CURRICULUM FOR MD PROGRAM IN
“NUCLEAR MEDICINE & MOLECULAR IMAGING”
AT ZIAUDDIN UNIVERSITY HOSPITAL, NORTH SITE

Program Faculty

S. No	Name	Designation	Qualifications	Discipline
1	**Dr. Nosheen Fatima**	Program Director (Asst. Professor)	MBBS, MS, FCPS (Pak), FEBNM (EU), FRCP (Edin), DCBNC (USA), FASNC (USA)	Nuclear Medicine
2	**Dr. Sajid Sattar**	Asst. Professor	MBBS, M.D (Pak)	Nuclear Medicine
3	**Dr. Kamran Ahmed**	Asst. Professor	MBBS, MCPS, FCPS Certified Interventional Cardiologist (Canada)	Cardiology
4	**Dr. Anwar Ahmed**	Asso. Professor	MBBS, FMRD, MD (Pak), FCPS	Radiology
5	**Dr. Ejaz Vohra**	Professor Dean PG clinical	MBBS, FRCP (Edin)	Medicine
6	**Dr. Tariq Siddiqui**	Professor (Director Cancer Centre)	MBBS, Diplomate American Board Internal Medicine	Medical Oncology
7	**Aziz Ahmed Siddiqui**	Chief Medical Physicist	M.Sc Physics, DCNS (France)	Health Physics
8	**Dr. Jawed Mallick**	Asso. Professor	MBBS, MD	Radiation Oncology
9	**Dr. Sobia Haqqi**	Asst. Professor	BS, MCPS, FCPS	Psychiatry

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Introduction

We are pleased to announce the MD program in Nuclear Medicine and Molecular Imagining at Ziauddin University Hospital that will be comprise of 4 years supervised training in the application, performance and interpretation of General Nuclear Medicine, PET- CT/MRI, Nuclear Cardiology, Radiopharmacy with cyclotron operation, DXA and Radionuclide therapy as they are applied to investigate a wide variety of disease processes, treatment planning and for targeted therapy. This will also comprise periodic rotations in General Medicine, Cross sectional Radiology, Cardiac catheterization and Oncology with participation in research activity and CME activity.

Program Outline

Duration of Program	4 years
Total Seats	4
Eligibility Criteria	MBBS recognized by PMDC with 1 year house job (06 months must in Medicine)
Date of start	1st July 2014

1. **Clinical Nuclear Medicine Training (36 months duration)**
    - Radiopharmacy (02 months)
    - General Nuclear Medicine (12 months)
    - Nuclear Cardiology (06 months)
    - PET-CT/MRI (12 months)
    - DXA (02 months)
    - Radionuclide therapy (02 months)
2. **Dissertation (06 months; 04 months data collection & 02 months dissertation writing)**
3. **Rotations (06 months)**
    - General Medicine (01 month)
    - Radiology (cross sectional CT/MRI studies) (03 months)
    - Cardiology (Cath lab/CTA); (01 month)
    - Oncology (01 month)

Competency Domains

The core competencies outlined in this document primarily reflect the clinical tasks of a MD resident, but residents may take on additional responsibilities at the discretion of the supervising physician. They were compiled in consideration of tasks required to work with general as well as specific patient populations in diagnostic and therapeutic settings.

The three competency domains are Patient Care, Clinical Nuclear Medicine, Interpersonal and Communication Skills. Patient Care competencies are described for general nuclear medicine procedures in all settings. Clinical Nuclear Medicine competencies incorporate general nuclear

medicine procedures with specialty competences outlined for nuclear cardiology, therapy, PET facility and elective competencies for those skills in which some residents may choose to become proficient depending on their practice setting and the evolution of the profession. Interpersonal and Communication Skills focuses on the ability to work effectively with others as a member or leader of a health care team or other professional group, with an emphasis on demonstrating team communication skills and leadership skills.

1. Patients' Care

I. Communicate effectively and demonstrate caring, respectful, and ethical behaviors when interacting with the patient, the family, physicians, and other health care professionals

II. Counsel and educate the patient and family
- Obtain patient informed consent for required procedures according to state law and institutional policy
- Educate the patient on preprocedural preparation and postprocedural care

III. Make informed decisions about diagnostic and therapeutic procedures under the direction of the supervising physician and based on patient information and preferences, up-to-date scientific evidence, and clinical judgment

- Gather and evaluate essential information, including correlative studies, about the patient and arrange follow-up as necessary under the direction of the supervising physician
- Obtain history and perform physical examination
- Evaluate findings for contraindications to testing and for indicators of additional patient pathology
- Consult with the physician as needed
- Counsel the patient and family as indicated

IV. Determine and implement a plan of care

- Use professional judgment to recommend or adapt protocols for procedures to improve diagnostic quality and outcome
- Consult with the supervising physician or appropriate health care provider to determine a modified action plan when necessary
- Report findings to the supervising physicians and the patient per protocol

V. Order and administer sedating pharmaceuticals under the direction of the supervising physician and monitor the patient who is receiving sedating pharmaceuticals as indicated by patient profile and diagnostic or therapeutic procedure as allowable by institutional practiced.

VI. Implement additional requirements for patient care for diagnostic or therapeutic procedures

- Perform patient bladder catheterizations
- Implement additional routes of radiopharmaceutical administration other than intravenous injection or oral
- Monitor vital signs and physiologic parameters
- Evaluate the need for contrast media (in case of SPECT or PET CT facility) in consultation with the supervising physician

VII. Provide indicated intervention per patient emergency event

- Provide supportive medical management
- Basic life support
- Advanced life support
- Facilitate transfer to definitive care environment

2. Clinical Nuclear Medicine

A. General Core Competencies

I. Basic concepts of radiation physics and radiation detection and protection

A. Radiation physics

- Atom
- Radioactive decay
- Decay series
- Nuclear Reaction

B. Radiation detection

- Gas filled detectors
- Solid state

C. Radiation protection

- Attenuation
- Radiation units
- Radiation protection standards
- Radiation dose
- Radiation shielding
- Transportation of radioisotopes

II. Clear Understanding of Nuclear Medicine instrumentation and Radiopharmacy

A. Generators
B. Radiopharmaceutical Quality Control
C. Geiger Counter:
D. Dose Calibrator:
E. Gamma Camera Characteristics:

F. Collimators:
G. Camera Quality Control
H. Agents and Critical Organs

III. Review requests and physician directives for nuclear medicine procedures

A. Review request for imaging procedures per protocol

B. Ensure the appropriate diagnostic study has been requested for the clinical presentation in consultation with the referring physician

C. Evaluate collaborative laboratory test results for indications/contraindications

D. Order or facilitate adjunctive pharmaceuticals for the imaging procedure under the direction of the supervising physician

IV. Competently perform clinical nuclear medicine procedures considered essential in the area of practice

A. Perform routine nuclear medicine procedures
B. Perform sentinel node imaging and lymphatic mapping
C. Prepare the patient and ancillary equipment for radiation therapy planning using positron and multimodality imaging systems

V. Prescribe and administer pharmacologic and non pharmacologic interventions under the direction of the supervising physician and as indicated by patient profile and diagnostic procedure
A. Perform preprocedure requirements and interventions as may be required
B. Perform intraprocedure requirements as may be required
C. Perform postprocedure requirements as may be required

VI. Order complementary diagnostic procedures as indicated by patient testing results under the direction of the supervising physician

VII. Analyze results of the procedure and prepare a preliminary description of findings for the supervising physician
A. Assess image quality and other associated data
B. Make a preliminary assessment
C. Document initial observations of imaging procedures according to protocol
D. Communicate initial observations as per the supervising physicians' discretion
E. Report findings to referring physicians and the patient per protocol

B. PET-CT/MRI course curriculum

I. To understand a basic knowledge of the physics and chemistry related to daily working practice of PET/CT
    A. Cyclotron
    B. PET radiopharmaceuticals
    C. Facility build up

II. Review requests and physician directives for PET imaging procedures
    A. Review request for imaging procedures per protocol
    B. Ensure the appropriate diagnostic study has been requested for the clinical presentation in consultation with the referring physician
    C. Evaluate collaborative laboratory test results for indications/contraindications

III. Competently perform clinical PET imaging procedures considered essential in the area of practice

    A. Competently perform PET imaging or therapeutic procedures

IV. Order complementary diagnostic procedures as indicated by patient testing results under the direction of the supervising physician
V. Analyze results of the procedure and prepare a preliminary description of findings for the supervising physician
    A. Assess image quality and other associated data
    B. Make a preliminary assessment
    C. Document initial observations of imaging procedures according to protocol
    D. Communicate initial observations as per supervising physician's discretion
    E. Report findings to referring physicians and the patient per protocol

C. Radionuclide Therapy Core Competencies

I. Review request for radionuclide therapy procedures under the direction of the supervising physician, analyzing the indications, contraindications, and complications for therapeutic interventions

    A. Interpret epidemiologic data, research, and trends related to incidence and prevalence of cancer
    B. Identify risk factors for cancer
    C. Understand Dosimetry and dosimetric consequences
    D. Understand the physiologic and radiobiological mechanisms by which differing radioisotope therapies are effective
    E. Conduct imaging protocols and evaluate images and laboratory values for presence of disease and metastasis
    F. Evaluate clinical criteria for radionuclide therapy, including expected biodistribution of radiotherapeutic pharmaceuticals

II. Counsel and educate the patient and family regarding the proposed therapeutic

intervention

A. Obtain translator/interpreter services as necessary
B. Fully understand the radiation protection regulations and procedures applicable to the administering department and relay the regulations to the patient/caregivers and family if applicable
C.
D. Explain in detail the processes, guidelines, and timelines for the radioisotope therapy regimen according to institution policy and guidelines
E.
F. Obtain patient informed consent for required procedures according to state law and institutional policy
G.
H. Educate the patient on preprocedural and postprocedural care

III. Calculate appropriate therapeutic dosage based on dosimetry, patient well-being, diagnostic imaging, and laboratory results under the direction of the supervising physician

A. Calculate radionuclide therapy dose for benign thyroid disease, basing dose selection on accepted standards

B. Calculate radionuclide therapy dose for malignant thyroid disease, basing dose selection on accepted standards

C. Calculate radionuclide therapy dose for palliative bone therapy, basing dose selection on accepted standards

D. Calculate radionuclide therapy dose for non-Hodgkin's lymphoma, basing dose selection on accepted standards

E. Calculate radionuclide therapy dose for polycythemia, basing dose selection on accepted standards

F. Calculate radionuclide therapy dose for malignant effusion, basing dose selection on accepted standards

G. Calculate radionuclide therapy dose for selective internal radiation therapy, basing dose selection on accepted standards

IV. Order or facilitate adjunctive pharmaceuticals for radiotherapy according to protocol

V. Administer the therapeutic dose, adhering to the applicable regulations and site protocols

VI. Report procedure to the supervising physician according to protocol

A. Overview of protocol compliance

B. Patient identification

C. Informed consent

D. Referral prescription

E. Patient preparation

F. Relevant clinical history

G. Radiopharmaceutical dose and route of administration

H. Patient status before, during, and following therapy

I. Brief statement outlining patient radiation safety instructions

J. Recommendations for follow-up diagnostic or therapeutic procedures as indicated

K. Recommend appropriate follow-up as needed

VII. In conjunction with the referring and supervising physician, monitor the patient and provide posttherapy intervention as needed for adverse side effects

A. Monitor the patient as indicated by protocol

B. Provide supportive care for symptoms

C. Maintain ongoing patient contact throughout the treatment regimen

D. Reevaluate patient status upon completion of therapy treatment(s) to determine patient's candidacy for additional therapy

D. Elective Competencies

I. Administer radiopharmaceuticals for radionuclide cisternography, cerebrospinal fluid shunt evaluations, cerebrospinal fluid leaks, or intraperitoneal procedures using aseptic technique and radiation safety standards at the discretion of the supervising physician

A. Explain complete procedure to the patient/family

B. Ensure scheduled imaging timeline compliance

C. Prepare injection site, adhering to predetermined aseptic/sterile technique

II. Manage pain and sedation for the patient receiving diagnostic testing or therapeutic treatment

A. Prescribe pharmacologic and non pharmacologic interventions as allowable by state and institutional practice
B. Monitor patient response to sedation and provide intervention according to accepted standards of practice

E. Nuclear Cardiology Competencies

I. Successfully complete Advanced Cardiac Life Support credentialing

A. Assess normal electrocardiogram to determine patient safety for stress testing
B. Assess abnormal electrocardiographic conduction in preparation for stress testing

II. Develop procedural policies and standards for pre–cardiac arrest emergencies that might occur within the department as directed by institutional policy and practice standards

A. Identify the signs and symptoms of symptomatic bradycardia and symptomatic tachycardia

B. Follow a step-by-step course of action for the patient who develops asymptomatic bradycardia or tachycardia while in office (before, during, or after stress test)

C. Follow a step-by-step course of action for the patient who develops signs and symptoms of bradycardia or tachycardia while in office (before, during, or after stress test)

D. Identify the proper medications and dosages for stable cardiac rhythms

E. List contraindications and precautions of common cardiac medications

F. Follow a step-by-step approach to handling an ST elevated myocardial infarction

G. Follow a step-by-step approach to handling a stroke situation

H. Follow a step-by-step approach to handling other patient incidents

I. Identify and delegate personnel to perform various tasks in preparation for cardiac emergencies

J. Incorporate the appropriate state, and institutional guidelines into departmental policies and procedures

III. Develop procedural policies and standards for cardiac arrest emergencies that occur within the department as directed by institutional policy and practice standards and provide indicated intervention for a cardiac emergency event

A. Establish intravenous access

B. Identify and administer the appropriate medications for commonly occurring cardiac arrhythmias under the direction of the supervising physician

C. Perform cardiac compression or defibrillate patient if required

D. Facilitate the ordering of laboratory tests or other tests as needed for a cardiac arrest event under the direction of the supervising physician

E. Facilitate admission of the patient to the hospital if necessary

IV. Provide indicated intervention for non cardiac emergency events

V. Manage crash cart for compliance

A. Follow the appropriate guidelines in implementing regulation for managing the department's crash cart

B. Inventory crash cart components according to institutional policy

C. Properly dispose of expired drugs

D. Replace expired drugs

E. Perform quality assurance testing on defibrillator and document results

VI. Take comprehensive patient history and evaluate for patient pathology

A. Interview the patient and document on department form a complete past and current cardiac history
B. Establish "nothing by mouth" compliance
C. Evaluate ambulatory ability
D. Review noncardiac history for prevalence to study requested

E. Perform physical assessment

VII. Evaluate patient laboratory biochemical markers relevant to cardiac pathology

A. Review most recent laboratory test results relevant to cardiovascular diseases
B. Order relevant blood tests if necessary (including pregnancy testing)

VIII. Evaluate patient medications for contraindications to stress testing

A. Understand contraindications to each type of stress test and evaluate for each

B. Review patient medications for contraindications to exercise stress testing

C. Conduct preoperative evaluation for orthopedic or other surgery

IX. Obtain patient informed consent as required for nuclear cardiology procedures according to state law and hospital policy

A. Understand the ethical and legal underpinnings of informed consent
B. Determine the capability of the patient to give informed consent
C. Explain the procedure to the patient, including all components of a valid informed consent
D. Obtain the patient's or guardian's signature

X. Conduct treadmill testing per all protocol options under the direction of the supervising physician

A. Prepare the patient for exercise protocol

B. Determine type of exercise stress test

C. Monitor electrocardiographic tracings and blood pressure for specific pathology and cardiac events during stress testing

D. Use the appropriate termination protocols

E. Calculate the Duke Treadmill Score

XI. Prescribe and administer interventional drugs for pharmacologic stress under the direction of the supervising physician

A. Explain the indications and contraindications for each pharmacologic stress agent

B. Identify the physiologic action of each pharmacologic agent as it relates to stress testing

C. Calculate total dose, volume, and dose rate for each of the most common pharmacologic stress agents

D. Set up drug administration pump

E. Prepare pharmacologic agents for administration utilizing sterile technique

F. Administer pharmacologic agents

G. Monitor patient response to pharmacologic agents and treat the patient appropriately in the event of an adverse effect

XII. Analyze results of the stress test and imaging portion of the examination and prepare a preliminary description of findings for the supervising physician

A. Create a preliminary description of findings detailing the results of the stress portion of the test

B. Examine rotating raw data from both stress and resting image acquisitions and evaluate image quality

C. Review data for incidental finding outside of the heart

D. Compare and contrast stress versus resting processed images for perfusion defects

E. Determine if the heart-to-lung ratio and transient ischemic dilation are abnormal

F. Evaluate the wall motion of stress and resting images for ejection fraction and kinetic abnormalities

G. Review and evaluate bull’s eye polar maps and summed stress scores

H. Create a preliminary description of findings detailing the results of the imaging portion of the test

XIII. Facilitate or recommend patient-specific cardiac-related procedures based on nuclear cardiology examination results (outcomes management) according to the supervising physician

A. Order or facilitate scheduling of complementary diagnostic procedures as indicated
B. Identify the clinical pathways as outlined by the American Society of Nuclear Cardiology for cardiac disease

F. Bone mineral densitometry; DXA (Dual Energy X-Ray Absorptiometry)

I. Content establishes a basic knowledge of bone densitometry and its purposes. The techniques from the past and present are explained, with an emphasis on dual-energy x-ray absorptiometry (DXA) and how it compares with conventional radiography.
A. Define bone densitometry.
B. Discuss the various uses for bone densitometry.
C. Explain the historical and current techniques, including peripheral adaptations.
D. Discuss and evaluate advantages and disadvantages of DXA.
E. Compare and contrast DXA to conventional radiography.

G. Interpersonal and Communication Skills

I. Demonstrate team communication and leadership skills to work effectively with others as a member or leader of a health care team or other professional group
A. Demonstrate leadership skills by leading a group project to successful completion
B. Communicate with the referring physician to assure appropriate examination selection, including actions to be taken if the requested procedure appears to be inappropriate
C. Collaborate with other health care team members to improve service delivery

II. Protect and preserve personal and confidential information of others to which access is provided
A. Adhere to privacy and regulatory standards and requirements regarding the accountability and protection of patient information
B. Identify potential abuses of confidential patient information
C. Describe the challenges associated with maintaining the confidentiality of patient information stored in computer systems and transmitted via networks

III. Use effective listening skills and elicit and provide information using effective nonverbal, explanatory, questioning, and writing skills
A. Listen to the “patient’s story,” extract important details from the history

taking, and provide information to their patients in an understandable way
B. Demonstrate effective interviewing skills for patient assessment
C. Demonstrate effective communication skills with and provide psychosocial support to specific groups of people, such as the terminally ill, physically or emotionally impaired, culturally diverse patients, families, and colleagues
D. Demonstrate effective age- and gender-specific communications
E. Be receptive to the clinical significance of patients' personal beliefs and values for adaptation of an examination protocol or departmental policies

IV. Demonstrate emotional resilience and stability, adaptability, flexibility, and tolerance of ambiguity and anxiety
A. Maintain composure in all situations
B. Refrain from negative conversations
C. Demonstrate self-awareness of personality traits

V. Follow appropriate protocol in resolution of conflict, exhibiting proper restraint when presented with potentially volatile situations

VI. Maintain comprehensive, timely, and legible records for medical, legal, quality improvement, and financial purposes

VII. Maintain appropriate protocol, courtesy, tact, and confidentiality in business communication, both written and oral

VIII. Demonstrate an appropriate level of communication skills when orally presenting professional or scholarly work

IX. Demonstrate technical writing ability in a variety of venues, including scholarly writing and business communications
A. Write an abstract according to published standards
B. Prepare a poster for presentation at a professional conference
C. Write scholarly articles
D. Develop patient procedure protocols
E. Develop department policies
F. Write business correspondence such as business letters, memos, or internal reports
G. Prepare reports, such as a needs assessment or progress report
H. Develop action plans for quality improvement projects
I. Develop patient education materials

X. Apply concepts of teaching and learning theories in design, implementation, and evaluation in the education of the patient, the family, colleagues, and community

CURRICULUM

1. Patient Care Curriculum Content

I. Communicate effectively and demonstrate caring, respectful, and ethical behaviors when interacting with the patient, the family, physicians, and other health care professionals

II. Counsel and educate the patient and family

A. Obtain patient informed consent for required procedures according to state law and institutional policy

1. Ethical and legal underpinnings of informed consent
    a) Autonomy, veracity, and confidentiality
    b) Who may give consent
        - Competency issues
        - Minors and mentally impaired adults
    c) Types of consent
        - Express
        - Implied by law
        - Informed consent
    d) Components of valid informed consent
        - Procedure that will be done
            - ➢ Diagnosis
            - ➢ Nature or purpose of the treatment or procedure
        - The name and qualifications of the person doing the procedure
        - The consequences or expected outcome
        - The risks involved, except for the very remote
            - ➢ Exceptions: risk of death or sterility if applicable
        - The alternatives to this procedure must be discussed
            - ➢ Includes alternative of doing nothing
            - ➢ Must then disclose the patient's prognosis
    e) Responsibilities of physician and health care providers
    f) When consent becomes invalid
        - The procedure exceeds the consent given
        - Inadequate information is given to the patient
        - The nurse or technologist answers medically related questions
        - The patient is given the consent form and told that it is just “routine papers”
        - Force of circumstances
        - Change of circumstances
2. Capability of the patient to give informed consent
3. Explanation of the procedure to the patient, including all components of a valid informed consent
    a) Risks

b) Benefits
c) Alternatives
d) Precautions used to reduce risks

4. Assessment of the patient's understanding of the risks, benefits, and alternatives and follow-up
5. Responding to questions or directing questions to the appropriate health care professional

B. Educate the patient on preprocedural preparation and postprocedural care
1. Dietary requirements
2. Modification of medication
a) Restrictions
b) Resumptions
3. Follow-up appointments
4. Next step in patient treatment algorithms
5. Physical activity limitations

III. Make informed decisions about diagnostic and therapeutic procedures under the direction of the supervising physician and based on patient information and preferences, up-to-date scientific evidence, and clinical judgment

A. Gather and evaluate essential information, including correlative studies, about the patient and arrange follow-up as necessary under the direction of the supervising physician
1. Pertinent patient laboratory biochemical markers relevant to pathology
a) Chemistry
b) Hematology
c) Microbiology
d) Histology/cytology
2. Pertinent previous diagnostic imaging studies
a) X-ray
b) Ultrasonography
c) Computed tomography
d) Nuclear procedures
e) Magnetic resonance imaging
f) Angiography
g) Mammography

B. Perform history and physical examinations
1. Review of systems
2. History of present illness
a) Onset
b) Provocation
c) Quality
d) Radiation
e) Severity
f) Time
g) Previous diagnosis

        h) Previous treatment
    3. Past medical history
        a) Medications
        b) Allergies
        c) Surgeries
        d) Medical conditions
    4. Family history
    5. Focused physical examination
        a) Neurologic
        b) General
        c) Psychosocial
        d) Cardiovascular
        e) Pulmonary
        f) Gastrointestinal
        g) Musculoskeletal
        h) Reproductive
        i) Genitourinary
        j) Pain
        k) Vital signs
C. Evaluate findings for contraindications to testing and for indicators of additional patient pathology
D. Consult with physician as needed
E. Counsel the patient and family as indicated

IV. Determine and implement a plan of care
A. Use professional judgment to recommend or adapt protocols for procedures to improve diagnostic quality and outcome
B. Consult with the supervising physician or appropriate health care provider to determine a modified action plan when necessary
C. Report findings to the supervising physicians and the patient per protocol

V. Order and administer sedating pharmaceuticals under the direction of the supervising physician and monitor the patient who is receiving sedating pharmaceuticals as indicated by patient profile and diagnostic or therapeutic procedure as allowable by institutional or state practice
A. Indications
B. Contraindications
C. Comorbidities
D. Legal issues

VI. Implement additional requirements for patient care for diagnostic or therapeutic procedures
A. Perform/implement patient bladder catheterizations
B. Establish additional routes of radiopharmaceutical administration other than intravenous injection or oral
    1. Feeding tube

a) Insertion
- Nasogastric
- Orogastric

b) Administration
- Nasogastric
- Orogastric
- Percutaneous endoscopic gastrostomy
- Gastrostomy

2. Rectal
- Insertion
- Administration
  - ➢ Radiopharmaceuticals
  - ➢ Pharmaceuticals
  - ➢ Contrast media

3. Administration into existing catheters or surgical routes
   a) Peritoneal catheters
   b) Ventriculoperitoneal shunts
   c) Central lines
   d) Intra-arterial lines

C. Monitor vital signs and physiologic parameters
   1. Blood pressure
   2. Pulse
   3. Pulse oxygen level
   4. Temperature
   5. O2saturation
   6. Electrocardiogram
   7. Drainage catheters

D. Evaluate the need for contrast media in consultation with the supervising physician
   1. Indications/contraindications
   2. Manage adverse events

VII. Provide indicated intervention per patient emergency event
   A. Provide supportive medical management
      1. Adverse response
      2. Allergic response
   B. Provide basic life support
   C. Provide advanced life support
   D. Facilitate transfer to definitive care environment

2. Clinical Nuclear Medicine Curriculum Content

A. Core Imaging

I. Basic concepts of radiation physics and radiation detection and protection
- **Radiation physics**
  a) Atom

1. Atomic structure
2. Radioactivity
    - Natural
    - Artificial

b) Radioactive decay
1. Decay constant
2. Half life

c) Decay series
1. Alpha decay
2. Gamma decay
3. Beta decay
4. Internal conversion
5. Characteristics x-ray
6. Positron emission

d) Nuclear Reaction
1. Fission
2. Fusion
3. Nuclear Reactor
4. Particle accelerator

- **Radiation detection**

a) Gas filled detectors
1. Ionization chambers
2. Proportional counter
3. GM counter

b) Solid state
1. Scintillator
2. Semiconductors

- **Radiation protection**

a) Attenuation
1. Interaction of radiation with matters
    - Raleigh scattering
    - Photoelectric effect
    - Compton scattering
    - Pair production

b) Radiation units

c) Radiation protection standards
1. ALARA
2. Time
3. Distance
4. Shielding
5. Contamination control

d) Radiation dose
1. Exposure
    - Internal
    - External
2. Absorbed dose

3. Equivalent dose
4. Effective dose

e) Radiation shielding
1. Half value layer
2. Attenuation coefficient
3. Mass attenuation

f) Transportation of radioisotopes

II. Clear Understanding of Nuclear Medicine instrumentation and Radiopharmacy

- **Generators and cyclotron**
- **Radiopharmaceutical Quality Control**
  a) Sterility
  b) Chemical Purity
  c) Radionuclide Purity
  d) Radiochemical Purity
- **Geiger Counter**
- **Dose Calibrator**
  a) Constancy
  b) Linearity
  c) Accuracy
  d) Geometry
- **Gamma Camera Characteristics**
  a) Spatial resolution
  b) Sensitivity
  c) Temporal resolution
- **Collimators**
  a) Resolution and Sensitivity
  b) Types of Collimators
    1. Parallel hole
    2. Converging and Diverging
    3. Pinhole
- **Camera Quality Control**
  a) SPECT Imaging
  b) Field Uniformity
  c) Center of Rotation
  d) Detector Alignment
  e) Patient motion
  f) Tomographic Reconstruction
    1. Attenuation Correction
    2. Filtered back-projection
    3. Iterative reconstruction
    4. Object Size Correction (Finite resolution effects)
- Agents and Critical Organs

3. Review requests and physician directives for nuclear medicine

procedures

A. Review request for imaging procedures per protocol
B. Ensure the appropriate diagnostic study has been requested for the clinical presentation in consultation with the referring physician
C. Evaluate collaborative laboratory test results for indications/contraindications
    I. Cardiac
        a) Cardiac enzymes/ Troponin
        b) Lipid panel
        c) Prior electrocardiogram
        d) Prior cardiac procedures (catheterization, bypass, etc)
    II. Hepatic
        a) Liver function tests
        b) Chemistry
    III. Pulmonary
        a) D-dimer
        b) Prothrombin time
        c) Partial thromboplastin time
        d) International normalized ratio

    IV. Oncology
        a) Tumor markers (eg, Ca-125, α-fetoprotein, serum carcinoembryonic antigen, serum thyroglobulin)
        b) Blood glucose
    V. Renal study
        a) Chemistry
        b) Urinalysis
    VI. Thyroid
        a) Free T3
        b) Free T4
        c) Thyroid-stimulating hormone
        d) Thyroglobulin
        e) Thyroglobulin antibodies
    VII. Parathyroid
        a) Parathyroid hormone
        b) Calcium
D. Order or facilitate adjunctive pharmaceuticals for the imaging procedure under the direction of the supervising physician
    I. Morphine
        a) Supersaturated Potassium Iodide
    II. Cimetidine
    III. Cardiac stress agents
    IV. Gastrointestinal agents
        a) Cimetidine
        b) Ranitidine
        c) Pentagastrin

d) Glucagon
e) Cholecystokinin or analogue

4. Competently perform clinical nuclear medicine procedures considered essential in the area of practice

A. Competently perform nuclear medicine imaging or therapeutic procedures

I. For each nuclear medicine procedure, identify the following
   a) Indications
   b) Contraindications
   c) Complications
   d) Limitations

II. For each nuclear medicine procedure, select the following
   a) Appropriate radiopharmaceutical and dose
   b) Imaging technique
   c) Data analysis
   d) Image presentation

III. Review image quality

IV. Determine the need for additional images

V. Correlate with other imaging studies such as x-rays, computed tomography (CT), magnetic resonance imaging (MRI), or ultrasonography

VI. Demonstrate competency in the following categories
   a) Musculoskeletal studies
      1. Bone scanning for benign disease
      2. Bone scanning for malignant disease
      3. Bone densitometry
   b) Myocardial perfusion imaging procedures performed with radioactive perfusion agents in association with treadmill and pharmacologic stress (planar and tomographic, including gated tomographic imaging)
   c) Radionuclide ventriculography performed with electrocardiographic gating for evaluation of ventricular performance
      1. First-pass studies
      2. Equilibrium studies
      3. Calculation of ventricular performance parameters (eg, ejection fraction and regional wall motion assessment)
   d) Endocrinologic studies
      1. Thyroid uptake and imaging
      2. Parathyroid imaging
      3. Adrenal imaging
      4. Octreotide and other receptor-based imaging studies
   e) Gastrointestinal studies
      1. Liver: reticuloendothelial function
      2. Liver: biliary function
      3. Salivary glands
      4. Esophagus

5. Stomach
6. Gastrointestinal bleeding
7. Meckel diverticulum
8. C-14 breath testing

f) Hematologic studies
   1. Red cell and plasma volume
   2. Splenic sequestration
   3. Hemangioma studies
   4. Labeled granulocytes for infection
   5. Thrombus imaging
   6. Bone marrow imaging

g) Oncology studies
   1. With agents using
      - Gallium
      - Thallium
      - Sestamibi
      - Antibodies
      - Peptides
      - Fluorodeoxyglucose (FDG)
      - Other agents as they become available
   2. Procedures of all common malignancies
      - Brain
      - Head and neck
      - Thyroid
      - Breast
      - Lung
      - Liver
      - Colon
      - Kidney
      - Bladder
      - Prostate
      - Lymphoma
      - Leukemia
      - Melanoma
      - Musculoskeletal tumors
      - Lymphoscintigraphy, including sentinel node mapping

h) Neurologic studies
   1. Procedures
      - Cerebral perfusion with single photon emission computed tomography (SPECT)
      - Cerebral perfusion with positron emission tomography (PET)
      - Cerebral metabolism with FDG
      - Cisternography
   2. Pathologies
      - Stroke

- Dementia
- Epilepsy
- Brain death
- Cerebrospinal fluid dynamics

i) Pulmonary studies
    1. Perfusion and ventilation performed with radiolabeled macroaggregates and radioactive gas or aerosols used in the diagnosis of pulmonary embolus
    2. Quantitative assessment of perfusion and ventilation

j) Genitourinary tract imaging
    1. Renal perfusion and function procedures
    2. Clearance methods
    3. Renal scintigraphy with pharmacologic interventions
    4. Renal transplant evaluation
    5. Vesicoureteral reflux

B. Perform sentinel node imaging and lymphatic mapping\

I. Anatomy and physiology of lymphatic system
    a) Breast
        1. Contains greater concentration than any other part of the body
        2. Lymph node or gland location and drainage patterns
    b) Melanoma
        1. Head and neck levels and drainage patterns
        2. Torso/trunk above umbilicus
        3. Pelvis (below umbilicus)
        4. Extremities: arms and legs
    c) Solid organ (eg, biopsy-proven colorectal cancer)

II. Injection technique
    a) Intradermal
        1. Local systemic route
        2. Melanoma
    b) Peritumoral
        1. Melanoma
        2. Breast
    c) Subcutaneous
    d) Periareolar
        1. Breast
    e) Perirectal
        1. Solid organ

III. Radiopharmaceutical
    a) Agent
    b) Dose
    c) Route of administration (see injection technique)
    d) Volume limitation
    e) Particle size

f) Needle size

IV. Pharmaceutical intervention: anesthetic

V. Patient positioning and immobilization devices

a) Positioning

1. Therapy planning table
2. Positioning devices (eg, wedges)

b) Immobilization

1. Casts/masks
2. Vacuum bags

C. Prepare the patient and ancillary equipment for radiation therapy planning

I. Equipment

a) Masks
b) Therapy planning table
c) Positioning appliances
d) Other ancillary equipment

II. Laser positioning and reference marking

5. Prescribe and administer pharmacologic and non-pharmacologic interventions

A. Perform preprocedure requirements and interventions

I. Dietary status

a) Nothing by mouth per department protocol

1. Hepatobiliary
2. Gastric emptying
3. Thyroid uptake/scan
4. Gastric reflux
5. C-14 urea breath test

b) Prearranged meals

1. Fatty
2. Low iodine
3. Low carbohydrate
4. High protein

II. Hydration per department protocol

a) Renal imaging
b) PET

III. Medication discontinued per department protocol

a) Thyroid uptake/scan

1. T3
2. T4
3. Propylthiouracil/methimazole
4. Iodinated contrast

b) Adrenal medullary imaging

1. Opioids

2. Tricyclic antidepressants
3. Sympathicomimetics
4. Antihypertensive/cardiovascular agents
5. Angiotensin-converting enzyme inhibitors
6. Antipsychotics

c) C-14 urea breath test
1. Antibiotics
2. Bismuth
3. Sulfates

d) Captopril renal scan
1. Diuretics
2. Angiotensin-converting enzyme inhibitors
3. Calcium antagonists
4. Angiotensin II receptor blockers

IV. Activity limitation as clinically indicated
1. PET: reduce physical activity
2. PET: eliminate speech

V. Laboratory evaluations as per department protocol

B. Perform intraprocedure requirements

I. Medications as per department protocol
a) Morphine intervention for hepatobiliary imaging
1. Dose
2. Dose limits
3. Administration technique

b) Cholecystokinin intervention for hepatobiliary imaging
1. Dose
2. Administration technique

c) Furosemide for renal imaging
1. Dose
2. Administration technique

II. Activity limitations as clinically indicated
III. Dietary status as per department protocol
IV. Laboratory evaluation as per department protocol
V. Vital signs

C. Perform postprocedure requirements

I. Activity limitations as clinically indicated
II. Medications as directed by referring physician or supervising physician
a) Administration of additional medications as directed
b) Ensure that the patient does not take metformin-containing medications 48 hours after administration of iodinated contrast material
c) Ensure children are rehydrated after diuretic study

III. Dietary limitations
a) Nothing by mouth 1 hour post dose – thyroid uptake

b) Hydration – facilitate urination

IV. Laboratory evaluation – as clinically indicated

6. Order complementary diagnostic procedures as indicated

7. Analyze results of the procedure and prepare a preliminary description

A. Assess image quality and associated data
   1. Adequacy
   2. Artifact
   3. Incidental findings

B. Make a preliminary assessment
   1. Incidental findings
   2. Review correlative data
   3. Summarize findings with a concise statement addressing the referring physician's question

C. Document initial observations according to protocol
   1. Patient identification
   2. Informed consent as necessary
   3. Referral prescription
   4. Patient preparation
   5. Relevant clinical history
   6. Radiopharmaceutical dose and route of administration
   7. Patient status before, during, and following procedure/therapy
   8. Statement outlining patient radiation safety instructions as necessary
   9. Recommendations for follow-up diagnostic or therapeutic procedures as indicated
   10. Recommendations for follow-up as needed

D. Communicate initial observations as per supervising physician's discretion

E. Report findings to referring physicians and the patient per protocol
   1. Recommend appropriate diagnostic or therapeutic procedures as indicated
   2. Recommend appropriate follow-up as needed

B. PET-CT / MRI Course Curriculum

I. To understand a basic knowledge of physics and chemistry related to daily PET/CT practice

A. Cyclotron
   1. Physics
   2. Types
   3. Shielding

B. PET radiopharmaceuticals
   1. PET agents
   2. Labeling with pharmaceuticals

3. Biodistribution
4. Quality control

C. Facility build up

II. Review requests and physician directives for PET imaging procedures

A. Review request for imaging procedures per protocol
B. Ensure the appropriate diagnostic study has been requested for the clinical presentation in consultation with the referring physician
C. Evaluate collaborative laboratory test results for indications / contraindications
    1. Cardiac
        a) Cardiac enzymes / Troponin
        b) Lipid panel
        c) Prior electrocardiogram
        d) Prior cardiac procedures (catheterization, bypass, etc.)
        e) Blood glucose
    2. Oncology
        a) Tumor markers
        b) Blood glucose
        c) Previous chemotherapy / radiation

III. Competently perform clinical PET imaging procedures essential in the area of practice

A. Competently perform PET imaging or therapeutic procedures
    1. For each procedure, identify
        a) Indications
        b) Contraindications
        c) Complications
        d) Limitations
    2. For each procedure, select the following
        a) Appropriate radiopharmaceutical and dose
        b) Imaging technique
        c) Data analysis
        d) Image presentation
    3. Review image quality
    4. Determine the need for additional images
    5. Correlate with other imaging studies such as X-rays, CT, MRI, or ultrasonography
    6. Demonstrate competency in the following categories
        a) PET imaging of the heart
            - Myocardial perfusion
            - Myocardial viability
        b) PET imaging of the brain
            - Dementia

- Epilepsy
- Brain tumours

c) PET imaging in oncology
   - Lung
   - Head and neck
   - Esophagus
   - Colon
   - Thyroid
   - Breast
   - Melanoma
   - Lymphoma
   - Other tumours as indications become established

d) Registration and image fusion of SPECT / PET images with CT and MRI studies
e) Anatomic CT imaging of brain, head & neck, thorax, abdomen, and pelvis to understand correlation between anatomic and functional imaging
f) Experience in radiation oncology and medical oncology

IV. Order complementary diagnostic procedures as indicated under supervising physician direction

V. Analyse procedure results and prepare preliminary findings

A. Assess image quality and associated data
   1. Adequacy
   2. Artifact
   3. Incidental findings

B. Make a preliminary assessment
   1. Incidental findings
   2. Review correlative data
   3. Summarise findings addressing the referring physician's question

C. Document initial observations according to protocol
   1. Patient identification
   2. Informed consent where necessary
   3. Referral prescription
   4. Patient preparation
   5. Relevant clinical history
   6. Radiopharmaceutical dose and administration route
   7. Patient status before, during, and after procedure / therapy
   8. Radiation safety instructions if required
   9. Recommendations for follow-up diagnostic or therapeutic procedures
   10. Recommendations for follow-up as needed

D. Communicate initial observations as per supervising physician discretion
E. Report findings to referring physicians and patient per protocol
    1. Recommend appropriate diagnostic or therapeutic procedures
    2. Recommend appropriate follow-up

C. Radionuclide Therapy Competencies

I. Review radionuclide therapy requests under supervising physician direction of the supervising physician, analyzing the indications, contraindications for therapeutic interventions

1. Interpret epidemiologic data, research, and cancer trends
    - Malignant versus benign tumours
    - Proto-oncogenes
    - Statistical interpretation
    - Lifestyle / environmental risks
    - Clinical treatments
        a) Curative or palliative
            ➢ Surgical
            ➢ Medical
            ➢ Medication
    - Clinical studies
    - Life expectancy

2. Identify cancer risk factors
    - Previous cancer or treatment
    - Genetic risk
    - Environmental risk

3. Understand dosimetry and dosimetric consequences
    - Interactions and energy deposition by ionising radiation in matter
    - Concepts, quantities, and units in radiologic physics
    - Principles and methods of radiation dosimetry

4. Understand the physiologic and radiobiological mechanisms by which differing radioisotope therapies are effective

    - Effects of ionizing radiations on living cells and organisms

    - Physical, chemical, and physiologic bases of radiation cytotoxicity, mutagenicity, and carcinogenesis

5. Conduct imaging protocols and evaluate images and laboratory values for presence of disease and metastasis

- Coordinate imaging protocols per protocol, reference patient care
- Tumor markers
- Evaluation for metastatic disease, reference patient care and core imaging
- Order or facilitate necessary laboratory and imaging studies per protocol and physician directive

6. Evaluate clinical criteria for radionuclide therapy, including expected biodistribution of radiotherapeutic pharmaceutical

    - Bone marrow suppression and secondary to added chemotherapy within 6-week window
    - Unintended thyroid ablation
    - Pulmonary fibrosis secondary to pulmonary metastasis
    - Exclude patients with pain from other causes that is mimicking bone pain
    - Evaluate impending spinal cord compression or impending long bone fractures
    - Evaluate renal function to lower dosage or delay therapy
    - Exclude pregnant patients
    - Exclude patients for 2-3 days receiving other phosphonate-based therapy

II. Counsel and educate the patient and family regarding the proposed therapeutic intervention
    1. Obtain translator/interpreter services as necessary
    2. Fully understand the radiation protection regulations and procedures applicable to the administering department and relay the regulations to the patient/caregivers and family if applicable
        - Written directive
            - ➢ Patient identification
            - ➢ Dose verification
        - Patient release requirements
            - ➢ Total effective dose equivalent (TEDE) to others not likely to exceed 5 mSv (0.5 rem)
            - ➢ Written instructions if TEDE to others could exceed 1 mSv (0.1 rem)

- Recordkeeping requirements
  - ➢ Basis for release
    - ➔ TEDE versus activity or dose rate
- Emergency preparedness
  - ➢ Contact information for the patient
  - ➢ Major spill cleanup
  - ➢ Medical emergencies or death
    - ➔ Notify Radiation Safety Officer
    - ➔ Notify medical personnel

3. Explain in detail the processes, guidelines, and timelines for the radioisotope therapy regimen according to institutional policy and guidelines
   - I-131 therapy
     - ➢ Preparation
     - ➢ Treatment
     - ➢ Follow-up
   - P-32 therapy
     - ➢ Preparation
     - ➢ Treatment
     - ➢ Follow-up
   - Ibritumomab tiuxetan
     - ➢ Preparation
     - ➢ Treatment
     - ➢ Follow-up
   - Tositumomab
     - ➢ Preparation
     - ➢ Treatment
     - ➢ Follow-up
   - 89Sr chloride
     - ➢ Preparation
     - ➢ Treatment
     - ➢ Follow-up
   - 153-Sm
     - ➢ Preparation
     - ➢ Treatment
     - ➢ Follow-up
   - 90-Y
     - ➢ Preparation
     - ➢ Treatment
     - ➢ Follow-up
4. Obtain patient informed consent for required procedures according to state law and institutional policy
   a) Educate the patient on the risks, benefits, and alternatives to the procedure
      - Thyroid disease
        A. Benign thyroid disease

1. Risks
    - More than one I-131 treatment may be necessary
    - Risk of hypothyroidism is high, resulting in lifelong daily ingestion of thyroid medication
    - Long-term follow-up necessary
    - Ophthalmopathy may improve or worse or develop after I-131 treatment (Graves' disease)
    - Radiation thyroiditis/thyroid storm (rare)
2. Benefits
    - Reduction/cell death of overactive thyroid tissue
    - Reduces/eliminates dependent medications
    - Reduces/eliminates associated symptoms
    - Prevents cardiac damage
3. Alternatives to treatment
    - Surgery
    - Pharmaceutical therapy
    - No therapy

B. Malignant thyroid disease
1. Risks
    - Normal as well as cancerous thyroid tissue will be destroyed; other normal tissues may also be affected
    - More than one I-131 treatment may be necessary
    - Early side effects
    - ➔ Mucositis
    - ➔ Nausea/vomiting
    - ➔ Pain/tenderness in salivary glands
    - ➔ Loss of saliva or taste
    - ➔ Metallic-like alterations in taste
    - ➔ Neck pain/swelling (rare)
    - ➔ Temporary decreased white blood cell count (increased susceptibility to infection) (very rare)
    - Late side effects
    - ➔ Temporary infertility

- ➔ Permanent damage to salivary glands
- ➢ Loss of saliva
- ➢ Excessive dental caries
- ➢ Reduced taste
- ➔ Dry eyes
- ➔ Epiphora from scarring of lacrimal ducts
- ➔ Development of other malignancies (rare)
- ➢ Stomach
- ➢ Bladder
- ➢ Colon
- ➢ Salivary glands
- ➢ Leukemia (dose related and most significant late sequelae)
- Lifelong daily ingestion of thyroid medication will be required
- Long-term follow-up necessary

2. Benefits
   - Destruction of malignant and normal thyroid tissue
3. Alternatives to treatment
   - External beam therapy
   - Surgery

C. Palliative bone therapy (P-32, Sm-153, Sr-89)

1. Risks
   - Potential for pain flare at 7 to 10 days post treatment
   - Reduction in leukocytes and platelet counts, resulting in bleeding/infection and potentially death
   - Chance of total pain relief rare
   - Not a curative treatment
2. Benefits
   - Reduces bone pain
   - Improves mobility/quality of life
   - Reduces dependence on narcotic and non-narcotic
   - Analgesics
   - Improves performance status and possibly survival
   - Reduces cotreatment costs
3. Alternatives to treatment
   - External beam therapy

- Chemotherapy

D. Non-Hodgkin's lymphoma (I-131 tositumomab, Y-90 ibritumomab tiuxetan)
    1. Risks
        - Hematologic events
        - ➢ Neutropenia
        - ➢ Thrombocytopenia
        - ➢ Anemia
        - ➢ Ecchymosis
        - Digestive symptoms
        - ➢ Nausea
        - ➢ Vomiting
        - ➢ Diarrhea
        - ➢ Anorexia
        - ➢ Abdominal enlargement
        - ➢ Constipation
        - Musculoskeletal system
        - ➢ Arthralgia
        - ➢ Myalgia
        - Nervous system
        - ➢ Dizziness
        - ➢ Insomnia
        - Respiratory system
        - ➢ Dyspnea
        - ➢ Increased cough
        - ➢ Rhinitis
        - ➢ Bronchospasm
        - Skin/appendages
        - ➢ Pruritus
        - ➢ Rash
        - Whole body
        - ➢ Fever
        - ➢ Infection
        - ➢ Chills
        - ➢ Abdominal pain
        - ➢ Pain
        - ➢ Headache
        - ➢ Throat irritation
        - ➢ Back pain
        - ➢ Flushing
        - Cardiovascular
        - ➢ Hypotension
        - Anaphylactic shock (acute)
        - ➢ Death
        - Nonresponse to treatment protocol

        - Human antimurine antibody
        - Hypothyroidism (tositumomab)
        - ➢ **Lifelong daily ingestion of thyroid medication may be required**
    2. Benefits
        - Target treatment to CD20 antigen expressed on normal and abnormal B cells, resulting in cell destruction/death (possible partial or complete remission)
        - Durable response to therapy; results comparable to chemotherapy and external beam therapy
        - Short outpatient treatment protocol (14 days)
        - Improved quality of life during/following treatment protocol
    3. Alternatives to treatment
        - Chemotherapy
        - External beam therapy
        - Watch/wait – no therapy
E. Polycythemia
    1. Risks
        - Hematologic event (transient reduction in platelet and leukocyte counts) resulting in possible bleeding/infection
    2. Benefits
        - Reduces total red blood cell volume
        - Repeat treatments possible
        - Reduces platelet counts to prevent clotting
    3. Alternatives to treatment
        - Chemotherapy
        - Pharmacologic therapy
F. Malignant effusion
    1. Risks
        - Hematologic events (transient reduction in platelet and leukocyte counts; rare)
        - Suboptimal treatment outcome due to loculation in thoracic or

peritoneal cavity
- Tissue necrosis
- Not a curative treatment

2. Benefits
   - Reduce malignant cells in the thoracic or peritoneal cavity
   - Delayed fluid buildup in thoracic or peritoneal cavity
   - Repeat procedures possible
3. Alternatives to treatment
   - Chemotherapy (treatment of choice)

G. Selective internal radiation therapy
1. Risks
   - Chronic pain
   - Ulceration/bleeding
   - Lung edema/fibrosis when lung shunting exceeds 20%
   - Local radiotherapeutic treatment may include destruction of normal liver tissue
   - Not a curative treatment
2. Benefits
   - Local radiotherapeutic treatment to embolized liver tumors produces cell death to malignant tumor
   - Procedure may be repeated
   - Short treatment protocol performed over 7 to 14 days (diagnostic + therapeutic)

3. Alternatives to treatment
   - Surgery
   - Chemotherapy
   - Hepatic arterial embolization with or without chemotherapy
   - Liver transplantation (probably not an alternative)

H. Radiosynoviorthesis
1. Risks
   - Pain
   - Joint inflammation
   - Infection
   - Not a curative procedure

2. Benefits
    - Reduction in painful joint swelling including postoperative prosthesis
    - Procedure may be repeated
3. Alternatives to treatment
    - Pharmacologic therapy
    - Surgery

b) Assess the patient's understanding of risks, benefits, and alternatives as well as follow-up
1. Address and document the patient's questions and concerns
    - Consider cultural diversity and ethical issues
2. When approved by patient, include family members/friends to improve communication/understanding
3. Identify the need for an interpreter as necessary
    - Language
    - Hearing impaired
4. Document as per institutional protocol
    - Discussion topics
        - ➢ Risks
        - ➢ Benefits
        - ➢ Alternatives to treatment
    - Patient's questions, issues, or concerns
    - Barriers to communication
        - ➢ Emotional
        - ➢ Psychological
        - ➢ Physical (motor deficit)
        - ➢ Cultural/spiritual
        - ➢ Age specific
            - ➔ Neonate
            - ➔ Pediatric
            - ➔ Adolescent
            - ➔ Geriatric

c) Ensure the patient will comply fully with the necessary therapy constrictions and guidelines
d) Determine a candidate's suitability for radioisotope therapy in collaboration with the treating physician
e) Final discussion outcome
    - Consent to treat
    - Refusal of treatment

5. Educate the patient on preprocedural and post procedural care
    a) Dietary requirements
        - Low-iodine diet 10-14 days pretreatment – I-131 treatment – thyroid cancer

- Nothing by mouth
    1. I-131 treatment (benign and malignant treatment protocols)
    2. Selective internal radiation therapy

b) Modification of medications
    - Restrictions
        1. Thyroid
            - ➢ Thyroid hormones (unless recombinant human thyroid-stimulating hormone is used)
            - ➢ Iodinated contrast
            - ➢ Medications that may limit/restrict the ability of thyroid tissue to absorb radioactive iodine
        2. Bone palliation
            - ➢ Oral/systemic myelosuppressive chemotherapy
            - ➢ Bisphosphonates
    - Resumptions – per procedural protocol and referring physician's/radiologist's directives

c) Follow-up appointments – per procedural protocol and referring physician's/radiologist's directives to include the following:
    - Diagnostic imaging
    - Laboratory follow-up
    - Referring physician follow-up
    - Treating physician follow-up

d) Next step in patient treatment algorithms – in consultation with treating physician, per referring physician's directives

e) Counsel the patient on the post administration requirement to reduce exposure rates to the public and document compliance
    - Oral and written instructions given to patient
        1. Two copies of written instructions
            - ➢ Chart copy signed by patient
                - ➔ Receipt of document noted in final patient report
            - ➢ Patient copy reviewed with patient and/or family member
                - ➔ I-131
                - Maintain appropriate distance from others
                - Separate sleeping arrangements
                - Minimize time spent in public places
                - Precautions to reduce the spread

of contamination, including urine and other body fluids
- Effective contraceptive methods
- Length of time for each precaution
- ➔ Beta-emitting radiopharmaceuticals (Sr-89, Sm-153, P-32)
- Hand-washing technique
- Precautions to reduce the spread of contamination, including urine and other body fluids
- Use of condoms for sexual relations
- Effective contraceptive methods

III. Calculate appropriate therapeutic dosage based on dosimetry, patient well-being, diagnostic imaging, and laboratory results under the direction of the supervising physician

1. Calculate radionuclide therapy dose for benign thyroid disease, basing dose selection on accepted standards
   - Recent radioiodine uptake or qualitative thyroid scan
   - Thyroid hormone levels
   - Delivered activity
   - Fixed-dose regimen based on disease
2. Calculate radionuclide therapy dose for malignant thyroid disease, basing dose selection on accepted standards
   - Postoperative ablation
   - Treatment of presumed thyroid cancer in the neck or mediastinal lymph nodes
   - Treatment of distant metastases
   - Dosimetrically determined thyroid calculations; customize dose levels from body clearance times
   - External beam therapy plus I-131 for bone disease
3. Calculate radionuclide therapy dose for palliative bone therapy, basing dose selection on accepted standards
   - Based on whole body bone imaging study
   - Sr-89
     a) Dose
     b) Route of administration
   - P-32
     a) Dose
     b) Route of administration
   - Sm-153
     a) Dose
     b) Route of administration

4. Calculate radionuclide therapy dose for non-Hodgkin's lymphoma, basing dose selection on accepted standards
    - Based on diagnostic whole body biodistribution scan
    - I-131 – dose calculations based on the following:
        a) Platelet counts
        b) Total body residence time
        c) Activity time using body mass to calculate
    - Y-90 – dose calculations based on the following:
        a) Patient's weight
        b) Platelet count
5. Calculate radionuclide therapy dose for polycythemia, basing dose selection on accepted standards
    - Extent of disease
    - Weight
    - Blood counts
    - Typical doses
6. Calculate radionuclide therapy dose for malignant effusion, basing dose selection on accepted standards
    - Based on depth in tissue, activity administered, and uniformity of distribution
    - Intraperitoneal dose range
    - Intrapleural dose range
    - Radiosynoviorthesis – dose based on size of joint, depth of tissue, activity administered, and uniformity of distribution
    - Proximal interphalangeal joints
    - Knee joints – 5-6 mCi is typical
7. Calculate radionuclide therapy dose for selective internal radiation therapy, basing dose selection on accepted standards
    - Tumor volume from CT
    - Liver size
    - Lung shunting

IV. Order or facilitate adjunctive pharmaceuticals for radiotherapy according to protocol
1. Rituximab
2. Supersaturated potassium iodide
3. Thyrotropin alfa

V. Administer the therapeutic dose, adhering to the applicable regulations and site protocols
1. Oral
2. Intravenous
3. Subcutaneous ports

VI. Report procedure to the supervising physician according to protocol
1. Overview of protocol compliance
2. Patient identification
3. Informed consent

4. Referral prescription
5. Patient preparation
6. Relevant clinical history
7. Radiopharmaceutical dose and route of administration
8. Patient status before, during, and following therapy
9. Brief statement outlining patient radiation safety instructions
10. Recommendations for follow-up diagnostic or therapeutic procedures as indicated
11. Recommendations for appropriate follow-up as needed

VII. In conjunction with the referring and supervising physician, monitor the patient and provide post therapy interventions as needed for adverse side effects

1. Monitor the patient as indicated by protocol
    - Bone marrow suppression
    - Laboratory results
    - Quality of life

2. Provide supportive care for symptoms
    - Pain management
    - Nausea
    - Fatigue
    - Gastrointestinal disturbance

3. Maintain ongoing patient contact throughout the treatment regimen
4. Reevaluate patient status upon completion of therapy treatment(s) to determine patient's candidacy for additional therapy
    - Diagnostic imaging follow-up
5. Laboratory testing follow-up

D. Elective Competencies

These procedures consist of those tasks that are infrequently performed in most practice settings but might be particularly useful in some settings.

1. Administer radiopharmaceuticals for radionuclide cisternography, cerebrospinal fluid shunt evaluations, cerebrospinal fluid leaks, or intraperitoneal procedures using aseptic technique and radiation safety standards at the discretion of the supervising physician\
    - Explain complete procedure to the patient/family
    - Ensure scheduled imaging timeline compliance
    - Prepare injection site, adhering to predetermined aseptic/sterile technique
    - Conduct a Joint Commission–recommended "time out" procedure
    - Monitor room, contents, and personnel as per institutional Radiation Safety Guidelines

2. Participate in image-guided biopsy at the discretion of the supervising physician
    - Prepare sterile field and biopsy area using aseptic/sterile technique
    - Obtain informed consent for biopsy
    - Evaluate for complications prohibiting safe biopsy
        a) Impaired coagulation
        b) Poor window to biopsy site
    - Identify appropriate instruments and use according to recommended standards of practice
    - Close and dress wound according to recommended standards of practice
    - Order appropriate follow-up imaging studies appropriate to biopsy site and procedure
    - Advise the patient of needed follow-up care
3. Manage pain and sedation for the patient receiving diagnostic testing or therapeutic treatment
    - Prescribe pharmacologic and non pharmacologic interventions as allowable by state and institutional protocol
    - Monitor patient response to sedation and provide intervention according to accepted standards of practice

E. Nuclear Cardiology Curriculum Content

a) Successfully complete and maintain Advanced Cardiac Life Support credentialing
    1. Assess normal ECG to determine patient safety for stress testing
        - Understand the conduction systems within the heart
        - Analyze and interpret recordings of the electrical activity of the heart
        - Identify the leads associated with the various walls of the heart
    2. Assess abnormal ECG conduction in preparation for stress testing
        - Identify conduction abnormalities, including those originating from the myocardium
        - Differentiate between abnormalities that arise from the inferior, anterior, posterior, and septal walls
        - Pathologic conditions
            ➢ New or old left bundle branch block
            ➢ New or old ST elevations or ST depressions
b) Develop procedural policies and standards for precardiac emergencies that might occur within the department as directed by institutional policy and practice standards
    1. Identify the signs and symptoms of symptomatic bradycardia and symptomatic tachycardia
        - Lightheadedness
        - Dizziness

- Fainting
- Near syncope
- Palpitations
- Chest pain
- Diaphoresis
- Chest pressure
- Arrhythmic heart beats
- Shortness of breath
- Nausea/vomiting
- Disturbances in vision
- New onset of confusion
- Changes in level of consciousness
- Hypotension or hypertension (unstable patient)

2. Follow a step-by-step course of action for the patient who develops asymptomatic bradycardia or tachycardia while in the office (before, during, or after stress test)
    - Immediately stop the stress test if applicable
    - Administer appropriate oxygen therapy
    - Obtain intravenous access if applicable
    - Assess vital signs frequently (ie, blood pressure as required)
    - Activate cardiac assistance team if necessary
    - Call for emergency if applicable
3. Follow a step-by-step course of action for the patient who develops signs and symptoms of bradycardia or tachycardia while in the office (before, during, or after stress test)
    - Immediately stop the stress test if applicable
    - Place patient flat on floor
    - Elevate lower extremities above heart
    - Administer appropriate oxygen therapy
    - Obtain intravenous access
    - Initiate intravenous fluid bolus of normal saline or lactated Ringer's solution
    - Obtain blood sugar level if appropriate
    - Activate cardiac assistance team if necessary
    - Call emergency if applicable
4. Identify the proper medications and dosages for stable cardiac rhythms
    A. Bradycardia
        a) Atropine
            - Usual dose
            - Maximum dose
            - Dose rate
    B. Sinus tachycardia
        a) Normal saline or lactated Ringer's solution
            - Usual dose
            - Maximum dose

- Dose rate

C. Narrow complex tachycardia of unknown etiology or supraventricular tachycardia
    a) Adenosine (therapeutic)
        - Usual dose
        - Maximum dose
        - Dose rate
    b) Calcium channel blockers
        ➢ Diltiazem
            - Usual dose
            - Maximum dose
            - Dose rate
        ➢ Verapamil
            - Usual dose
            - Maximum dose
            - Dose rate
    c) Beta-blockers
        ➢ Metoprolol
            - Usual dose
            - Maximum dose
            - Dose rate
        ➢ Labetalol
            - Usual dose
            - Maximum dose
            - Dose rate
    d) Amiodarone
        - Usual dose
        - Maximum dose
        - Dose rate

D. Narrow complex tachycardia of unknown etiology or supraventricular tachycardia non-medicine
    a) Valsalva maneuver
    b) Ice to face
    c) Blow into an occluded straw
    d) Carotid massage

E. Atrial fibrillation/atrial flutter
    a) Diltiazem
        - Usual dose
        - Maximum dose
        - Dose rate
    b) Beta-blockers
        ➢ Metoprolol
            - Usual dose
            - Maximum dose
            - Dose rate
        ➢ Labetalol

- Usual dose
- Maximum dose
- Dose rate

c) Amiodarone
- Usual dose
- Maximum dose
- Dose rate

d) Digoxin
- Usual dose
- Maximum dose
- Dose rate

F. Ventricular tachycardia of monomorphic etiology

a) Magnesium
- Usual dose
- Maximum dose
- Dose rate

b) Amiodarone
- Usual dose
- Maximum dose
- Dose rate

c) Lidocaine
- Usual dose
- Maximum dose
- Dose rate
- Use lidocaine only if amiodarone is not available or patient is allergic to amiodarone

d) Ventricular tachycardia of polymorphic etiology

➢ Magnesium
- Usual dose
- Maximum dose
- Dose rate

➢ Amiodarone
- Usual dose
- Maximum dose
- Dose rate

➢ Lidocaine
- Usual dose
- Maximum dose
- Dose rate
- Use lidocaine only if amiodarone is not available or patient is allergic to amiodarone

5. List contraindications and precautions of common cardiac medications

A. Atropine

a) Acute myocardial infarct
b) Ventricular escape rhythm (heart rate <40 beats/min with wide complex)

B. Calcium channel blockers
a) Wolff-Parkinson-White syndrome
b) Lown-Ganong-Levine syndrome
c) Sick sinus syndrome

C. Beta-blockers
a) Wolff-Parkinson-White syndrome
b) Sick sinus syndrome
c) Atrial fibrillation with slow ventricular response
d) Heart block, second and third degree

D. Verapamil
a) Wolff-Parkinson-White syndrome
b) Lown-Ganong-Levine syndrome
c) Sick sinus syndrome
d) Atrial fibrillation with slow ventricular response
e) Poor left ventricular function (ejection fraction <30%)

E. Adenosine
a) Known or suspected bronchoconstrictive or bronchospastic lung disease
b) Poor left ventricular function

F. Amiodarone
a) Acute myocardial infarction

6. Follow a step-by-step approach to handling an ST elevation myocardial infarction
A. Oxygen 2-4 L nasal cannula
B. Aspirin 325 mg (non-EC aspirin) or two to four 81-mg chewable aspirin
C. Nitroglycerin 0.4-mg tablets every 5 minutes for maximum of 3 tablets or 3 nitroglycerin sprays
D. Morphine
7. Follow a step-by-step approach to handling other patient incidents
A. Exercise-induced hypotension or hypertension
B. Vasovagal syncope
C. Asystole
D. Ventricular tachycardia
8. Identify and delegate personnel to perform various tasks in preparation for cardiac emergencies
A. Crash cart checks
B. Required training or drills
a) Incorporate the appropriate institutional/departmental policies and procedures
b) Develop procedural policies and standards for cardiac arrest emergencies that occur within the department as directed by institutional policy and practice

standards and provide indicated intervention for a cardiac emergency event

c) Provide indicated intervention for noncardiac emergency events
    - Diabetic patient
        - ➢ Obtain blood sugar level
        - ➢ Indications for administering oral medications/food versus intravenous dextrose
    - Respiratory distress
        - ➢ Oxygen
        - ➢ Medications as needed
    - Panic attack
        - ➢ Relaxation techniques
        - ➢ Medications as needed
d) Manage crash cart for compliance
e) Follow the appropriate guidelines in implementing regulation for managing the department's crash cart
    - Institution
    - State
    - American Heart Association
f) Inventory crash cart components according to institutional policy
    - Personnel responsible for checking the crash cart
    - Frequency of checks
    - Items checked
        - ➢ Testing the defibrillator
        - ➢ Medications
        - ➢ Pads on the crash cart
        - ➢ Portable oxygen tank level
        - ➢ Security lock
g) Properly dispose of expired drugs
h) Replace expired drugs
i) Perform quality assurance testing on defibrillator and document results

c) Take comprehensive patient history and evaluate for patient pathology
1. Interview the patient and document on department form a complete past and current cardiac history
    - Height and weight
    - Medication history
    - Family history of known cardiovascular disease
        - ➢ Acute syndromes
        - ➢ Chronic syndromes
        - ➢ Heart failure
    - Patient history of related disorders

- ➢ Hypertension/hypotension
- ➢ Thyroid disorders
- ➢ Diabetes
- ➢ Stroke
- ➢ Previous thoracic surgery and/or cardiac intervention
- ➢ Tobacco abuse
- ➢ Metabolic syndrome
- ➢ Glaucoma
- ➢ Chest/back/jaw pain
- ➢ Dyspnea
- ➢ New onset of fatigue
- ➢ Dyslipidemia

2. Establish “nothing by mouth” compliance
3. Evaluate ambulatory ability
4. Review noncardiac history for prevalence to study requested
5. Perform physical assessment
    - Heart sounds
    - Lung sounds
    - Blood pressure and heart rate

d) Evaluate patient laboratory biochemical markers relevant to cardiac pathology
    1. Review most recent laboratory test results relevant to cardiovascular diseases
        A. Relevant laboratory tests
            - Glucose content
            - Presence of albumin or blood cells
            - pH
            - Pregnancy
            - Blood tests
            - Cholesterol
            - Hemoglobin values
            - Hematocrit values
            - Leukocyte count
            - Serum chemistries
            - Blood urea nitrogen
            - Creatinine
            - Serum electrolytes
                - ➢ Calcium
                - ➢ Potassium
                - ➢ Sodium
            - Serum enzymes
            - Creatine phosphokinase
            - Lactic dehydrogenase
            - Glucose
            - Thyroid

        B. Normal and abnormal results.

C. Relationship to cardiovascular disease

2. Order relevant blood tests if necessary (including pregnancy testing)

e) Evaluate patient medications for contraindications to stress testing
   1. Understand contraindications to each type of stress test and evaluate for each
      A. Contraindications to exercise testing
         - Absolute
         - Acute myocardial infarction (within 2 days)
         - Unstable angina not previously stabilized by medical therapy
         - Uncontrolled cardiac arrhythmias causing symptoms or hemodynamic compromise
         - Symptomatic severe aortic stenosis
         - Uncontrolled symptomatic heart failure
         - Acute pulmonary embolus or pulmonary infarction
         - Acute myocarditis or pericarditis
         - Acute aortic dissection

      B. Relative
         - Left main coronary stenosis
         - Moderate stenotic valvular heart disease (emphasis on aortic stenosis)
         - Electrolyte abnormalities
         - Severe arterial hypertension
         - Tachyarrhythmias or bradyarrhythmias
         - Hypertrophic cardiomyopathy and other forms of outflow tract obstruction
         - Mental or physical impairment leading to inability to exercise adequately
         - High-degree atrioventricular block

      C. Contraindications to adenosine
         - Second- or third-degree atrioventricular block (except in patients with a functioning artificial pacemaker)
         - Sinus node disease, such as sick sinus syndrome or symptomatic bradycardia (except in patients with a functioning artificial pacemaker)
         - Known or suspected bronchoconstrictive or bronchospastic lung disease (eg, asthma)
         - Known hypersensitivity to adenosine
         - Use of methylxanthines

      D. Contraindications to dipyridamole

- Known sensitivity to dipyridamole
- Known sensitivity to aminophylline
- Use of medications containing methylxanthine
- Unstable angina
- Acute myocardial infarction
- Severe asthma or bronchospasm
- Hypotension
- Caffeine within 12–24 hours

E. Contraindications to dobutamine
    - Idiopathic hypertrophic subaortic stenosis
    - Hypersensitivity to dobutamine
    - Cardiac arrhythmias

2. Review patient medications for contraindications to exercise stress testing
    A. Evaluate medications and understand how they can affect the response to and assessment of exercise or pharmacologic stress testing
    B. Recognize the effect medications can have on heart rate, blood pressure, contractility, and left ventricular ejection fraction
    C. Know recommendations for length of time to discontinue medication if necessary
    D. Relevant medications
        - Antiarrhythmics
        - Beta-blockers
        - Calcium channel blockers
        - Inotropics
        - Vasoactives
        - Diuretics
        - Analgesics
        - Caffeine-containing medications
        - Theophylline
        - Inhalers
        - Nitrates
3. Conduct preoperative evaluation for orthopedic or other surgery
    A. Chronic obstructive pulmonary disease
    B. Left bundle branch block
    C. Pacemaker/automatic implantable cardioverter defibrillator

f) Obtain patient informed consent as required for nuclear cardiology procedures according to state law and hospital policy
1. Understand the ethical and legal underpinnings of informed consent
    A. Autonomy, veracity, and confidentiality
    B. Who may give consent
        a) Competency issues
        b) Minors and mentally impaired adults

C. Types of consent
    a) Express
    b) Implied by law
    c) Informed consent

D. Components of valid informed consent
    a) Procedure that will be done
        - Diagnosis
        - Nature or purpose of the treatment or procedure

    b) The name and qualifications of the person doing the procedure
    c) The consequences or expected outcome
    d) The risks involved, except for the very remote
    e) Exceptions: risk of death or sterility if applicable

E. Responsibilities of physician and health care providers

2. Determine the capability of the patient to give informed consent
3. Explain the procedure to the patient, including all components of a valid informed consent
    A. List precautions used to reduce risks
    B. Review the confidentiality policy
    C. Answer any questions or direct questions to the appropriate health care professional

4. Obtain the patient's or guardian's signature

g) Conduct treadmill testing per all protocol options under the direction of the supervising physician
    1. Prepare the patient for exercise protocol
        A. ECG preparation
            - Skin preparation
            - Electrode placement
        B. Intravenous establishment
        C. Baseline readings
            - Blood pressure
                ➢ Normal
                ➢ Abnormal
            - ECG tracings
                ➢ Normal
                ➢ Abnormal
    2. Determine type of exercise stress test
        A. Exercise equipment options
            - Treadmills and monitors
            - Bicycle ergometer

B. Protocol options
    - Bruce
    - Modified Bruce
    - Ramp
    - Isometric
    - Pharmacologic
3. Monitor ECG tracings and blood pressure for specific pathology and cardiac events during stress testing
    A. Normal responses to exercise
        - ST-segment changes
        - T-wave changes
    B. Arrhythmias
    C. Hypotensive/hypertensive response
    D. Non-diagnostic ECG
4. Use the appropriate termination protocols
    A. Absolute indication for termination
    B. Relative indication for termination
5. Calculate the Duke Treadmill Score
    A. Methodology
    B. Risk stratification
        - Low
        - Moderate
        - High

h) Prescribe and administer interventional drugs for pharmacologic stress under the direction of the supervising physician
1. Explain the indications and contraindications for each pharmacologic stress agent
    A. Adenosine
    B. Dipyridamole
    C. Dobutamine
2. Identify the physiologic action of each pharmacologic agent as it relates to stress testing
    A. Expected or normal responses
    B. Abnormal responses
3. Calculate total dose, volume, and dose rate for each of the most common pharmacologic stress agents
4. Set up drug administration pump
5. Prepare pharmacologic agents for administration utilizing sterile technique
6. Administer pharmacologic agents
7. Monitor the patient's response to pharmacologic agents and treat appropriately in the event of an adverse effect
    A. Possible side effects
    B. Treatment of side effects

i) Analyze the results of the stress test and imaging portion of the examination and prepare a preliminary description of findings for the

supervising physician

1. Create a preliminary description of findings detailing the results of the stress portion of the test
    A. Indications and patient demographics
    B. Methodology
        a) Exercise time
        b) Maximum heart rate
        c) Blood pressure
        d) Symptoms
        e) Tolerance (exercise reserve)
    C. Findings
        a) PQRST changes
        b) Ectopy
        c) T-wave abnormalities
        d) Affected leads
        e) Dysrhythmia
            - Tachycardia
            - Bradycardia
            - Blocks
        f) Physiologic responses
    D. Risk assessment: Duke Treadmill Score
    E. Validity of examination
    F. Conclusion with clinically relevant comments
2. Examine rotating raw data from both stress and resting image acquisitions and evaluate image quality
    A. Upward creep
    B. Contamination
    C. Body habitus
    D. Motion
    E. Patient exceeds field of view
3. Review data for incidental findings outside of the heart
    A. Tumor uptake
    B. Enlarged viscera
    C. Halo patterns around heart
    D. Breast uptake
    E. Liver uptake
4. Compare and contrast stress versus resting processed images for perfusion defects
    A. Enlarged right ventricle
    B. Enlarged left ventricle
    C. Evaluate chamber volume data
5. Determine if the heart-to-lung ratio and transient ischemic dilation are abnormal
    A. Normal values
    B. Abnormal values
6. Evaluate the wall motion of stress and resting images for ejection

fraction and kinetic abnormalities
    A. Dyskinesis
    B. Akinesis
    C. Hypokinesis
7. Review and evaluate bull's eye polar maps and summed stress scores
    A. Normal values
    B. Abnormal values
8. Create a preliminary description of findings detailing the results of the imaging portion of the test
    A. Indications
    B. Patient demographics
    C. Dosing information
    D. Imaging parameters
    E. Findings
    F. Conclusion
        - Normal
        - Abnormal
        - Ejection fraction
        - Summed stress score

j) Facilitate or recommend patient-specific cardiac-related procedures based on nuclear cardiology examination results (outcomes management) according to the supervising physician
1. Order or facilitate scheduling of complementary diagnostic procedures as indicated
    A. Multi-gated acquisition scan
    B. Viability
    C. Blood test
    D. Computed tomographic angiography/calcium scoring
    E. Positron emission tomography
    F. Heart catheterization
    G. Equilibrium radionuclide angiocardiography
    H. Magnetic resonance imaging
2. Identify the clinical pathways as outlined by the American Medical Association/American College of Cardiology for cardiac disease
    A. Cardiac intervention
        - Stents
        - Bypass
        - Angioplasty
            ➢ Drug eluting
            ➢ Non–drug eluting
    B. Medication adjustments
    C. Risk factor modification and lifestyle changes
    D. Surgical intervention

F. Bone Mineral Densitometry; DXA (Dual Energy X-Ray Absorptiometry) contents

I. Bone Densitometry
   a) Definition
   b) Uses
      1. Quantitative measurement of bone density
      2. Monitor therapy
      3. Predict future fracture risk
      4. Children and adolescents
      5. Other
   c) DXA
      1. Most versatile method
      2. Advantages
         - Low radiation dose
         - High-resolution images
         - Good precision
         - Stable calibration
         - Other
      3. Disadvantages
         - Higher cost for equipment and scans
         - Generally not portable
         - More operator training and skill required
         - Other
   d) DXA compared with conventional radiography
      1. Only two x-ray photon energies used
      2. Computer manipulation required
      3. Images used for positioning and region of interest (ROI), not for diagnosis
      4. Manufacturer-specific operation
      5. Low radiation dose

II. Technique History and Overview
   a) Radiographic absorptiometry (RA)
   b) Radiogrammetry
   c) Quantitative computed tomography (QCT)
   d) Single and dual photon absorptiometry (SPA/DPA)
   e) Single and dual-energy x-ray absorptiometry (SXA/DXA)
   f) Quantitative ultrasound (QUS)
   g) Peripheral skeleton adaptation

3. Interpersonal and Communication Skills Curriculum Content

I. Demonstrate team communication and leadership skills to work effectively with others as a member or leader of a health care team or other professional group
   A. Demonstrate leadership skills by leading a group project to successful completion
   B. Communicate with the referring physician to assure appropriate examination selection, including actions to be taken if the requested procedure appears to be

inappropriate
1. Requisition process
    a) Receipt of order
    b) Verification of order
    c) Appropriateness of indication
    d) Correlation with history
    e) Contraindications
2. Verbal orders

C. Collaborate with other health care team members to improve service delivery
1. Communications regarding
    a) Patient preparation
    b) Schedule necessary procedures before the nuclear medicine procedure
    c) Secure results of necessary procedures before the nuclear medicine procedure
    d) Schedule or facilitate the scheduling of follow-up examinations upon completion of the nuclear medicine procedure
    e) Report nuclear medicine examination results under the direction of the supervising physician and as allowed by institutional policy
        - To the patient if indicated
        - To the referring physician

II. Protect and preserve personal and confidential information of others to which access is provided

A. Adhere to privacy and regulatory standards and requirements regarding the accountability and protection of patient information
1. Accountability for protecting patient information
    - Information collection
    - Information maintenance
    - Use of personally identifiable health information
2. Consents
    - Informed
    - Specific
    - Voluntary
3. Education regarding policies, rights, and responsibilities
    - Patient education
    - Provider education
    - Patient information standards
        a) Privacy issues
            - Uniformity of electronic data interchange
            - Confidentiality of electronic health data
    - Technical standards
        a) Formats
        b) Data content
    - Information systems and standards
        a) Hospital information system (HIS)
        b) Radiology information system (RIS)

c) Picture archiving and communications system (PACS)
d) Digital Imaging and Communications in Medicine (DICOM)

B. Identify potential abuses of confidential patient information
   1. Information as a commodity
   2. Potential abuses

C. Describe the challenges associated with maintaining the confidentiality of patient information stored in computer systems and transmitted via networks
   1. Patient issues
      - Trust in the physician
      - Who gets what information
      - Rights in the case of an error or unauthorized disclosure of information
   2. Provider issues
      - Implementation of confidentiality procedures
      - Patient education on confidentiality rights
   3. Managed care organizations
      - Information shared with external parties
   4. Research
      - Access to information without breaching patient rights

III. Use effective listening skills and elicit and provide information using effective nonverbal, explanatory, questioning, and writing skills

A. Listen to the “patient’s story,” extract important details from the history taking, and provide information to their patients in an understandable way

B. Demonstrate effective interviewing skills for patient assessment
   1. Skills of good interviewing
      a) Nonverbal communication
      b) Facilitation
      c) Reflection
      d) Clarification
      e) Summarization
      f) Validation
      g) Empathic responses
   2. Challenges to the practitioner
      a) Patients at different ages and comprehension abilities
      b) Situations that call for specific responses

C. Demonstrate effective communication skills with and provide psychosocial support to specific groups of people such as the terminally ill, physically or emotionally impaired, culturally diverse patients, families, and colleagues
   1. Cultural diversity
      a) Development of a personal value system
      b) Interrelationship between personal, community, and societal values
      c) Influence of personal value system on behavior
      d) Development of professional values
      e) Influence of professional values on patient care
      f) Influence of cultural beliefs regarding illness and recovery

D. Demonstrate effective age- and gender-specific communications
E. Be receptive to the clinical significance of the patient's personal beliefs and values for adaptation of an examination protocol or departmental policies
    1. Religion
        a) Use of blood products in an examination
        b) Mandatory presence of a family member during studies
    2. Lifestyle (e.g., vegetarians and gastric emptying studies)

IV. Demonstrate emotional resilience and stability, adaptability, flexibility, and tolerance of ambiguity and anxiety
A. Maintain composure in all situations
B. Refrain from negative conversations
C. Demonstrate self-awareness of personality traits

V. Follow appropriate protocol in resolution of conflict, exhibiting proper restraint when presented with potentially volatile situations
A. Potential areas of conflict in the workplace
    1. Harassment in the workplace
    2. Hostile work environment
    3. Protected persons
    4. Unwelcome conduct
    5. Employer's liability
    6. Sexual harassment
    7. Harassment
    8. Assault and battery
    9. Infliction of emotional distress
    10. Invasion of privacy
    11. Wrongful discharge
    12. Unclear expectations
    13. Lack of clear jurisdiction
    14. Operational or staffing changes
B. Conflict prevention
    1. Chain of command
    2. Standard Operating Procedures (SOP)
    3. Mediation
C. Common resolution strategies
    1. Avoidance
    2. Fight
    3. Surrender
    4. Compromise
    5. Collaborate

VI. Maintain comprehensive, timely, and legible records for medical, legal, quality improvement, and financial purposes
A. Medical records
B. Legal records
C. Health information systems
D. Informatics
E. Quality improvement

F. Regulatory
G. Health law/legal

VII. Maintain appropriate protocol, courtesy, tact, and confidentiality in business communications, both written and oral
   A. E-mail
   B. Correspondence: letters and memos
   C. Telephone conversations

VIII. Demonstrate an appropriate level of communication skills when orally presenting professional or scholarly work
   A. Grand rounds/reporting sessions
   B. Presenting lectures/seminars/conferences/posters

IX. Demonstrate technical writing ability in a variety of venues, including scholarly writing and business communications
   A. Write an abstract according to published standards
   B. Prepare a poster for presentation at a professional conference
   C. Write scholarly articles
   D. Develop patient procedure protocols
   E. Develop departmental policies
   F. Write business correspondence such as business letters, memos, or internal reports
   G. Prepare reports, such as a needs assessment or progress report
   H. Develop action plans for quality improvement projects
   I. Develop patient education materials

X. Apply concepts of teaching and learning theories in design, implementation, and evaluation in the education of the patient, family, colleagues, and the community

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Syllabus for M.D. in "Nuclear Medicine and Molecular imaging"

1st Year

1. **Statistics** (25 hrs)

Population-Sample -kinds of samples -stastical methods-types of measurements or data-frequency distribution-frequency histogram Bar graphs- pie diagrams-centiles-Mean-Median-Mode-Standard Deviation Coefficient of variation-percentage error-Normal or Gaussian distribution Poisson distribution-Chi-square-standard error of mean-confidence limits testing hypothesis-null hypothesis-variation & co variation-computer methods of analyzing medical data.-Counting Statistics-Nuclear counting statistics.

2. **Mathematics** (25 hrs)

Basic Mathematical concepts for Nuclear Medicine-Calculus Derivatives or Differential-Differential equations- Integrals- laws of indices- limits- limit concept-continuity-evaluation using log tables compartmental analysis- numbers- Function and Variables- index notation-Logarithms- logarithmic function-Graphs & Equations- exponential equations- Mathematic models of physiologic systems etc.

3. **Computer and IT Applications** (50 hrs)

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-hardware-keyboard skills-hard ware description-software packages-Computer limitations-Storage devices. Basics on Nuclear Medicine image hard copies-Computer applications with emphasis on digital image acquisition, image analysis, processing and enhancement- tomographic reconstruction display and recording of findings. Fundamental Soft ware processing-Filters and their applications- Components of Image quality-image sharpness-spatial relationships optimum image viewing options. [Internal examinations on these three supportive subjects should be conducted by the institute by 6 months of starting the course and marks to be submitted to the University]

4. **Patient's care, Interpersonal and Communication Skills** (50 hrs)

Ethical behavior, counseling, informed consent, procedural briefing, informed decision about diagnosis, history taking, examination, collect essential correlative information, determine and implement plan of care, implement sedation policy, mange emergency situation. Team communication and leadership skills, privacy and regulatory standards, effective listening skills, emotional resilience and stability, adaptability, flexibility, and tolerance of ambiguity and anxiety, resolution of conflict, Maintain comprehensive, timely, and legible records, appropriate level of communication skills when orally presenting professional or scholarly work, technical

writing ability, application of concepts of teaching and learning theories in design, implementation, and evaluation in the education of the patient, the family, colleagues, and community.

5. **Clinical applications** (50 hrs)

Disease oriented Basic Sciences-Human Anatomy, physiology, Biochemistry, Pathology, diagnosis, investigations, management. Special emphasis on CNS (brain tumors, brain death, sensor-motor dysfunction, ischemia, dementia, hydrocephalus, CSF leak etc), Thyroid disorder (goiter, thyroid malignancies), parathyroid (hyperplasia, adenoma, cancer), Neuroendocrine tumors (Pheochromocytoma, paragnaglioma, neuroblastoma, medullary ca thyroid, carcinoid, insulinoma etc), cardiac (ischemia, MI, post-intervention assessment, CCF, arrhythmias, BLS, ALS), lung (pulmonary embolism, Sarcoidosis, pneumonia, AIDS related pulmonary syndrome), GI (Meckel's diverticulum, GI bleed, malabsorption syndrome, Ca colon), Hepatobilliary (CLD, hepatoma, TACE, choleocystitis, biliary dyskinesia, biliary leak), Genitourinary (renal failure, GFR, obstructive uropathy, nephropathy, transplant rejection, infection, VUR, testicular torsion, hydrocele, varicocele, epididymitis, testicular tumors, ovarian and uterine malignancies), musculoskeletal (osteomyelitis, septic arthritis, primary bone tumors, bone metastasis, sports injury).

6. **Basic Physics & Nuclear Physics** (100 hrs)

Basics: Elementary introduction to structure of matter- elements- compounds and mixtures-molecules and atoms-Atomic & Nuclear structures-Atomic models-Periodic table-simple ideas of quantum mechanics- Mass energy equivalence- Fluorescence- Phosphorescence luminescence-electromagnetic spectrum. Radioactivity & Interaction of Radiation: Radioactivity-Discovery- Natural & Artificial Radioactivity-Isotopes and nuclides-binding forces between nuclear particles-alpha & beta particles-gamma radiation-mechanisms of radioactive decay-half life – Interaction of electrons, X-ray & r-rays with matter- Radiation intensity & exposure-radiation dose- Radiation quality- law of exponential attenuation- half value layer-linear attenuation coefficient- Scattering- photo elective effect- Compton-scattering-pair production-particle interactions-total attenuation coefficient-relative clinical importance. Basics on Electricity, Magnetism and Electromagnetic induction

EXAMINATION SCHEDULES FIRST YEAR

THEORY PRACTICALS & VIVA

	Theory	**Practical and Viva**

Paper I **Section A:** Patient's care & communication skills Section B: Clinical applications	**Patient's care & communication-Basics sciences and clinical applications**	**Professional ethics and communication skills** **Systemic Disease oriented clinical viva**
Paper II	**Basic physics and Nuclear Physics**	**Practical and viva**

Note: For the supportive subjects – Statistics, Mathematics & Computer applications in Nuclear Medicine; the internal tests to be conducted by the institute conducting the course at first 6 months during I st year and marks should be submitted to the University

MARK SHEDULE

SCHEME OF EXAMINATION FIRST YEAR

(270 WORKING DAYS)

Theory subject Title	**University Theory Exam Marks**		**Practical Subjects Title**	**Practical/ Examination Marks**		**Viva**		**Internal Assessment** **IA**	
PAPER-I	**Max**	**Min**	Systemic disease oriented clinical examination and viva	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**
Section A: Patient's care & communication skills **Section B:** Clinical Application	100	50		100	50	50	25	50	25

PAPER II:	**Max**	**Min**	Experiments charts,	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**

Basic Physics and Nuclear Physics	100	50	graphs, models and demo	100	50	50	25	50	25

Internal assessment	**Marks**
Theory (cumulative Sessional results)	20
Practical (cumulative Sessional results)	20
Log/Record work	10
Total	50

Theory 100 Marks
Practical 100 Marks
Viva 50 Marks
IA 50 Marks

BOOKS FOR STUDY

1. Physics in Nuclear Medicine – Simon Cherry, James Sorenson & Michael Phelps.
2. Basic Medical Radiation Physics: Stanton.
3. Medical Radiation Physics – William R. Hendee.
4. The Essential Physics of Medical Imaging, Third Edition by Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt Jr., John M. Boone.
5. Nuclear Medicine: The Requisites 4th Edition by Harvey A. Ziessman MD, Janis P. O'Malley MD, James H. Thrall MD.
6. Basics of Computers and Image hard copy production in Nuclear Medicine.
7. Computers in Nuclear Medicine – A Practical Approach – Kai. H.LEE.
8. Computer Fundamentals – concepts, systems & Applications – D.P. Nagpal.
9. Effective use of computers in Nuclear Medicine: Medical J.Gelf and Stephen. R.Thomas.

Books to be added for-

- Statistics
- Mathematics

- Anatomy
- Physiology
- Biochemistry
- Pathology
- Medicine Surgery

Syllabus for M.D. in "Nuclear Medicine and Molecular imagining"
2nd Year

6. **Physics of Nuclear Medicine instrumentation & Nuclear Medicine Techniques** (120 hrs)

Electronic instruments – amplifiers – pulse height analyzer – count rate meters – computer interface – gating system –Principles of radiation detection – detectors – Scintillation Cameras – Scanners –Nuclear Reactors –Cyclotron – Radionuclide Generators – Isotope Calibrators – Well Counters – liquid scintillation counters – Whole body counters – Quality control of Nuclear Medicine Equipments –Collimation of detectors – Newer Computer applications in Nuclear Medicine – DICOM Technology – Medical Data Communications and Computer Networks.
Techniques of all kinds of radionuclide scan procedures including in-vitro procedures.

7. **Radiochemistry & Radio pharmacy** (120 hrs)

Radiopharmaceutical Production – Nuclear Reactors – Cyclotron – radionuclide Generators – Quality Control – chemical, physical & biological properties – criteria for selection – biological behaviour – mechanisms of localization – radiopharmaceuticals for diagnosis & treatment in humans – PET radionuclides – Good manufacturing practices – laws related – RIA radiopharmaceuticals and kits production.

EXAMINATION SCHEDULES

SECOND YEAR

	Theory	**Practical and Viva**
Paper I	**Physics of Nuclear Medicine instrumentation & Nuclear Medicine Techniques**	**Identification of equipments and parts**
Paper II	**Radiochemistry & Radio pharmacy**	**Radiopharmaceutical preparation/formulae**

MARK SHEDULE

SCHEME OF EXAMINATION SECOND YEAR

(270 WORKING DAYS)

Theory subject Title	University Theory Exam Marks		ical Subjects Title	Practical/ Examination Marks		Viva		Internal Assessment IA	
PAPER-I	**Max**	**Min**		**Max**	**Min**	**Max**	**Min**	**Max**	**Min**
Physics of Nuclear Medicine instrumentation & Nuclear Medicine Techniques	100	50	Identification of equipments and parts	100	50	50	25	50	25
PAPER II:	**Max**	**Min**		**Max**	**Min**	**Max**	**Min**	**Max**	**Min**
Radiochemistry & Radio pharmacy	100	50	Radiopharmaceutical preparation/formula e	100	50	50	25	50	25

Internal assessment	Marks
Theory (cumulative Sessional results)	20
Practical (cumulative Sessional results)	20
Log/Record work	10
Total	50

Theory 100 Marks
Practical 100 Marks
Viva 50 Marks
IA 50 Marks

BOOKS FOR STUDY

1. Instrumentation in Nuclear Medicine – Gerald J. Hine.
2. Hand book of Nuclear Medicine – Frederick L. Datz.
3. Essentials of Nuclear Medicine Imaging – Fred A Mettler, Milton J Guiberteau.
4. Fundamentals of Nuclear Pharmacy – Gopal. B. Saha.
5. Modern Nuclear Chemistry – Waltor D Loveland, David Morrissey and Glenn.
6. The Essential Physics of Medical Imaging, Third Edition by Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt Jr., John M. Boone.
7. Nuclear Medicine: The Requisites 4th Edition by Harvey A. Ziessman MD, Janis P. O'Malley MD, James H. Thrall MD.

Syllabus for M.D. in "Nuclear Medicine and Molecular imagining"
3rd Year

8. **Clinical Nuclear Medicine, elective procedures and Nuclear Cardiology** (150 hrs)
Clinical indications for radionuclide procedures – limitations – patient preparation – In-vivo function studies of all organ systems Liver Scan – Hepatobiliary Study– Gallium Scan – Bone Scan (whole body and spot views) – Thyroid scan – Brain Scan – Lung Scan, Perfusion, Ventilation –Renal Studies, Renal image, Renal flow (GFR), Reno gram (ERPF) –Cardiac studies – In Vivo procedures – thyroid uptake and calculate data etc. – all other radionuclide scans. Other elective procedures like Radionuclide cisternography, cerebrospinal fluid shunt evaluations, cerebrospinal fluid leaks, or intraperitoneal procedures. Nuclear Cardiology Assess normal/abnormal electrocardiogram, standards for cardiac arrest emergencies, Manage crash cart for compliance, comprehensive patient history, informed consent as required for nuclear cardiology procedures, Conduct treadmill testing per all protocol options, administer interventional drugs for pharmacologic stress, Analyze results of the stress test and imaging, recommend patient-specific cardiac-related procedures.

9. **Radio Biology, Radiation safety Quality Assurance in Nuclear Medicine** (150 hrs)
Biological effects of Radiation – induction of Radiation injury – somatic and hereditary effects of radiation – effects of radiation on embryo – normal and abnormal human exposure to radiation – maximum permissible levels – Choice of Radiopharmaceutical for the clinical situation and the equipments in hand – Dosimetry – absorbed dose – calculation of absorbed dose – Dosimetry of individuals – absorbed dose from diagnostic & therapeutic nuclear survey & monitoring – Quality assurance in Nuclear Medicine – Administrative and technical means of procuring radionuclides – Diagnosis, evaluation and treatment of radiation overexposure –ICRP recommendations – Management of radiation accidents – Radiation protection in different Nuclear isotope therapy procedures – protection of workers, patient relatives – Radiation effect on pregnancy and fertility – Role of National & International bodies. Plan & Designing a Nuclear Medicine dept. of varying capacities.

EXAMINATION SCHEDULES THIRD YEAR

	THEORY
PAPER- I	**Clinical Nuclear Medicine, elective procedures and Nuclear Cardiology**
PAPER-II	**Radio Biology, Radiation safety Quality Assurance in Nuclear Medicine**

	PRACTICAL AND VIVA
PAPER- I	**Clinics with NM procedures Demo short-long cases presentation and scan reading session**
PAPER-II	**Planning and Radiation survey-Demo**

SCHEME OF EXAMINATION THIRD YEAR

(270 WORKING DAYS)

Theory subject Title	**University Theory Exam Marks**		**ical Subjects Title**	**Practical/ Examination Marks**		**Viva**		**Internal Assessment IA**	
PAPER-I	**Max**	**Min**		**Max**	**Min**	**Max**	**Min**	**Max**	**Min**
Clinical Nuclear	100	50	NM procedures Demo short-long	100	50	50	25	50	25
Medicine, elective procedures and Nuclear Cardiology			cases presentation and scan reading session						
PAPER II:	**Max**	**Min**		**Max**	**Min**	**Max**	**Min**	**Max**	**Min**
Radio Biology, Radiation safety Quality Assurance in Nuclear			Planning and Radiation survey-Demo						

Medicine	100	50		100	50	50	25	50	25

Internal assessment	**Marks**
Theory (cumulative Sessional results)	20
Practical (cumulative Sessional results)	20
Log/Record work	10
Total	50

Theory 100 Marks
Practical 100 Marks
Viva 50 Marks
IA 50 Marks

BOOKS FOR STUDY

Text Books:

1. Diagnostic Nuclear Medicine Martin P Sandler, Edward Colmann.
2. The Essential Physics of Medical Imaging, Third Edition by Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt Jr., John M. Boone.
3. Nuclear Medicine: The Requisites 4th Edition by Harvey A. Ziessman MD, Janis P. O'Malley MD, James H. Thrall MD.
4. Recent advances in Nuclear Medicine John. H. Lawrence.
5. Radiation Biology and Physics PaulF Wilson and Joel S Bedford
6. Radiation safety in Nuclear Medicine – Max. H.Lombardi.
7. An introduction to Radiobiology – A.H.W.Nias.
8. Biological assessment of Radiation Damage – Thomas. L, Walden.Jr and Nushin K
9. Radiobiology for the Radiologist –Eric J Hall, and Amato J Giaccia.
10. PET: Physics, Instrumentation, and Scanners – Michael Phelps.
11. PET and PET-CT A clinical Guide –Eugence Lin and Abbas Alavi
12. Nuclear Medicine and PET/CT Technology and Techniques –Paul Christian and Kristin Waterstram.

Syllabus for M.D. in "Nuclear Medicine and Molecular imagining"

4th Year

10. **Hybrid imaging and Recent advances** (150 hours)
Physics of cyclotron, PET radiopharmaceuticals, PET radiochemistry, qulity control of PET radiopharmaceuticals, dose calculations, indication and pre-procedural preparation, Facility build up, imaging procedures per protocol, complementary diagnostic procedures, Assess image quality, preliminary assessment, initial observations of imaging procedures, findings to referring physicians and the patient per protocol. Recent advances in SPECT, PET including hybrid systems. Recent advanced in radiopharmaceuticals – FDG – Sodium fluoride for bone imaging – Neuro & cardiac radiopharmaceuticals. Cross sectional CT and MRI imaging physics and interpretation, contrast media indication/contraindication. Semiconductors and animal PET physics, implementation.

11. **Radionuclide therapy and bone mineral densitometry** (100 hours)
Therapeutic uses of Radionuclide (Patient selection, including the diagnostic procedures necessary to establish the need for radionuclide therapy, indications and contra-indications for the use of Radionuclide therapeutic procedures and their efficiency in relation to other Therapeutic approaches – Dose administration in patient management including dose to the target areas, to the surrounding tissues and or other organ systems and total-body exposure; the range of doses in each specific application; the special problems of patient care caused by radionuclide therapeutic procedures, potential early and late adverse reactions, the timing and parameters of anticipated clinical response, and the follow-up care and evaluation as needed) – Thyrotoxicosis – Differentiated thyroid cancers – Receptor targeted therapy – 1311 MIBG Therapy – Palliation of painful osseous metastases: 32p,89Sr & 153Sm – Radiosynovectomy using Yttrium, Holmium – Targeted internal radiation in HCC:90Y – Sirsphers;131I – Lipidol. Recent advances in imaging techniques & image processing including fusion techniques – image guiding for radiotherapy & stereo tactic surgeries. Basic knowledge of bone densitometry, various uses for bone densitometry, historical and current techniques, including peripheral adaptations, advantages and disadvantages of DXA, Compare and contrast DXA to conventional radiography.

EXAMINATION SCHEDULES
FOURTH YEAR

	THEORY
PAPER- I	**Hybrid imaging and recent advances**
PAPER-II	**Radionuclide therapy and bone mineral densitometry**
	PRACTICAL AND VIVA
PAPER- I	**Clinics with PET-CT/MRI procedures Demo cases presentation and scan reading session**
PAPER-II	**Clinics with therapeutic procedures and bone mineral densitometry**

SCHEME OF EXAMINATION

FOURTH YEAR

(270 WORKING DAYS)

Theory subject Title	University Theory Exam Marks		ical Subjects Title	Practical/ Examination Marks		Viva		Internal Assessment IA	
PAPER-I Hybrid imaging and recent advances	**Max** 100	**Min** 50	Clinics with PET-CT/MRI procedures Demo cases presentation and scan reading session	**Max** 100	**Min** 50	**Max** 50	**Min** 25	**Max** 50	**Min** 25
PAPER II: Radionuclide therapy and bone mineral densitometry	**Max** 100	**Min** 50	Clinics with Elective therapeutic procedures and bone mineral densitometry	**Max** 100	**Min** 50	**Max** 50	**Min** 25	**Max** 50	**Min** 25

Thesis: Thesis should be started in 6 months of joining the course, completed & approved before appearing for 4th Year examination

Internal assessment	Marks
Theory (cumulative Sessional results)	20
Practical (cumulative Sessional results)	20
Log/Record work	10
Total	50

Theory 100 Marks
Practical 100 Marks
Viva 50 Marks
IA 50 Marks

BOOKS FOR STUDY

Text Books:

1. Diagnostic Nuclear Medicine Martin P Sandler, Edward Colmann.
2. The Essential Physics of Medical Imaging, Third Edition by Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt Jr., John M. Boone.
3. Nuclear Medicine: The Requisites 4th Edition by Harvey A. Ziessman MD, Janis P. O'Malley MD, James H. Thrall MD.
4. Recent advances in Nuclear Medicine John. H. Lawrence.
5. Radiation Biology and Physics PaulF Wilson and Joel S Bedford
6. Radiation safety in Nuclear Medicine – Max. H.Lombardi.
7. An introduction to Radiobiology – A.H.W.Nias.
8. Biological assessment of Radiation Damage – Thomas. L, Walden.Jr and Nushin K
9. Radiobiology for the Radiologist –Eric J Hall, and Amato J Giaccia.
10. PET: Physics, Instrumentation, and Scanners – Michael Phelps.
11. PET and PET-CT A clinical Guide –Eugence Lin and Abbas Alavi
12. Nuclear Medicine and PET/CT Technology and Techniques –Paul Christian and Kristin Waterstram.

Journals:

1. Clinical Nuclear Medicine.
2. Seminars in Nuclear Medicine.
3. Journal of Nuclear Medicine.
4. Annals of Nuclear Medicine.
5. European journal of Nuclear Medicine and Molecular Imaging.
6. Nuclear Medicine Communication.
7. Indian Journal of Nuclear Medicine.

LOG BOOK

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

1. Investigations Performed
2. Cases Presented in
    a) Clinical meetings with other departments.
    b) Departmental seminars.
    c) Journal clubs along with Title& Journal Issue with title.
3. Cases worked up for radionuclide therapy.
4. Schedule of interdepartmental rotations.
5. Details of apprenticeship.
6. Conferences attended – National / International.
    a) Papers presented of conference with title name of the conference, date of presentation.
7. Paper published with title, name& issue of the journal. Mid Term Evaluation Each candidates shall have mid term evaluation in terms of
    a) Case presentation session.
    b) Scan Interpretation session.

c) Oral Viva.
d) Evaluation of the Log book.
e) Presentation of work completed in Thesis.

Pre examination Evaluation

Examination appearing students shall be evaluated by the faculty & observe for following:

1. **Case presentation**
2. **Scan Interpretation**
3. **Oral Viva**
4. **Summary of results of thesis experiments**

Thesis

Each candidate has to submit a thesis after reviewing by supervisor/Co- supervisor. Which should be accepted by the University before appearing in the final examination. The protocol should be submitted 6 months of admission & presented to entire faculty.

Thesis Evaluation

The thesis should reflect substantial work for the advancement of scientific knowledge, design or development or applied work. It should show competence in critical analysis of scientific data as well as through familiarity with back ground literature.

1. The evaluation of the thesis will consist of;
   a) Evaluation by 2 external examiners.
   b) Oral examination of the candidate on the thesis during the viva for final examination.
2. In his / her report, each examiner should highlight the salient features of the thesis and make a clear recommendation regarding its acceptance Or rejection for MD Degree. It one of the examiners gives a definite recommendation against the award of the degree, reference to a third examiner will be made. If the report from the third examiner is positive, the oral examination will be held. If his / her report is negative, the Thesis will be rejected.
3. If two examiners recommend against the award of the degree, the thesis will be rejected.

Report of Examiners

1. Each examiner will be requested to send his report within 2 months of the receipt of the thesis to the registrar. The reports must contain a critical evaluation of the thesis and a clear recommendation as to whether it has attained the standard of MD or not.
2. In case the examiners are unable to make a definite recommendation they should indicate one of the following alternatives;
   a) Minor revision, which does not involve retyping or binding of the thesis.
   b) Major revision involving rewriting of one or more sections but not involving additional research.
   c) Rewriting the thesis; If the candidate's work justifies another opportunity being given to him to do further research & rewriting the thesis (this will be treated as a new examination).

Training Programme

1. Didactic Lecture in Physics related in Nuclear Medicine, Radiopharmacy, Radioisotope, Techniques, instrumentation data processing and quality control.
2. Participation in the daily routine work of the department including work rounds of patient admitted for radionuclide therapy.
3. Presentation of cases in the reporting sessions of the department.
4. Active participation in the combined clinical meeting with other departments for case discussions.

Apprenticeship

a. **Medicine - 1 month**
b. **Radiology (cross sectional)---3 months**
c. **Cardiology (Cath lab/CTA)—01 month**
d. **Oncology ---01 month**

FINAL EXAMINATION FOR AWARD OF M.D. DEGREE

<table>
<tr><th>Theory subject Title</th><th colspan="2">University Theory Exam Marks</th><th>Practical Subjects Title</th><th colspan="2">Practical/ Examination Marks</th><th colspan="2">Viva</th><th colspan="2">Internal Assessment IA</th></tr>
<tr><td rowspan="2">PAPER-I Nuclear Medicine I</td><td>Max</td><td>Min</td><td rowspan="2">Long case/ scan reading session</td><td>Max</td><td>Min</td><td>Max</td><td>Min</td><td>Max</td><td>Min</td></tr>
<tr><td>100</td><td>50</td><td>100</td><td>50</td><td>50</td><td>25</td><td rowspan="4">100</td><td rowspan="4">50</td></tr>
<tr><td rowspan="2">PAPER II: Nuclear Medicine II</td><td>Max</td><td>Min</td><td rowspan="2">Spotting</td><td>Max</td><td>Min</td><td>Max</td><td>Min</td></tr>
<tr><td>100</td><td>50</td><td>100</td><td>50</td><td>50</td><td>25</td></tr>
<tr><td rowspan="2">Thesis writing scoring</td><td>Max</td><td>Min</td><td colspan="3" rowspan="2">Thesis Defense (20 minutes oral presentation)</td><td>Max</td><td>Min</td></tr>
<tr><td>100</td><td>50</td><td>100</td><td>50</td></tr>
</table>

a) **Theory=200 marks**
b) **Practical=200 marks**

c) **Viva=100 marks**
d) **Thesis =200 marks**
e) **IA=100 marks**