
CURRICULUM/STATUTES & REGULATIONS

FOR

5 YEARS DEGREE PROGRAMME

IN

RADIOLOGY

(MD RADIOLOGY)



**UNIVERSITY OF HEALTH SCIENCES,
LAHORE**

STATUTES

1. Nomenclature Of The Proposed Course

The name of degree programme shall be MD Radiology. This name is well recognized and established for the last many decades worldwide.

2. Course Title:

MD Radiology

3. Training Centers

Departments of Radiology (accredited by UHS) in affiliated institutes of University of Health Sciences Lahore.

4. Duration of Course

The duration of MD Radiology course shall be five (5) years (first year in Part I, first two years in Part II and next three years in Part III) with structured training in a recognized department under the guidance of an approved supervisor.

The course is structured in three parts:

Part I is structured for the 1st calendar year. The candidate shall undertake didactic training in Basic Medical Sciences, Behavioural Sciences, Biostatistics & Research Methodology.

Part II is structured for the 1st and 2nd calendar years. The candidate shall undertake clinical training in fundamental concepts of Internal Medicine. At the end of 2nd year, the examination shall be held in fundamental concepts of Internal Medicine. The clinical training in Radiology shall start from 3rd year onwards in the recognized institutions.

Part III is structured for 3rd, 4th and 5th calendar years in MD Radiology. The candidate shall undergo training to achieve educational objectives of MD Radiology (knowledge & skills) along with rotation in relevant fields. The research component and thesis writing shall also be included in this part. Over the five years duration of the course, candidate will spend total time

equivalent to one calendar year for research during the training. Research can be done as one block in 5th year of training or it can be done in the form of regular periodic rotations over five years as long as total research time is equivalent to one calendar year.

5. Admission Criteria

1. For admission in MD Radiology course, the candidate shall be required to have:
 - MBBS degree
 - Completed one year House Job
 - One year experience in Radiology/Internal Medicine/Allied medical discipline in the given order of preference
 - Registration with PMDC
 - Passed Entry Test conducted by the University & aptitude interview by the Institute concerned
 - Having up to the mark credentials as per UHS rules (no. of attempts in each professional, any gold medals or distinctions, relevant work experience, Rural/ Army services, research experience in a recognized institution, any research article published in a National or International Journal) may also be considered on case to case basis.

2. Exemptions: A candidate holding FCPS/MRCP/Diplomate American Board/equivalent qualification in Internal Medicine shall be exempted from Part-I & Part-II Examinations and shall be directly admitted to Part-III Examinations, subject to fulfillment of requirements for the examination.

6. Registration and Enrollment

- Total number of students enrolled for the course must not exceed 2 per supervisor/year.

- The maximum number of trainees that can be attached with a supervisor at a given point of time (inclusive of trainees in all years/phases of MD training), must not exceed 6.
- Beds to trainee ratio at the approved teaching site shall be at least 5 beds per trainee.
- The University will approve supervisors for MD courses.
- Candidates selected for the courses after their enrollment at the relevant institutions shall be registered with UHS as per prescribed Registration Regulations.

7. Accreditation Related Issues of the Institution

1. Faculty

Properly qualified teaching staff in accordance with the requirements of Pakistan Medical and Dental Council (PMDC)

2. Adequate Space

Including class-rooms (with audiovisual aids), demonstration rooms, computer lab and clinical pathology lab etc.

3. Library

Departmental library should have latest editions of recommended books, reference books and latest journals (National and International).

- Accreditation of Radiology training program can be suspended on temporary or permanent basis by the University, if the program does not comply with requirements for residents training as laid out in this curriculum.
- Program should be presented to the University along with a plan for implementation of curriculum for training of residents.
- Programs should have documentation of residents training activities and evaluation on monthly basis.
- To ensure a uniform and standardized quality of training and availability of the training facilities, the University reserves the right to make surprise visits of the training program for monitoring purposes and may take appropriate action if deemed necessary.

AIMS AND OBJECTIVES OF THE COURSE

AIM

The aim of five years MD programme in Radiology is to train residents to acquire the competency of a specialist in the field of Radiology so that they can become good teachers, researchers and clinicians in their specialty after completion of their training.

GENERAL OBJECTIVES

MD Radiology training should enable a student to:

- Access and apply relevant knowledge to clinical practice:
 - Maintain currency of knowledge
 - Apply scientific knowledge in practice
 - Appropriate to patient need and context
 - Critically evaluate new technology
- Safely and effectively performs appropriate clinical skills & procedures:
 - Consistently demonstrate sound clinical skills
 - Demonstrate procedural knowledge and technical skill at a level appropriate to the level of training
 - Demonstrate manual dexterity required to carry out procedures
 - Adapt their skills in the context of each patient and procedure
 - Maintain and acquire new skills
 - Approach and carries out procedures with due attention to safety of patient, self and others
 - Critically analyze their own clinical performance for continuous improvement
- Design and implement effective management plans:
 - Recognize the clinical features, accurately diagnose and interpret the radiological findings
 - Formulate a differential diagnosis based on investigative findings
 - Manage patients in ways that demonstrate sensitivity to their physical, social, cultural and psychological needs
 - Recognize disorders of the organ systems and differentiate those amenable to medical or surgical treatment

- Effectively recognize and manage complications
- Accurately identify the benefits, risks and mechanisms of action of current and evolving treatment modalities
- Indicate alternatives in the process of interpreting investigations and in decision-making
- Manage complexity and uncertainty
- Consider all issues relevant to the patient
- Identify risk
- Assess and implement a risk management plan
- Critically evaluate and integrate new technologies and techniques.
- Organize diagnostic testing, imaging and consultation as needed:
 - Appraise and interpret appropriate diagnostic imaging and investigations according to patients' needs
 - Critically evaluates the advantages and disadvantages of different investigative modalities
- Communicate effectively:
 - Communicate appropriate information to patients (and their family) about procedures, potentialities and risks associated with the procedure in ways that encourage their participation in informed decision making
 - Communicate with the patient (and their family) the treatment options including benefits and risks of each
 - Communicate with and co-ordinate health management teams to achieve an optimal radiological environment
 - Initiate the resolution of misunderstandings or disputes
 - Modify communication to accommodate cultural and linguistic sensitivities of the patient
- Recognize the value of knowledge and research and its application to clinical practice:
 - Assume responsibility for self-directed learning
 - Critically appraise new trends in Radiology
 - Facilitate the learning of others

- Appreciate ethical issues associated with Radiology:
 - Consistently apply ethical principles
 - Identify ethical expectations that impact on medico-legal issues
 - Recognize the current legal aspects of informed consent and confidentiality
 - Be accountable for the management of their patients.
- Professionalism by:
 - Employing a critically reflective approach to Radiology
 - Adhering with current regulations concerning workplace harassment
 - Regularly carrying out self and peer reviewed audit
 - Acknowledging and have insight into their own limitations
 - Acknowledging and learning from mistakes
- Work in collaboration with members of an interdisciplinary team where appropriate:
 - Collaborate with other professionals in the selection and use of various types of treatments assessing and weighing the indications and contraindications associated with each type
 - Develop a care plan for a patient in collaboration with members of an interdisciplinary team
 - Employ a consultative approach with colleagues and other professionals
 - Recognize the need to refer patients to other professionals.
- Management and Leadership
 - Effective use of resources to balance patient care and system resources
 - Identify and differentiate between system resources and patient needs
 - Prioritize needs and demands dealing with limited system resources.
 - Manage and lead clinical teams
 - Recognize the importance of different types of expertise which contribute to the effective functioning of clinical team
 - Maintain clinically relevant and accurate contemporaneous records
- Health advocacy:
 - Promote health maintenance of patients
 - Advocate for appropriate health resource allocation

SPECIFIC LEARNING OUTCOMES

Residents completing MD Radiology training will have formal instruction, clinical experience, and will be able to demonstrate competence in the

- Describe aetiology, pathophysiology, and principles of diagnosis and management of common problems including emergencies, in adults and children
- Demonstrate understanding of basic sciences relevant to this specialty.
- Take a proper clinical history, examine the patient, perform essential diagnostic/interventional procedures and interpret the results to come to a reasonable diagnosis or differential diagnosis in the condition
- Provide basic life saving support service in emergency situations
- Demonstrate appropriate proficiency in Body Imaging with the proper clinical and radiologic indications including scientific principles in:
 - Basic radiation biology and radiation protection
 - Basic radiopharmacy and radiochemistry
 - Principles of tracer technology
 - Diagnostic imaging: mode of pharmaceutical uptake; normal and abnormal appearances of images, normal variants and common artifacts in bone, heart, lung, kidney, brain, thyroid, tumor and infection images.
 - Therapeutic applications: basic principles of radionuclide therapy; treatment of hyperthyroidism, thyroid cancer and metastatic bone pain.
 - Principles of radiation protection: ALARA (as low as reasonably achievable), ALARP (as low as reasonably practicable).
 - Diagnosis and treatment of thyroid diseases.
 - Tracer kinetics
 - Computing and image processing
 - Radiobiology including the biological effects of high and low levels of radiation
 - Linear hypothesis and the threshold hypothesis of the biological response to low level radiation
 - The effective dose equivalent and the calculation of radiation dose from radiopharmaceuticals.
 - Radiopharmacy:
 - Properties of commonly used diagnostic and therapeutic radiopharmaceuticals
 - Production of radionuclides by reactors, cyclotrons and radionuclide generators
 - Quality assurance and quality control of radiopharmaceuticals.
 - Principles of radiology including dual energy X ray absorption (DEXA), ultrasound, CT and MRI imaging
 - Learning of cross-sectional anatomy
 - Correlative imaging of NM images and those from other imaging techniques
 - Special diagnostic investigations in cardiology, lung disease, gastroenterology, hepatobiliary diseases, nephro-urology,

neurology and psychiatry, endocrinology, hematology, oncology and infection

- Therapeutic applications
- Treatment of bone metastases, neuroendocrine tumours and other malignancies as well as polycythemia
- Use of radio-labeled monoclonal antibodies and peptides for tumor therapy
- State the physiologic properties, proper concentrations and proper indications for the use of the following contrast material:
 - Barium
 - Water soluble contrast media (oral Hypaque or Gastrografin)
 - Ionic intravenous contrast media
 - Non-ionic intravenous contrast media
- Discuss the following information about Glucagon:
 - Proper indications and dosages used in GI radiology
 - Physiologic effects
 - Side effects
 - Contraindications
- List the high risk factors for allergic reaction to intravenous contrast media and their treatment
- Given an appropriate radiograph, demonstrate a basic knowledge of radiographic abnormalities
- Demonstrate basic knowledge of the equipment to be used during fluoroscopy, including proper kilovoltage (KV) techniques for the various procedures, radiation safety features of the machines, and proper radiation safety techniques.
- Demonstrate knowledge of proper KV techniques, patient positioning, and type of after-films that should be taken for the procedures
- Given a fluoroscopic examination, demonstrate the ability to identify the abnormality at fluoroscopy and modify the technique or change the patient's position to take more diagnostic fluoroscopic spot films
- Evaluate and integrate data from other studies (CT, MRI, sonography and nuclear medicine) to make recommendations to the referring physician about more appropriate or additional diagnostic studies needed for evaluation of the patient's abnormality
- State the indications the technical skills and interpret a defecography study
- Discuss thoroughly the ultrasound procedures and findings in:
 - Gallbladder/biliary tree ultrasound (cholelithiasis/cholecystitis)
 - Renal ultrasound (obstruction/renal failure)
 - Pelvic ultrasound (ectopic pregnancy)
 - Cranial ultrasound (intracranial hemorrhage)
 - Duplex Doppler (venous thrombosis of extremities)
- Discuss the basic ultrasound physics and instrumentation, especially related to equipment operation and the specifications for various probes
- Discuss all aspects of ultrasound and radiographic imaging, including indications, pathology, and correlative studies used for each examination:
 - Liver/biliary tree (biliary obstruction/tumors)
 - Pancreas (acute and chronic inflammatory process/tumors)
 - Renal (transplant rejection/Doppler, tumors and inflammatory processes)
 - Pelvis (uterine leiomyoma/ovarian neoplastic and non-neoplastic

- Diseases)
 - Cranial ultrasound (hydrocephalus/cerebral ischemia and infarction)
 - Duplex Doppler (duplex sonography of carotids and abdominal duplex)
 - Barium swallow /enema
 - Upper GI series
 - Small bowel follow through (SBFT)
 - Enteroclysis
 - Endoscopic retrograde cholangiopancreatography (ERCP)
 - Fistulograms
 - Intravenous Urogram (IVU)
 - Cystogram
 - Voiding cystourethrogram
 - Hysterosalpingraphy (HSG)
- Demonstrate a proficient knowledge of the anatomy, the basic principles and imaging protocols, interpretation and differential diagnosis in the following organ system disorders:

Chest Radiology

- Asthma
- Haemoptysis
- Aneurysms and vascular dissection
- Pulmonary emboli
- Pulmonary neoplasms
- Cardiac enlargement
- Cardiac failure and pulmonary oedema
- Pleural effusion
- Pulmonary collapse and consolidation
- Misplaced endoluminal tubes
- Pneumothorax, including tension
- Pneumomediastinum and subcutaneous emphysema
- Hyperinflation of lungs
- Free gas beneath the diaphragm
- Detection of pulmonary and mediastinal masses
- Signs of acute vascular problems, including aortic dissection and trauma

Musculoskeletal Radiology

- Common fractures in the limbs
- Fracture of femoral neck
- Fractures of the wrist and scaphoid
- Fractures of the shoulder, including dislocation
- Pelvic fractures
- Signs of osteoarthritis/rheumatoid arthritis
- Sclerotic and lytic metastases
- Skull fracture
- Cervical spine fracture and dislocation
- Fractures in children
- Bone and soft tissue infection
- Bone and soft tissue trauma
- Bone and soft tissue tumours

- Diagnosis of undisplaced or stress fractures
- Investigation of spinal injury
- Investigation of low back pain
- Metabolic bone disease
- Arthritides
- Investigation of haematological disease including anaemia and leukaemia
- Basic knowledge of potential complications of oncological treatment and means of detection

Gastrointestinal Radiology

- Abdominal pain
- Abdominal masses
- Abdominal trauma
- Inflammatory bowel disease
- Jaundice
- Hepatic neoplasms
- Biliary disease
- Small and large bowel obstruction
- Toxic megacolon
- Signs of intestinal perforation
- Aortic aneurysm
- Urinary calculi
- Gallstones
- Endoluminal foreign bodies

Genitourinary Radiology

- Renal failure and urinary obstruction
- Haematuria
- Urological neoplasms
- Renal and urinary infection
- Investigation of suspected pregnancy, including ectopic gestation.
- Post menopausal bleeding
- Gynaecological neoplasms

Neuro and Head & neck-Radiology

- Head injury
- Intracranial haemorrhage and infarction
- Spinal cord compression and radiculopathy
- Intracranial space occupying lesions
- Disease of the ear nose and throat
- Deafness
- Disease of paranasal sinuses
- Cervicofacial cancer
- Salivary disease
- Oropharyngeal lesions

Paediatric Radiology:

- Disease in childhood
- The principles of imaging in children, including protection of the patient and confidentiality.

- Disease of the chest and gastrointestinal tract in childhood, and certain paediatric neoplasms.

Breast Imaging

- Endocrine and breast disease
- Oncological and inflammatory disease
- Principles of oncological staging by imaging and knowledge of common staging classifications

Vascular and Interventional Radiology

- Ultrasound (including Doppler)
- Intravenous and intra-arterial angiography
- CT angiography
- Aortography
- Venography
- Arterial and venous catheterization
- Principles and precautions of interventional radiology

Emergency Radiology:

- Evaluation of the emergency radiographic examinations
- Medicolegal cases (MLC) procedures
- Indications for and limitations of the common emergency imaging procedures
- Findings, diagnosis and other relevant information to the emergency room physician
- Special imaging procedures needed in emergency room e.g.; barium studies, excretory urography, CT, ultrasound, Doppler and angiography

Radiological Skills and Procedures

- Plain film
- Barium Enema
- Barium Meal
- Small Bowel Barium Enema
- Sialogram
- T-Tube cholangiogram
- Knee Arthrogram
- Sinogram/Fistulogram
- Leg Venogram
- Angiographic Examination
- Hysterosalpingogram
- Lymphangiogram
- Abdominal Ultrasound
- Obstetrics and Gynecology
- Neonatal Brain
- Angiography
- Myelogram
- CT Brain & Spine Reporting
- CT Neck and Base of Skull Reporting

- CT Abdomen & Pelvis Reporting
- CT Chest Reporting
- MRI Reporting
- Excretion Urography
- Retrograde Pyelography
- Micturating Cystourethrogram
- Small parts ultrasound
- Portable Ultrasonography
- Mammography
- Radionuclide scanning

Research:

All residents in the categorical program are required to complete an academic outcomes-based research project during their training. This project can consist of original bench top laboratory research, clinical research or a combination of both. The research work shall be compiled in the form of a thesis which is to be submitted for evaluation by each resident before end of the training. The designated Faculty will organize and mentor the residents through the process, as well as journal clubs to teach critical appraisal of the literature.

REGULATIONS

1. *Scheme of the Course*

A summary of five years course in MD Radiology is presented as under:

Course Structure	Components	Examination
Part I	<ul style="list-style-type: none"> • Basic medical sciences Anatomy, Physiology, Biochemistry, Pathology, Pharmacology, Behavioural Sciences and Biostatistics & Research Methodology. 	Part-I examination at the end of 1 st year of MD Radiology programme. <ul style="list-style-type: none"> • Written: Paper I: MCQs Paper II: SEQs
Part-II	<ul style="list-style-type: none"> • Fundamental Concepts in Internal Medicine: Training in clinical techniques of Internal Medicine with compulsory rotations for two years starting from the first day of enrollment 	Part-II examination at the end of 2 nd year of MD Radiology programme. <ul style="list-style-type: none"> • Written: Papers 1 & 2: Problem-based questions in Internal Medicine • Oral & Practical/ Clinical Examination <ul style="list-style-type: none"> • OSCE • Clinical Examination (Long case, Short cases) • Log Book
Part-III	<p style="text-align: center;"><u>Clinical component of Part III</u></p> <ul style="list-style-type: none"> • Professional Education in Radiology Training in Radiology during 3rd, 4th and 5th years of MD programme <p>Three years of training with compulsory/ optional rotations in related fields</p> <p style="text-align: center;"><u>Research component of Part III</u></p> <ul style="list-style-type: none"> • Research and Thesis Writing: Research work/Thesis writing project must be completed and thesis be submitted before the end of training. 	Part-III examination in specialized components of Radiology at the end of 5 th year of MD programme <ul style="list-style-type: none"> • Written: Paper 1 & 2: Problem-based questions in the subject • Oral & Practical / Clinical Examination <ul style="list-style-type: none"> • OSCE • Clinical Examination (Long case, Short cases) • Log Book <p>Part-III thesis examination with defence at the end of fifth (5th) year of MD Radiology programme</p>

2. Examinations

Part-I Examination

1. All candidates admitted in MD Radiology courses shall appear in Part-I examination at the end of 1st calendar year.
2. The examination shall be held on biannual basis.
3. The candidate who fails to pass the examination in 3 consecutive attempts availed or un-availed, shall be dropped from the course.
4. The examination shall have two components:

Paper-I MCQs (single best)	100 Marks
Paper-II SEQs	100 Marks
5. Subjects to be examined shall be Basic Sciences relevant to Radiology (Anatomy, Physiology, Biochemistry, Pathology, Pharmacology), Behavioural Sciences and Biostatistics & Research Methodology.
6. To be eligible to appear in Part-I examination the candidate must submit;
 - i. duly filled, prescribed Admission Form to the Controller of Examinations duly recommended by the Principal/Head of the Institution in which he/she is enrolled;
 - ii. a certificate by the Principal/Head of the Institution, that the candidate has attended at least 75% of the lectures, seminars, practical/clinical demonstrations;
 - iii. Examination fee as prescribed by the University
7. To be declared successful in Part-I examination the candidate must secure 60% marks in each paper.

Part-II Examination

1. All candidates admitted in MD Radiology course shall appear in Part-II examination at the end of 2nd calendar year, and having passed part I examination.
2. The examination shall be held on biannual basis.
3. The candidate who fails to pass the examination within 3 years of passing the Part-I examination shall be dropped from the course.
4. The examination shall have the following components:
 - a. Written 200 Marks
 - b. OSCE 50 Marks
 - c. Clinical examination 100 Marks
 - d. Log Book Evaluation 80 Marks (40 marks per year)
5. There shall be two written papers of 100 marks each:
Paper 1 & 2: Principles of Internal Medicine
6. The types of questions shall be of Short/Modified essay type and MCQs (single best).
7. Oral & practical/clinical examination shall be held in clinical techniques in Internal Medicine.
8. To be declared successful in Part-II examination the candidate must secure 60% marks in each component and 50% in each sub-component.
9. Only those candidates, who pass in theory papers, will be eligible to appear in the Oral & Practical/clinical Examination.
10. The candidates, who have passed written examination but failed in oral & practical/ clinical examination, will re-appear only in oral & practical/clinical examination.
11. The maximum number of attempts to re-appear in oral & practical /clinical Examination alone shall be three, after which the candidate shall have to appear in both written and oral & practical/clinical examinations as a whole.
12. To be eligible to appear in Part-II examination the candidate must submit;
 - i. duly filled, prescribed Admission Form to the Controller of Examinations duly recommended by the Principal/Head of the Institution in which he/she is enrolled;

- ii. a certificate by the Principal/Head of the Institution, that the candidate has attended at least 75% of the lectures, seminars, practical/clinical demonstrations;
- iii. a certificate of having passed the Part-I examination;
- iv. Examination fee as prescribed by the University.

Part-III Examination

1. All candidates admitted in MD Radiology course shall appear in Part-III (clinical) examination at the end of structured training programme (end of 5th calendar year), and having passed the part I & II examinations. However, a candidate holding FCPS / MRCP / Diplomate American Board/equivalent qualification in Internal Medicine shall be exempted from Part-I & Part-II Examinations and shall be directly admitted to Part-III Examinations, subject to fulfillment of requirements for the examination.
2. The examination shall be held on biannual basis.
3. To be eligible to appear in Part-III examination the candidate must submit;
 - i. duly filled, prescribed Admission Form to the Controller of Examinations duly recommended by the Principal/Head of the Institution in which he/she is enrolled;
 - ii. a certificate by the Principal/Head of the Institution, that the candidate has attended at least 75% of the lectures, seminars, practical/clinical demonstrations;
 - iii. Original Log Book complete in all respect and duly signed by the Supervisor (for Oral & practical/clinical Examination);
 - iv. certificates of having passed the Part-I & part-II examinations;
 - v. Examination fee as prescribed by the University.
4. The Part-III clinical examination shall have the following components:

▪ Written	300 marks
▪ Oral & practical/clinical examination	300 marks
▪ Log Book Evaluation	120 marks (40 marks per year)
5. There shall be two written papers of 150 marks each.
6. Both papers shall have problem-based Short/Modified essay questions and MCQs.
7. Oral & practical/clinical examination shall have 300 marks for:

i. 1 Long Case	100
ii. 4 Short Cases	100(25 marks each)
iii. OSCE	100
8. To be declared successful in Part-III examination the candidate must secure 60% marks in each component and 50% in each sub-component.

9. Only those candidates, who pass in theory papers, will be eligible to appear in the Oral & Practical/ Clinical Examination.
10. The candidates, who have passed written examination but failed in Oral & Practical/ Clinical Examination, will re-appear only in Oral & Practical / Clinical examination.
11. The maximum number of attempts to re-appear in oral & practical /clinical Examination alone shall be three, after which the candidate shall have to appear in both written and oral & practical/clinical examinations as a whole.
12. The candidate with 80% or above marks shall be deemed to have passed with distinction.
13. *Log Book/Assignments:* Through out the length of the course, the performance of the candidate shall be recorded on the Log Book.
14. The Supervisor shall certify every year that the Log Book is being maintained and signed regularly.
15. The Log Book will be developed & approved by the Advanced Studies & Research Board.
16. The evaluation will be maintained by the Supervisor (in consultation with the Co- Supervisor, if appointed).
17. The performance of the candidate shall be evaluated on annual basis, e.g., 40 marks for each year in five years MD Radiology course. The total marks for Log Book shall be 200. The log book shall reflect the performance of the candidate on following parameters:
 - Year wise record of the competence of skills.
 - Year wise record of the assignments.
 - Year wise record of the evaluation regarding attitude & behaviour
 - Year wise record of journal club / lectures / presentations / clinico-pathologic conferences attended & / or made by the candidate.

3. Submission / Evaluation of Synopsis

1. The candidates shall prepare their synopsis as per guidelines provided by the Advanced Studies & Research Board, available on UHS website.
2. The research topic in clinical subject should have 30% component related to basic sciences and 70% component related to applied clinical sciences. The research topic must consist of a reasonable sample size and sufficient numbers of variables to give training to the candidate to conduct research, to collect & analyze the data.
3. Synopsis of research project shall be submitted by the end of the 3rd year of MD program. The synopsis after review by an Institutional Review Committee shall be submitted to the University for consideration by the Advanced Studies & Research Board, through the Principal / Dean /Head of the institution.

4. Submission of Thesis

1. Thesis shall be submitted by the candidate duly recommended by the Supervisor.
2. The minimum duration between approval of synopsis and submission of thesis shall be one year, but the thesis can not be submitted later than 8 years of enrolment.
3. The research thesis must be compiled and bound in accordance with the Thesis Format Guidelines approved by the University and available on website.
4. The research thesis will be submitted along with the fee prescribed by the University.

5. Thesis Examination

1. All candidates admitted in MD course shall appear in Part-III thesis examination at the end of 5th year of their training course.
2. Only those candidates shall be eligible for thesis evaluation who have passed Part I, II & III (clinical) Examinations.
3. The examination shall include thesis evaluation with defense.

4. The Vice Chancellor shall appoint three external examiners for thesis evaluation, preferably from other universities and from abroad, out of the panel of examiners approved by the Advanced Studies & Research Board. The examiners shall be appointed from respective specialty. Specialists from Internal Medicine and related fields may also be appointed/co-opted, where deemed necessary.
5. The thesis shall be sent to the external examiners for evaluation, well in time before the date of defense examination and should be approved by all the examiners.
6. After the approval of thesis by the evaluators, the thesis defense examination shall be held within the University on such date as may be notified by the Controller of Examinations. The Controller of Examinations shall make appropriate arrangements for the conduct of thesis defense examination in consultation with the supervisor, who will co-ordinate the defense examination.
7. The thesis defense examination shall be conducted by two External Examiners who shall submit a report on the suitability of the candidate for the award of degree. The supervisor shall act as coordinator.

6. Award of MD Radiology Degree

After successful completion of the structured courses of MD Radiology and qualifying Part-I, Part-II and Part-III examinations, the degree with title MD Radiology shall be awarded.

CONTENT OUTLINE

Part-I MD Radiology

Basic Sciences:

Student is expected to acquire comprehensive knowledge of Anatomy, Physiology, Pathology (Microbiology), Biochemistry, Pharmacology relevant to the clinical practice appropriate for Radiology

1. Anatomy

- Cell Biology: Cytoplasm – Cytoplasmic matrix, cell membrane, cell organelles, cytoskeleton, cell inclusions, cilia and flagella.
- Nucleus – nuclear envelope, nuclear matrix, DNA and other components of chromatin, protein synthesis, nucleolus, nuclear changes indicating cell death.
- Cell cycle, mitosis, meiosis, cell renewal.
- Cellular differentiation and proliferation.
- Tissues of Body: Light and electron microscopic details and structural basis of function, regeneration and degeneration. Confocal microscopy.
- The systems/organs of body – Cellular organization, light and electron microscopic features, structure function correlations, and cellular organization.

Histology:

Structural and Functional Organization of the Tissues of Body

- Classification of tissues and identification of various tissues particularly those related to the musculoskeletal system, in routine histological preparations under the light microscope.

The Epithelial Tissue

- General structure, functions and classification of epithelia
- Their location in the body
- General characters of serous and mucous membranes
- General structural features of exocrine and endocrine glands

The Connective Tissue

- Cartilage
- Structure of bone marrow. Cell lines seen in haemopoiesis.
- Factors required for bone growth.

The Muscular Tissue

- Structural and functional differences between the smooth skeletal and cardiac types of muscle.
- Fine structure of skeletal and cardiac muscle fibers, and its relationship to the mechanism of contraction.
- Specialized conducting tissue of the heart.

The Neural Tissue

- The neuron, morphology of the perikaryon and its processes.

- Coverings of the axons in the peripheral nerves and the central nervous system.
- Types of neuroglia and their functions.
- Process of myelination in the peripheral nerves and the central nervous system.
- Axon terminals and synapses. Nerve fiber degeneration and regeneration.

Embryology

General Organization of the Body

- Anatomical nomenclature
- Terms of position
- Divisions of the body according to the regions and organ systems
- Detailed Anatomy of the organ systems, their blood supply, nerve supply, lymphatic drainage and important gross relations to other organs
- Developmental Anatomy and associated common congenital abnormalities
- Cell biology, cell cycle, cellular differentiation and proliferation.
- Tissues of Body: Light and electron microscopic details, structural basis of function, regeneration and degeneration of the organ systems.

General Features of Human Development

- Features of mitotic and meiotic modes of cell division. Genetic consequences of meiotic division.
- Abnormal mitotic and meiotic divisions of clinical importance.
- Gametogenesis: origin of germ cells.
- Oogenesis: prenatal and postnatal development of ova.
- Spermatogenesis: proliferation and maturation of male germ cells. Abnormal gametes, their clinical significance.
- Ovulation, fertilization and the consequences of fertilization.

Early Embryonic Development:

- Cleavage, morula and blastocyst formation and implantation. Formation of the three primary germ layers.
- List of the derivatives of the respective germ layers.

Period of the Growing Fetus:

- Various stages and salient features of the fetus development

Extraembryonic Membranes:

- Development, functions and anomalies of yolk sac, amnion, chorion, allantois, umbilical cord and placenta.

Development of the External Body Form:

- Shaping of the head, neck, trunk and limbs. Common developmental anomalies associated with this.

The Branchial Apparatus:

- Development and fate of the bronchial grooves, arches and pouches. Their derivatives and anomalies.

Teratogenesis:

- Factors known to be involved in the development of congenital anomalies. Concept of critical periods.

The Nervous System

- Development of the nervous system and common developmental anomalies.

The Brain

- Subdivisions of the brain.
- External morphology of cerebellum, lobes, surface, sulci and gyri. External morphology of cerebellum and its subdivisions.
- External morphology of midbrain, pons and medulla.
- Different grey matter masses in the brain.
- Ventricular system of the brain.
- Circulation of cerebrospinal fluid and its composition.
- Blood supply of the brain. Parts of the cranial dura, formation and drainage of dural sinuses.
- Appearance of CT and MRI scans and identification of structures.
- Cerebrum as seen in horizontal sections.

Cerebral Cortex

- Gross and microscopic organization of the cortex, location of motor and sensory cortical areas.
- Functions and blood supply of various regions. White matter of the cerebrum, definition of association, commissural and projection fibers and their role in cortical functioning. Internal capsule, location, fibre content and blood supply.

Limbic System

- Core structures of the limbic system.
- Other nuclei and pathways associated with the limbic system.
- Functions of thalamus, hypothalamus and the limbic system.

Basal Ganglia

- Subdivisions, connections, functions and effects of lesions.

Thalamus

- Nuclear groups, afferent and efferent connections and their functional correlations.

Hypothalamus

- The nuclei, afferent and efferent connections and their functional correlations.
- Effects of lesions.

Internal Structure of Cerebellum

- Cerebellar cortex: organization and functions.
- Cerebellar nuclei: main connections.

- Cerebellar peduncles, cerebellar afferent and efferent connections, functional correlations.
- Effects of lesions.

Spinal Cord

- External morphology, meninges and blood supply of the spinal cord. Relationship of the "segments" to vertebrae at different ages.
- Internal structure of the spinal cord, organization of the grey and white matter.
- Variations in the structure of the grey matter at different levels and location of the important nuclei.
- Location of ascending and descending tracts, and their functions.
- Effects of injury or disease.

Peripheral Nervous System

- Anatomy and functions of cranial nerves with their intracranial and extracranial course and distribution.
- Location of various cranial nerve nuclei.
- Anatomy and functions of spinal nerves.
- Foundation, course and distribution of a typical nerve.
- Effects of lesions.

Organs of Special Senses

- Development of special sense organs and common developmental anomalies of the eye, ear and nose.
- Basic mechanisms of olfaction, taste, vision and hearing.
- The nose skeleton, walls of the nasal cavity, morphological features, nasal conchae, meatuses, location of openings of the sinuses.
- Mucosa of the nasal cavity, blood supply and nerve supply.
- The paranasal sinuses, their location and general morphology.

Olfaction:

- Structure of olfactory mucous membrane, receptors, olfactory pathway and its termination.
- Characters of smell and its significance.

The Eye / Orbit

- Walls, bony constituents and salient morphological features.
- Disposition of the contents of the orbit including muscles, nerves and vessels. Structure and function of eyelids.
- Conjunctival sac, lacrimal gland and lacrimal apparatus, structure and functions.
- Orbicularis oculi muscle, attachments, nerve supply and functions.

Eyeball

- Tunics of the eyeball and their anatomical constituents.
- Microscopic anatomy of cornea and lens, layers of retina.
- Chambers of the eye, boundaries and contents.
- Formation, circulation and functions of aqueous humour, sinus venous sclerae (canal of Schlemm), filtration angle.

- General morphological and structural features of refracting media.
- Blood supply of retina.
- The visual pathway and effect of lesions at different levels.
- Pupillary light reflex and its pathway.
- Accommodation, its mechanism and pathway.
- Colour vision and colour blindness.
- Photopic, scotopic and binocular vision.
- Field of vision and stereoscopic vision.

The Ear

External ear:

- Skeleton, general morphology of the auricle and the external acoustic meatus.
- Blood supply and nerve supply of the external ear.
- Tympanic membrane, size, shape, structure and nerve supply.

Middle ear (tympanic cavity):

- Shape, size boundaries and contents.

Internal ear:

- General morphology of bony labyrinth. Parts of membranous labyrinth, their general morphology, location of special sensory areas and nerve supply.
- Mechanism of hearing, auditory receptors and auditory pathway.
- Functions of the Vestibular apparatus.

Organ of Taste

- Structure of taste buds and location.
- Gustatory receptors, gustatory pathway and its termination.

Gastrointestinal System

- Development of the gastrointestinal tract and common developmental anomalies e.g. oesophageal fistulae, Meckel's diverticulum, atresias.
- Rectal and associated urinary bladder anomalies related to partitioning of the cloaca.
- Rotation of gut, physiological herniation and its withdrawal and related anomalies.
- Development and partitioning of the coelomic cavity and formation of the diaphragm.
- Parts, relations, history, functional correlation with structure, common pattern of blood supply, nerve supply and lymphatic drainage of the mouth, tongue and salivary glands, oesophagus, stomach, small intestine, appendix, colon (including caecum), rectum, anal canal, liver, gallbladder, bile ducts and pancreas.

Cardiovascular System

- Development of the heart and vascular system and common developmental anomalies such as septal defects, patent ductus arteriosus, Fallot's tetralogy and coarctation of aorta.
- Microscopic structure of the heart including conducting system
- Characteristics of the cardiac muscle contraction, duration, refractory period, pacemaker and rhythmicity.
- General structural features of atria, ventricles, conducting tissues, and valves of the heart and their relationship to cardiac function.
- Blood supply of heart.
- Structure and functions of the arteries, arterioles, capillaries and veins.

Urinary System

- Development of the urinary system and common developmental anomalies.
- Morphology, including microscopic structure of the nephron.
- Relations, common pattern of blood supply, nerve supply and lymphatic drainage of the kidneys, ureters, urinary bladder, urethra and prostate.

Respiratory System

- Development of the respiratory system and common developmental anomalies.
- Histology of the trachea, bronchi and the lung.
- Physiological anatomy and structure of the respiratory system.

Larynx

- General form and skeleton of the larynx
- Blood and nerve supply of the larynx

Endocrine and Reproductive System

- Development and common developmental anomalies of the pituitary, thyroid, parathyroid, adrenal glands, testis, uterine tubes, ovary, uterus etc.

Musculoskeletal System

- Functions of the skeletal system.

Bones

- Identification of bony outlines on plain x-ray.
- Classification of bones.
- Bone growth and ossification.
- Blood supply of all long and small bones of human body

Joints

- Classification of joints
- Factors contributing to the stability of joints.
- Movements of the joints of shoulder, elbow, hip, knee and ankle.
- Movements of the shoulder girdle as a whole, supination and pronation of forearm, inversion and aversion of foot and movements of fingers and thumb. Maintenance of normal posture

Muscles and Fasciae

- Muscles of the human body
- General disposition, nerve supply and effects of nerve lesions
- Muscle attachments, group actions and nerve supply.

Body Cavities:

- Abdominal, thoracic, cranial, pelvic cavity
- A general description of the boundaries, land marks and surface anatomy of the internal organs and dermatomes of the body cavities
- General disposition, morphology, relations, blood and nerve supply, lymph nodes and areas of drainage of the viscera contained in these cavities.
- Identification of bony outlines on plain X-ray.

2. Physiology

Cellular organization, structure function correlations and physiological alterations in the endocrine organ systems of body

Structural and Functional Organization of the Cells of the Body

- Concept of cells as the structural, functional and genetic units of the body.
- Composition of protoplasm, division into cytoplasm and nucleus.
- Role of macromolecules in the structural organization of the cell.
- Cell components with their role in cell function.
- Diversity of cell morphology as related to the varied functional demands. Physical activities of the living cells, intracellular movements, cellular locomotion, endocytosis and exocytosis.
- Basic concepts of the principles of transport through cell membrane, membrane potential and action potential.
- The cell cycle and cell division.
- Energy balance, metabolism & nutrition
- Uses of cell and tissue cultures.
- DNA and RNA structure and protein synthesis.

Blood:

- General properties and composition.
- Structure, production, functions and fate of red blood cells, white blood cells and platelets.
- Structure, formation, functions, and fate of haemoglobin.
- Blood volume and principles of its measurement.
- Disorders of blood.
- Blood groups (ABO, Rh and other systems), blood transfusion and exchange transfusion.
- Precautions and hazards of blood transfusion.
- Plasma proteins, their production and functions.
- Diagnosis of various types of anaemias and leukaemias.
- Values of various components of blood in different age groups e.g. haemoglobin, WBCs, hormones etc.

- Interpretation of complete blood picture, haematological changes in infectious and non infectious diseases

Cardiovascular System:

- Cardiac muscle: electrical and mechanical properties.
- Metabolism
- Origin of the HR beat, the electrical activity of the heart
 - (normal and findings is cardiac and systemic diseases)
- Mechanism of production of heart sounds, their location, characters and relationship with the cardiac cycle.
- The normal electrocardiogram and characters of its various components. Significance of its parts, voltage and calibration
- Principles and methods of recording, electrocardiographic leads and general information obtained from ECG.
- Physiology and abnormalities of apex beat.
- Cardiac output, amount, distribution, measurement, control, cardiac index and cardiac reserve.
- Echocardiography, exercise tolerance test and the basis of ETT.
- Patho-physiology of cardiac failure, valvular heart disease and hypertension. Interpretation of data of diagnostic tests.
- Dynamics of blood and lymph flow: biophysics
- Arterial and arteriolar circulation capillary circulation, lymphatic circulation and venous circulation
- Laws of haemodynamics governing flow, pressure and resistance in blood vessels.
- Arterial blood pressure, measurement and regulation.
- Vasomotor system and control of blood vessels.
- Characters of arterial pulse and venous pulse.
- Significance of central venous pressure.
- Mechanism of haemorrhage and shock.
- Coronary, cutaneous, splanchnic and peripheral circulation.
- Its measurement, control and special features, circulatory changes during muscular exercise
- Cardiovascular regulatory mechanisms local regulation
- Endothelium; systemic regulation by hormones and systemic regulation by nervous system.
- Circulation through special organs: organs: coronary circulation, cerebral circulation and pulmonary circulation.
- Cardiovascular homeostasis in health and diseases: exercise, gravity, shock, hypertension and heart failure.

Respiration:

- Pulmonary ventilation
- Mechanics of respiration, pulmonary volumes, capacities and pressures.
- Transport and exchange of oxygen and carbon dioxide.
- Regulation of respiration. (chemical and neural)
- Physiology of respiratory insufficiencies, hypoxia, dyspnoea, asphyxia and hypercapnia.
- Exercise hypoxia and cyanosis
- Physiological changes due to altitude and space travel

- Principles and methods of artificial respiration.
- Principles of pulmonary function tests.
- Interpretation of data of diagnostic tests.
- Cardiopulmonary resuscitation.
- Patho-physiology of respiratory failure.

Renal function:

- Renal circulation
- Glomerular filtration
- Tubular function
- Water excretion
- Acidification of urine
- Regulation of Na + and K + excretion
- Regulation of extracellular fluid composition and volume
- Homeostatic mechanisms to maintain
 - Tonicity
 - Volume
 - H⁺ concentration of ECF.

Endocrinology:

- General concepts of chemical nature, mechanism, site of action and functions of hormones of the hypothalamus, pituitary, thyroid, adrenal, parathyroid, pancreas, and pineal glands, ovaries and testis.
- Comprehensive knowledge of all hormones including their chemistry, biosynthesis, storage, release, transport, mechanism of inactivation mode and site of action, distribution, physiological and pathological activities and assessment of functions.
- Calcium homeostasis
- Effects of hypo-and hyperactivity of the endocrine glands.
- Production and functions of hormones related to the sex characters in the male and female.
- Endocrinology of the menstrual cycle.
- Role of hormones in pregnancy, parturition and lactation.
- Functions of placenta. Libido, impotence and infertility.
- Endocrine function of the kidney, heart, lung and gastrointestinal tract

Gastrointestinal function:

- Digestion and absorption
- Regulation of gastrointestinal function
- Motility: mastication, swallowing, gastric motility, intestinal motility and gall bladder motility.
- Secretory activity: formation, composition, function and control of saliva, gastric, pancreatic, bile and intestinal secretions.
- GIT hormones controlling activities: Functions of the stomach, pancreas, gall bladder, liver and large intestine. Formation and composition of faeces, mechanism of defecation.
- Circulation of bile. Principles and assessment of liver function tests. Interpretation of data, diagnostic tests.
- Hyperbilirubinaemia and congenital hyperbilirubinaemias.
- Control of hunger, appetite and its disorders.

Central Nervous System

- Motor cortex corticospinal and corticobulbar system.
- Basal ganglia
- Cerebellum

Autonomic Nervous System

- Overall functions of sympathetic and parasympathetic nervous systems.
Autonomic reflex activity.

Functional Aspects of the Nervous System

- Sensory activity: Peripheral sensory receptors, sensory pathways, physiology of pain and disorders of sensations.
- Motor activity: corticospinal and extracorticospinal pathways, cerebellum and Vestibular system.
- Motor neurons, motor units and neuromuscular junction.
- Disorders of motor activity.

Muscle and nerve physiology.

- Reflex activity: Monosynaptic stretch reflexes, polysynaptic withdrawal reflexes, general characters of reflexes.
- Electroencephalogram and its uses.
- Sleep, types, physiological changes during sleep.
- Speech mechanism and its disorders.
- Cerebrospinal fluid, cerebral circulation, metabolism and functions.
- Blood brain and blood CSF barriers.

3. Biochemistry

Membrane biochemistry and signal transduction

- Gene expression and the synthesis of proteins
- Bioenergetics; fuel oxidation and the generation of ATP
- Enzymes and biologic catalysis
- Tissue metabolism

VITAMINS

- Classification, components, sources, absorption and functions (physiological and biochemical role).
- Daily requirements, effects of deficiency and hypervitaminosis.
- Salient morphologic features of diseases related to deficiency or excess of vitamins.

MINERALS

- Sources of calcium, phosphorous, iron, iodine, fluorine, magnesium and manganese.
- Trace elements and their clinical importance.
- Absorption and factors required for it.
- Functions and fate.

METABOLISM

- Metabolic rate and basal metabolic rate
- Factors influencing metabolic rate, principles of measurement.

Carbohydrates

- Classification and dietary sources.
- Digestion, absorption and utilization of dietary carbohydrates. Glucose tolerance test.
- Glycogenesis, glycolysis, gluconeogenesis, glycogenolysis, processes with the steps involved and effects of hormones.
- Citric acid cycle, steps involved, its significance and the common final metabolic pathway.
- Hexose monophosphate shunt: mechanism and significance.

Lipids

- Classification of simple, derived and compound lipids.
- Dietary sources.
- Digestion, absorption, utilization and control.
- Fatty acid oxidation with steps involved.
- Ketogenesis and its significance.
- Lipotropic factors and their actions. Lipoproteins, types and importance.

Proteins And Amino Acids

- Classification and dietary sources of proteins.
- Digestion, absorption, utilization and control.
- Fate of amino acids.
- Urea formation with steps involved.
- Functions and effects of deficiency.

Nucleoproteins:

- Structure and metabolism.

Pigment Metabolism

- Basic concept of endogenous and exogenous pigments.
- Causes of pigmentation and depigmentation.
- Disorders of pigment metabolism, inherited disorders, acquired disorders from deficiency or excess of vitamins, minerals, fats, carbohydrates, proteins etc.

Balanced Diet

- Requisites of an adequate diet.
- Role of carbohydrates, fats, proteins, minerals, vitamins and water in diet.
- Principles of nutrition as applied to medical problems
- Biotechnology and concepts of molecular biology with special emphasis on use of recombinant DNA techniques in medicine and the molecular biology of cancer

4. Pharmacology

- The Evolution of Medical Drugs
- British Pharmacopia
- Introduction to Pharmacology
- Receptors
- Mechanisms of Drug Action
- Pharmacokinetics

- Pharmacokinetic Process
 - Absorption
 - Distribution
 - Metabolism
 - Desired Plasma Concentration
 - Volume of Distribution
 - Elimination
 - Elimination rate constant and half life
 - Creatinine Clearance
- Drug Effect
 - Beneficial Responses
 - Harmful Responses
 - Allergic Responses
- Drug Dependence, Addiction, Abuse and Tolerance
- Drug Interactions
- Drug use in pregnancy and in children
- Autonomic Pharmacology

Radiopharmacy Fundamentals:

- Introduction: definitions and history
- Tracer theory: concepts and techniques
- Radio-tracer design: radiopharmacology
- Radiopharmaceutical. Safety and efficacy
- Radiopharmaceuticals mechanisms of localization
- Radiopharmaceuticals quality control
- Radionuclide / radiopharmaceutical production & regulation

5. Pathology

Pathological alterations at cellular and structural level along with brief introduction of Basic Microbiology and Haematological pathology as related to medicine

Cell Injury and adaptation

- Reversible and Irreversible Injury
- Fatty change, Pathologic calcification
- Necrosis and Gangrene

Cellular adaptation

- Atrophy, Hypertrophy,
- Hyperplasia, Metaplasia, Aplasia

Inflammation

- **Acute inflammation**
 - Cellular components and chemical mediators of acute inflammation
 - Exudates and transudate
 - Sequelae of acute inflammation
- **Chronic inflammation**
 - Etiological factors and pathogenesis

- Distinction between acute and chronic (duration) inflammation
- Histologic hallmarks
- Types of chronic inflammation, non-granulomatous and granulomatous, and their causes

Haemodynamic disorders

- Etiology, pathogenesis, classification and morphological and clinical manifestations of Edema, Haemorrhage, Thrombosis, Embolism, Infarction & Hyperaemia
- Shock; classification etiology, and pathogenesis, manifestations.
- Describe the compensatory mechanisms involved in shock
- Describe the pathogenesis and possible consequences of thrombosis
- Describe the difference between arterial and venous emboli

Neoplasia

- Dysplasia and Neoplasia
- Benign and malignant neoplasms
- Etiological factors for neoplasia
- Different modes of metastasis
- Tumor staging system and tumor grade

Immunity and Hypersensitivity

- Immunity
- Immune response
- Diagnostic procedures in a clinical microbiology laboratory
- Protective immunity to microbial diseases
- Tumour immunology
- Immunological tolerance, autoimmunity and autoimmune diseases.
- Transplantation immunology
- Hypersensitivity
- Immunodeficiency disorders
- Immunoprophylaxis & Immunotherapy

Haematopathology

- Normal blood picture & variation in disease

Microbiology

- A brief account of the classification of microorganisms .
- Role of microbes in various human diseases
- Infection source
- Names, habitat, modes of transmission/infection, pathogenic mechanism and pathological changes produced by bacteria, commonly causing human diseases in Pakistan
- Gram staining and AFB staining, Culture of blood and fluid; details regarding methodology in collection, transportation and preservation
- Culture media for common pathogens and methods of culture.
- Special culture media. Basis of sensitivity tests.

- Names, general morphological features, and diseases produced by fungi commonly found in Pakistan, including dermatophytes, maduromycosis and opportunistic infections.
- Names and modes of infection of parasitic diseases commonly found in Pakistan including amoebiasis, malaria, leishmaniasis, ascariasis, cestodiasis, ankylostomiasis, giardiasis, hydatid disease and guinea worm disease
- Important viruses
- Sterilization and disinfection
- Immunization
- Morphology: identification of various shapes of bacteria and viruses under the microscope.
- Distribution, size, motility, reproduction and functions of bacteria and viruses.
- Nosocomial infections
- Use of investigation and procedures in laboratory
- Sputum, urine, stool, cerebrospinal fluid(CSF), pus, aspirates

6. Biostatistics & Research Methodology

- Introduction to Bio-Statistics
- Introduction to Bio- Medical Research
- Why research is important?
- What research to do?
 - Selecting a Field for Research
 - Drivers for Health Research
 - Participation in National and International Research
 - Participation in Pharmaceutical Company Research
 - Where do research ideas come from
 - Criteria for a good research topic
- Ethics in Health Research
- Writing a Scientific Paper
- Making a Scientific Presentation
- Searching the Literature

7. Behavioural Sciences

- Bio-psycho-social (BPS) model of health care
- Use of non-medicinal interventions in clinical practice
 - Communication skills
 - Counseling
 - Informational skills
- Crisis intervention/disaster management
- Conflict resolution
- Breaking bad news
- Medical ethics, professionalism and doctor-patient relationship

- Hippocratic oath
- Four pillars of medical ethics (autonomy, beneficence, non-maleficence and justice)
 - Informed consent and confidentiality
 - Ethical dilemmas in a doctor's life

- Delivery of culturally relevant care and cultural sensitivity
- Psychological aspects of health and disease
 - Psychological aspect of health
 - Psychological aspect of disease
 - Stress and its management
 - Psychological aspect of pain
 - Psychological aspect of aging

Part-II MD Radiology

Internal Medicine training for first two years starting from first day of enrollment. Resident should get exposure in the following organ and system competencies (listed below) while considering and practicing each system in terms of: -

- Medical ethics
- Professional values, student teachers relationship
- Orientation of in-patient, out-patients and pulmonary labs
- Approach to the patient
- History taking
- General physical examination
- Systemic examination
- Routine investigations
- Special investigations
- Diagnostic and therapeutic procedures

Course Contents:

1. Cardiovascular Medicine

Common and / or important Cardiac Problems:

- Arrhythmias
- Ischaemic Heart Disease: acute coronary syndromes, stable angina, atherosclerosis
- Heart Failure
- Hypertension – including investigation and management of accelerated hypertension
- Valvular Heart Disease
- Endocarditis
- Aortic dissection
- Syncope
- Dyslipidaemia

Clinical Science:

- Physiological principles of cardiac cycle and cardiac conduction
- Pharmacology of major drug classes: beta blockers, alpha blockers, ACE inhibitors, Angiotensin receptor blockers (ARBs), anti-platelet agents, thrombolysis, inotropes, calcium channel antagonists, potassium channel activators, diuretics, anti-arrhythmics, anticoagulants, lipid modifying drugs, nitrates, centrally acting anti-hypertensives

2. Dermatology;

Common and / or Important Problems:

- Cellulitis
- Cutaneous drug reactions
- Psoriasis and eczema
- Skin failure: eg erythryoderma, toxic epidermal necrolysis
- Urticaria and angio-oedema
- Cutaneous vasculitis

- Herpes zoster and Herpes Simplex infections
- Skin tumours
- Skin infestations
- Dermatomyositis
- Scleroderma
- Lymphoedema

Clinical Science:

- Pharmacology of major drug classes: topical steroids, immunosuppressants

3. Diabetes & Endocrine Medicine

Common and / or Important Diabetes Problems:

- Diabetic ketoacidosis
- Non-acidotic hyperosmolar coma / severe hyperglycaemia
- Hypoglycaemia
- Care of the acutely ill diabetic
- Peri-operative diabetes care

Common or Important Endocrine Problems:

- Hyper/Hypocalcaemia
- Adrenocortical insufficiency
- Hyper/Hyponatraemia
- Thyroid dysfunction
- Dyslipidaemia
- Endocrine emergencies: myxoedemic coma, thyrotoxic crisis, Addisonian crisis, hypopituitary coma, pheochromocytoma crisis

Clinical Science:

- Outline the function, receptors, action, secondary messengers and feedback of hormones
- Pharmacology of major drug classes: insulin, oral anti-diabetics, thyroxine, anti-thyroid drugs, corticosteroids, sex hormones, drugs affecting bone metabolism

4. Gastroenterology and Hepatology

Common or Important Problems:

- Peptic Ulceration and Gastritis
- Gastroenteritis
- GI malignancy (oesophagus, gastric, hepatic, pancreatic, colonic)
- Inflammatory bowel disease
- Iron Deficiency anaemia
- Acute GI bleeding
- Acute abdominal pathologies: pancreatitis, cholecystitis, appendicitis, leaking abdominal aortic aneurysm
- Functional disease: irritable bowel syndrome, non-ulcer dyspepsia
- Coeliac disease
- Alcoholic liver disease
- Alcohol withdrawal syndrome
- Acute liver dysfunction: jaundice, ascites, encephalopathy
- Liver cirrhosis
- Gastro-oesophageal reflux disease

- Nutrition: indications, contraindications and ethical dilemmas of nasogastric feeding and EG tubes, IV nutrition, re-feeding syndrome
- Gall stones
- Viral hepatitis
- Auto-immune liver disease
- Pancreatic cancer

Clinical Science:

- Laboratory markers of liver, pancreas and gut dysfunction
- Pharmacology of major drug classes: acid suppressants, anti-spasmodics, laxatives, anti-diarrhoea drugs, aminosalicylates, corticosteroids, immunosuppressants, infliximab, pancreatic enzyme supplements

5. Renal Medicine

Common and / or Important Problems:

- Acute renal failure
- Chronic renal failure
- Glomerulonephritis
- Nephrotic syndrome
- Urinary tract infections
- Urinary Calculus
- Renal replacement therapy
- Disturbances of potassium, acid/base, and fluid balance (and appropriate acute interventions)

Clinical Science:

- Measurement of renal function
- Metabolic perturbations of acute, chronic, and end-stage renal failure and associated treatments

6. Respiratory Medicine

Common and / or Important Respiratory Problems:

- COPD
- Asthma
- Pneumonia
- Pleural disease: Pneumothorax, pleural effusion, mesothelioma
- Lung Cancer
- Respiratory failure and methods of respiratory support
- Pulmonary embolism and DVT
- Tuberculosis
- Interstitial lung disease
- Bronchiectasis
- Respiratory failure and cor-pulmonale
- Pulmonary hypertension

Clinical Science:

- Principles of lung function measurement
- Pharmacology of major drug classes: bronchodilators, inhaled corticosteroids, leukotriene receptor antagonists, immunosuppressants

7. Allergy

Common or Important Allergy Problems

- Anaphylaxis

- Recognition of common allergies; introducing occupation associated allergies
- Food, drug, latex, insect venom allergies
- Urticaria and angioedema

Clinical Science

- Mechanisms of allergic sensitization: primary and secondary prophylaxis
- Natural history of allergic diseases
- Mechanisms of action of anti-allergic drugs and immunotherapy
- Principles and limitations of allergen avoidance

8. Haematology

Common and / or Important Problems:

- Bone marrow failure: causes and complications
- Bleeding disorders: DIC, haemophilia
- Thrombocytopenia
- Anticoagulation treatment: indications, monitoring, management of over-treatment
- Transfusion reactions
- Anaemia: iron deficient, megaloblastic, haemolysis, sickle cell,
- Thrombophilia: classification; indications and implications of screening
- Haemolytic disease
- Myelodysplastic syndromes
- Leukaemia
- Lymphoma
- Myeloma
- Myeloproliferative disease
- Inherited disorders of haemoglobin (sickle cell disease, thalassaemias)
- Amyloid

Clinical Science:

- Structure and function of blood, reticuloendothelial system, erythropoietic tissues

9. Immunology

Common or Important Problems:

- Anaphylaxis (see also 'Allergy')

Clinical Science:

- Innate and adaptive immune responses
- Principles of Hypersensitivity and transplantation

10. Infectious Diseases

Common and / or Important Problems:

- Fever of Unknown origin
- Complications of sepsis: shock, DIC, ARDS
- Common community acquired infection: LRTI, UTI, skin and soft tissue infections, viral exanthema, gastroenteritis
- CNS infection: meningitis, encephalitis, brain abscess
- HIV and AIDS including ethical considerations of testing
- Infections in immuno-compromised host
- Tuberculosis
- Anti-microbial drug monitoring

- Endocarditis
- Common genito-urinary conditions: non-gonococcal urethritis, gonorrhoea, syphilis

Clinical Science:

- Principles of vaccination
- Pharmacology of major drug classes: penicillins, cephalosporins, tetracyclines, aminoglycosides, macrolides, sulphonamides, quinolones, metronidazole, anti-tuberculous drugs, anti-fungals, anti-malarials, anti-helminthics, anti-virals

11. Medicine in the Elderly

Common or Important Problems:

- Deterioration in mobility
- Acute confusion
- Stroke and transient ischaemic attack
- Falls
- Age related pharmacology
- Hypothermia
- Continence problems
- Dementia
- Movement disorders including Parkinson's disease
- Depression in the elderly
- Osteoporosis
- Malnutrition
- Osteoarthritis

Clinical Science:

- Effects of ageing on the major organ systems
- Normal laboratory values in older people

12. Musculoskeletal System

Common or Important Problems:

- Septic arthritis
- Rheumatoid arthritis
- Osteoarthritis
- Seronegative arthritides
- Crystal arthropathy
- Osteoporosis – risk factors, and primary and secondary prevention of complications of osteoporosis
- Polymyalgia and temporal arteritis
- Acute connective tissue disease: systemic lupus erythematosus, scleroderma, poly- and dermatomyositis, Sjogren's syndrome, vasculitides

Clinical Science:

- Pharmacology of major drug classes: NSAIDS, corticosteroids, immunosuppressants, colchicines, allopurinol, bisphosphonates

13. Neurology

Common or Important Problems:

- Acute new headache
- Stroke and transient ischaemic attack

- Subarachnoid haemorrhage
- Coma
- Central Nervous System infection: encephalitis, meningitis, brain abscess
- Raised intra-cranial pressure
- Sudden loss of consciousness including seizure disorders (see also above syncope etc)
- Acute paralysis: Guillian-Barré, myasthenia gravis, spinal cord lesion
- Multiple sclerosis
- Motor neuron disease

Clinical Science:

- Pathophysiology of pain, speech and language
- Pharmacology of major drug classes: anxiolytics, hypnotics inc. benzodiazepines, antiepileptics, anti-Parkinson's drugs (anti-muscarinics, dopaminergics)

14. Psychiatry

Common and /or Important Problems:

- Suicide and parasuicide
- Acute psychosis
- Substance dependence
- Depression

Clinical Science:

- Principles of substance addiction, and tolerance
- Pharmacology of major drug classes: anti-psychotics, lithium, tricyclic antidepressants, mono-amine oxidase inhibitors, SSRIs, venlafaxine, donepezil, drugs used in treatment of addiction (bupropion, disulpharam, acamprosate, methadone)

15. Cancer and Palliative Care

Common or Important Oncology Problems:

- Hypercalcaemia
- SVC obstruction
- Spinal cord compression
- Neutropenic sepsis
- Common cancers (presentation, diagnosis, staging, treatment principles): lung, bowel, breast, prostate, stomach, oesophagus, bladder)

Common or Important Palliative Care Problems:

- Pain: appropriate use, analgesic ladder, side effects, role of radiotherapy
- Constipation
- Breathlessness
- Nausea and vomiting
- Anxiety and depressed mood

Clinical Science:

- Principles of oncogenesis and metastatic spread
- Apoptosis
- Principles of staging
- Principles of screening
- Pharmacology of major drug classes in palliative care: anti-emetics, opioids, NSAIDs, agents for neuropathic pain, bisphosphonates, laxatives, anxiolytics

16. Clinical Genetics

Common and / or Important problems:

- Down's syndrome
- Turner's syndrome
- Huntington's disease
- Haemochromatosis
- Marfan's syndrome
- Klinefelter's syndrome
- Familial cancer syndromes
- Familial cardiovascular disorders

Clinical Science:

- Structure and function of human cells, chromosomes, DNA, RNA and cellular proteins
- Principles of inheritance: Mendelian, sex-linked, mitochondrial
- Principles of pharmacogenetics
- Principles of mutation, polymorphism, trinucleotide repeat disorders
- Principles of genetic testing including metabolite assays, clinical examination and analysis of nucleic acid (e.g. PCR)

17. Clinical Pharmacology

Common and / or Important problems:

- Corticosteroid treatment: short and long-term complications, bone protection, safe withdrawal of corticosteroids, patient counseling regarding avoid adrenal crises
- Specific treatment of poisoning with:
 - Aspirin,
 - Paracetamol
 - Tricyclic anti-depressants
 - Beta-blockers
 - Carbon monoxide
 - Opiates
 - Digoxin
 - Benzodiazepines

Clinical Science:

- Drug actions at receptor and intracellular level
- Principles of absorption, distribution, metabolism and excretion of drugs
- Effects of genetics on drug metabolism
- Pharmacological principles of drug interaction
- Outline the effects on drug metabolism of: pregnancy, age, renal and liver impairment

Investigation Competencies

Outline the indications for, and interpret the following investigations:

- Basic blood biochemistry: urea and electrolytes, liver function tests, bone biochemistry, glucose, magnesium
- Cardiac biomarkers and cardiac-specific troponin
- Thyroid function tests
- Inflammatory markers: CRP / ESR
- Arterial Blood Gas analysis
- Lipid profile
- Full blood count
- Coagulation studies
- Blood film report
- Blood / Sputum / urine culture
- Fluid analysis: pleural, cerebro-spinal fluid, ascitic
- Urinalysis and urine microscopy
- Auto-antibodies

Procedural Competencies

- The trainee is expected to be competent in performing the following procedures by the end of core training. The trainee must be able to outline the indications for these interventions. For invasive procedures, the trainee must recognize the indications for the procedure, the importance of valid consent, aseptic technique, safe use of local anaesthetics and minimization of patient discomfort.
- Venepuncture
- Cannula insertion, including large bore
- Arterial blood gas sampling
- Lumbar Puncture
- Pleural tap and aspiration
- Intercostal drain insertion: Seldinger technique
- Ascitic tap
- Abdominal paracentesis
- Central venous cannulation
- Initial airway protection: chin lift, Guedel airway, nasal airway, laryngeal mask
- Basic and, subsequently, advanced cardiorespiratory resuscitation
- Bronchoscopy
- Cytology: pleural fluid, ascitic fluid, cerebro-spinal fluid, sputum
- DC cardioversion
- Urethral catheterization
- Nasogastric tube placement and checking

Part-III Specialty training in Radiology

Specific Program Content

1. Specialized training in Radiology
2. Compulsory rotations
3. Research & thesis writing
4. Maintaining of Log-book

1. Specialized training in Radiology

First Year:

- The Physical Basis of Radiology
- General Radiography
- Special Investigations
- Contrast Media and Pharmacological Aids to Radiology
- Radiological Emergencies

Second Year:

- Radiological manifestations of disease of the body systems with all diagnostic modalities

Third Year:

- Radiology in relation to clinical problems

Course Outlines:

PHYSICS:

Introduction

- General properties of radiation and matter
- Fundamentals of nuclear physics and radioactivity
- Structure of the atom
- Definition of atomic number, mass number, nuclide, isotope and electron volt

Electromagnetic radiation

- Spectrum
- General properties, wave and quantum theories

Radioactivity

- Exponential decay
- Specific activity
- Physical, biological and effective half- life
- Properties of radioactive materials
- Radioactive decay schemes
- Units of activity
- Half life
- Properties of radiations - alpha, beta, gamma
- Basic knowledge of reactors

Production of X-rays

- Principles
- Essential components of x - ray tubes
- Continuous spectra
- Characteristic radiation
- Factors' controlling the nature of x - ray emission

Tube rating

- Stationary and rotating anodes
- Heat capacity
- Methods of cooling
- Effect of focal spot size
- Exposure time
- Voltage wave form
- Multiple exposures
- Failing load operation,
- Exposure timers
- Automatic exposure control

Interaction

- Interaction of X - rays and gamma rays with matter and their effects on the irradiated materials
- Interaction processes and their relative importance for various materials and at different radiation energies
- Attenuation, absorption, scatter, exponential law, attenuation coefficients, half- value thickness.
- Homogeneous and heterogeneous radiation contrast
- Effects: heat, excitation, ionization, range of secondary electrons, chemical, photographic, fluorescent, phosphorescent, thermo luminescent

Measurement of X and gamma rays

- Quantity: ionization, TLD, and photographic dosimetry
- Exposure: absorbed dose, and the relationship between them and radiation energy
- Exposure and exposure rate meters
- Geiger -Muller and scintillation detectors
- Radionuclide detection measurement
- Counting statistics.
- Quality: radiation, beam energy, mean, effective and peak energy, half value thickness and filtration

Interaction of X rays with the patient

- Attenuation in various body tissues, high voltage radiography mammography, enhancement by contrast media.
- Geometric factors: magnification, distortion, positioning geometric grid movement unsharpness, obliteration, micro-radiography, beam limitation, focal spot size

The radiological image

Image quality: description and meaning, resolution, noise, definition and contrast

The image receptor

- Intensifying screens: construction, physical principles and applications

- X ray film : structure and operation
- Characteristic curve
- Density
- Speed
- Contrast
- Latitude
- Processing and the dark room
- Automatic x ray film processor
- Functions
- Principles
- Construction
- Advantages and disadvantages
- Handling and storage
- Labeling and identification
- Design and care of cassettes
- Display and perception of the radiographic image
- Image intensities: construction, operation, brightness gain, optical couplings, tv systems.
- Recording media': 35 mm cine film, 100 mm or 60mm spot film, video tape /disc
- Electrostatic processes: xeroradiography.

Scattered radiation

- Effect and control scatter
- Beam limitation
- Compression
- grid construction and operation
- Radiographic subtraction techniques
- Tomography (conventional) : principles, layer thickness
- Digital fluoroscopic systems: data collection, storage and display including digital subtraction techniques, implication of digital storage media

Radiation Protection

- Biological effects of radiation, risks of somatic and genetic effects. Objectives of radiation protection.
- Recommendations of I.C.R.P
- Concepts of dose equivalent quality factor, detriment limitation
- Annual limits of intake
- Radio logical protection regulations
- Relevant codes of practice
- Dose control by design and by operation in diagnostic X ray procedures and nuclear medicine for both staff and patients.
- Doses received in diagnostic procedures
- Population, somatic and genetic dose
- Risk estimates
- Benefits
- Personnel monitoring.

Quality assurance

- Methods of assessing image quality and their relationship to specifications of system performance
- Methods of monitoring equipment performance

General Radiology:

- The photographic process
- Characteristics of x-ray film
- Fluorescent and intensifying screens
- X-ray exposure factors
- Definition and image quality
- Camera and lenses
- The x-ray dark room
- Film labeling and identification
- Standard radiographic projection relating to the regions outlined
- In radiological anatomy syllabus.
- Positioning of patient and patient radiation protection.
- Correction of errors in centering and exposure.
- Soft tissue radiography — mammography.
- Magnification radiographic techniques.
- Localization techniques particularly foreign bodies in eye
- Tomography — general principles.
- Contrast investigations including barium examination
- Radioisotope examination
- Ultrasound examination
- Computed tomography
- Radiological investigations are:
 - Indications and contra- indications
 - Preparation required
 - Apparatus e.g a. Fluoroscopic equipments
 - Choice of ultrasound transducer, etc.
 - Contrast media and pharmacological aids to radiology
 - Alternative approach
 - Complications of radiological procedures
 - Chemical composition and classification of contrast media
 - Mode of administration and its clinical uses
 - Routes of elimination
 - Relative advantage of different types of media
 - Physiological responses and adverse reactions to contrast-media and their treatment.
 - Drugs commonly used in radiological practice
 - Preparations of the bowel, purgatives and colonic activators
 - Sedation before radiological procedures
 - Prophylaxis and treatment of reactions to radiological procedures other than to contrast, e.g. in phaeochromocytoma
 - Drugs modifying the behavior of the gastrointestinal tract during investigations

CLINICAL RADIOLOGY

CHEST RADIOLOGY:

- The chest wall, diaphragm and pleura
- Collapse and consolidation
- Inflammatory diseases of the lung

- Chronic bronchitis and emphysema
- Occupational diseases
- Tumour of the lung
- pulmonary disease of unknown aetiology
- Pulmonary disease with an immunological basis
- Pulmonary collagen diseases
- Mediastinal lesions
- Chest trauma
- Post operative chest
- Intensive care chest

CARDIOVASCULAR RADIOLOGY

- The pericardium
- The pulmonary circulation
- Acquired heart disease
- Congenital heart disease
- Vascular disease:
 - Arterial
 - Venous
 - Lymphatic

MUSCULOSKELETAL RADIOLOGY:

- Congenital skeletal anomalies
- Dysplasia of bone
- Chromosomal disorders
- Periosteal reaction
- Bone and joint infection
- Avascular necrosis of bone
- Diseases of joints
- Tumours and tumour-like lesions of bone
- Disorders of lymphoreticular system and other haemopoietic disorders
- Skeletal disorders of metabolic and endocrine origin
- Skeletal trauma
- Miscellaneous bone lesion, e.g., Paget's disease, etc.

GASTROINTESTINAL RADIOLOGY:

- The salivary glands
- Pharynx and oesophagus
- The stomach and duodenum
- The small bowel
- The colon
- The acute abdomen
- The biliary tract
- The liver, spleen and pancreas
- The adrenal glands

GENITOURINARY RADIOLOGY:

- Congenital lesion
- Cystic disease of the kidney
- Tumour of the kidney

- Renal calculi and nephrocalcinosis
- Urinary tract infection
- Renal vascular disease
- Disorders of the ureters, bladder, prostate and urethra
- Marginal and disease of scrotal content
- Gynecologic radiology
- Obstetric radiology

BREAST IMAGING:

- Requirements and standards for Mammography
- Mammographic Interpretation
- Pathologic and mammographic appearance and clinical significance of benign breast conditions
- Atypical ductal hyperplasia (ADH), lobular neoplasia (LCIS) and other histologic risk factors.
- Pathologic and mammographic appearance, clinical features significance, and prognosis of malignant breast disorders
- Mammography quality control
- Mammographic appearance of artifacts such as roller marks, grid lines, motion unsharpness, noise, dust, poor screen-film contact, pickoff and scratches.
- Breast Ultrasound
- Need for correlation with mammography.
- Ultrasound guided core biopsy and/or FNA. Importance of correlation of pathologic, mammographic and sonographic findings and history in determining patient management.
- Galactography.

NEURORADIOLOGY:

- The normal skull
- Vascular, infectious, inflammatory, space occupying lesions of the cranial cavity
- Disease of the brain
- Vascular disease of the brain
- Disease of the spine

HEAD AND NECK RADIOLOGY

- Imaging Modalities (including current indications, radiation dose, use of intravenous contrast)
- Plain film radiography, including barium swallow
- Percutaneous and transvenous or transarterial interventions
- Biopsy; Ultrasound, CT or MR guided
- The petrous temporal bone
- Temporomandibular joint
- Nose and Paranasal Sinuses
- Midface
- The orbit and eye
- Esophagus
- Sialography
- Teeth and jaws

- Dentscan - technique, anatomy, implant technology
- Oral cavity - tongue, floor of mouth, retromolar trigone
- The pharynx and larynx

EMERGENCY RADIOLOGY:

- Evaluation of the emergency radiographic examinations
- Medicolegal (MLC) procedures
- Radiography in emergency patients and review and interpretation of radiographs
- Indications for and limitations of the common emergency imaging procedures
- Findings, diagnosis and other relevant information to the emergency room physician
- Special imaging procedures needed in emergency room e.g.; barium studies, excretory urography, CT, ultrasound, Doppler and angiography
- Investigations (both conventional and newer methods), interpretation of the results and diagnosis/ differential diagnosis based on the clinical and biochemical results
- Common procedures performed in the department (e.g.; thyroid, kidney, bone, cardiac scans), understand the principle underlying the procedure and the basis for using a particular isotope in an investigation

PAEDIATRIC RADIOLOGY:

- Airways on chest x-ray of the infant or older child
- Abnormalities associated with congenital heart disease on the chest radiograph of the infant/older child
- Normal vs. abnormal skeletal structures (esp. extremities on a bone survey)
- Proper procedure for fluoroscopy of an infant/older child
- Bone age on the basis of radiographic findings
- Positioning techniques and technical factors leading to optimum chest, GU radiographs of the infant and older child
- Bone age on the basis of radiographic findings
- Chest radiology and congenital diseases of the heart
- Normal vs. abnormal findings on skeletal, skull (and contents), and spine radiographs

VASCULAR AND INTERVENTIONAL RADIOLOGY:

- Seldinger technique to obtain non-selective arterial access in normal and diseased arteries
- Seldinger technique to obtain non-selective venous access
- Selective and super-selective arterial and venous catheterizations
- Appropriate injection and filming procedures for all selective and non-selective vascular diagnostic examinations
- Basic and advanced guide wire exchange techniques
- Local anesthesia
- Conscious sedation
- Vascular and nonvascular procedures for diagnostic and therapeutic purposes

- Non-functioning or poorly functioning vascular access devices and drains
- Risks, benefits, indications, and contraindications of VIR procedures
- Drugs used in VIR procedures including analgesics, anti-anxiety agents, vasodilator drugs, thrombolytic agents and antibiotics
- Basics of iodinated contrast, including alternatives to standard agents
- Common and uncommon vascular normal variants
- Pathophysiology of all diseases particularly peripheral vascular disease, renovascular hypertension, carotid occlusive disease, venous thromboembolic disease, biliary and genitourinary obstruction and abscesses
- Indications, basic technique, tools, results, complications and outcomes of percutaneous transluminal angioplasty of arteries and veins
- Use of vascular stents including results
- Basic principles and utility of vascular ultrasound
- Basic and advanced principles of thrombolysis
- Percutaneous biliary and urinary drainage, including strategies for internal drainage using stents
- TIPS procedure, including indications, contraindications and results
- Thrombolysis and PTA in dialysis access
- Principles of venous access including PICCs, tunneled catheters and dialysis catheters
- Basic principles of MRA, CTA, and vascular ultrasound Discuss indications for and contraindications to inferior vena caval filter placement, as well as advantages and disadvantages of various available filters

RADIATION PROTECTION:

- X-ray tube and imaging
- General Radiography X-ray facility
- Fluoroscopy X-ray equipment
- Interventional radiology
- Computed tomography (CT)
- Mammography
- Pediatric radiology
- Dental practice
- Radiation Protection Programme in Diagnostic Radiology
- Organizational structure of radiation protection in a typical diagnostic radiology department
- Persons and groups involved in a radiation protection program
- Legal Person(Licensee/Registrant)
- Radiation Protection Committee
- Inspections and audits
- Design, layout and shielding in a diagnostic and interventional radiology department
- Radiation protection of staff
- Working environment
- Personal safety and monitoring
- Radiation protection of patients
- Safe design criteria for equipment
- Risks of diagnostic and interventional radiology treatment for the patient (side effects)

- Techniques to reduce dose
- Diagnostic reference levels (Guidance levels)
- Persons supporting the patient
- Reporting of incidents and accidents
- Radiation protection of the public
- Review of facility design
- Designation of areas
- Documentation of procedures and record keeping
- ISO and IEC Standards
- Treatment documentation
- Log books
- Access to information
- Electronic storage devices
- Audits
- Accidents and incidents
- Potential exposures in the different stages of the installation, acceptance and operation
- Case Studies of accidental and incidental exposures
- Reporting and dissemination of information
- The need for training and drills
- Education and Training
- Updating of education and training
- Accreditation of training and courses
- Quality management
- Quality assurance and quality control
- Concepts of QA and its application to radiation protection in diagnostic and interventional radiology
- Patient related QA
- Equipment selection, installation and commissioning
- Maintenance
- Organization and administration – the responsibility of the user
- The role of different professions
- External checks
- Practical sessions will cover exercises related to “Authorization for the possession

NUCLEAR RADIOLOGY:

- Clinical indications, general procedures (including radiopharmaceutical and dose), and scintigraphic findings in:
 - Pulmonary (emboli) ventilation and perfusion imaging
 - Hepatobiliary imaging and functional studies
 - GI tract imaging and functional studies
 - GI blood loss imaging
 - Bone imaging
 - Renal and urinary tract studies
 - Thyroid imaging and functional studies
 - Brain imaging and functional studies
 - Tumor and abscess imaging

- Basic physical principles of nuclear medicine imaging and instrumentation

- Isotopes (including physical and chemical properties) that are used routinely in the compounding of radiopharmaceuticals for nuclear radiology procedures
- Indications for isotopes used for therapeutic purposes
- Normal and abnormal findings on all imaging and functional studies, other than nuclear cardiology studies
- Nuclear studies, including indications, pathologies, protocols, correlative studies, radiopharmaceuticals used for each study, and various parameters that might interfere with the results of the procedure
- Clinical indications, general procedures, and findings in:
 - Myocardial perfusion studies (rest and stress)
 - Myocardial infarct imaging
 - Multigated acquisition imaging and function studies
- Radiopharmaceuticals used in cardiac nuclear studies, including the methods of red cell labeling, patient dosages, and physical properties of the isotopes.
- Patient conditions and patient monitoring requirements, particularly in relation to exercise and drug stress studies
- Range of invasive and noninvasive tests, test characteristics, and the prognostic value of tests used to evaluate cardiac disease
- Radiopharmaceuticals used in Nuclear Radiology studies:
 - Production of isotopes
 - Physical properties of isotopes
 - Generation elution and quality control
 - Compounding of radiopharmaceuticals
 - Radiochemical quality control
 - Biodistribution and mechanisms of localization
- Calculation of patient doses, using information related to decay factors, volume concentration, and patient parameters
- Procedures and rationale for instrument quality control in nuclear medicine
- Rules and regulations that apply to the practice of nuclear radiology

2. Compulsory rotations in the relevant fields

Clinical training experiences are described below. The frame work for core training will consist of the rotations in:

- Nuclear medicine ----- 6 weeks
- MRI ---- 8 weeks
- Children's' Hospital Lahore ----4 weeks
- Neuro-radiology----- 4 weeks
- Oncology/ Radiotherapy----- 2 weeks

The educational objective of rotations is to give appropriate experience in;

System - based subspecialties:

- Breast imaging
- Cardiac imaging
- Gastrointestinal imaging
- Head and neck imaging including ear, nose and throat
- Muscular skeleton and trauma imaging

- Neuro-radiology
- Obstetric imaging
- Gynaecological imaging
- Thoracic imaging
- Uro-radiology
- Vascular imaging

Technique- based subspecialties:

- C.T., MRI, US, Interventional Radiology and Radionuclide radiology

Disease- based subspecialty:

- Oncological imaging

Age - based subspecialty:

- Paediatric imaging

3. Research/ Thesis Writing

Total of one year will be allocated for work on a research project with thesis writing. Project must be completed and thesis be submitted before the end of training. Research can be done as one block in 5th year of training or it can be stretched over five years of training in the form of regular periodic rotations during the course as long as total research time is equivalent to one calendar year.

Research Experience

The active research component program must ensure meaningful, supervised research experience with appropriate protected time for each resident while maintaining the essential clinical experience. Recent productivity by the program faculty and by the residents will be required, including publications in peer-reviewed journals. Residents must learn the design and interpretation of research studies, responsible use of informed consent, and research methodology and

interpretation of data. The program must provide instruction in the critical assessment of new therapies and of the surgical literature. Residents should be advised and supervised by qualified staff members in the conduct of research.

Clinical Research

Each resident will participate in at least one clinical research study to become familiar with:

1. Research design
2. Research involving human subjects including informed consent and operations of the Institutional Review Board and ethics of human experimentation
3. Data collection and data analysis
4. Research ethics and honesty
5. Peer review process

This usually is done during the consultation and outpatient clinic rotations.

Case Studies or Literature Reviews

Each resident will write, and submit for publication in a peer-reviewed journal, a case study or literature review on a topic of his/her choice.

Laboratory Research

Bench Research

Participation in laboratory research is at the option of the resident and may be arranged through any faculty member of the Division. When appropriate, the research may be done at other institutions.

Research involving animals

Each resident participating in research involving animals is required to:

1. Become familiar with the pertinent Rules and Regulations of the University of Health Sciences Lahore i.e. those relating to "Health and Medical Surveillance Program for Laboratory Animal Care Personnel" and "Care and Use of Vertebrate Animals as Subjects in Research and Teaching"
2. Read the "Guide for the Care and Use of Laboratory Animals"
3. View the videotape of the symposium on Humane Animal Care

Research involving Radioactivity

Each resident participating in research involving radioactive materials is required to

1. Attend a Radiation Review session
2. Work with an Authorized User and receive appropriate instruction from him/her.

METHODS OF INSTRUCTION/COURSE CONDUCTION

As a policy, active participation of students at all levels will be encouraged.

Following teaching modalities will be employed:

1. Lectures
2. Seminar Presentation and Journal Club Presentations
3. Group Discussions
4. Grand Rounds
5. Clinico-pathological Conferences
6. SEQ as assignments on the content areas
7. Skill teaching in ICU, emergency and ward settings
8. Attend genetic clinics and rounds for at least one month.
9. Attend sessions of genetic counseling
10. Self study, assignments and use of internet
11. Bedside teaching rounds in ward
12. OPD & Follow up clinics
13. Long and short case presentations

In addition to the conventional teaching methodologies interactive strategies like conferences will also be introduced to improve both communication and clinical skills in the upcoming consultants. Conferences must be conducted regularly as scheduled and attended by all available faculty and residents. Residents must actively request autopsies and participate in formal review of gross and microscopic pathological material from patients who have been under their care. It is essential that residents participate in planning and in conducting conferences.

1. Clinical Case Conference

Each resident will be responsible for at least one clinical case conference each month. The cases discussed may be those seen on either the consultation or clinic service or during rotations in specialty areas. The resident, with the advice of the Attending Physician on the Consultation Service, will prepare and present the case(s) and review the relevant literature.

2. Monthly Student Meetings

Each affiliated medical college approved to conduct training for MD Radiology will provide a room for student meetings/discussions such as:

- a. Journal Club Meeting
- b. Core Curriculum Meetings
- c. Skill Development

a. Journal Club Meeting

A resident will be assigned to present, in depth, a research article or topic of his/her choice of actual or potential broad interest and/or application. Two hours per month should be allocated to discussion of any current articles or topics introduced by any participant. Faculty or outside researchers will be invited to present outlines or results of current research activities. The article should be critically evaluated and its applicable results should be highlighted, which can be incorporated in clinical practice. Record of all such articles should be maintained in the relevant department.

b. Core Curriculum Meetings

All the core topics of Radiology should be thoroughly discussed during these sessions. The duration of each session should be at least two hours once a month. It should be chaired by the chief resident (elected by the residents of the relevant discipline). Each resident should be given an opportunity to brainstorm all topics included in the course and to generate new ideas regarding the improvement of the course structure

c. Skill Development

Two hours twice a month should be assigned for learning and practicing clinical skills.

List of skills to be learnt during these sessions is as follows:

1. Residents must develop a comprehensive understanding of the indications, contraindications, limitations, complications, techniques, and interpretation of results of those technical procedures integral to the discipline (mentioned in pg. 10).
2. Residents must acquire knowledge of and skill in educating patients about the technique, rationale and ramifications of procedures and in obtaining procedure-specific informed consent. Faculty supervision of residents in their performance is required, and each resident's experience in such procedures must be documented by the program director.
3. Residents must have instruction in the evaluation of medical literature, clinical epidemiology, clinical study design, relative and absolute risks of disease, medical statistics and medical decision-making.
4. Training must include cultural, social, family, behavioral and economic issues, such as confidentiality of information, indications for life support systems, and allocation of limited resources.
5. Residents must be taught the social and economic impact of their decisions on patients, the primary care physician and society. This can be achieved by attending the bioethics lectures and becoming familiar with Project Professionalism Manual such as that of the American Board of Internal Medicine.

6. Residents should have instruction and experience with patient counseling skills and community education.
7. This training should emphasize effective communication techniques for diverse populations, as well as organizational resources useful for patient and community education.
8. Residents may attend the series of lectures on Nuclear Medicine procedures (radionuclide scanning and localization tests and therapy) presented to the Radiology residents.
10. Residents should have experience in the performance of clinical laboratory and radionuclide studies and basic laboratory techniques, including quality control, quality assurance and proficiency standards.
11. Each resident will observe and participate in each of the related procedures (pg.12 & 13), preferably done on patients firstly under supervision and then independently

3. Annual Grand Meeting

Once a year all residents enrolled for MD Radiology should be invited to the annual meeting at UHS Lahore.

One full day will be allocated to this event. All the chief residents from affiliated institutes will present their annual reports. Issues and concerns related to their relevant courses will be discussed. Feedback should be collected and suggestions should be sought in order to involve residents in decision making.

The research work done by residents and their literary work may be displayed.

In the evening an informal gathering and dinner can be arranged. This will help in creating a sense of belonging and ownership among students and the faculty.

LOG BOOK

The residents must maintain a log book and get it signed regularly by the supervisor. A complete and duly certified log book should be part of the requirement to sit for MD examination. Log book should include adequate number of diagnostic and therapeutic procedures observed and performed, the indications for the procedure, any complications and the interpretation of the results, routine and emergency management of patients, case presentations in CPCs, journal club meetings and literature review.

Proposed Format of Log Book is as follows:

Candidate's Name: -----

Supervisor -----

Roll No. -----

The procedures shall be entered in the log book as per format

Residents should become proficient in performing the related procedures (pg.12 & 13). After observing the technique, they will be observed while performing the procedure and, when deemed competent by the supervising physician, will perform it independently. They will be responsible for obtaining informed consent, performing the procedure, reviewing the results with the pathologist and the attending physician and informing the patient and, where appropriate, the referring physician of the results.

Procedures Performed

Sr.#	Date	Name of Patient, Age, Sex & Admission No.	Diagnosis	Procedure Performed	Supervisor's Signature
1					
2					
3					
4					

Radiological Emergencies Handled

Sr. #	Date	Name of Patient, Age, Sex & Admission No.	Diagnosis	Procedure/ Management	Supervisor's Signature
1					
2					
3					
4					

Case Presented

Sr.#	Date	Name of Patient, Age, Sex & Admission No.	Case Presented	Supervisor's Signature
1				
2				
3				
4				

Seminar/Journal Club Presentation

Sr.#	Date	Topic	Supervisor's Signature
1			
2			
3			
4			

Evaluation Record

(Excellent, Good, Adequate, Inadequate, Poor)

At the end of the rotation, each faculty member will provide an evaluation of the clinical performance of the fellow.

Sr.#	Date	Method of Evaluation (Oral, Practical, Theory)	Rating	Supervisor's Signature
1				
2				

EVALUATION & ASSESSMENT STRATEGIES

Assessment

It will consist of action and professional growth oriented ***student-centered integrated assessment*** with an additional component of ***informal internal assessment, formative assessment*** and measurement-based ***summative assessment***.

Student-Centered Integrated Assessment

It views students as decision-makers in need of information about their own performance. Integrated Assessment is meant to give students responsibility for deciding what to evaluate, as well as how to evaluate it, encourages students to **'own'** the evaluation and to use it as a basis for self-improvement. Therefore, it tends to be growth-oriented, student-controlled, collaborative, dynamic, contextualized, informal, flexible and action-oriented.

In the proposed curriculum, it will be based on:

- Self Assessment by the student
- Peer Assessment
- Informal Internal Assessment by the Faculty

Self Assessment by the Student

Each student will be provided with a pre-designed self-assessment form to evaluate his/her level of comfort and competency in dealing with different relevant clinical situations. It will be the responsibility of the student to correctly identify his/her areas of weakness and to take appropriate measures to address those weaknesses.

Peer Assessment

The students will also be expected to evaluate their peers after the monthly small group meeting. These should be followed by a constructive feedback according to the prescribed guidelines and should be non-judgmental in nature. This will enable students to become good mentors in future.

Informal Internal Assessment by the Faculty

There will be no formal allocation of marks for the component of Internal Assessment so that students are willing to confront their weaknesses rather than hiding them from their instructors.

It will include:

- a. Punctuality
- b. Ward work
- c. Monthly assessment (written tests to indicate particular areas of weaknesses)
- d. Participation in interactive sessions

Formative Assessment

Will help to improve the existing instructional methods and the curriculum in use

Feedback to the faculty by the students:

After every three months students will be providing a written feedback regarding their course components and teaching methods. This will help to identify strengths and weaknesses of the relevant course, faculty members and to ascertain areas for further improvement.

Summative Assessment

It will be carried out at the end of the programme to empirically evaluate **cognitive, psychomotor** and **affective domains** in order to award degrees for successful completion of courses.

MD RADIOLOGY EXAMINATIONS

Part-I MD Radiology

Total Marks: 200

All candidates admitted in MD Radiology course shall appear in Part I examination at the end of first calendar year.

Components of Part-I Examination:

Paper-I, 100 MCQs (single best, having one mark each)	100 Marks
Paper-II, 10 SEQs (having 10 marks each)	100 Marks

Topics included in paper:

	Paper-I	Paper-II
1. Anatomy, Histology and Embryology	(20 MCQs)	(2 SEQs)
2. Physiology	(20 MCQs)	(2 SEQs)
3. Pathology	(20 MCQs)	(2 SEQs)
4. Biochemistry	(15 MCQs)	(1 SEQ)
5. Pharmacology	(10 MCQs)	(1 SEQ)
6. Behavioural Sciences	(10 MCQs)	(1 SEQ)
7. Biostatistics & Research Methodology	(05 MCQs)	(1 SEQ)

Part-II MD Radiology

Total Marks: 430

All candidates admitted in MD Radiology course shall appear in Part II examination at the end of 2nd calendar year.

There shall be two written papers of 100 marks each, Oral & practical/clinical examination of 150 marks and log book assessment of 80 marks.

Topics included in paper 1

Principles of internal medicine including;

1. Pulmonary Medicine	(10 MCQs)
2. Allergy and Immunology	(10 MCQs)
3. Cardiovascular Illness	(10 MCQs)
4. Endocrinology and Metabolism	(10 MCQs)
5. Ophthalmology & Otolaryngology	(05 MCQs)
6. Infectious Disease	(05 MCQs)

Topics included in paper 2

Principles of internal medicine including;

- | | |
|----------------------------------|-----------|
| 1. Nephrology | (10 MCQs) |
| 2. Neurology | (10 MCQs) |
| 3. Gastroenterology & Hepatology | (10 MCQs) |
| 4. Hematology & Oncology | (10 MCQs) |
| 5. Dermatology | (05 MCQs) |
| 6. Rheumatology | (05 MCQs) |

Components of Part II Examination**Theory:**

Paper 1:	<u>100 Marks</u>	3 Hours
10 SEQs (No Choice; 05 marks each)	50 Marks	
50 MCQs	50 Marks	
Paper 2:	<u>100 Marks</u>	3 Hours
10 SEQs (No Choice; 05 marks each)	50 Marks	
50 MCQs	50 Marks	

The candidates, who pass in theory papers, will be eligible to appear in the structured viva voce.

Oral & practical/clinical examination shall be held in basic clinical techniques relevant to internal medicine.

OSCE **50 Marks**

10 stations each carrying 05 marks of 10 minutes duration; each evaluating performance based assessment with five of them interactive

Clinical **100 Marks**

Four short cases (15 marks each)	60 Marks
One long case:	40 Marks

Log Book **80 Marks**

Part-III MD Radiology
Total Marks: 920

All candidates admitted in MD course shall appear in Part-III examination at the end of structured training programme (end of 5th calendar year and after clearing Part I & II examinations).

There shall be two written papers of 150 marks each, practical/ clinical examination of 300 marks, log book assessment of 120 marks and thesis examination of 200 marks.

Topics included in paper 1

- | | |
|---|-----------|
| 1. Physics | (05 MCQs) |
| 2. General Radiology | (15 MCQs) |
| 3. Breast Imaging | (10 MCQs) |
| 4. Chest & Cardiovascular Radiology | (15 MCQs) |
| 5. Vascular and interventional Radiology | (10 MCQs) |
| 6. Nuclear radiology & Radiation Protection | (10 MCQs) |
| 7. Emergency radiology | (10 MCQs) |

Topics included in paper 2

- | | |
|-------------------------------|-----------|
| 1. Musculoskeletal Radiology | (15 MCQs) |
| 2. Genitourinary Radiology | (15 MCQs) |
| 3. Gastrointestinal Radiology | (10 MCQs) |
| 4. Neuroradiology | (10 MCQs) |
| 5. Head and neck Radiology | (10 MCQs) |
| 6. Paediatric Radiology | (15 MCQs) |

Components of Part III Examination

Theory

Paper I	<u>150 Marks</u>	3 Hours
15 SEQs (No Choice)	75 Marks	
75 MCQs	75 Marks	
 Paper II	 <u>150 Marks</u>	 3 Hours
15 SEQs (No Choice)	75 Marks	
75 MCQs	75 Marks	

The candidates, who pass in theory papers, will be eligible to appear in the clinical & viva voce.

OSCE/ Viva

100 Marks

10 stations each carrying 10 marks of 10 minutes duration; each evaluating performance based assessment with five of them interactive

Clinical

200 Marks

Four short cases (each 25 marks)

100 Marks

One long case:

100 Marks

Log Book

120 Marks

Thesis Examination

200 Marks

All candidates admitted in MD courses shall appear in Part-III thesis examination at the end of 5th calendar year of the MD programme and not later than 8th calendar year of enrolment. The examination shall include thesis evaluation with defense.

RECOMMENDED BOOKS

1. Ryan S. ***Anatomy for Diagnostic Imaging***. 2nd ed. Saunders; 2004 .
2. Bushong S. C. ***Radiological Science for Technologists Physics, Biology and Protection***. 8th ed. Mosby; 2004.
3. Chapman S. and Nakienly R. ***A Guide to Radiological Procedures***. 4th ed. Baillier Tindall, Jaypee Brothers; 2001.
4. Bhargava S. K. ***Radiological Procedures***. 1st ed. Delhi: Peepee Publishers; 2004.
5. Chapman S. and Nakielny R. ***Aids to Radiological Differential Diagnosis***. 4th ed. Elsevier Science Limited; 2003.
6. Holm T. ***WHO Basic Radiologic System: Manual of Radiographic Techniques***. Delhi: AITBS Publishers; 2002.
7. Sutton D. ***Textbook of Radiology and imaging (Vol. I and II)***. 7th ed. UK: Churchill Livingstone; 2003.
8. Clark. ***Clark's Textbook of Positioning in Radiology***. 12th ed. Hoddler Arnold Publications; 2005.

RECOMMENDED BOOKS

BASIC SCIENCES PART-I EXAMINATIONS

Anatomy

- General Anatomy By: Professor Tassaduq Hussain
- Embryology: Langman's Embryology
- Gross Anatomy: Clinical Anatomy By: Shell
- Basic Histology By: Jenquiera
- Neuroanatomy By: Snell

Behavioral Sciences

- Rana M.H., Ali S. Mustafa M.A. Handbook of Behavioral Sciences for Medical and Dental students. Lahore: university of Health Sciences.

Physiology

- Human Physiology By: Guyton

Research Methodology

- The Medical Research Handbook, planning a research project. Amar-Singh HSS, Azman Abu Bakar and Sondi Sararaks. © 2008, Kuala Lumpur. Online available at URL, <http://www.crc.gov.my/wp-content/uploads/documents/researchHandBook.pdf>

Pathology

- Microbiology By: Jawetz
- Haematology By: Hoffbrand Postgraduate Hematology
- Histopathology By: Robin's Pathology Basic Disease
- Chemical Pathology By: Bishop's

Pharmacology

- Review of Pharmacology By: Lippincott's Illustrated