MAHATMA GANDHI UNIVERSITY
of
MEDICAL SCIENCES & TECHNOLOGY
JAIPUR

Syllabus

MD – Nuclear Medicine

(3 Years Post Graduate Degree Course)

Notice

1. Amendment made by the NMC in Rules/Regulations of Post Graduate Medical Courses shall automatically apply to the Rules/Regulations of the Mahatma Gandhi University of Medical Sciences & Technology (MGUMST), Jaipur.

2. The University reserves the right to make changes in the syllabus/books/guidelines, fees-structure or any other information at any time without prior notice. The decision of the University shall be binding on all.

3. The Jurisdiction of all court cases shall be Jaipur Bench of Hon'ble Rajasthan High Court only.

RULES & REGULATIONS
MD-Nuclear Medicine
(3 Years Post Graduate degree course)

TITLE OF THE COURSE:
It shall be called Doctor of Medicine.

ELIGIBILITY FOR ADMISSION:
No candidate of any category (including NRI quota) shall be eligible for admission to MD/MS courses, if he or she has not qualified NEET PG (MD/MS) conducted by National Board of Examinations or any other Authority appointed by the Government of India for the purpose.

(1) General Seats

(a) Every student, selected for admission to postgraduate medical course shall possess recognized MBBS degree or equivalent qualification and should have obtained permanent Registration with the NMC, or any of the State Medical Councils or should obtain the same within one month from the date of his/her admission, failing which the admission of the candidate shall be cancelled;

(b) Completed satisfactorily one year's rotatory internship or would be completing the same before the date announced by the University for that specific year as per NMC rules after passing 3rd professional MBBS Part II Examination satisfactorily.

(c) In the case of a foreign national, the NMCmay, on payment of the prescribed fee for registration, grant temporary registration for the duration of the postgraduate training restricted to the medical college/institution to which he/she is admitted for the time being exclusively for postgraduate studies; however temporary registration to such foreign national shall be subject to the condition that such person is duly registered as medical practitioner in his/her own country from which he has obtained his basic medical qualification and that his degree is recognized by the corresponding Medical Council or concerned authority.

(2) NRI Seats

(a) Students from other countries should possess passport, visa and exchange permits valid for the period of their course of study in this Institution and should also observe the regulations of both central and state governments regarding residential permits and obtain no-objection certificate from the same.

(b) The candidate should have a provisional "Student Visa". If he comes on any other visa and is selected for admission, he will have to first obtain a student visa from his country and then only he will be allowed to join the course. Therefore it is imperative to obtain provisional student visa before coming for Counseling.

(c) This clause is applicable to NRI/Foreign Students only.

CRITERIA FOR SELECTION FOR ADMISSION:

(1) NRI Quota

15% of the total seats are earmarked for Foreign National / PIO / OCI/ NRI / Ward of NRI/NRI sponsored candidates who would be admitted on the basis of merit obtained in NEET PG or any other criteria laid down by Central Government/NMC.

(2) Remaining Seats (Other than NRI Quota Seats)

(a) Admissions to the remaining 85% of the seats shall be made on the basis of the merit obtained at the NEET conducted by the National Board of Examinations or any other Authority appointed by the Government of India for the purpose.

(b) The admission policy may be changed according to the law prevailing at the time of admission.

COUNSELING/INTERVIEW:

(1) Candidates in order of merit will be called for Counseling/Interview and for verification of original documents and identity by personal appearance.

(2) Counseling will be performed and the placement will be done on merit-cum-choice basis by the Admission Board appointed by the Government of Rajasthan.

RESERVATION:

Reservation shall be applicable as per policy of the State Government in terms of scheduled caste, scheduled tribe, back ward class, special back ward class, women and handicapped persons.

ELIGIBILITY AND ENROLMENT:

Every candidate who is admitted to MD/MS course in Mahatma Gandhi Medical College & Hospital shall be required to get himself/herself enrolled and registered with the Mahatma Gandhi University of Medical Sciences & Technology after paying the prescribed eligibility and enrolment fees.

The candidate shall have to submit an application to the MGUMST through Principal of College for the enrolment/eligibility along with the following original documents and the prescribed fees within the prescribed period without late fees. Then after, students will have to pay applicable late fees as per prevailing University Rules

(a) MBBS pass Marks sheet/Degree certificate issued by the University (Ist MBBS to Final MBBS)

(b) Certificate regarding the recognition of medical college by the Medical Council of India.

(c) Completion of the Rotatory Internship certificate from a recognized college.

(d) Migration certificate issued by the concerned University.

(e) Date of Birth Certificate

(f) Certificate regarding registration with Rajasthan Medical Council / NMC/ Other State Medical Council.

REGISTRATION

Every candidate who is admitted to MD/MS course in Mahatma Gandhi Medical College & Hospital shall be required to get himself/herself registered with the Mahatma Gandhi University of Medical Sciences & Technology after paying the prescribed registration fees.

The candidate shall have to submit application to the MGUMST through Principal of College for registration with the prescribed fees within the prescribed period without late fees. Then after, students will have to pay applicable late fees as per prevailing University Rules.

DURATION OF COURSE:

The course shall be of 3 years duration from the date of commencement of academic session.

PERIOD OF TRAINING:

(1) The period of training for obtaining Post graduate degrees (MD/MS) shall be three completed years including the period of examination.

(2) It shall however be two years for candidates who have obtained the recognised PG Diploma in the subject.

MIGRATION:

No application for migration to other Medical Colleges will be entertained from the students already admitted to the MD/MS course at this Institute.

METHODS OF TRAINING FOR MD/MS:

Method of training for MD/MS courses shall be as laid down by the NMC.

ONLINE COURSE IN RESEARCH METHODS

i. All postgraduate students shall complete an online course in Research Methods to be conducted by an Institute(s) that may be designated by the NMC by way of public notice, including on its website and by Circular to all Medical Colleges. The students shall have to register on the portal of the designated institution or any otherinstitute as indicated in the public notice.
ii. The students have to complete the course by the end of their 2nd semester.
iii. The online certificate generated on successful completion of the course and examination thereafter, will be taken as proof of completion of this course
iv. The successful completion of the online research methods course with proof of its completion shall be essential before the candidate is allowed to appear for the final examination of the respective postgraduate course.
v. This requirement will be applicable for all postgraduate students admitted from the academic year 2019-20 onwards

ATTENDANCE, PROGRESS AND CONDUCT:

(1) Attendance:

(a) 80% attendance in each course is compulsory. Any one failing to achieve this, shall not be allowed to appear in the University examination.
(b) A candidate pursuing MD/MS course shall reside in the campus and work in the respective department of the institution for the full period as a full time student. No candidate is permitted to run a clinic/work in clinic/laboratory/ nursing home while studying postgraduate course. No candidate shall join any other course of study or appear for any other examination conducted by this university or any other university in India or abroad during the period of registration. Each year shall be taken as a unit for the purpose of calculating attendance.
(c) Every candidate shall attend symposia, seminars, conferences, journal review meetings, grand rounds, CPC, CCR, case presentation, clinics and lectures during each year as prescribed by the department and not absent himself / herself from work without valid reasons. Candidates should not be absent continuously as the course is a full time one.

(2) Monitoring Progress of Studies- Work diary/Log Book:

(a) Every candidate shall maintain a work diary in which his/her participation in the entire training program conducted by the department such as reviews, seminars, etc. has to be chronologically entered.
(b) The work scrutinized and certified by the Head of the Department and Head of the Institution is to be presented in the University practical/clinical examination.

(3) Periodic tests:

There shall be periodic tests as prescribed by the NMC and/or theBoard of Management of the University, tests shall include written papers, practical/clinical and viva voce.

(4) Records:

Records and marks obtained in tests will be maintained by the Head of the Department and will be made available to the University when called for.

THESIS:

(1) Every candidate pursuing MD/MS degree course is required to carry out work on research project under the guidance of a recognized post graduate teacher. Then such a work shall be submitted in the form of a Thesis.
(2) The Thesis is aimed to train a postgraduate student in research methods & techniques.
(3) It includes identification of a problem, formulation of a hypothesis, designing of a study, getting acquainted with recent advances, review of literature, collection of data, critical analysis, comparison of results and drawing conclusions.
(4) Every candidate shall submit to the Registrar of the University in the prescribed format a Plan of Thesis containing particulars of proposed Thesis work within six months of the date of commencement of the course on or before the dates notified by the University.
(5) The Plan of Thesis shall be sent through proper channel.
(6) Thesis topic and plan shall be approved by the Institutional Ethics Committee before sending the same to the University for registration.
(7) Synopsis will be reviewed and the Thesis topic will be registered by the University.
(8) No change in the thesis topic or guide shall be made without prior notice and permission from the University.
(9) The Guide, Head of the Department and head of the institution shall certify the thesis. Three printed copies and one soft copy of the thesis thus prepared shall be submitted by the candidate to the Principal. While retaining the soft copy in his office, the Principal shall send the three printed copies of the thesis to the Registrar six months before MD/MS University Examinations. Examiners appointed by the University shall evaluate the thesis. Approval of Thesis at least by two examiners is an essential pre-condition for a candidate to appear in the University Examination.
(10) Guide: The academic qualification and teaching experience required for recognition by this University as a guide for thesis work is as laid down by Medical Council of India/Mahatma Gandhi University of Medical Sciences & Technology, Jaipur.
(11) Co-guide: A co-guide may be included provided the work requires substantial contribution from a sister department or from another institution recognized for teaching/training by Mahatma Gandhi University of Medical Sciences & Technology, Jaipur/Medical Council of India. The co-guide shall be a recognized postgraduate teacher.
(12) Change of guide: In the event of a registered guide leaving the college for any reason or in the event of death of guide, guide may be changed with prior permission from the University.

ELIGIBILITY TO APPEAR FOR UNIVERSITY EXAMINATION:

The following requirements shall be fulfilled by every candidate to become eligible to appear for the final examination:

(1) Attendance: Every candidate shall have fulfilled the requirement of 80% attendance prescribed by the University during each academic year of the postgraduate course. (as per NMC rules)

(2) Progress and Conduct: Every candidate shall have participated in seminars, journal review meetings, symposia, conferences, case presentations, clinics and didactic lectures during each year as designed by the department.

(3) Work diary and Logbook: Every candidate shall maintain a work diary for recording his/her participation in the training program conducted in the department. The work diary and logbook shall be verified and certified by the Department Head and Head of the Institution.

(4) Every student would be required to present one poster presentation, to read one paper at a National/State Conference and to have one research paper which should be published/accepted for publication/ sent for publication to an indexed journal during the period of his/her post graduate studies so as to make him/her eligible to appear at the Post Graduate Degree Examination.

(5) Every student would be required to appear in and qualify the Pre-University Post graduate degree Mock examination. Post graduate students who fail to appear in or do not qualify the Pre-University Post graduate degree Mock examination shall not be permitted to appear in the final examination of the University.

The certification of satisfactory progress by the Head of the Department/ Institution shall be based on (1), (2), (3), (4) and (5) criteria mentioned above.

ASSESSMENT:

(1) The progress of work of the candidates shall be assessed periodically by the respective guides and report submitted to the Head of the Institution through the Head of the Department at the end of every six months. The assessment report may also be conveyed in writing to the candidate who may also be advised of his/her shortcomings, if any.

(2) In case the report indicate that a candidate is incapable of continuing to do the work of the desired standard and complete it within the prescribed period, the Head of the Institution may recommend cancellation of his/her registration at any time to the University.

(3) Formative Assessment:

(a) General Principles

i. The assessment is valid, objective, constructive and reliable.
ii. It covers cognitive, psychomotor and affective domains.
iii. Formative, continuing and summative (final) assessment is also conducted.
iv. Thesis is also assessed separately.

(b) Internal Assessment

i. The internal assessment is continuous as well as periodical. The former is based on the feedback from the senior residents and the consultants concerned. Assessment is held periodically.
ii. Internal assessment will not count towards pass/fail at the end of the program, but will provide feedback to the candidate.
iii. The performance of the Postgraduate student during the training period should be monitored throughout the course and duly recorded in the log books as evidence of the ability and daily work of the student.
iv. Marks should be allotted out of 100 as under
    1) Personal Attributes - 20 marks
        a. Behavior and Emotional Stability: Dependable, disciplined, dedicated, stable in emergency situations, shows positive approach.
        b. Motivation and Initiative: Takes on responsibility, innovative, enterprising, does not shirk duties or leave any work pending.

c. Honesty and Integrity: Truthful, admits mistakes, does not cook up information, has ethical conduct, exhibits good moral values, loyal to the institution.

2) Clinical Work - 20 marks
   a Availability: Punctual, available continuously on duty, responds promptly on calls and takes proper permission for leave.
   b Diligence: Dedicated, hardworking, does not shirk duties, leaves no work pending, does not sit idle, competent in clinical case work up and management.
   c Academic Ability: Intelligent, shows sound knowledge and skills, participates adequately in academic activities and performs well in oral presentation and departmental tests.
   d Clinical Performance: Proficient in clinical presentations and case discussion during rounds and OPD work up. Preparing Documents of the case history/examination and progress notes in the file (daily notes, round discussion, investigations and management) Skill of performing bed side procedures and handling emergencies.
3) Academic Activities - 20 marks
   Performance during presentation at Journal club/ Seminar/Case discussion/Stat meeting and other academic sessions. Proficiency in skills as mentioned in job responsibilities.
4) End of term theory examination - 20 marks
   End of term theory examination conducted at end of 1st, 2nd year and after 2 years 9 months.
5) End of term practical examination - 20 marks
   a. End of term practical/oral examinations after 2 years 9 months.
   b. Marks for personal attributes and clinical work should be given annually by all the consultants under whom the resident was posted during the year. Average of the three years should be put as the final marks out of 20.
   c. Marks for academic activity should be given by the all consultants who have attended the session presented by the resident.
   d. The Internal assessment should be presented to the Board of examiners for due consideration at the time of Final Examinations.
   e. Yearly (end of 1st, 2nd & 3rd year) theory and practical examination will be conducted by internal examiners and each candidate will enter details of theory paper, cases allotted (2 long & 2 short) and viva.
   f. Log book to be brought at the time of final practical examination.

APPOINTMENT OF EXAMINERS:

Appointment of paper setters, thesis evaluators, answer books evaluators and practical & viva voce examiners shall be made as per regulations of the Medical Council of India.

SCHEME OF EXAMINATION:

Scheme of examination in respect of all the subjects of MD/MS shall be as under :

(1) The examination for MD/MS shall be held at the end of three Academic Years.
(2) Examinations shall be organized on the basis of marking system.
(3) The period of training for obtaining MD/MS degrees shall be three completed years including the period of examination.

(4) The University shall conduct not more than two examinations in a year for any subject with an interval of not less than 4 months and not more than 6 months between the two examinations.

(5) The examinations shall consist of:

(a) Thesis :

i. Thesis shall be submitted at least six months before the main Theory examinations.

ii. The thesis shall be examined by a minimum of three examiners – one Internal and two External examiners who shall not be the examiners for Theory and Clinical/Practical.

iii. In departments where besides the two earmarked practical/clinical examiners no one else is a qualified P.G. teacher, in that case the Thesis shall be sent to the third external examiner who shall actually be in place of the internal examiner.

iv. Only on the acceptance of the thesis by any two examiners, the candidate shall be eligible to appear for the final examination.

v. A candidate whose thesis has been once approved by the examiners will not be required to submit the Thesis afresh, even if he/she fails in theory and/or practical of the examination of the same branch.

vi. In case the Thesis submitted by a candidate is rejected, he/she should be required to submit a fresh Thesis.

(b) Theory papers:

i. There shall be four theory papers, as below:

Paper I: Basic Sciences related to Nuclear Medicine

Paper II: Diagnostic Nuclear Medicine

Paper III: Therapeutic Nuclear Medicine

Paper IV: Recent advances in Nuclear Medicine

ii. Each theory paper examination shall be of three hours duration.

iii. Each theory paper shall carry maximum 100 marks.

iv. The question papers shall be set by the External Examiners.

v. There will be a set pattern of question papers.

Every question paper shall contain three questions. All the questions shall becompulsory, having no choice.

Question No. 1 shall be of long answer type carrying 20 marks.

Question No. 2 shall have two parts of 15 marks each. Each part will be requiredto be answered in detail.

Question No. 3 shall be of five short notes carrying 10 marks each.

vi. The answer books of theory paper examination shall be evaluated by two External and two internal examiners. Out of the four paper setters, the two paper setters will be given answer books pertaining to their papers and the answer books of the remaining two papers will be evaluated by two Internal Examiners. It will bedecided by the President as to which paper is to be assigned to which Internal Examiner for evaluation.

vii. A candidate will be required to pass theory and practical examinations separatelyin terms of the governing provisions pertaining to the scheme of examination in the post graduate regulations. The examinee should obtain minimum 40% marksin each theory paper and not less than 50% marks cumulatively in all the four papers for degree examination to be cleared as "passed" at the said Degree examination.

(c) Clinical/ Practical & Oral examinations:

i. Clinical/Practical and Oral Examination of 400 marks will be conducted by atleast four examiners, out of which two (50%) shall be External Examiners.

ii. A candidate will be required to secure at least 50% (viz. 200/400) marks in thePractical including clinical and viva voce examinations.

(6) If a candidate fails in one or more theory paper(s) or practical, he/she shall have toreappear in the whole examination i.e. in all theory papers as well as practical.

GRACE MARKS

No grace marks will be provided in MD/MS examinations.

REVALUATION / SCRUTINY:

No Revaluation shall be permitted in the MD/MS examinations. However, the student canapply for scrutiny of the answer books as per University Rules.

GUIDELINES FOR COMPETENCY BASED POSTGRADUATE TRAINING PROGRAMME FOR MD IN NUCLEAR MEDICINE

Preamble:

The purpose of PG education is to create specialists who would provide high quality health care and advance the cause of science through research & training.

Nuclear medicine is a multi-disciplinary practice and the training of medical doctors is critical to the performance of a Nuclear Medicine department. Successful post graduate students are awarded a final degree that is recognized by the government, local health authority and hospital employer as an assurance of specialist competence in Nuclear Medicine. Post graduate training programme in Nuclear Medicine consists of an integrated training course of three years duration and would enable the post graduate student to practice nuclear medicine safely.

The purpose of this document is to provide teachers and learners illustrative guidelines to achieve defined outcomes through learning and assessment. This document was prepared by various subject-content specialists. The Expert Group has attempted to render uniformity without compromise to purpose and content of the document. Compromise in purity of syntax has been made in order to preserve the purpose and content. This has necessitated retention of “domains of learning” under the heading “competencies”.

SUBJECT SPECIFIC LEARNING OBJECTIVES

At the end of the MD training program in Nuclear Medicine, the student should meet the following objectives:

1. **Acquisition of knowledge**

At the end of the MD program in Nuclear medicine, the student should acquire extensive knowledge on the concepts and principles of nuclear medicine in which the nuclear properties of radioactive nuclides is used (a) to make diagnostic evaluation of the anatomy and/or physiology of the subject, and (b) in providing therapy using

unsealed radioactive sources. The student should have acquired the theoretical knowledge needed for a competent nuclear medicine practice.

2. Acquisition of Skills

Nuclear medicine, being the bridge between a specific clinical problem and use of relevant test/s using radionuclides, the student should have acquired the required skills in the technical processes and routine procedures undertaken in this specialty. He/she should be able to apply such skills in nuclear medicine-based services, in self-directed learning for evolving educational needs and scientific information, in the conduct of research and in managerial assignments in the department.

3. Teaching and training

The MD student should be able to effectively teach and assess undergraduate medical students and allied health science courses so that they become competent healthcare professionals and are able to contribute to training of undergraduate and postgraduate trainees.

4. Research

The MD student should acquire research skills to support evidence-based practice in the specialty, be able to conduct a research project (basic/clinical), to pursue academic interests and continue life-long learning, to become more experienced teacher & mentor in all the above areas.

5. Professionalism, Ethics and Communication skills

The student should acquire communication skills of a high order, so as to report/interact with referring doctors, other health professionals, and with patients and their family members.

The student should acquire educational skills of high order to support a teaching role in areas related to the specialty, especially with medical students, junior staff, allied health professionals, and members of the public.

The student should be able to learn and apply principles of professionalism, ethics and effective communication in conduct of research, nuclear medicine-based services, educational activities and day to day work.

The overall **objective** of the programme is therefore, to enable the MD students to perform Nuclear Medicine practice, teaching and research independently and fulfill the manpower needs of ever expanding new branch of diagnostic and therapeutic medicine.

Post Graduate Training will consist of Theoretical and Practical Training:

SUBJECT SPECIFIC COMPETENCIES

By the end of the course, the student should have acquired knowledge (cognitive domain), professionalism (affective domain) and skills (psychomotor domain) as given below:

A. Cognitive domain

1. Should have knowledge of basic principles of radiation physics and its subsequent applications.
2. Should have knowledge of radiation protection principles.
3. Should have knowledge of safe handling of radionuclides and their disposal.
4. Should have knowledge of International Commission for Radiological Protection (ICRP) and National Regulatory guidelines pertaining to nuclear medicine practice.
5. Should have knowledge of diagnostic tests, interpretation of results and pitfalls.
6. Knowledge of good clinical practice of therapeutic nuclear medicine and dosimetry.
7. Should be able to conduct clinical research and write a thesis/dissertation under supervision.
8. Should develop good working relationship with user specialties and handling inter-specialty referrals

B. Affective domain:

1. Should be able to function as a part of a team, develop an attitude of cooperation with colleagues, and interact with the patient and the clinician or other colleagues to provide the best possible diagnosis or opinion.
2. Always adopt ethical principles and maintain proper etiquette in dealings with patients, relatives and other health personnel and to respect the rights of the patient including the right to information and second opinion.

3. Develop communication skills to word reports and professional opinion as well as to interact with patients, relatives, peers and paramedical staff, and for effective teaching.

C. Psychomotor domain

At the end of the course, the student should have acquired the following skills:

A) Basic Sciences Experiment:

1. Practical related to Physics, Instrumentation and its quality Control.
2. Preparation of radiopharmaceuticals and their quality control.
3. Detection of contamination in various workplaces.
4. Characterization of unknown isotopes.
5. Management of accidental spillage.
6. Practical related to Hybrid Imaging & Fusion Imaging.
7. Practical on qualitative and quantitative aspects of Hybrid Imaging.
8. Practical on optimized and safe operation of Hybrid imaging Instrumentation

B) Clinical Experiments on:

1. GFR Estimation.
2. Esophageal transit time.
3. Gastric emptying time.
4. Renal transplant evaluation.
5. Determination of Ejection Fraction and RWMA (wall motion).
6. Acquisition, Processing, Post Processing of Hybrid Imaging.

Syllabus

Course contents:

Cognitive Domain:

The syllabus is divided into the following four parts:

1. Basic Science aspects of Radiation Physics and its application to diagnostic/ therapeutic Nuclear Medicine
2. Diagnostic Nuclear Medicine and its applications
3. Therapeutic Nuclear Medicine and its applications
4. Recent Advances in Nuclear Medicine

At the end of the course, the student should have acquired knowledge in the following:

Part I: Basic Science related to Nuclear Medicine

1.1 Radiation Physics and Instrumentation

a. Structure of atom, Natural and artificial radioactivity.
b. Modes of Radioactive decay.
c. Interaction of radiation with matter.
d. Principles of radiation detection and detectors.
e. Basic principles of production of radionuclides by reactors and cyclotrons.
f. Nuclear Medicine Instrumentation including Gamma Cameras, Single Photon Computed Tomography (SPECT), Positron Emission Tomography (PET), Hybrid Imaging Systems like SPECT/CT, PET/CT and PET/MR
g. Counting Systems: Well counters, liquid scintillation counters, spectrometers, Radioactive Iodine Uptake (RAIU) probe and radiation monitoring devices.
h. Quality control of Nuclear Instruments, as in (f and g).
i. Collimation of radiation detectors and the characteristics of various collimators, their response to point, line and plane sources.
j. Electronic instruments, such as pulse amplifiers, pulse height analyzer, count rate meters and computer interfaces including gating devices.
k. Software and hardware fusion technology, Digital Imaging and Communications in Medicine (DICOM) technology and Picture Archiving and Communication System (PACS).

1.2 Mathematics, Statistics and Computer Sciences.

a. Principle of Biostatistics for Diagnostic and Therapeutic Medicine
b. Basic Mathematical concepts, counting statistics, probability distribution, Baysian and McNemmar statistics, parametric and non-parametric statistics and statistics of agreements.

c. Research methodology: Sample size calculation, case-control study and the design of randomized control trials.
d. Compartmental analysis and mathematical models of physiologic systems.
e. Basic aspects of computer structure, function and programming.
f. Computer applications with emphasis on digital image acquisition, analysis, processing and enhancement, tomographic reconstruction, display and recordings of findings.
g. Fundamental of filters, their applications and uses.

1.3 Radiation Biology

a. The biological effects of radiation exposure with emphasis on the effects of low level exposure.
b. Methods of reducing unnecessary radiation exposure to patients, personnel and environment.
c. ICRP recommendations and their amendments from time to time and other international recommendations, environmental regulations-regarding limits of radiation exposure, handling of radioactive patients, transport of radioactivity material and disposal of radioactive wastes.
d. The diagnosis, evaluation and treatment of radiation over exposure in any form.
e. Biodosimetry.

Part 2: Diagnostic Nuclear Medicine

2.1 Radiopharmaceuticals

The chemical, physical and biological properties of radiopharmaceuticals used in Nuclear Medicine investigations; production, Quality Control and Regulations of hospital based-Nuclear Pharmacy.

The emphasis will be on:

a. Physical and chemical characteristics of radionuclide used in diagnostic Nuclear Medicine
b. Criteria for selection of radionuclide for diagnostic purposes
c. The biological behavior of radiopharmaceuticals
d. Active Pharmaceutical Ingredients
e. Quality control

f. Mechanism of localization

g. Positron emitting radionuclides, target reactions, and their radiopharmaceuticals chemistry, various synthetic modules.

h. **Specific topics on Radiopharmaceuticals:** Bone seeking, hepatobiliary, brain and cerebrospinal fluid (CSF), renal, thyroid, parathyroid, infection imaging, Tumor Seeking, cardiac imaging, etc.

i. Good Manufacturing Practice (GMP) and laws pertaining to in-house manufacturing of Radiopharmaceuticals.

j. Radiopharmaceuticals for Research.

k. Principles of Production of Radioisotopes in reactors and accelerators.

l. Oral and IV contrast for CT & MRI

2.2 *In vivo* Diagnostic Imaging

a. General clinical indications for organ imaging; normal and altered anatomy, physiology, biochemistry and metabolism of various organs. Must learn the technical aspects of performing the procedures including proper patient preparation and patient management before, during and after the procedure.

b. *In vivo* imaging and/or functional studies including brain Single Photon Emission Computed Tomography (SPECT), tracing of cerebrospinal fluid pathways, thyroid imaging, salivary glands, lungs, heart, gastrointestinal, hepatobiliary system, spleen, kidney, prostate, adrenal, bone and joints, bone marrow evaluation etc.

c. The use of physiologic gating techniques for functional studies and patient monitoring during intervention, both physical exercise and using pharmacological stress agents.

d. Cellular kinetics, absorption and excretion analysis, nuclear hematology and metabolic balance studies using radiotracers.

e. Principles of CT, MR and US imaging. Comparative analysis of Nuclear Medicine procedures with X-ray, Ultrasound, Echo, MRI, CT and angiography etc.

f. Nuclear Cardiology: Stress and redistribution studies using Thallium^{201} and other technetium-based myocardial perfusion agents; myocardial viability, Gated SPECT studies, etc.

g. Essential Knowledge of CT & MRI, so as to report findings of immediate consequence and those pertaining to hybrid imaging so as to provide comprehensive information for which the study was undertaken as a single examination. This is to abide by the principle of ALARA, to achieve the least radiation burden.

h. Positron Emission Tomography (PET), PET-CT and PET/MR: All indications for use of PET-CT and PET/MR imaging in oncology, cardiology, neurosciences and psychiatric disorders, rheumatological diseases and infection.

i. PET-CT guided biopsy: technique, patient preparation and precautions.

j. Grading and staging systems for various common cancers including breast, lung, prostate cancer, neuroendocrine tumors and lymphomas.

2.3 *In vitro* Studies

a. Radioactive Iodine Uptake measurements- Principles, quality control and data analysis for various metabolic conditions of Thyroid Gland.

b. Glomerular Filtration Rate (GFR) estimation

Part 3: Therapeutic Nuclear Medicine

3.1 Principles of Internal Dosimetry: Calculation of the radiation dose from internally administered radionuclide

3.2 Characteristics of Radionuclides/Radiopharmaceuticals for radionuclide therapy

3.3 Radiation protection in therapeutic set up: Design of Isolation ward as per the norms of Atomic Energy Regulatory Board (AERB)

3.4 Principles of OPD and in-door therapy administration

3.5 **Therapy in thyroid disorders:** benign thyroid diseases, aetiology of hyperthyroidism, various modalities of treatment and follow up strategy, long-term outcome and various national and international regulations pertaining to therapeutic administration of radionuclides.

Therapy in thyroid disorders: aetiopathology, classification and diagnosis of thyroid nodules and malignancies - various modalities of treatment and follow-up strategies, long-term outcome and various

national and international regulations pertaining to therapeutic administration of radionuclides**.**

3.6 Basic principles and common treatment protocols in oncology, especially w.r.t lymphomas, breast, prostate and lung cancers and neuroendocrine tumors.

3.7 Bone pain palliation using various radionuclides such as P^{32}, Sr^{89}, Y^{90}, Sm^{153}, Ra^{223}, Lu^{177} etc.

3.8 Radiosynevectomy

3.9 Radiopeptide therapy and Radioconjugate therapy

3.10 Radioimmunotherapy

3.11 Locoregional internal radiation therapy

3.12 Research agents in radionuclide therapy

Part 4: Recent Advances in Nuclear Medicine

Covering all aspects of the following areas:

4.1 Instrumentation

4.2 Radiopharmaceuticals

4.3 Diagnostic procedures

4.4 Therapeutic procedures

TEACHING AND LEARNING METHODS

General principles

Acquisition of competencies being the keystone of doctoral medical education, such training should be skills oriented. Learning in the program, essentially autonomous and self-directed, and emanating from academic and clinical work, shall also include assisted learning. The formal sessions are meant to supplement this core effort.

All students joining the postgraduate (PG) courses shall work as full-time (junior) residents during the period of training, attending not less than 80% of the training activity during the calendar year, and participating in all assignments and facets of the educational process. They shall maintain a log book for recording the training they have undergone, and details of the procedures done during laboratory and clinical postings in real time.

Teaching-Learning methods

This should include a judicious mix of demonstrations, symposia, journal clubs, clinical meetings, seminars, small group discussion, bed-side teaching, case-based learning, simulation-based teaching, self-directed learning, integrated learning, interdepartmental meetings and any other collaborative activity with the allied departments. Methods with exposure to the applied aspects of the subject relevant to basic/clinical sciences should also be used. **The suggested examples of teaching-learning methods are given below but are not limited to these. The frequency of various below mentioned teaching-learning methods can vary based on the subject's requirements, competencies, work load and overall working schedule in the concerned subject.**

A. Lectures: Didactic lectures should be used sparingly. A minimum of 10 lectures per year in the concerned PG department is suggested. Topics to be selected as per subject requirements All postgraduate trainees will be required to attend these lectures. Lectures can cover topics such as:

1. Subject related important topics as per specialty requirement
2. Recent advances
3. Research methodology and biostatistics
4. **Salient features of Undergraduate/Postgraduate medical curriculum**
5. Teaching and assessment methodology.

Topic numbers 3, 4, 5 can be done during research methodology/biostatistics and medical education workshops in the institute.

B. Journal club: Minimum of once in 1-2 weeks is suggested.

Topics will include presentation and critical appraisal of original research papers published in peer reviewed indexed journals. The presenter(s) shall be assessed by faculty and grades recorded in the logbook.

C. Student Seminar: Minimum of once every 1-2 weeks is suggested.

Important topics should be selected as per subject requirements and allotted for in-depth study by a postgraduate student. A teacher should be allocated for each seminar as faculty moderator to help the student prepare the topic well. It should aim at

comprehensive evidence-based review of the topic. The student should be graded by the faculty and peers.

D. Student Symposium: Minimum of once every 3 months.

A broad topic of significance should be selected, and each part shall be dealt by one postgraduate student. A teacher moderator should be allocated for each symposium and moderator should track the growth of students. The symposium should aim at an evidence-based exhaustive review of the topic. All participating postgraduates should be graded by the faculty and peers.

E. Laboratory work / Bedside clinics: Minimum - once every 1-2 weeks.

Laboratory work/Clinics/bedside teaching should be coordinated and guided by faculty from the department. Various methods like DOAP (Demonstrate, Observe, Assist, Perform), simulations in skill lab, and case-based discussions etc. are to be used. Faculty from the department should participate in moderating the teaching-learning sessions during clinical rounds.

F. Interdepartmental colloquium

Faculty and students must attend monthly meetings between the main Department and other department/s on topics of current/common interest or clinical cases; eg., combined clinical round with Radiology, Pathology etc.

G a. Posting under "District Residency Programme" (DRP):

All postgraduate students pursuing MS/MS in broad specialities in all Medical Colleges/Institutions shall undergo a compulsory rotation of three months in District Hospitals/District Health System as a part of the course curriculum, as per the Postgraduate Medical Education (Amendment) Regulations (2020). Such rotation shall take place in the 3rd or 4th or 5th semester of the Postgraduate programme and the rotation shall be termed as "District Residency Programme" and the PG medical student undergoing training shall be termed as "District Resident".

Every posting should have its defined learning objectives. It is recommended that the departments draw up objectives and guidelines for every posting offered in conjunction with the collaborating department/s or unit/s. This will ensure that students acquire expected competencies and are not considered as an additional helping hand for the department / unit in which they are posted. The PG student must be tagged along with

those of other relevant departments for bedside case discussion/basic science exercises as needed, under the guidance of an assigned faculty.

Opportunities to present and discuss infectious disease cases through bedside discussion and ward/grand rounds with specialists / clinicians in different hospital settings must be scheduled to address antimicrobial resistance issues and strategies to deal with it.

G. b. Rotational clinical / institutional postings

The postgraduate trainees are be posted in relevant departments/ units as per details given below: The aim would be to acquire more in-depth knowledge as applicable to the concerned specialty.

Apprenticeship/Rotation in:

a)	Radio-diagnosis	03 months [CT 2 months and MR 1 month]
b)	Cardiac stress lab	2 weeks
c)	Hospital Emergency	2 weeks
d)	Endocrinology OPD	2 weeks
e)	Oncology / Radiotherapy OPD	4 weeks

The year-wise schedule of training would be as follows:

Year 1

(a) Scientific principles:

- Basic physics and mathematics,
- Instrumentation,
- Principles of computing
- Basic radiation biology and radiation protection,
- Basic radiopharmacy and radiochemistry,
- Principles of tracer technology.

(b) Clinical Nuclear Medicine:

- **Diagnostic**: Normal and abnormal appearances of images, mode of pharmaceutical uptake; normal variants and common artifacts in bone, heart, lung, kidney, brain, thyroid, tumour and infection images. Principles of CT &

MRI. Understanding selected Protocols and interpretations of CT & MRI, when performed as a part of simultaneous, PET/CT & PET/MRI.

- **Therapeutic**: Basic principles of radionuclide therapy; treatment of hyperthyroidism, thyroid cancer and metastatic bone pain.
- **Principles of radiation protection**: ALARA (as low as reasonably achievable) ALARP (as low as reasonably practicable).

Year 2

(a) Requirements of Year 1 in greater depth:

- Tracer kinetics;
- Computing and image processing;
- Radiobiology including the biological effects of high and low level radiation;
- Linear hypothesis and the threshold hypothesis of the biological response to low level radiation;
- The effective dose equivalent and the calculation of radiation dose from radiopharmaceuticals.

(b) Radiopharmacy:

- Properties of commonly used diagnostic and therapeutic radiopharmaceuticals;
- Production of radionuclides by reactors, cyclotrons and radionuclide generators;
- Quality assurance and quality control of radiopharmaceuticals.

(c) Diagnostic Nuclear medicine

- Tomography & hybrid SPECT-CT
- Integrated Protocols Of PET/CT & PET/MRI
- Optimization of CT & MRI protocols for simultaneous PET/CT & PET/MRI

Year 3

(a) Requirements of Year 2 in greater depth:

- Principles of radiology including ultrasound, computerized tomography and magnetic resonance imaging.
- Co-registration of nuclear medicine images and those from other imaging techniques.

- Diagnostic: special investigations in cardiology, lung disease, gastroenterology, hepato-biliary diseases, nephro-urology, neurology and psychiatry, endocrinology, haematology, oncology and infection.
- Radionuclide based hybrid imaging in Oncology, Cardiology, Neurology, Psychiatry, infection & inflammation, Pediatrics, Gastroenterology, and Orthopedics.

(b) Therapeutic applications:

- Treatment of bone metastases, neural crest tumors, prostate malignancies, solid malignancies;
- Use of radionuclide monoclonal antibodies and radionuclide labeled peptides for tumor therapy.

(c) Further practice and experience of work accomplished in years 1 to 3:

- Legal and regulatory requirements,
- Audit,
- Departmental management,
- Research techniques and evaluation,
- Teaching and training.

Practical training

The post graduate students are obliged to play an active 'in-service' role in the practice of Nuclear Medicine to familiarize themselves with all the techniques required as a nuclear medicine practitioner, such as:

- Protocols of *in vivo* and therapeutic procedure,
- Data acquisition and processing with various equipment, quality control of instruments and labeled agents,
- Interventional procedures, including physiological, pharmacological, and mental stress for diagnostic application, and all therapeutic interventions,
- *In vitro* protocols and procedures, if appropriate.

Since post graduate students will take on the responsibilities of a nuclear physician, they must pass a qualifying test that covers both theoretical knowledge and practical abilities in the daily practice of nuclear medicine.

SUGGESTED SCHEDULE FOR POST-GRADUATE TRAINING

Subject	Duration (hrs)	Suggested content of teaching	Recommended practice and time period
Nuclear physics	40	Decay features, spectrum, Radioisotope production & detection	Reactor-cyclotron generator, Radioisotope identification (5-7 days)
Radiochemistry	40	Labelling, technical design & quality control, interaction, kinetics	Synthesis, labelling, quality control, animal test (3-4 wks)
Radiobiology	40	Dosimetry, bio-modelling, tracer technology, radiation protection	Dosage-effect, molecular biology, radiation injury (4 wks)
Instrumentation	100	Scintillating camera, SPECT/CT, PET/CT, PET/MR imaging procedure, US examinations	Daily operation and quality control, trouble shooting (4 wks)
Related fields	50	Medical imaging modalities, epidemiology, statistics	Short round (6 wks)
Clinical use	240-300	Cardiology, neurology, GI tract, respiratory, endocrine, bones, haematology, tumour and infection	Clinical practice, image interpretation etc. (12-18 months)
In-vitro use	10	RAIU, RBC mass, survival, hypersplenism GFR measurements	RAIU practice (2 wks) GFR estimation (4 weeks)
Therapy	60	RIT, 177Lu-PRRT, 177Lu-PSMA Therapy, palliation, Loco-regional Therapies	Ward duty (3-4 months)

Postings in CT scan and MRI rooms are recommended as an aid to PET Scan imaging.

During the training program, patient safety is of paramount importance; therefore, relevant clinical skills are to be learnt initially on the models, later to be performed under supervision followed by independent performance. For this purpose, provision of skills laboratories in medical colleges is mandatory.

ASSESSMENT

FORMATIVE ASSESSMENT, during the training programme

Formative assessment should be continual and should assess medical knowledge, patient care, procedural & academic skills, interpersonal skills, professionalism, self-directed learning and ability to practice in the system.

General Principles

Internal Assessment should be frequent, cover all domains of learning and used to provide feedback to improve learning; it should also cover professionalism and communication skills.

The Internal Assessment should be conducted in theory and practical/clinical examination, should be frequent, cover all domains of learning and used to provide feedback to improve learning; it should also cover professionalism and communication skills.

Quarterly assessment during the MD training should be based on:

- Case presentation, case work up, case handling/management : once a week
- Laboratory performance : twice a week
- Journal club : once a week
- Seminar : once a fortnight
- Case discussions : once a fortnight/month
- Interdepartmental case or seminar : once a month

Note: These sessions may be organized and recorded as an institutional activity for all postgraduates.

- Attendance at Scientific meetings, CME programmes (at least 02 each)

The student to be assessed periodically as per categories listed in postgraduate student appraisal form (Annexure I).

SUMMATIVE ASSESSMENT, ie., assessment at the end of training

Essential pre-requisites for appearing for examination include:

1. **Log book** of work done during the training period including rotation postings, departmental presentations, and internal assessment reports should be submitted.

2. At least **two presentations** at national level conference. One research paper should be published / accepted in an indexed journal**. (It is suggested that the local or University Review committee assess the work sent for publication).**

The summative examination would be carried out as per the Rules given in the latest POSTGRADUATE MEDICAL EDUCATION REGULATIONS. The theory examination shall be held in advance before the Clinical and Practical examination, so that the answer books can be assessed and evaluated before the commencement of the clinical/Practical and Oral examination**.**

The postgraduate examination shall be in three parts**:**

1. **Thesis**

   Thesis shall be submitted at least six months before the Theory and Clinical / Practical examination. The thesis shall be examined by a minimum of three examiners; one internal and two external examiners, who shall not be the examiners for Theory and Clinical examination. A post graduate student in broad specialty shall be allowed to appear for the Theory and Practical/Clinical examination only after the acceptance of the Thesis by the examiners**.**

2. **Theory examination**

   The examinations shall be organized on the basis of 'Grading'or 'Marking system' to evaluate and to certify post graduate student's level of knowledge, skill and competence at the end of the training, as given in the latest POSTGRADUATE MEDICAL EDUCATION REGULATIONS. Obtaining a minimum of 50% marks in 'Theory' as well as 'Practical' separately shall be mandatory for passing examination as a whole. The examination for M.D./ M.S shall be held at the end of 3rd academic year.

There will be 4 theory papers:

Paper I: Basic Sciences related to Nuclear Medicine

Paper II: Diagnostic Nuclear Medicine

Paper III: Therapeutic Nuclear Medicine

Paper IV: Recent advances in Nuclear Medicine

Each theory paper to include a combination of long and short answer questions, to be completed in 3 hours. No MCQs.

3. Practical/Clinical and Oral Examination

Practical examination should be spread over **two** days and include various major components of the syllabus focusing mainly on the psychomotor domain. Practical examination shall consist of carrying out special investigative techniques for diagnosis and therapy. Oral examination shall be comprehensive enough to test the post graduate student's overall knowledge of the subject.

There shall be:

1. One long case and two short cases.
2. One practical consisting of basic science concepts
3. Spots
4. Scan readings
5. Oral/viva-voce examination

Recommended Reading:

Books (latest edition)

1. The Pathophysiological basis of nuclear medicine: by A.H. Elgazzar.
2. Physics and radiobiology of nuclear medicine: by Gopal B Saha.
3. Fundamentals of nuclear pharmacy: by Gopal B Saha.
4. Neuro PET: by Herholz.
5. Molecular anatomic Imaging: by Von Schulthess .
6. Principles and Practice of Nuclear Medicine: by Paul, J. Early, D. Bruce Sodee
4. Diagnostic Nuclear Medicine: by Sandler and Gottchalk.
5. Nuclear Medicine in Clinical Diagnosis and Treatment: by Ell and Gambhir.
6. Positron Emission Tomography: by Valk, Bailey, Townsend.
7. Practical FDG Imaging A teaching File: by Debelke, Martin, Patton, Sandler.
8. Functional Cerebral SPECT and PE Imaging.
9. CT and MR Imaging of the whole body: by Haaga, Lanzieri, Gilkeson.
10. Multidetector CT : Principle Techniques and Clinical Applications: by Fishman

Jeffrey Normal Lymph node Topography.

11. CT atlas: by Richter Feyerabind.
12. Therapeutic nuclear medicine: by Richard P Baum.
13. PET/MRI In Oncology: Current Clinical Applications, Editors: Andrei Iagaru, Thomas Hope and Patrick Veit-Haibach.
14. PET/MRI: Methodology and Clinical Applications, Editors: Ignasi Carrio and Pablo Ros.
15. PET/MR Imaging: Current and Emerging Applications: by Lale Umutlu, Ken Herrmann.

Journals

03-05 international Journals and 02 national (all indexed) journals

Annexure I

Student appraisal form for MD in Nuclear Medicine

	Element	Less than Satisfactory		Satisfactory				More than satisfactory			Comments
		1	2	3	4	5	6	7	8	9	
1	**Scholastic Aptitude and Learning**										
1.1	Has knowledge appropriatefor level of training										
1.2	Participation and contributionto learning activity (e.g., Journal Club, Seminars, CME etc)										
1.3	Conduct of research andother scholarly activity assigned (e.g. Posters, publications etc.)										
1.4	Documentation of acquisitionof competence (eg. Log book)										
1.5	Performance in work basedassessments										
1.6	Self-directed Learning										
2	**Care of the patient**										
2.1	Ability to provide patient careappropriate to level of training										
2.2	Ability to work with other members of the health careteam										
2.3	Ability to communicate appropriately and empathetically with patientsfamilies and care givers										
2.4	Ability to do procedures appropriate for the level of training and assigned role										
2.5	Ability to record and document work accuratelyand appropriate for level of training										

2.6	Participation and contributionto health care quality improvement										
3	**Professional attributes**										
3.1	Responsibility and accountability										
3.2	Contribution to growth oflearning of the team										
3.3	Conduct that is ethically appropriate and respectful atall times										
4	**Space for additional comments**										
5	**Disposition**										
	Has this assessment been discussed with the trainee?	Yes	No								
	If not explain										
	Name and Signature of theassesse										
	Name and Signature of theassessor										
	Date										

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MODEL PAPER

M.D. - **Nucl.Med.-I**

MD Examination Month, Year

Nuclear Medicine

Paper - I

(Basic Sciences related to Nuclear Medicine)

Time : Three Hours

Maximum Marks : 100

Attempt all questions

All the parts of one question should be answered at one place in sequential order.

Draw diagrams wherever necessary

Q.1 ……. 20

Q.2 Write in detail 2x15 = 30

a) ……..

b) …….

Q.3 Write short notes on - 5x10 = 50

a) ……

b) …….

c) …….

d) …….

e) …….

MODEL PAPER

M.D. - **Nucl.Medi-II**

MD Examination Month, Year

Nuclear Medicine

Paper - II

(Diagnostic Nuclear Medicine)

Time : Three Hours

Maximum Marks : 100

Attempt all questions

All the parts of one question should be answered at one place in sequential order.

Draw diagrams wherever necessary

Q.1 ……. 20

Q.2 Write in detail 2x15 = 30

a) ……..

b) …….

Q.3 Write short notes on - 5x10 = 50

a) ……

b) …….

c) …….

d) …….

e) …….

MODEL PAPER

M.D. - **Nucl.Med.-III**

MD Examination Month, Year

Nuclear Medicine

Paper - III

(Therapeutic Nuclear Medicine)

Time : Three Hours

Maximum Marks : 100

Attempt all questions

All the parts of one question should be answered at one place in sequential order.

Draw diagrams wherever necessary

Q.1 ……. 20

Q.2 Write in detail 2x15 = 30

a) ……..

b) …….

Q.3 Write short notes on - 5x10 = 50

a) ……

b) …….

c) …….

d) …….

e) …….

MODEL PAPER

M.D. - **Nucl.Med.-IV**

MD Examination Month, Year

Nuclear Medicine

Paper - IV

(Recent advances in Nuclear Medicine)

Time: Three Hours

Maximum Marks: 100

Attempt all questions

All the parts of one question should be answered at one place in sequential order.

Draw diagrams wherever necessary

Q.1 …… 20

Q.2 Write in detail 2x15 = 30

a) ……..

b) …….

Q.3 Write short notes on - 5x10 = 50

a) ……

b) …….

c) …….

d) …….

e) …….