.

UNIT III – 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

Unit – IV 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.

Unit – IV 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.

Unit-V - 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: radiopharmaceuticals dose&dosimetry, methodology. Scintigraphy for CSF leak.

Unit-VI - 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 including analague imaging-indication and comparison, of different studies as per the pathology-renal cortical imaging techniques. Evaluation of Renovascularhypertension,Transplant scintigraphy. Radionuclide cystography-Radio pharmaceutical & imaging techniques. Scrotal scintigraphy:Radio pharmaceutical, dosimetry, methodology.

Reference books

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

BSC. NMT-403: RECENT ADVANCES IN NUCLEAR MEDICINE TECHNIQUES

SUBJECT DESCRIPTION: The students should learn and appreciate recent advances in nuclear medicine techniques.

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 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.,

Reference books:

1. PET: Physics, Instrumentation, and Scanners – Michael Phelps.
2. PET and PET-CT A clinical Guide – Eugene Lin and Abass Alavi
3. Nuclear Medicine and PET/CT Technology and Techniques – Paul Christian and Kristin Waterstram.

SEMESTER-5: 20 CREDITS

BSC. NMT - 501: NUCLEAR MEDICINE TECHNIQUES AND SPECIAL PROCEDURES - PART 2

SUBJECT DESCRIPTION - In this paper the students are expected to learn about different nuclear medicine techniques and special procedure related to nuclear medicine.

Unit I - Gastrointestinal tract:

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

Unit II- Heptobiliary scintigraphy:

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

Unit III - 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.

Unit IV - 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 -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.

Unit V - 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.

pathologic

Unit VI - Tumor imaging: Radio pharmaceuticals, dosimetry, comparison of the radio pharmaceuticals used, imaging techniques, applications

UNIT VII - *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.

UNIT VIII - *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.

UNIT IX - 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

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

References:

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

BSC. NMT -502: RESEARCH METHODOLOGY:

SUBJECT DESCRIPTION – The students should learn and appreciate about how to start a research and different steps of research.

Unit I - Accessing research literature : Use of databases and other sources.

Unit II - Understanding research design: Qualitative and quantitative methodologies - their differences and potential integration. Evaluating research and its potential for informing practice. Developing research questions and devising methods for their investigation. Ethical issues in research

Unit III - Analysis: Analysis of qualitative and quantitative data. Utilization of appropriate software to assist in the retrieval of information and data analysis.

Unit IV - Clinical audit: Distinctiveness of research and audit processes and their function

Unit V - Research Skills and Management: The role of evidence-based practice within health and welfare

Reference books:

1. Research Methodology and Biostatistics: A Comprehensive Guide for Health Care Professionals by Sharma Suresh
2. Research Methodology for Health Professionals by R.C. Goyal

BSC. NMT -503: QUALITY CONTROL IN NUCLEAR MEDICINE

SUBJECT DESCRIPTION: The students should learn and appreciate the need for quality control and different quality control procedures in Nuclear Medicine.

UNIT I - 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.

UNIT II - 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.

UNIT III - 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

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

UNIT V - 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.

UNIT VI - 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.

Reference Books:

1. Quality Control of Nuclear Medicine Instruments, International Atomic Energy Agency
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-6: 20 CREDITS

BSC. NMT -601: RADIOBIOLOGY

SUBJECT DESCRIPTION: The students should learn and appreciate different aspects of Radiobiology.

General Cell Biology and mammalian cell growth and replication cycles, interaction of radiation with cells, mechanism of damage, nature of damage

- Effect of radiation on cells: Directly and indirectly ionising radiation, Direct and Indirect action of radiation, Deterministic (Tissue reaction) and Stochastic effects of radiation, Mechanisms of chromosomal & DNA damage and repair
- Cell survival curve, Linear-quadratic and multitarget models of cell damage, Mechanisms of cell killing, Relationship of dose, dose rate, oxygen, and cell age to radiosensitivity; Linear energy transfer and Relative Biological effectiveness of radiation
- Acute effects of radiation: Acute radiation syndrome, Prodromal, Cerebrovascular, Gastrointestinal, and Haematopoietic syndromes, Acute effects on lungs and skin; Medical countermeasures to radiation exposure (radioprotectors)
- Radiation cataractogenesis Radiation carcinogenesis: Mechanism of carcinogenesis and the role of radiation, Types of radiation-induced cancers and their temporal relation to the exposure, Cancer risk estimate to radiation, Dose and Dose-rate effectiveness factor (DDREF)
- Heritable effects of radiation: Mechanisms of radiation-induced heritable effects (Mendelian disorders, Chromosomal aberrations, and multifactorial disorders), Examples of such disorders in human beings.
- Effects of radiation on the embryo and foetus: Radiation-induced death and disorders and their relation to the radiation dose & gestational time
- Radiation risks in diagnostic and therapeutic Nuclear Medicine procedures: Effective whole body and organ doses to patients during Nuclear Medicine and relevant radiological diagnostic procedures; Occupational exposures to radiation workers.

References:

1. Radiation Biology and Physics Paul F Wilson and Joel S.Bedford
2. An introduction to Radiobiology – A.H.W.Nias
3. Introduction to Health Physics – Herman Cember.
4. Biological assessment of Radiation Damage – Thomas.L, Walden.Jr and Nushin K
5. Radiobiology for the Radiologist – Eric J Hall, and Amato J Giaccia.

BSC. NMT-602: PLANNING AND REGULATORY REQUIREMENT IN NUCLEAR MEDICINE FACILITY

SUBJECT DESCRIPTION - The students should learn and appreciate the design, safety standards, and regulatory requirements for establishing and operating a nuclear medicine facility

Unit I - Planning of Nuclear Medicine (NM) facilities:
Classification and general features of NM laboratories (site, typical floor plan, ventilation, surface walls, floor and ceiling); Planning of radiation installation (Radio pharmacy, gamma camera, SPECT/CT, PET/CT, radionuclide therapy wards): protection from primary, leakage, and scattered radiation. Concepts of workload use factor, occupancy factor & distance.

Unit II - Barrier design:
barrier materials-concrete, brick and lead, Primary & secondary barrier design calculations, design of doors, control of radiation effects of time, distance and shielding.

Unit III - Regulatory requirements
AERB safety code and ethics, No Objection Certificates for facilities, radionuclides, and radiation equipment; Procedure for Commissioning, Operation, and Decommissioning of equipment, Calibration of radiation detection equipment (survey meters, area zone monitors, dose calibrators)

Unit IV - Operational safety, Radiation protection programme, Personnel requirements and responsibilities, Annual report submission to AERB.

Unit V - Record keeping for radionuclide storage, waste disposal, survey, spills, misadministration, personnel dosimeter recordings, quality control of equipment

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. Maintenance of service record**.**

Reference books:

1. .AERB safety code and manuals.
2. ICRP Publications
3. IAEA safety manuals
4. AERB Safety code for Nuclear Medicine

BSC. NMT-603: RADIATION PROTECTION

SUBJECT DESCRIPTION - The students should learn and appreciate the principles of Radiation protection and different AERB guidelines for the safe Nuclear Medicine procedures.

Unit I - Radiation protection

Principles of radiation protection, the need for radiation protection, Safe handling of radioactive materials, recommendations (ICRP, NCRP) and the regulatory requirements (IAEA, AERB), Negligible individual dose, Radiation detriment, ALARA, Dose limits to radiation workers, caregivers, and public, Annual limit of intake, Derived air concentration

Unit II - Radiation protective equipment

Radiation protective equipment: Shielding - lead barriers, syringe shields, lead aprons, lead gloves,

Unit III - Radiation monitoring devices:

Personnel monitoring systems - pocket dosimeters, film badges and thermoluminescent dosimeters (chest, wrist, ring, eye, etc); Survey meters, Contamination monitors, zone monitors and phantoms

Unit IV - Radiation monitoring procedures:

Wipe test, Area monitoring and radiation survey of nuclear medicine lab

UNIT V - Radioactive materials: Types of radioactive material packaging and testing; Transport of radioactive materials (Categories of radioactive materials and Transport Index), TREMCARD, Receipt of radioactive material - procedure and test for contamination, and maintenance of records

UNIT- VI - Radioactive waste management: Solid, Liquid, and Gaseous wastes; Principles of waste management, disposal of corpses containing therapeutic doses of radionuclides

UNIT VII – Radiation Emergencies and preparedness: Procedure for handling spills - Minor and major spills, Measures for containment, Decontamination procedure of Personnel, equipment and work area, decontamination kit ● Radiation emergencies and preparedness, Misadministration: Definition, procedure for reporting, and measures to minimise such events

Reference books:

1. Radiation Protection in Hospitals. Richard F.Mould
2. Basic radiological physics. Jaypee Brothers Private limited, New Delhi.
3. An Introduction to Radiation Protection. Allen Martin & Samuel.
4. Radiation safety in Medical practice. M.M. Rehani.
5. Radiation Protection. Ronald L. Kathren.