

**Jawaharlal Institute of Postgraduate Medical
Education & Research
(JIPMER)
Puducherry**



**BSc Medical Radiology and Imaging
Technology**

CURRICULUM

2021

This curriculum was approved at the 16th meeting of the Standing Academic Committee held on September 21, 2021, and will be applicable for students joining BSc (Allied Health Sciences) – Medical Radiology and Imaging Technology from the academic year 2021-22. The curriculum document was prepared based on the model curricula for allied health sciences courses issued by the Ministry of Health and Family Welfare, Government of India.

TABLE OF CONTENTS

Sl. No.	TITLE	Page No.
1	About JIPMER and Department of Radiodiagnosis	4
2	Subject details	8
3	Syllabus	10
4	Course and Examination regulations	48
5	Model question papers	52

About JIPMER

Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry (JIPMER) under Government of India since the year 1956, is one of the leading Medical Institutions of India. Spread over a sprawling 195-acre campus in an urban locale of Puducherry (formerly Pondicherry), JIPMER is 170 kms by road from Chennai.

JIPMER has been declared as an “Institution of National Importance” by an Act of Parliament, JIPMER, Puducherry, Act, 2008. A copy of the Act was Gazette notified on 14-7-2008 to enforce this Act. Prior to this, the Institute was functioning under the administrative control of Directorate General of Health Services, Ministry of Health and Family Welfare, New Delhi. The Institution is now empowered to award Medical Degrees under the clauses 23 & 24 of the said Act. Such Degrees shall be deemed to be included in the schedules to the respective Acts governing Medical Council of India/National Medical Commission, Indian Nursing Council, and Dental Council of India, entitling the holders to the same privileges as those attached to the equivalent awards from the recognized Universities of India.

JIPMER imparts Undergraduate (UG), Postgraduate (PG) and Super Specialty Medical Training through a large hospital complex (JIPMER Hospital) and a Nursing College. Some of the courses offered are MBBS, BSc, MSc, MD, MS, DM, and MCh courses. Full-time Ph.D. programs are available in several disciplines.

About the Department of Radiodiagnosis

The department of Radiodiagnosis was started in 1961 as the Department of Radiology comprising the departments of Radiodiagnosis, Radiotherapy and Nuclear Medicine. The Department of Radiology bifurcated into the departments of Radio-diagnosis and Radiotherapy in 1990. Currently, the Department is located in five blocks namely the main hospital block, super specialty block, emergency medical services block, super specialty block annex and women and children’s hospital.

COURSE DETAILS

Nomenclature: BSc (Allied Health Sciences) – Medical Radiology and Imaging Technology

Introduction:

BSc (Allied Health Sciences) – Medical Radiology and Imaging Technology is a four year course with three year academic program divided into three phases of one year each and one year compulsory internship period.

Learning Objectives of the course:

- To learn basic anatomy and physiology relevant to imaging
- To learn basic physics with respect to each imaging modality
- to perform diagnostic radiology procedures safely and effectively
- to perform necessary post-processing of images
- to learn concepts of prevention of infection during Imaging procedures
- to understand the importance of radiation protection and radiation safety during imaging procedures

First phase: one year

In addition to the subjects of Foundation course, Anatomy, and Physiology, students will learn the basic concepts in areas such as Biochemistry, Pathology, and Physics of diagnostic radiology

Second phase: one year

In the Second phase, the students will learn the concepts of radiation physics including interaction of radiation with matter, various radiation measurements, quantities, units, image processing techniques and positioning of patients for various radiological procedures. and the concepts behind treatment planning. This includes gaining knowledge about basic imaging modalities.

Third phase: one year

In the Third phase, the students will learn basic principles of computed tomography, digital subtraction angiography and an introduction to interventional radiological techniques. They will also learn the basic principles and techniques involved in Magnetic Resonance Imaging, Ultrasonography, Nuclear Medicine in addition to the radiation safety measures and the regulatory requirements in diagnostic radiology

Internship: one year

Internship of one year is compulsory. The interns will be given hands-on training in techniques pertaining to various imaging modalities and patient positioning for various procedures. They will also take part in the quality assurance and quality control related activities of the department.

Expectation from the future graduate:

- The BSc Graduate in Radiodiagnosis is expected
- to perform radiographic procedures including special investigations, contrast enhanced CT scan including angiograms.
- to be able to assist senior technicians in performing MRI examinations and DSA
- to be able to assist Radiologists in performing image guided interventions
- to perform basic post processing of images as required
- to perform basic quality assurance procedures

Available postgraduate programmes in India:**MSc Radio-imaging**

- All India Institute of Medical Sciences, New Delhi
- Post Graduate Institute of Medical Education and Research (PGIMER), Chandigarh
- Armed Forces Medical College, Pune
- University College of Medical Science, New Delhi
- School of Allied Health Sciences, Manipal University, Manipal
- Sri Ramachandra Medical College & Research Institute (SRMCRI), Chennai
- Pandit Jawaharlal Nehru Memorial Medical College (PJNMMC), Raipur
- Dr. Bhubaneswar Borooah Cancer Institute (BBCI) , Guwahati
- Chettinad Group Of Colleges , Kanchipuram

Job profile

- The practice of radiography is performed by health care professionals responsible for the administration of ionizing radiation for diagnostic purposes. A Technologist (Radiodiagnosis) performs radiographic procedures at the request of practitioner.
- The complex nature of disease processes involves multiple imaging modalities. Although an interdisciplinary team of clinicians, radiographers and support staff plays a critical role in the delivery of health services, it is the Diagnostic Radiologic Technologist (Radiographer) who performs the radiographic procedure that creates the images needed for diagnosis.
- Radiography integrates scientific knowledge, technical skills, patient interaction and compassionate care resulting in diagnostic information. Diagnostic Radiographer / Technologist recognizes patient conditions essential for successful completion of the procedure.
- Radiographers are at the heart of modern medicine. Diagnostic radiographers employ a range of different imaging techniques and sophisticated equipment to produce high quality

images of an injury or disease. Diagnostic radiographers will take the images using range of techniques including: X-rays • Fluoroscopy • CT (computed tomography) • MRI (magnetic resonance imaging) • Nuclear medicine • Angiography

- Diagnostic Radiographer / Technologist maintain a high degree of accuracy in radiographic positioning and exposure technique. They possess, utilize and maintain knowledge of radiation protection and safety. Radiographers are the primary liaison between patients, Radiologist and other members of the support team. Diagnostic Radiographer / Technologist remain sensitive to needs of the patient through good communication, patient assessment, patient monitoring and patient care skills. As members of the health care team, Diagnostic Radiographer / Technologist participate in quality improvement processes and continually assess their professional performance. They engage in continuing education to include their area of practice to enhance patient care, public education, knowledge and technical competence

Eligibility for the course:

- The Applicant should be an **Indian National**.
- He/she should have completed **17 years** at the time of application cut-off date.
- There is **no upper age limit**.

The applicants should have passed the qualifying examinations in the manner mentioned below:

- The Higher / Senior Secondary Examination or the Indian School Certificate Examination which is equivalent to 10+2 Higher/Senior Secondary Examination after a period of 12 years study, the last two years of such study comprising Physics, Chemistry, Biology/ Botany & Zoology (which shall include practical tests in these subjects) and with English as a subject.
- The applicant must have passed in the subjects of Physics, Chemistry, Biology/Botany & Zoology and English individually and must have obtained a minimum of 50% marks taken together in Physics, Chemistry, Biology/Botany & Zoology at the qualifying examination
- Candidates belonging to the Scheduled Castes/Scheduled Tribe or Other Backward Classes must have obtained a minimum of 40% marks in the subjects of Physics, Chemistry, Biology / Botany & Zoology taken together in the qualifying examination.
- For PwD candidates in general and EWS categories, the minimum marks in Physics, Chemistry, Biology/ Botany & Zoology taken together in the qualifying examination is 45%.

Candidates intake per year:

Five candidates will be admitted to the course every year. There is no provision for sponsored / nominated candidates.

Duration of the course

4 years (48 months) duration including 3 years of classes and one year of compulsory internship.

Medium of instruction:

English

Vacation:

Students will be eligible for 4 weeks of vacation in summer and 2 weeks in winter.

Subject details:

Phase	Paper	Title of the paper
I	I	Foundation Course (T & P)
	II	Anatomy and Physiology (T & P)
	III	Pathology and Microbiology (T)
	IV	Physics of diagnostic radiology (T & P)
II	I	Interaction of radiation with matter, Radiation measurements, quantities and units (T & P)
	II	Image processing techniques and Special radiographic procedures (T & P)
	III	Radiographic procedures and positioning (T & P)
III	I	Computed tomography, Digital subtraction Angiography, Interventional radiology (T & P)
	II	Magnetic Resonance Imaging, Ultrasonography, Nuclear Medicine (T & P)
	III	Radiation safety and Regulatory requirements in diagnostic radiology (T & P)
IV	Internship period	

T- Theory, P- Practical

Teaching hours:

Phase	Subject	Theory	Practical	Others
I	Foundation course	80	40	
	Anatomy	60	180	
	Physiology	60	180	
	Pathology	40		
	Microbiology	40		
	Physics of diagnostic radiology	60	280	
	Self-study/Library			60
Total				1080
II	Interaction of radiation with matter, Radiation measurements, quantities and units	60	280	
	Image processing techniques and Special radiographic procedures	60	280	
	Radiographic procedures and positioning	60	280	
	Self-study/Library			60
Total				1080
III	Computed tomography, Digital subtraction Angiography, Interventional radiology	60	280	
	Magnetic Resonance Imaging, Ultrasonography, Nuclear Medicine	60	280	
	Radiation safety and Regulatory requirements in diagnostic radiology	60	280	
	Self-study/Library			60
Total				1080
IV	Internship			

SYLLABUS

Phase I

Paper I: Foundation course

Theory:

Introduction to National Healthcare System

The course provides the students a basic insight into the main features of Indian health care delivery system and how it compares with the other systems of the world. Topics to be covered under the subject are as follows:

1. Introduction to healthcare delivery system
 - a. Healthcare delivery system in India at primary, secondary and tertiary care
 - b. Community participation in healthcare delivery system
 - c. Health system in developed countries.
 - d. Private Sector
 - e. National Health Mission
 - f. National Health Policy
 - g. Issues in Health Care Delivery System in India
2. National Health Programme- Background objectives, action plan, targets, operations, achievements, and constraints in various National Health Programme.
3. Introduction to AYUSH system of medicine
 - a. Introduction to Ayurveda.
 - b. Yoga and Naturopathy
 - c. Unani
 - d. Siddha
 - e. Homeopathy
 - f. Need for integration of various system of medicine
4. Health scenario of India- past, present, and future
5. Demography & Vital Statistics-
 - a. Demography – its concept
 - b. Vital events of life & its impact on demography
 - c. Significance and recording of vital statistics
 - d. Census & its impact on health policy
6. Epidemiology
 - a. Principles of Epidemiology
 - b. Natural History of disease
 - c. Methods of Epidemiological studies

d. Epidemiology of communicable & non-communicable diseases, disease transmission, host defence immunizing agents, cold chain, immunization, disease monitoring and surveillance.

Medical terminologies and record keeping

This course introduces the elements of medical terminology. Emphasis is placed on building familiarity with medical words through knowledge of roots, prefixes, and suffixes. Topics include origin, word building, abbreviations and symbols, terminology related to the human anatomy, reading medical orders and reports, and terminology specific to the student's field of study. Spelling is critical and will be counted when grading tests.²⁵ Topics to be covered under the subject are as follows:

1. Derivation of medical terms.
2. Define word roots, prefixes, and suffixes.
3. Conventions for combined morphemes and the formation of plurals.
4. Basic medical terms.
5. Form medical terms utilizing roots, suffixes, prefixes, and combining roots.
6. Interpret basic medical abbreviations/symbols.
7. Utilize diagnostic, surgical, and procedural terms and abbreviations related to the integumentary system, musculoskeletal system, respiratory system, cardiovascular system, nervous system, and endocrine system.
8. Interpret medical orders/reports.
9. Data entry and management on electronic health record system.

Basic computers and information science

The students will be able to appreciate the role of computer technology. The course has focus on computer organization, computer operating system and software, and MS windows, Word processing, Excel data worksheet and PowerPoint presentation. Topics to be covered under the subject are as follows:

1. Introduction to computer: Introduction, characteristics of computer, block diagram of computer, generations of computer, computer languages.
2. Input output devices: Input devices (keyboard, point and draw devices, data scanning devices, digitizer, electronic card reader, voice recognition devices, vision-input devices), output devices (monitors, pointers, plotters, screen image projector, voice response systems).
3. Processor and memory: The Central Processing Unit (CPU), main memory.
4. Storage Devices: Sequential and direct access devices, magnetic tape, magnetic disk, optical disk, mass storage devices.

5. Introduction of windows: History, features, desktop, taskbar, icons on the desktop, operation with folder, creating shortcuts, operation with windows (opening, closing, moving, resizing, minimizing, and maximizing, etc.).
6. Introduction to MS-Word: introduction, components of a word window, creating, opening and inserting files, editing a document file, page setting and formatting the text, saving the document, spell checking, printing the document file, creating and editing of table, mail merge.
7. Introduction to Excel: introduction, about worksheet, entering information, saving workbooks and formatting, printing the worksheet, creating graphs.
8. Introduction to power-point: introduction, creating and manipulating presentation, views, formatting and enhancing text, slide with graphs.
9. Introduction of Operating System: introduction, operating system concepts, types of operating system.
10. Computer networks: introduction, types of networks (LAN, MAN, WAN, Internet, Intranet), network topologies (star, ring, bus, mesh, tree, hybrid), components of network.
11. Internet and its Applications: definition, brief history, basic services (E-Mail, File Transfer Protocol, telnet, the World Wide Web (WWW)), www browsers, use of the internet.
12. Application of Computers in clinical settings.

Medical law and ethics

Legal and ethical considerations are firmly believed to be an integral part of medical practice in planning patient care. Advances in medical sciences, growing sophistication of the modern society's legal framework, increasing awareness of human rights and changing moral principles of the community at large, now result in frequent occurrences of healthcare professionals being caught in dilemmas over aspects arising from daily practice.²⁶

Medical ethics has developed into a well based discipline which acts as a "bridge" between theoretical bioethics and the bedside. The goal is "to improve the quality of patient care by identifying, analysing, and attempting to resolve the ethical problems that arise in practice".²⁶ Doctors are bound by, not just moral obligations, but also by laws and official regulations that form the legal framework to regulate medical practice. Hence, it is now a universal consensus that legal and ethical considerations are inherent and inseparable parts of good medical practice across the whole spectrum. Few of the important and relevant topics that need to focus on are as follows:

1. Medical ethics - Definition - Goal - Scope
2. Introduction to Code of conduct
3. Basic principles of medical ethics – Confidentiality
4. Malpractice and negligence - Rational and irrational drug therapy
5. Autonomy and informed consent - Right of patients
6. Care of the terminally ill- Euthanasia

7. Organ transplantation
8. Medico legal aspects of medical records – Medico legal case and type- Records and document related to MLC - ownership of medical records - Confidentiality Privilege communication - Release of medical information - Unauthorized disclosure - retention of medical records - other various aspects.
9. Professional Indemnity insurance policy
10. Development of standardized protocol to avoid near miss or sentinel events
11. Obtaining an informed consent.

Communication and soft skills

Major topics to be covered under Communication course –

1. Basic Language Skills: Grammar and Usage.
2. Business Communication Skills. With focus on speaking - Conversations, discussions, dialogues, short presentations, pronunciation.
3. Teaching the different methods of writing like letters, E-mails, report, case study, collecting the patient data etc. Basic compositions, journals, with a focus on paragraph form and organization.
4. Basic concepts & principles of good communication
5. Special characteristics of health communication
6. Types & process of communication
7. Barriers of communication & how to overcome

Introduction to Quality and patient safety

1. Quality assurance and management - The objective of the course is to help students understand the basic concepts of quality in health Care and develop skills to implement sustainable quality assurance program in the health system.
 - a. Concepts of Quality of Care
 - b. Quality Improvement Approaches
 - c. Standards and Norms
 - d. Quality Improvement Tools
 - e. Introduction to NABH guidelines
2. Basics of emergency care and life support skills - Basic life support (BLS) is the foundation for saving lives following cardiac arrest. Fundamental aspects of BLS include immediate recognition of sudden cardiac arrest (SCA) and activation of the emergency response system, early cardiopulmonary resuscitation (CPR), and rapid defibrillation with an automated external defibrillator (AED). Initial recognition and response to heart attack and stroke are also

considered part of BLS. The student is also expected to learn about basic emergency care including first aid and triage. Topics to be covered under the subject are as follows:

- a. Vital signs and primary assessment
- b. Basic emergency care – first aid and triage
- c. Ventilations including use of bag-valve-masks (BVMs)
- d. Choking, rescue breathing methods
- e. One- and Two-rescuer CPR
- f. Using an AED (Automated external defibrillator).
- g. Managing an emergency including moving a patient

At the end of this topic, focus should be to teach the students to perform the manoeuvres in simulation lab and to test their skills with focus on airways management and chest compressions. At the end of the foundation course, each student should be able to perform and execute/operate on the above-mentioned modalities.

3. Bio medical waste management and environment safety- The aim of this section will be to help prevent harm to workers, property, the environment, and the general public. Topics to be covered under the subject are as follows:

- a. Definition of Biomedical Waste
- b. Waste minimization
- c. BMW – Segregation, collection, transportation, treatment, and disposal (including colour coding)
- d. Liquid BMW, Radioactive waste, Metals / Chemicals / Drug waste
- e. BMW Management & methods of disinfection
- f. Modern technology for handling BMW
- g. Use of Personal protective equipment (PPE)
- h. Monitoring & controlling of cross infection (Protective devices)

4. Infection prevention and control - The objective of this section will be to provide a broad understanding of the core subject areas of infection prevention and control and to equip AHPs with the fundamental skills required to reduce the incidence of hospital acquired infections and improve health outcomes. Concepts taught should include –

- a. Evidence-based infection control principles and practices [such as sterilization, disinfection, effective hand hygiene and use of Personal protective equipment (PPE)],
- b. Prevention & control of common healthcare associated infections,
- c. Components of an effective infection control program, and
- d. Guidelines (NABH and JCI) for Hospital Infection Control

5. Antibiotic Resistance-

- a. History of Antibiotics
- b. How Resistance Happens and Spreads
- c. Types of resistance- Intrinsic, Acquired, Passive
- d. Trends in Drug Resistance
- e. Actions to Fight Resistance
- f. Bacterial persistence
- g. Antibiotic sensitivity
- h. Consequences of antibiotic resistance
- i. Antimicrobial Stewardship- Barriers and opportunities, Tools and models in hospitals

6. Disaster preparedness and management- The objective of this section will be to provide knowledge on the principles of on-site disaster management. Concepts to be taught should include-

- a. Fundamentals of emergency management,
- b. Psychological impact management,
- c. Resource management,
- d. Preparedness and risk reduction,
- e. Key response functions (including public health, logistics and governance, recovery, rehabilitation, and reconstruction), information management, incident command and institutional mechanisms.

Professionalism and values

The module on professionalism will deliver the concept of what it means to be a professional and how a specialized profession is different from a usual vocation. It also explains how relevant professionalism in terms of healthcare system is and how it affects the overall patient environment.

1. Professional values- Integrity, Objectivity, Professional competence and due care, Confidentiality
2. Personal values- ethical or moral values
3. Attitude and behaviour- professional behaviour, treating people equally
4. Code of conduct, professional accountability and responsibility, misconduct
5. Differences between professions and importance of team efforts
6. Cultural issues in the healthcare environment

Research Methodology and Biostatistics

The objective of this module is to help the students understand the basic principles of research and methods applied to draw inferences from the research findings.

1. Introduction to research methods
2. Identifying research problem
3. Ethical issues in research
4. Research design
5. Basic Concepts of Biostatistics
6. Types of Data
7. Research tools and Data collection methods
8. Sampling methods
9. Developing a research proposal

Principles of Management

The course is intended to provide a knowledge about the basic principles of Management.

1. Introduction to management
2. Strategic Management
3. Foundations of Planning
4. Planning Tools and Techniques
5. Decision Making, conflict and stress management
6. Managing Change and Innovation
7. Understanding Groups and Teams
8. Leadership
9. Time Management
10. Cost and efficiency

Community orientation and clinical visit

The objective of this section of the foundation course is to sensitize potential learners with essential knowledge; this will lay a sound foundation for their learning across the undergraduate program and across their career. Innovative teaching methods should be used to ensure the attention of a student and make them more receptive such as group activities, interactive fora, role plays, and clinical bed-side demonstrations.

1. The community orientation and clinical visit will include visit to the entire chain of healthcare delivery system -Sub centre, PHC, CHC, SDH, DH and Medical College, private hospitals, dispensaries, and clinics.
2. The student will also be briefed regarding governance at village level including interaction and group discussion with village panchayat and front-line health workers.
3. Clinical visit to their respective professional department within the hospital.

Practical:**Fundamentals of computers**

1. Learning to use MS office: MS word, MS PowerPoint, MS Excel
2. To install different software.
3. Data entry efficiency

Paper II: Anatomy and Physiology**Gross anatomy and Histology****Theory:****General Anatomy:**

Introduction – Anatomical terms, position, movements; epithelium – classification, structure & examples; Tissues – classification and structure; skin – structure, thick and thin skin; cartilage – types, structure, hyaline, elastic, and white fibrocartilage; bones – classification, structure, growth; muscles - classification & structure; glands - classification & structure.

Musculoskeletal system:

Axial and appendicular skeleton – muscle groups and regions muscles with action.

Cardiovascular and lymphatic system:

Structure of pericardium, heart & major blood vessels – arteries, veins, and lymphatic system – classification and structure of lymphoid organs – thymus, spleen, lymph node, tonsil, and major lymphatic vessels.

Respiratory system:

Parts of respiratory system, structure of external nose, paranasal air sinuses, nasal cavity, nasopharynx, larynx, trachea, pleura, lungs & diaphragm.

Gastrointestinal system:

Parts of gastrointestinal system, salivary glands, oral cavity, oropharynx and laryngopharynx, esophagus, stomach, small intestine, large intestine, liver, gallbladder, extrahepatic biliary apparatus, and pancreas.

Excretory system:

Parts of excretory system – structure of kidney, ureter, urinary bladder & urethra.

Male and female reproductive systems:

Structure & parts of male reproductive system, external genitalia, testis, epididymis, vasdeferens, seminal vesicle and prostate.

Structure & parts of female reproductive system, uterus, ovary, fallopian tubes, and mammary gland

Endocrine system:

Location & structure of thyroid, parathyroid, pituitary, adrenal glands.

Special senses:

Structure of eyeball, external, middle & internal ear, and papillae of tongue.

Nervous system:

Neuron, neuroglia, classification, autonomic nervous system, meninges, parts of brain, cerebrum, cerebellum, basal nuclei, limbic system, thalamus, hypothalamus, spinal cord, circulation of cerebrospinal fluid.

Histology:

General histology:

Microscopy – Types of microscopes, parts of microscope, cleaning, and maintenance of microscope.

Microscopic features of

1. Cartilages
 - 1.1 Hyaline,
 - 1.2 Elastic
 - 1.3 White fibro cartilages
2. Bones
 - 2.1 Longitudinal section of compact bone
 - 2.2 Cross section of compact bone
3. Muscles
 - 3.1 Skeletal muscle
 - 3.2 Cardiac muscle
4. Glands
 - 4.1 Serous gland
 - 4.2 Mucous gland
 - 4.3 Mixed gland
5. Blood vessels
 - 5.1 Medium sized artery
 - 5.2 Large sized artery
 - 5.3 Medium sized vein
 - 5.4 Large sized vein

6. Nervous tissue
 - 6.1 Peripheral nerve H & E stain
 - 6.2 Peripheral nerve Osmic acid stain
 - 6.3 Dorsal root (spinal) ganglia
 - 6.4 Autonomic ganglia
7. Lymphoid organs
 - 7.1 Thymus
 - 7.2 Lymph node
 - 7.3 Spleen
 - 7.4 Tonsil
8. Skin
 - 8.1 Thick skin
 - 8.2 Thin skin

Practical: Anatomy (Gross anatomy and Histology)

1. Demonstration of bones
2. Demonstration of various parts of body
3. Demonstration of parts of digestive system
4. Demonstration of parts of respiratory system
5. Demonstration of parts of reproductive system
6. Demonstration of parts of excretory system
7. Demonstration of various parts of circulatory system
8. Demonstration of various parts of nervous system
9. General histology slides

Textbooks Recommended (Latest edition):

General anatomy:

1. Handbook of General Anatomy – B.D. Chaurasia - CBS Publishers

Systemic Anatomy:

1. Textbook of Anatomy – Vishram Singh – Elsevier
2. B.D. Chaurasia's Human Anatomy – CBS Publishers
3. Manipal Manual of Anatomy for Allied Health Science Courses

Histology:

1. Textbook of Human Histology: With Color Atlas 3D Illustrations – Dr. Yogesh Sontakke
2. Textbook of Histology - A Practical guide – Dr. J. P Gunasegaran
3. Di Fiore's Atlas of Histology – Eroschenko – Lippincott Williams & Wilkins

Reference textbook:

Gray's Anatomy: The Anatomical Basis of Clinical Practice – Susan Standring – Elsevier

Physiology

Theory:

1. General Physiology

- a. Principle of homeostasis
- b. Cell membrane, cell organelles, intercellular junctions
- c. Transport across cell membrane
- d. Body fluids: Classification of body fluid compartments, ionic composition, measurement
- e. Resting membrane potential

2. Blood

- a. Composition of blood
- b. Plasma proteins: classification and functions
- c. RBC: development, morphology, counts, functions and dysfunctions
- d. Hemoglobin: types, structure, synthesis, function, degradation, anemia
- e. WBC: development, classification, morphology, counts, functions and dysfunctions
- f. Immunity: definition, classification, Innate, Cellular and Humoral Immunity
- g. Platelets: morphology, counts, development, functions and dysfunctions
- h. Blood coagulation: clotting factors, mechanism, dysfunctions
- i. Anticoagulants
- j. Blood grouping: classification, cross matching, blood transfusion, Rh factor and incompatibility

3. Nerve

- a. Structure, function, classification of neurons
- b. Neuronal action potential: ionic basis and properties
- c. Conduction of nerve impulses
- d. Nerve Injuries
- e. Neuromuscular junction: structure, mechanism of transmission & applied aspects

4. Muscle

- a. Structure of skeletal muscle & sarcotubular system
- b. Mechanism of contraction and relaxation of skeletal muscle
- c. Isotonic and isometric contraction
- d. Properties of skeletal muscle
- e. Smooth muscle: structure, properties, and mechanism of contraction
- f. Differences between skeletal, smooth, and cardiac muscles

5. Autonomic nervous system

- a. Divisions and functions

6. Gastrointestinal (GI) system

- a. Functional anatomy of GIT
- b. Gastrointestinal hormones
- c. Principles & Functions of GI secretions, applied aspects
- d. Movements of GIT, applied aspects

7. Endocrine system

Hormones, actions, and dysfunctions of various endocrine glands:

- a. Hypothalamus
- b. Pituitary
- c. Thyroid
- d. Parathyroid and hormones involved in calcium homeostasis
- e. Adrenal gland
- f. Endocrine pancreas

8. Reproductive System

- a. Male and female gametogenesis
- b. Structure and function of male reproductive system
- c. Structure of female reproductive system, menstrual cycle, pregnancy, parturition, lactation
- d. Contraceptives

9. Kidney

- a. Structure & function of kidney, structure of nephron, composition of urine
- b. Glomerular filtration rate: definition, values, regulation and measurement
- c. Mechanism of urine formation: tubular functions, concentration of urine, acidification of urine
- d. Micturition reflex
- e. Diuretics
- f. Dialysis

10. Cardiovascular system

- a. Functional anatomy of heart
- b. Circulatory system: arterial, venous, capillary circulation
- c. Structure and properties of cardiac muscle
- d. Electrophysiology of heart and conduction of impulse
- e. ECG: waveforms and physiological basis
- f. Cardiac cycle, heart sounds, Jugular venous pulse
- g. Stroke volume, heart rate, cardiac output – definition, normal values and their regulation
- h. Blood pressure and regulation
- i. Coronary circulation
- j. Lymphatic circulation
- k. Applied aspects: shock, hypertension, hypotension, tachycardia, bradycardia, heart failure

11. Respiratory system

- a. Functional anatomy of respiratory system
- b. Mechanics of breathing, lung volumes and capacities, compliance, surfactant
- c. Alveolar ventilation, dead space, pulmonary circulation, ventilation-perfusion ratio
- d. Diffusion and gas exchange

- e. Transport of oxygen and carbon dioxide
- f. Brief account of respiratory regulation
- g. Acclimatization, definition & types of hypoxia, oxygen therapy, cyanosis, asphyxia.
- h. Methods of artificial respiration

12. Central nervous system

- a. Parts and functions of brain and spinal cord
- b. Sensory system: receptors and ascending pathways
- c. Motor system: motor neurons, motor units, muscle spindle, stretch reflex, and descending tracts with emphasis on corticospinal tract
- d. Cerebellum- functional anatomy, functions, and dysfunctions
- e. Basal ganglia- functional anatomy, functions, and dysfunctions
- f. Functions of hypothalamus
- g. Functions of Thalamus
- h. Types of sleep and EEG
- i. Cerebrospinal fluid
- j. Higher functions: types of memory, centers of speech, types of aphasia in brief, Cerebral cortex-lobes and functions
- k. Blood-brain barrier

13. Special senses

- a. Vision: Components of visual apparatus, visual acuity, color vision, accommodation, errors of refraction, visual pathway, pupillary reflexes
- b. Hearing: External, middle ear, inner ear and their functions, auditory pathway, hearing tests.
- c. Taste – receptors and pathway
- d. smell: receptors and pathway

14. Integrative Physiology

- a. Structure and functions of skin
- b. Regulation of temperature

Practical: Physiology

1. Hematology

- a. Methods of collection of blood
- b. Microscopy
- c. Haemocytometry
- d. Total RBC count
- e. Estimation of haemoglobin
- f. Calculation of blood indices
- g. Demonstration of osmotic fragility of red blood cells
- h. Determination of ESR
- i. Total leucocyte count

- j. Absolute eosinophil count
- k. Peripheral blood smear
- l. Differential leukocyte count
- m. Arneth count
- n. Determination of blood group
- o. Bleeding time, Clotting time
- p. Demonstration of reticulocyte count
- q. Demonstration of platelet count
- r. Demonstration of PCV

2. Clinical

- a. General physical examination
- b. Clinical examination of Radial pulse
- c. Determination of blood pressure
- d. Recording of Electrocardiogram
- e. Examination of cardiovascular system
- f. Examination of respiratory system
- g. Demonstration of spirometry
- h. Determination of vital capacity and effect of posture of vital capacity
- i. Examination of sensory system
- j. Examination of motor system
- k. Visual acuity
- l. Color vision
- m. Pupillary reflexes
- n. Perimetry
- o. Tests of hearing
- p. Mosso's ergography

Textbooks recommended: (Latest edition)

1. Textbook of Medical Physiology by G.K. Pal (Theory)
2. Textbook of Practical Physiology by G.K. Pal & Pravati Pal (Practical)

Teaching learning methodology:

The course content in Physiology will be covered by:

1. Interactive Lectures
2. Group Discussions
3. Practical classes & demonstrations
4. Seminars
5. Assignments

Paper III: Pathology and Microbiology

Pathology

The Pathology syllabus introduces the principles of **Pathology** with emphasis on applied aspects of Pathology particularly in the following areas:

1. Collection and transport of specimens for routine pathological investigations
2. Common routine pathology tests
3. General concepts of Pathology
4. Laboratory diagnosis of common pathological conditions
5. Systemic Pathology
6. Applied Surgical Pathology, cytopathology, hematopathology, renal pathology and neuropathology

Theory:

1. Adaptations, cell injury and repair

- a. Hyperplasia,
- b. hypertrophy,
- c. atrophy,
- d. metaplasia,
- e. Necrosis and
- f. Apoptosis

2. Acute and chronic inflammation

- a. Cardinal signs of inflammation
- b. Outcomes of acute inflammation
- c. Chronic inflammation
- d. Granulomatous inflammation
- e. Acute phase proteins

3. Tissue repair, regeneration, and hemodynamic disorders

- a. Cutaneous wound healing
- b. Pathological aspects of repair
- c. Hyperaemia and congestion
- d. Thrombosis and Virchow triad
- e. Embolism, infarction, and shock

4. Disorders of immune system

- a. Types of hypersensitivity reactions
- b. Autoimmune diseases

5. Neoplasia

- a. Definition of neoplasia.
- b. Differences between benign and malignant tumours

- c. Metastasis
- d. Carcinogenesis – causes

6. Applied general pathology related to transfusion medicine

- a. ABO blood group & Rh system (terminologies)
- b. Principles of blood grouping and cross matching
- c. Shelf life of stored blood
- d. Anticoagulants used for storing blood and temperature for storage

7. RBC, WBC, and bleeding disorders

- a. Anaemia – definition and classification
- b. Iron deficiency anaemia and haemolytic anaemia
- c. Leukocytosis and leukaemia
- d. Causes of splenomegaly
- e. Thrombocytopenia and coagulation disorders
- f. Phlebotomy, haemoglobin estimation, peripheral smear examination, bleeding time, PT and APTT

8. Disorders of GI tract, liver, biliary tract, and pancreas

- a. Causes of peptic ulcer, carcinoma stomach, intestinal obstruction, acute appendicitis, and colonic carcinoma
- b. Jaundice – classification based on pathophysiology
- c. Cirrhosis – definition and causes
- d. Hepatitis – types and mode of transmission
- e. Portal hypertension and hepatic failure

9. Blood vessels, heart, and lung diseases

- a. Risk factors for atherosclerosis and their classification
- b. Hypertension – definition and causes
- c. Varicose veins, thrombophlebitis and phlebothrombosis
- d. Congenital heart disease and heart failure
- e. Myocardial infarction and cor-pulmonale
- f. Rheumatic heart disease
- g. Chronic obstructive airway disease
- h. Asthma, pneumonia, and lung carcinoma

10. The kidney and lower urinary tract, male and female genital tract

- a. Acute and chronic renal failure
- b. Nephrotic and nephritis syndrome
- c. Acute tubular necrosis and urolithiasis
- d. Carcinoma penis, testicular tumours, and prostatic hyperplasia
- e. Endometriosis, adenomyosis and leiomyoma

11. Endocrine and nervous system

- a. Diagnostic criteria, types, and complications of diabetic mellitus

- b. Intracerebral, subarachnoid, and subdural haemorrhage
- c. Meningitis and encephalitis
- d. Epilepsy and CNS tumours

12. Applied Surgical Pathology & Cytopathology, renal pathology, and neuropathology

- a. Histopathology techniques
- b. Fine needle aspiration cytology and imprint cytology
- c. Basic terminologies of surgical specimens
- d. Urine analysis and renal biopsy
- e. CSF cytology, nerve and muscle biopsy, squash cytology

Textbooks recommended (latest edition):

- 1. Illustrated Pathology – McFarlen
- 2. Essentials of Rubin's Pathology
- 3. Basic Pathology by Robbins
- 4. General and systemic Pathology – Underwood and Cross

Teaching and Learning methodology

Mostly will be didactic lectures with tutorials.

Microbiology

The Microbiology syllabus introduces the principles of **Microbiology** with emphasis on applied aspects of Microbiology of infectious diseases particularly in the following areas

- 1. Universal and Standard precaution.
- 2. Collection and transport of specimens for routine microbiological investigations.
- 3. Common routine serological tests
- 4. General concept of infection
- 5. Common Bacteriological, Viral, Fungal, Parasitic infection and Laboratory diagnosis
- 6. Nosocomial infection
- 7. Biomedical waste management
- 8. Vaccine

Theory:

Introduction and Morphology

Introduction of microbiology, Classification of microorganisms, size, shape and structure of bacteria. Use of microscope in the study of bacteria.

Growth and Nutrition

Nutrition, Culture media, Types of medium with example and uses of culture media in diagnostic bacteriology, antimicrobial sensitivity test.

Sterilisation and Disinfection

Principles and use of equipment of sterilization namely Hot Air oven, Autoclave and serum inspissator. Pasteurization, Anti septic and disinfectants.

Immunology

Immunity, Types of Immunity, Vaccines, Types of Vaccine and immunization schedule. Principles and interpretation of commonly done serological tests namely Widal, VDRL, ASLO, ELISA, Rapid tests for HIV and HbsAg

Systematic Bacteriology

Morphology, diseases caused, laboratory diagnosis including specimen collection of the following bacteria (the classification, antigenic structure and pathogenicity are not to be taught) Staphylococci, Streptococci, Pneumococci, Gonococci, Meningococci, C. diphtheriae, Mycobacterium tuberculosis, Clostridium spp., Bacillus spp., Shigella spp., Salmonella spp., Escherichia coli, Klebsiella spp., Proteus spp., Vibrio cholera, Pseudomonas spp. & Spirochaetes

Parasitology

Morphology, life cycle, laboratory diagnosis of following parasites E. histolytica, Plasmodium spp., Tapeworms, Intestinal nematodes, Filariasis

Mycology

Morphology, diseases caused, laboratory diagnosis of following fungi. Candida, Cryptococcus, opportunistic fungi

Virology

General properties of viruses, diseases caused, lab diagnosis and prevention of following viruses, Herpes, Hepatitis, HIV, Rabies and Poliomyelitis

Hospital Infection

Causative agents, transmission methods, investigation, prevention and control Hospital infection, Universal precaution, Standard precaution

Principles And Practice Biomedical Waste Management**Applied Microbiology**

Causative agents, Sample collection and Laboratory diagnosis

Gastrointestinal infections, Nosocomial infections, Urinary tract infections, Respiratory tract infections, Pyogenic Meningitis, Food borne infections, Vector borne infections, Blood borne infections, Aerosol borne infections.

Textbooks recommended (latest editions):

1. CP. Baveja. Textbook of Microbiology for nurses. Arya Publishing Company.

2. RL Ichhpujani, Rajesh Bhatia. Essentials of Medical Microbiology. Jaypee Brothers Medical Pub (p) Ltd.
3. Seema Sood. Microbiology for Nursing Students & Nurses. Elsevier India Pvt.Ltd.
4. Satish Gupte. Short Textbook of Medical Microbiology. Jaypee Brothers Medical Pub (p) Ltd.
5. CK Jayaram Paniker, Ananthanarayan R. Textbook of Microbiology for nurses. Publisher Universities Press (India) Limited.
6. B.S.Nagoba. Clinical Microbiology. Bi Publications Pvt Ltd.
7. Clint E Carter, Burton J Bogitsh, Thomas N Oeltmann. Human Parasitology. Publisher Elsevier India Pvt. Ltd.

Paper IV: Physics of diagnostic Radiology**1. Essential Concepts of Radiologic Science**

- a. Matter and Energy
- b. Sources of Ionizing Radiation
- c. Discovery of X-Rays
- d. Development of Medical Imaging
- e. Reports of Radiation Injury
- f. Basic Radiation Protection: Filtration, Collimation, Protective Apparel, Gonadal Shielding, Protective Barriers
- g. Standard Units of Measurement: Length, Mass, Time, Units
- h. Mechanics:
Velocity, Acceleration, Newton's Laws of Motion, Weight, Momentum, Work, Power, Energy, Heat
- i. Terminology for Radiologic Science: Numeric Prefixes, Radiologic Units
- j. The Medical Imaging Team

2. The Structure of Matter

- a. Fundamental Particles
- b. Atomic Structure
- c. Electron Arrangement
- d. Electron Binding Energy
- e. Atomic Nomenclature
- f. Combinations of Atoms
- g. Radioactivity
- h. Radioisotopes
- i. Radioactive Half-life
- j. Types of Ionizing Radiation
- k. Particulate Radiation
- l. Electromagnetic Radiation

3. Electromagnetic Energy

- a. Photons
 - i. Velocity and Amplitude
 - ii. Frequency and Wavelength
- b. Electromagnetic Spectrum
 - i. Measurement of the Electromagnetic Spectrum
 - ii. Visible Light
 - iii. Radiofrequency
 - iv. Ionizing Radiation

- c. Waves and Particles
 - i. Wave Model: Visible Light
 - ii. Inverse Square Law
 - iii. Particle Model: Quantum Theory
- d. Matter and Energy

4. Electricity, Magnetism, and Electromagnetism

- a. Electrostatics
 - i. Electrostatic Laws
 - ii. Electric Potential
- b. Electrodynamics
 - i. Electric Circuits
 - ii. Electric Power
- c. Magnetism
 - i. Magnetic Laws
 - ii. Magnetic Induction
- d. Electromagnetism
 - i. Electromagnetic Induction
 - ii. Electromechanical Devices
 - iii. The Transformer

5. The X-ray Imaging System

- a. Operating Console
- b. Autotransformer
 - i. Adjustment of Kilovolt Peak (kVp)
 - ii. Control of Milliamperage (mA)
 - iii. Filament Transformer
- c. Exposure Timers
 - i. Synchronous Timers
 - ii. Electronic Timers
 - iii. mAs Timers
 - iv. Automatic Exposure Control
- d. High-Voltage Generator
 - i. High-Voltage Transformer
 - ii. Voltage Rectification
 - iii. Single-Phase Power
 - iv. Three-Phase Power
 - v. High-Frequency Generator
 - vi. Capacitor Discharge Generator
 - vii. Falling Load Generator
 - viii. Voltage Ripple
 - ix. Power Rating
 - x. X-ray Circuit

6. X-ray tube

- a. External Components
- b. Ceiling Support System
- c. Floor-to-Ceiling Support System
- d. C-Arm Support System
- e. Protective Housing
- f. Glass or Metal Enclosure
- g. Internal Components
- h. Cathode
- i. Anode
- j. X-ray Tube Failure
- k. Rating Charts
- l. Radiographic Rating Chart
- m. Anode Cooling Chart
- n. Housing Cooling Chart

7. X-ray production

- a. Electron Target Interactions
 - i. Anode Heat
 - ii. Characteristic Radiation
 - iii. Bremsstrahlung Radiation
- b. X-ray Emission Spectrum
 - i. Characteristic X-ray Spectrum
 - ii. Bremsstrahlung X-ray Spectrum
- c. Factors Affecting the X-ray Emission Spectrum
 - i. Effect of mA and mAs
 - ii. Effect of kVp
 - iii. Effect of Added Filtration
 - iv. Effect of Target Material
 - v. Effect of Voltage Waveform

8. X-ray Emission

- a. X-ray Quantity
 - i. X-ray Intensity
 - ii. Factors That Affect X-ray Quantity
- b. X-ray Quality
 - i. Penetrability
 - ii. Half-Value Layer
 - iii. Factors That Affect X-ray Quality
 - iv. Types of Filtration

9. X-ray Interaction with Matter

- a. Five X-ray Interactions with Matter
 - i. Coherent Scattering
 - ii. Compton Scattering
 - iii. Photoelectric Effect
 - iv. Pair Production
 - v. Photodisintegration
- b. Differential Absorption
 - i. Dependence on Atomic Number
 - ii. Dependence on Mass Density
- c. Contrast Examinations
- d. Exponential Attenuation

10. Scatter Radiation

- a. Production of Scatter Radiation
 - i. kVp
 - ii. Field Size
 - iii. Patient Thickness
- b. Control of Scatter Radiation
 - i. Effect of Scatter Radiation on
 - ii. Image Contrast
 - iii. Beam Restrictors
 - iv. Radiographic Grids
- c. Grid Performance
 - i. Contrast Improvement
 - ii. Factor
 - iii. Bucky Factor
- d. Grid Types
 - i. Parallel Grid
 - ii. Crossed Grid
 - iii. Focused Grid
 - iv. Moving Grid
- e. Grid Problems
 - i. Off-Level Grid
 - ii. Off-Center Grid
 - iii. Off-Focus Grid
 - iv. Upside-Down Grid
- f. Grid Selection
 - i. Patient Radiation Dose
 - ii. Air-Gap Technique

11. Fluoroscopy

- a. An Overview
- b. Special Demands of Fluoroscopy
 - i. Illumination
 - ii. Visual Physiology
- c. Fluoroscopic Technique
- d. Image Intensification
 - i. Image-Intensifier Tube
 - ii. Multifield Image Intensification
- e. Fluoroscopic Image Monitoring
 - i. Television Monitoring
 - ii. Image Recording
- f. Fluoroscopy Quality Control
 - i. Exposure Rate
 - ii. Spot-Film Exposures
 - iii. Automatic Exposure Systems

Practical

- Identification of different parts of X-ray Tube
- Identification of parts of the rotating anode
- Identification of different beam restrictors
- Identification of filters
- Identification of grids and Grid cut-offs
- Calculation of magnification factor
- Reading power rating charts

Textbooks recommended (Latest editions):

1. The Physics of Radiology and Imaging. K Thayalan
2. Radiologic Science for Technologists - Bushong
3. Christensen's Physics of Diagnostic Radiology – Thomas S curry, James E. Dowdey, Robert C. Murry
4. A Primer in Applied Radiation Physics by F A Smith
5. Atomic Physics – J. B. Rajam
6. The Physics of Radiology Harold Elford Johns & John Robert Cunningham.
7. The Physics of Radiation Therapy - Faiz M. Khan

Phase II

Paper I: Interaction of radiation with matter, Radiation measurements, quantities, and units

Theory:

1. Interaction of Radiation with matter:

Narrow Beam and Broad Beam - Exponential Attenuation of X and Gamma Rays in medium – X-rays transmission through the medium - HVT and TVT - linear and mass attenuation coefficient - Total Attenuation Coefficient – Rayleigh Scattering - Photo Nuclear Reaction – Elastic Nuclear Scattering – Nuclear Resonance Scattering - Auger Electrons – Photoelectric Interaction – Coherent Scattering – Thompson Scattering – Compton Scattering – Ionization of matter, Energy absorbed from X-rays, X-rays scattering - Pair production - Positron Annihilation – Triplet production - Interaction of Neutron with matter – Resonance absorption – Neutron scattering – Reaction with fast neutron - In-elastic scattering – Elastic scattering - Interaction of charged particles with matter

2. Radiation Quantities and Units:

SI system — Stochastic and Non Stochastic quantities – Particle Number - Radiant Energy – Flux - Energy Flux – Fluence - Energy Fluence – Fluence Rate - Energy Fluence Rate Cross Section – Mass Attenuation Coefficient – Mass Energy Transfer Coefficient – Mass Stopping power - Dosimetry – Conversion of Energy – KERMA – KERMA rate – Exposure – Exposure Rate – CEMA – CEMA Rate – Energy - Deposition of Energy – Energy Imparted – Linear Energy – Specific Energy – Absorbed Dose – Absorbed Dose Rate - Physical Quantities – Protection Quantities – Operational Quantities – Equivalent Dose – Effective Dose – Weighting factor – ICRU Sphere Phantom.

3. Measurement of Radiation:

Ionization of Gases -Fluorescence and Phosphorescence – Effect on Photographic Emulsion – Free air Ion chamber - Ionization chambers – Proportional counter - G.M. counters - Scintillation detectors – Semiconductor diode detectors – Neutron detectors - Pocket dosimeters - TL Dosimeters and their use in personnel monitoring badges – Advantages and disadvantages of various detectors - appropriateness of different types of detectors for different types of radiation measurement.

Principle of Radiation Detectors - General properties of Radiation detectors – Zone monitor – Teletector – Contamination Monitor - Personnel monitoring devices – Film and TLD badges. In vivo – Direct patient dosimeter (DPD) - TLD, Diodes, MOSFET

Practical:

1. Personnel Monitoring Services – TLD
2. Radiation Measuring Instruments
3. Measurement of HVT and TVT
4. Measurement of Wedge Factor
5. Measurement of Tray Factor
6. Measurement of Couch Attenuation
7. Calibration of CTDI phantom
8. Ionization Chambers and Dosimeters

Textbooks recommended (Latest edition):

1. The Physics of Radiology Harold Elford Johns & Jonh Robert Cunningham.
2. The Physics of Radiation Therapy Faiz M. Khan.
3. Radiation Oncology physics A Handbook for Teachers and Students – E.B. Podgorsak.
4. ICRU report 83
5. Radiation Detection and measurement – Glenn F. Knoll.
6. Radiation Dosimetry – H.E.Johns
7. Atomic Nucleus – M. Korsunsky
8. Radiological physics – M.E.J. Young.
9. Text book of physics applied to Radiotherapy and Radio-diagnosis – Massey and Meredith.
10. X-Rays their origin dosage and practical application - Schall W E
11. Nuclear Physics – Enrico Fermi.
12. Radiation Detection and measurement – Glenn F. Knoll.
13. Radiation Dosimetry –Hine & Brownell
14. Radiation Dosimetry - Attix F. H. and Roesch. W. C.

Paper II: Image processing techniques and Special radiographic procedures**Theory****Image processing techniques:****1. Film-screen radiography**

- a. Dark room planning
- b. Dark room – safelight, passbox, dry and wet side
- c. Luminescent Screens
- d. X-Ray Cassette
- e. X-Ray Film
 - i. film structure and film technology, film type, size and packing, other types of films and handling of X-ray film
 - ii. Physical characteristics of X-ray film
 - iii. Film processing
 - iv. Automatic film processor
 - v. Photographic characteristics of X-ray film – photographic density and characteristic curve
 - vi. Speed, Latitude, Emulsion Absorption
 - vii. Film defects and their possible causes

2. Digital Radiography

- a. Cassette-Based Equipment - The Computed Radiography Cassette, Imaging Plate, and Reader
- b. CR Cassette-Based Image Acquisition
- c. DR - Cassetteless Equipment and Image Acquisition
- d. Digital Radiographic Image Processing and Manipulation
- e. Total Quality Management of CR and DR Systems

3. PACS

- a. Basic Computer Principles
- b. Networking and Communication Basics
- c. PACS Fundamentals
- d. PACS Archiving
- e. Digitizing, Printing, and Burning
- f. Quality Control and Quality Management
- g. Management
- h. Ensuring Quality in PACS

Special radiographic procedures:

- Responsibility of Radiographer during radiological procedures.
- Preparation of patient for different procedures.

- Aseptic technique.
- Radiation protection in Fluoroscopy
- Contrast media –
 - Ionic & non ionic contrast media
 - Adverse reactions to contrast media and patient management.
 - Emergency Drugs in the Radiology Department.
 - Emergency Equipments In the Radiology Department.
- Procedure
 - IVU
 - MCU/RGP
 - Myelogram
 - Contrast media in GIT
 - Barium Swallow
 - Barium Meal
 - Ba MFT
 - Enteroclysis
 - Barium Enema
 - Contrast meal and enema, Loopogram
 - HSG, Fallopian tube recanalisation
 - Sialography/ Dacryocystography
 - T-tube cholangiography/PTC/Direct portography
 - Arthrography
 - Sinography, Fistulography

Practical:

1. Developing exposed film using conventional technique and auto-processor
2. Acquiring and post-processing radiographic images with Computerised Radiography and Digital radiography
3. Interacting with PACS
4. Performing various special radiographic procedures

Textbooks recommended (Latest edition):

1. Medical X-ray film Processing by Thayalan
2. Christi Carter MSRS RT(R) - Digital Radiography & PACS
3. Radiographic latent image processing – W.E.J Mckinney
4. Photographic processing chemistry – L.F.A. Mason
5. Physical and photography principles of medical radiography – Seeman & Herman
6. Bhushan N. Lakhkar - Radiological Procedures (A Guideline)-Arya Publications
7. Stephen Chapman & Richard Nakielny: A Guide to Radiological Procedures

Paper III: Radiographic procedure and positioning**Theory**

- General theory Preliminary Steps in Radiography
- General Anatomy and Radiographic Positioning Terminology

- Upper Extremity and Shoulder Girdle
 - Anatomy
 - Radiography
 - Hand, Fingers, and Thumb
 - Wrist
 - Forearm
 - Elbow
 - Humerus
 - Shoulder

- Lower Extremity and Pelvis
 - Anatomy
 - Radiography
 - Foot and Toes
 - Ankle
 - Lower Leg
 - Knee
 - Femur
 - Pelvis

- Vertebral Column
 - Anatomy
 - Radiography
 - Cervical Spine
 - Thoracic Spine
 - Lumbar Spine
 - Sacrum
 - Coccyx

- Sternum and Sternoclavicular Joints

- Head and Neck
 - Anatomy
 - Radiography
 - Skull
 - Cranium
 - Orbits
 - Facial Bones, Zygomatic Arches, and Nasal Bones
 - Mandible and Temporomandibular Joints (TMJs)
 - Paranasal Sinuses
 - Soft Tissue Neck

- Respiratory System
 - Anatomy
 - Radiography
 - Introduction
 - Chest; PA, Lateral, and Obliques
 - Chest; Axial and Decubitus

- Airway
 - Terminology and Pathology
- Digestive System
 - Anatomy
 - Radiography
 - Introduction
 - Patient Preparation
 - Abdomen
 - Terminology and Pathology
- Urinary System
 - Anatomy
 - Radiography
 - Introduction
 - Patient Preparation and Procedure
 - Types of Examinations
 - KUB
 - Terminology and Pathology
- Mammography
 - Principles of mammography
 - Anatomy
 - Tissue variations
 - Exposure technique chart
 - Routine projections of the breast.
 - Significant mammographic findings.
 - Image enhancement methods.
 - Supplemental projections.
 - Localization of nonpalpable lesions.
 - Breast specimen radiography.
 - Examination of milk ducts.
 - Computer-aided detection and computer-aided diagnosis
 - Digital Tomosynthesis
- Mobile Radiography
 - Principles
 - Machines
 - Technical considerations
 - Radiation safety
 - Isolation
 - Performing examinations – general points
 - Chest
 - Abdomen
 - Femur
 - Cervical spine
 - Neonate- chest and abdomen
- Surgical Radiography
 - Surgical team
 - Proper Surgical attire
 - Operating room attire
 - The Operating room

- Equipment – C-arm
- Cleaning of equipment
- Fluoroscopic procedures
- Mobile radiography
- Definition of terms
- Bone Densitometry
- Dental Radiography
 - Dental X-ray equipment
 - Dental X-Ray Film
 - Infection Control and the Dental Radiographer
 - Introduction to Dental Imaging Examinations
 - Paralleling Technique
 - Bisecting Technique
 - Bite-Wing Technique
 - Exposure and Technique Errors
 - Occlusal and Localization Techniques
 - Panoramic Imaging
 - Extraoral Imaging
- Macro Radiography
- Foreign Body Localization
- Forensic Radiography

Practical:

1. Performing radiography of axial and appendicular skeleton, head and neck, respiratory system, digestive system, urinary system etc.
2. Facility Preparation and Efficient use of available radiographic equipment
3. Patient preparation and communication, including radiation safety instruction
4. Assessment of Radiographic Image Quality
5. Identification of anatomical landmarks in acquired images

Textbooks recommended (Latest edition):

1. Bruce W. Long, Jeannean Hall Rollins, Barbara J. Smith - Merrill's Atlas of Radiographic Positioning and Procedures. Mosby
2. Dental Radiography: Principles and Techniques. Joen M. Iannucci
3. Anita Biedrzycki - Radiography Procedure and Competency Manual-F.A. Davis Company
4. Philip W. Ballinger: Atlas of radiographic positioning and Radiological Procedures.
5. RA Swallow, E Naylor: Clark's positioning in Radiography. EJ Roebuck, AS Whitley
6. Dental Radiography: Principles and Techniques. Joen M. Iannucci,

Phase III

Paper I: Computed tomography, Digital subtraction Angiography, Interventional radiology

Theory

Computed tomography

- Basic Principles of CT
- Data Acquisition – axial, helical, multidetector
- Image Reconstruction
- Image Display
- Methods of Data Acquisition
- Image Quality
- Quality Assurance
- Post-Processing
- Patient Communication
- Patient Preparation
- Injection Techniques
- Radiation Dosimetry in CT & dose reduction in CT
- Cross sectional anatomy
 - Neuroanatomy
 - Thoracic Anatomy
 - Abdominopelvic Anatomy
 - Musculoskeletal Anatomy
- CT scan procedures
 - Neurologic Imaging Procedures
 - Thoracic Imaging Procedures
 - Abdomen and Pelvis Imaging Procedures
 - Musculoskeletal Imaging Procedures
 - CT perfusion
 - CT angiography
 - Dual energy CT
- Interventional CT and CT Fluoroscopy
- PET/CT Fusion Imaging

Digital subtraction Angiography, Interventional radiology

Physics

- Basic X-Ray Physics
- Fluoroscopy
- Digital fluoroscopy
- Principles of Radiation Safety in Interventional Radiology
- Common Equipment in Interventional Radiology, Catheters, Guides, and Introducer Sheaths
- Seldinger Technique. Retrograde and Antegrade Approach Through the Femoral Artery

- Complications of Vascular Access.
- Medications Used in Interventional Radiology

Techniques

1. Biopsy and Drainage
2. Arterial and Venous Access
3. Embolization Materials and Principles
4. Image-Guided Tumor Ablative Therapies
5. Common Interventional Radiology Procedures

Angiography

1. The Thoracic Aorta. Obtaining a Thoracic Aortogram
2. The Abdominal Aorta. Obtaining an Aortogram
3. The Pelvis. Angiographic Study
4. Lower Limbs. Angiographic Study
5. Upper Limbs. Angiographic Study

Interventional radiology

1. Thoracic Interventional Radiology
2. Gastrointestinal Interventions
3. Hepatobiliary and Pancreatic Interventions
4. Genitourinary Interventions
5. Peripheral Vascular Intervention
6. Neurointervention

Practical

1. Computed tomography- anatomy, planning, positioning and contrast media
2. Planning CT studies of the Head, body including angiograms
3. Various contrast media used in CT scanning – indications, dosage, advantages & disadvantages, safety screening, injection techniques
4. Assessing adequacy of acquired CT images
5. Interpretation of CT anatomical landmarks in acquired images
6. Quality assurance in CT
7. Patient preparation and communication, including radiation safety instruction

Textbooks recommended (Latest editions):

1. Computed Tomography for Technologists A Comprehensive Text by Lois E. Romans
2. Sriharsha Athreya (eds.) - Demystifying Interventional Radiology_ A Guide for Medical Students-Springer International Publishing
3. José J. Muñoz, Ramón Ribes (auth) - Learning Vascular and Interventional Radiology - Springer-Verlag Berlin Heidelberg
4. John R. Haaga, Charles F. Lanzion, David J. Sartoris & Elias A. Aershouni: Computerised Tomography and Magnetic Resonance Imaging of the whole Body (Vol I & II) (Saunders)
5. Vascular and Interventional Radiology: The Requisites John A. Kaufman , Michael J. Lee. Mosby.

Paper II: Magnetic Resonance Imaging, Ultrasonography, Nuclear Medicine**Theory****Magnetic Resonance Imaging****MRI Physics**

1. Basic Principles
2. Image weighting and contrast
3. Introduction to pulse sequences
4. Encoding and image formation
5. Data collection and image formation
6. Parameters and trade-offs
7. Basic Pulse sequences – spin echo, gradient echo, inversion recovery, diffusion, perfusion imaging, spectroscopy, susceptibility weighted imaging
8. Flow phenomena
9. Artefacts and their compensation
10. Vascular and cardiac imaging ,MRA and MRV
11. Instrumentation and equipment
12. MRI safety
13. Contrast agents in MRI
14. Functional imaging techniques, Diffusion tensor imaging

MRI procedure

1. Brain
 - i. temporal lobes
 - ii. Posterior fossa and internal auditory meatus
 - iii. Pituitary fossa
2. Head and neck
 - i. Orbits
 - ii. Paranasal sinuses
 - iii. Pharynx
 - iv. Larynx
 - v. thyroid and parathyroid glands
 - vi. Salivary glands
 - vii. temporomandibular joints
 - viii. Vascular imaging
3. Spine
 - i. Cervical spine
 - ii. thoracic spine
 - iii. Lumbar spine
 - iv. Whole spine imaging
4. Chest

5. Abdomen
 - i. Liver and biliary system
 - ii. Kidneys and adrenal glands
 - iii. Pancreas
 - iv. Vascular imaging
6. Pelvis
 - i. Male pelvis
 - ii. Female pelvis
 - iii. Obstetrics
7. Upper limb
8. Lower limb

Ultrasonography

Physics

1. Introduction to B-mode imaging
2. Transducers and beam-forming
3. B-mode instrumentation
4. Properties, limitations and artefacts of B-mode images
5. B-mode measurements
6. Principles of Doppler ultrasound
7. Contrast agents

Procedure

1.
 1. Abdominal Ultrasound
 2. Gynaecologic Ultrasound
 3. Obstetric Ultrasound
 4. Colour Doppler Sonography in Obstetrics
 5. Chromosomal Abnormalities
 6. Ultrasound of Small Parts and Superficial Organs
 7. Neonatal Cranial Ultrasound
 8. Ultrasound-Guided Biopsy, Aspiration and Fine Needle Aspiration Cytology

Nuclear medicine

1. Radionuclides.
2. Radiopharmaceuticals and their preparation, precautions while handling radiopharmaceuticals
3. Gamma camera, SPECT, PET- Principles of operation-Indication and Contraindications
4. Disposal of Radio-active waste, safety considerations

Practical

1. Magnetic Resonance Imaging- anatomy, planning, positioning and contrast media
2. Planning MRI studies of the Head, body including angiograms
3. Various contrast media used in MRI scanning – indications, dosage, advantages & disadvantages, safety screening, injection techniques
4. Assessing adequacy of acquired MRI images
5. Interpretation of MRI anatomical landmarks in acquired images
6. Quality assurance in MRI
7. Patient preparation and communication, including MRI safety instruction

Textbooks recommended (Latest editions):-

1. Catherine Westbrook, Carolyn Kaut Roth, John Talbot-MRI in Practice-Wiley-Blackwell
2. Catherine Westbrook - Handbook of MRI Technique-Wiley-Blackwell
3. Diagnostic Ultrasound Physics and Equipments Edited by Peter Hoskins, Kevin Martin and Abigail Thrush
4. Rajendra K. Diwakar (eds.) - Basics of Abdominal, Gynaecological, Obstetrics and Small Parts Ultrasound
5. Farr's Physics for Medical Imaging. PA Roberts,J. Williams. Saunders
6. Essentials of Nuclear Medicine Imaging 5th edition .Fred A. Mettler Jr. Milton J. Guiberteau . Saunders

Paper III: Radiation safety in diagnostic radiology, Regulatory requirements in diagnostic radiology**1. Radiation Hazard Evaluation and Control**

Natural background radiation – Dose limits – Occupational & Public Exposure Limits - Dose Constraints for Comforters of Patients - Radiation Protection of Self and Patient - Philosophy of Radiation Protection - Effect of Time, Distance and Shielding - ALARA - Calculation of Workload - Calculation of Dose to Radiation Worker and General Public - Good Work Practices in Radiology - Radiation Survey – Personnel Dosimeters – Storage and Handling of Personnel Dosimeters - Planning Consideration for Radiology Installation Layout - Effect of Different Shielding Material.

2. Biological Effects of radiation

Ionization, Excitation and Free Radical Formation - Hydrolysis of Water - Action of Radiation on Cell - Chromosomal aberration and its Application for Biological Dosimetry - Effects of Whole Body and Acute Irradiation - Dose Fractionation - Effects of Ionizing Radiation on Each of Major Organ System Including Foetus -Somatic Effects and Hereditary Effects - Stochastic and Deterministic Effects -Acute Exposure and Chronic Exposure - LD50/60 - Factors Affecting Radio Sensitivity - Biological Effects of Non-Ionizing Radiation like Ultrasound, Lasers, IR, UV and Magnetic Fields.

3. Radiation Emergency Preparedness

Safety and security of radiation generating equipment, Case histories of radiation accidents and preparedness, Regulatory requirements and prevention of emergency, Preventive maintenance and Safety Culture, Role of technologist in handling radiation accident. Incident reporting

4. Regulatory requirements

International Commission on Radiation Protection (ICRP) - Atomic Energy Regulatory Board (AERB) - Responsibilities, organization, Safety Standards, Codes and Guides, Responsibilities of licensees, registrants and employers and Enforcement of Regulatory requirements, Registration in e-LORA.

5. Quality Assurance

General principles and preventive maintenance for routine, daily, weekly, monthly, quarterly, annually – machine calibration. Basic concepts of quality assurance – LASER printer – Central axis beam alignment; Optical and radiation field congruence ; X-ray output and beam quality check; KVp check; Focal spot size and angle measurement; Timer check; mAs test; Grid alignment test; High and low contrast resolutions; Mechanical and electrical checks; Cassette leak check; Proper screen-film contact test; Safe light test; Radiation proof test; Field alignment test for fluoroscopic device; Resolution test; Phantom measurements - CT, US and MRI. Patient support system, Beam on and off mechanisms, Technician's role in QA tests on radiation generating equipment

QA and QC of X-ray, CT, US, MRI and PACs related Image artifacts their different types, causes and remedies Film processing; Consideration for storage of film and chemicals; Faults tracing; Accuracy of imaging- image distortion for digital imaging devices. LASER printer calibration Sensitometry; Characteristic curve; Film latitude; Film contrast; Film speed Resolution; Distortion; Artifacts of films and image recording. Monitor calibration. SMPTE pattern

6. Maintenance and care of equipment:

Safe operation of equipment; maintenance of equipment and instruments; Cassette, screen maintenance; Maintenance of automatic processor and manual processing units; Routine maintenance of equipment's; Record keeping and log book maintenance.

Practical

Radiation Survey of Various Diagnostic Units And Dosimetry

1. Practice principles of Time, Distance, Shielding
2. Calculation of workload, use and occupancy factors
3. Standard layout of X-ray unit
4. Standard layout of CT unit
5. Quality Assurance tests in X-ray unit – Technologist Perspective
6. Quality Assurance tests in CT unit – Technologist Perspective
7. Familiarization of Radiation survey meters and their function
8. Radiological Protection Survey of X-ray and CT Installations
9. Technologist perspective in handling radiation emergencies and accidents
10. Radiation warning signage/beam indicators for X-ray units and CT
11. Personnel Monitoring Services
12. Regulatory requirements in radiology
13. Maintenance and care of equipments
14. Radiation safety of public, radiation workers and other staffs
15. Biological effects of radiation

Textbooks recommended (Latest editions):-

1. AERB safety code for Medical diagnostic x-ray
2. AERB safety code for Radiation Therapy Sources, Equipment and Installations
3. The Physics of Radiology Harold Elford Johns & Jonh Robert Cunningham.
4. ICRU, ICRP and NCRP reports
5. The Physics of Radiation Therapy Faiz M. Khan.
6. Principles of Radiation Protection – K. Z. Morgan and J. E. Turner.
7. Radiation protection in Medical radiography – Mary Alice
8. Radiation Oncology physics A Handbook for Teachers and Students – E.B. Podgorsak.
9. An introduction to Radiation Protection – Allen Martin & Samuel.

COURSE AND EXAMINATION REGULATIONS

Attendance:

- Students are required to attend 75% or more of all theory classes held, and 75% or more of practical in each subject to be eligible to appear in the final examination. Under no condition will a student with less than the prescribed attendance in any subject in theory and practical separately shall be allowed to appear in the Annual examination of that subject.
- Students with less than 75% attendance in theory and practical separately at the end of any year must start afresh by joining the junior batch of students. No extra classes will be arranged to make such students eligible for the final annual examinations. The attendance accrued in the previous academic year in those subject(s) will not be transferred. The student will need to secure 75% attendance afresh in theory and practical/laboratory postings after joining the junior batch to become eligible to appear in the final summative examination.
- The 25% leverage in attendance includes all types of leaves (including leave on medical grounds). For absence because of illness or any medical condition, a duly approved medical leave from Dean (Academic) with medical and fitness certificate issued/verified by authorized JIPMER clinical faculty member is mandatory. Certificate must be submitted before or within 10 days after availing medical leave.
- Students who are detained in all the subjects of a year due to lack of attendance should join the classes with junior batch within 7 days of declaration of the eligibility/detention list or when classes commence, whichever is earlier.
- Students who are detained in one or more subject(s) because of lack of attendance but are eligible to appear for final Annual examination in at least one subject of the year should join classes with junior batch within 7 days of completion of the last final theory/practical examination or when classes, whichever is earlier. Attendance will be calculated from the date of joining.
- A show cause notice will be issued to students on continuous unauthorized absence without prior permission for two weeks or more. If such absence extends to a period more than one month for any reason, the student is liable for termination for the course. The decision of the competent authority is final.
- There is **no condonation permissible** for shortage of attendance.

Internal Assessment (IA)

- A minimum of three notified internal assessments will be held periodically in each year (in a one-year period) and one model examination before the final annual examination.
- Each of the notified IA tests will carry 20% weightage and the model examination will carry 40% weightage. The sum of notified IA tests and model examination will decide the eligibility to appear in the examination and for contribution to aggregate marks.

- A student must secure at least 30% of the maximum marks fixed for internal assessment in theory and practical/clinical separately in a particular subject to be eligible to appear for the final annual examination in that subject.
- Of the final total aggregate marks in each subject, internal assessment marks will contribute 40% and annual examination marks will contribute the remaining 60%. This will apply to both theory and practical/clinical papers separately.
- If a student misses up to one notified test because of illness, marks of the remaining notified tests can be considered for calculating the internal assessment, ignoring the absence on medical grounds. To avail this concession, the student should submit a valid medical certificate signed by the treating clinical faculty member of JIPMER before or within 10 days after the missed test. This exemption will not apply to model examination. This is applicable only up to one missed notified internal assessment test.
- No repeat/additional notified internal assessment or model examination will be conducted.
- Students who are detained in all the subjects of a year because of lack of sufficient internal assessment marks should join the classes with junior batch within 7 days of declaration of the eligibility/detention list or when classes of the year commence, whichever is earlier.
- Students who are detained in one or more subject(s) due to lack of sufficient internal assessment marks but are eligible to appear in the annual examination in at least one subject of the year should join classes with junior batch within 7 days of completion of the last annual theory/practical examination or when classes of the year commence, whichever is earlier.
- The internal assessment marks accrued in the previous year will not be transferred to the next year.

Annual Examinations

Number and timing of examinations

- Annual examinations will be held at the end of each academic year. The Institute shall conduct not more than two annual examinations in an academic year, a regular annual and a supplementary examination in each subject. The supplementary examinations will be held within 6 weeks after publication of the result of the regular annual examination.
- Practical Examinations shall be jointly conducted by one internal and one external examiner duly appointed by the Professor of Examinations.
- Students should obtain a minimum of 40% in the annual examination and a minimum of 50% in the final total aggregate (total of internal assessment and annual examination marks) in a subject (theory and practical separately) to be declared as pass in that subject.

Marks scheme:

	Maximum marks
Theory	200
Practical	100
Total	300

Theory

	Maximum marks
Internal Assessment test 1 (weighted)	16
Internal Assessment test 2 (weighted)	16
Internal Assessment test 3 (weighted)	16
Model Examination	32
Annual Theory Examination	100
Viva-voce Examination	20
Total Theory marks	200

Practical

	Maximum marks
Internal Assessment test 1 (weighted)	7
Internal Assessment test 2 (weighted)	7
Internal Assessment test 3 (weighted)	7
Model Examination	14
Record marks	5
Annual Practical Examination	60
Total Practical marks	100

Question paper pattern

	Maximum marks
Section A	50
Section B	50
Total	100

Each section

		Marks
Answer in detail	1 X 10	10
Short notes	5 X 5	25
Brief answers	5 X 3	15
		50

Number of attempts and Training Period

- The academic program of the BSc Allied Health Sciences courses must be completed within 6 years from the date of joining (excluding internship). Maximum permissible duration for each year shall be four years and a maximum four attempts (including the annual and supplementary examinations) in any subject will be permitted.
- If a student does not appear in both theory and practical final examination, it will NOT be considered as an attempt for the purpose of calculation of maximum number of attempts in a subject.
- If a student appears for theory in the Annual Examination but does not appear for Practical Examination or vice-versa, his/her theory or practical appearance shall be counted as an attempt. In the next attempt, the student will have to appear for both Theory and Practical Examinations. Mere submission of application form for examination will not be considered as an attempt.
- Passing in the exams of all the previous year subjects is compulsory before proceeding to the classes of next phase.
- A student who fails in theory and/or practical papers of one or more subjects in the regular annual examinations at the end of each year can appear in the supplementary examination (to be held within 6 weeks of announcement of the regular annual examination results) in those subjects.
- If he/she passes these subjects in the supplementary examination, he/she should join the regular batch within 7 days of declaration of supplementary examination results or when classes commence, whichever is earlier. Attendance calculation for students who join after passing supplementary examination will begin from their date of joining of that year.
- Students who fail in theory and/or practical in one or more subjects in the supplementary examination and those who do not appear in the supplementary examination should join classes with the junior batch within 7 days of declaration of supplementary examination results or when classes, whichever is earlier. These students should secure 75% attendance and 30% internal assessment afresh to be eligible to appear in the final regular annual examination of that year along with the junior batch. Attendance calculation for students who join after failing in supplementary examination will begin from their date of joining the year with junior batch.
- A maximum of four attempts in any subject is allowed. If a student fails even in the 4th attempt, no further chances will be given, and his/her name will be struck off the rolls of JIPMER.
- No grace marks will be awarded for either theory or practical examinations under any circumstances.

Model Question paper**Phase I - Paper I: Foundation course**

Maximum marks: 100

Maximum duration: 3 hours

Answer all the questions. Draw suitable diagrams where necessary

Section A**1. Answer the following question in detail:** 1 x 10 = 10

- a. Describe in detail healthcare delivery system in India at the primary, secondary, and tertiary levels.

2. Write short notes on the following: 5 x 5 = 25

- a. What is the role of processor and RAM in a computer?
- b. Describe the types of networks in computing.
- c. Write a short note on right to healthcare.
- d. What is medical negligence? What are the laws governing medical negligence in India?
- e. Write in brief about the importance of informed consent and the process.

3. Answer the following questions briefly: 5 x 3 = 15

- a. What are the components of a medical term?
- b. What are the input and output devices of a computer?
- c. What is paralanguage? What are its implications?
- d. Describe the characteristics of good communicator.
- e. What are the alternative medicine systems recognised by the Government of India?

Section B**1. Answer the following question in detail:** 1 x 10 = 10

- a. Explain the concepts of quality of care. Describe various approaches to quality improvement.

2. Write short notes on the following: 5 x 5 = 25

- a. Describe the principles of management with suitable examples.
- b. Describe the methods of disinfection in biomedical waste management.
- c. Describe the methods of prevention & control of common healthcare associated infections.
- d. Classify the types of antibiotic resistance and describe each of them.
- e. Write a short note on research study designs.

3. Answer the following questions briefly: 5 x 3 = 15

- a. What are the components of cardiopulmonary resuscitation?
- b. What is integrity and what is its importance of integrity in healthcare practice?
- c. What are the qualities of a good leader?
- d. What are the different types of data?
- e. Describe the concept of ethics and its relevance in healthcare practice.

Model Question paper**Phase I - Paper II: Anatomy and Physiology**

Maximum marks: 100

Maximum duration: 3 hours

Answer all the questions. Draw suitable diagrams where necessary

Section A - Anatomy

- 1. Answer the following question in detail:** 1 x 10 = 10
- a. Describe the position, parts, structure, blood supply and supports of uterus.
- 2. Write short notes on the following:** 5 x 5 = 25
- a. Parts and blood supply of stomach
b. Simple epithelium
c. Histology of lymph node
d. Chambers and valves of heart
e. Surfaces and lobes of lung
- 3. Answer the following questions briefly:** 5 x 3 = 15
- a. Name three major salivary glands.
b. Mention two contents of spermatic cord
c. Name two paranasal air sinuses
d. Name the parts of small intestine
e. Name two upper limb muscles

Section – B - Physiology

- 4. Write essay answer on the following:** 1 x 10 = 10
- a. Define immunity. Mention the different types of immunity. Write briefly about the different types of immunity. (2+2+6)
- 5. Write short notes on the following:** 5 x 5 = 25
- a. Active transport
b. Movements of small intestine
c. Factors affecting glomerular filtration rate
d. Oxygen haemoglobin (Oxy-Hb) dissociation curve
e. Factors regulating cardiac output
- 6. Write very short answers on the following:** 5 x 3 = 15
- a. Name the hormones secreted from Adrenal gland
b. Mention the Indicators of ovulation
c. Define tidal volume. Mention its normal value.
d. Draw a labelled diagram of lead II ECG.
e. List four functions of hypothalamus.

Model Question paper**Phase I - Paper III: Pathology and Microbiology**

Maximum marks: 100

Maximum duration: 3 hours

Answer all the questions. Draw suitable diagrams where necessary

Section A - Pathology**1. Answer the following question in detail:** 1 x 10 = 10

- a. What is inflammation? What are the cardinal signs of inflammation? Mention the difference between acute and chronic inflammation. Add a note on granuloma with example. (1+2+4+3)

2. Write short notes on the following: 5 x 5 = 25

- a. Define necrosis (1). Give examples of different types of necrosis (2). Differences between necrosis and apoptosis (2).
- b. What is thrombosis (1)? Explain Virchow's triad (4).
- c. Define neoplasia (1). What are the differences between benign and malignant tumours (2)? List the different routes of metastasis (2).
- d. Mention the differences between wound healing by primary and secondary intention (5).
- e. Principles and procedures of blood grouping (3) and cross-matching (2).

3. Answer the following questions briefly: 5 x 3 = 15

- a. Define anemia. Give any two causes of anemia.
- b. What is jaundice? Give the classification based on pathophysiology.
- c. What is atherosclerosis? Give some of its risk factors.
- d. What is nephrotic syndrome? Give any two examples.
- e. How will you do urine analysis?

Section – B - Microbiology**4. Write essay answer on the following:** 1 x 10 = 10

- a. Define sterilization. Draw a labelled diagram of autoclave. Write principle of autoclave and its application in hospital. (1+3+3+3)

5. Write short notes on the following: 5 x 5 = 25

- a. Enumerate vector borne diseases. Add a note on the laboratory diagnosis of malaria
- b. What do you understand by segregation of biomedical waste? How is it done in your hospital?
- c. Describe in detail about various method of urine sample collection
- d. Enumerate sexually transmitted microorganisms. Write laboratory diagnosis of HIV
- e. Describe laboratory diagnosis of Mucormycosis.

6. Write very short answers on the following: 5 x 3 = 15

- a. Name two transport media
- b. Name two foodborne pathogens
- c. Enumerate four Personal Protective Equipment (PPE)
- d. Name two nosocomial pathogens
- e. List two opportunistic fungal infection

Model Question paper**Phase I - Paper IV: Physics of diagnostic radiology**

Maximum marks: 100

Maximum duration: 3 hours

Answer all the questions. Draw suitable diagrams where necessary

Section A

- 1. Answer the following question in detail:** 1 x 10 = 10
- a. Construction and working of a modern X-ray tube.
- 2. Write short notes on the following:** 5 x 5 = 25
- a. Image intensifier.
b. Coherent scattering
c. Collimators.
d. Characteristic radiation.
e. Auto-transformer.
- 3. Answer the following questions briefly:** 5 x 3 = 15
- a. Tungsten in radiography.
b. Types of anode.
c. Advantages of high frequency generator.
d. Grid cut off
e. Bucky factor

Section B

- 4. Write essay answer on the following:** 1 x 10 = 10
- a. Explain the importance of grids in routine radiography. Describe the types of grids. What is Grid cut-off?
- 5. Write short notes on the following:** 5 x 5 = 25
- a. Inherent and added filtration.
b. Anode heel effect and its use.
c. Mobile X-ray maintenance.
d. Line focus principle.
e. Air-gap technique
- 6. Write very short answers on the following:** 5 x 3 = 15
- a. Bremsstrahlung radiation
b. Cones.
c. Grid ratio.
d. Focal spot of X-ray tube.
e. Space charge effect.

Model Question paper**Phase II - Paper I: Interaction of radiation with matter,
Radiation measurements, quantities, and units**

Maximum marks: 100 Maximum duration: 3 hours
Answer all the questions. Draw suitable diagrams where necessary

Section A

- 1. Answer the following question in detail:** 1 x 10 = 10
- a. Explain in detail about the Compton effect with neat diagram.
- 2. Write short notes on the following:** 5 x 5 = 25
- a. What is Flux and Fluence?
b. What is Mass attenuation coefficient and Mass energy transfer coefficient?
c. Explain photo electric effect
d. Derive the exponential equation for photon attenuation
e. Explain the working principle of ionization chamber
- 3. Answer the following questions briefly:** 5 x 3 = 15
- a. What is narrow beam?
b. Convert 10Ci in to Becquerel
c. What is radiation weighting factor?
d. What is gamma zone monitor
e. Old and new unit and their relationship for effective dose

Section B

- 4. Write essay answer on the following:** 1 x 10 = 10
- a. Explain the working principle of TLD and their usages
- 5. Write short notes on the following:** 5 x 5 = 25
- a. Explain the operational quantities with flow chart
b. What is KERMA and CEMA?
c. What is fluorescence and phosphorescence?
d. Discuss about scintillation detectors
e. Explain the different types of survey meters
- 6. Write very short answers on the following:** 5 x 3 = 15
- a. Convert 10 mSv in to REM
b. What is contamination monitor?
c. Name few ionization chambers
d. What is in-vivo dosimeter?
e. What is HVT and TVT?

Model Question paper**Phase II - Paper II: Image processing techniques and Special radiographic procedures**

Maximum marks: 100 Maximum duration: 3 hours
Answer all the questions. Draw suitable diagrams where necessary

Section A

1. Answer the following question in detail: 1 x 10 = 10

- a. Discuss the indications, contraindications, patient preparation, precautions, and procedure of performing micturating cystourethrogram.

2. Write short notes on the following: 5 x 5 = 25

- a. Digital Radiography
- b. Barium swallow.
- c. Clean, sterile and aseptic technique.
- d. Retrograde pyeloureterography
- e. Myelogram

3. Answer the following questions briefly: 5 x 3 = 15

- a. Passbox
- b. Automatic exposure rate control
- c. Dental Xray film
- d. Radiation dose during fluoroscopy
- e. Sialography

Section B

4. Write essay answer on the following: 1 x 10 = 10

- a. Describe the working principle of computed radiography
- b. Mention the advantages and disadvantages of Computed Radiography compared to conventional film screen radiography (5+5)

5. Write short notes on the following: 5 x 5 = 25

- a. Phlebography.
- b. Hysterosalpingography
- c. Arthrography
- d. Contrast media used in GIT radiography.
- e. Small bowel enema (enteroclysis)

6. Write very short answers on the following: 5 x 3 = 15

- a. Risk factors for contrast nephropathy.
- b. Drugs used in preparation for IVU
- c. Conventional fistulography
- d. Dacryocystography
- e. Differences of appearance of jejunum and ileum in barium meal follow through

Model Question paper**Phase II - Paper III: Radiographic Procedures and Positioning**

Maximum marks: 100

Maximum duration: 3 hours

Answer all the questions. Draw suitable diagrams where necessary

Section A**1. Answer the following question in detail:** 1 x 10 = 10

- a. Enumerate the routine and supplementary radiographic views for imaging the cranium and facial bones. Describe in detail the positioning and technique of imaging paranasal sinuses.

2. Write short notes on the following: 5 x 5 = 25

- a. Radiographic evaluation of mastoids.
- b. Lateral decubitus view of abdomen.
- c. Radiographic views to evaluate mandible.
- d. Radiographic anatomy of PA view of chest.
- e. Precautions to be taken while acquiring chest radiograph of a newborn.

3. Answer the following questions briefly: 5 x 3 = 15

- a. Frog leg view.
- b. Radiographic view for evaluation of nasal bones.
- c. Radiographic view for zygomatic arches.
- d. Name the foraminae in base of skull.
- e. Apical lardotic view.

Section B**4. Write essay answer on the following:** 1 x 10 = 10

- a. Mention the basic radiographic views of the Chest including indications and technique. Add a note on special views.

5. Write short notes on the following: 5 x 5 = 25

- a. Radiographic views for elbow joint and explain the radiographic anatomy.
- b. Skeletal survey.
- c. Role of Grid in radiography and types of Grids.
- d. Radiographic imaging of scoliosis.
- e. Radiographic views for hand and wrist.

6. Write very short answers on the following: 5 x 3 = 15

- a. Enumerate the spinal vertebral segments.
- b. AP of Acromioclavicular joint.
- c. Skyline view.
- d. What is flat foot?
- e. Carpal Tunnel view.

Model Question paper**Phase III - Paper I: Computed tomography, Digital subtraction Angiography, Interventional radiology**

Maximum marks: 100 Maximum duration: 3 hours
Answer all the questions. Draw suitable diagrams where necessary

Section A

1. Answer the following question in detail: 1 x 10 = 10

- a. Describe the scanning parameters that affect image quality in CT

2. Write short notes on the following: 5 x 5 = 25

- a. Typical window settings for common CT examinations
b. What are the methods of CT image reformation? Describe any two in detail
c. Write the procedure to start a peripheral intravenous line for the purpose of contrast enhanced CT scanning.
d. Write a note on common Interventional Radiology Procedures
e. Describe Seldinger technique

3. Answer the following questions briefly: 5 x 3 = 15

- a. What is Hounsfield number?
b. Scanogram
c. Bolus triggering.
d. Scan field of view and display field of view
e. DICOM and HL7

Section B

4. Write essay answer on the following: 1 x 10 = 10

- a. Describe in detail the various Generations of CT scanners

5. Write short notes on the following: 5 x 5 = 25

- a. Methods of contrast medium delivery in CT.
b. Pitch in CT scanning
c. Enumerate the various CT guided interventional procedures and write in detail about CT guided biopsy
d. Write a note on quality assurance in CT
e. What is CTDI_{vol}?

6. Write very short answers on the following: 5 x 3 = 15

- a. Route taken by intravenous contrast in the body
b. Mention CT HU value range of bone and fat
c. What is the use of slip rings in CT?
d. Name two CT artifacts and their cause
e. Mention two GI contrast media used in CT

Model Question paper**Phase III - Paper II: Magnetic Resonance Imaging, Ultrasonography,
Nuclear Medicine**

Maximum marks: 100 Maximum duration: 3 hours
Answer all the questions. Draw suitable diagrams where necessary

Section A

- 1. Answer the following question in detail:** 1 x 10 = 10
- a. Describe the various MRI artifacts with a note on how to rectify each of them
- 2. Write short notes on the following:** 5 x 5 = 25
- a. Describe the different ultrasound display modes.
b. Magnetic resonance Cholangiopancreatography
c. MR contrast media and their adverse reactions
d. Describe the parts of an ultrasound transducer with the help of a diagram
e. List the protocols for MRI of Lumbosacral spine.
- 3. Answer the following questions briefly:** 5 x 3 = 15
- a. What is T1 relaxation time?
b. What is Tissue harmonic imaging?
c. List the different types of magnetic susceptibility
d. Mention four fast pulse sequences in MRI.
e. What do you mean by Specific Absorption Rate?

Section B

- 4. Write essay answer on the following:** 1 x 10 = 10
- a. Enumerate the indications, equipment, patient positioning and protocols for MRI of the Brain in a patient presenting with weakness of Right upper and lower limbs.
- 5. Write short notes on the following:** 5 x 5 = 25
- a. Describe the factors affecting image quality in MRI.
b. Describe the principle and applications of Inversion recovery sequence in MRI
c. List the use of Antenatal Ultrasound.
d. List the safety precautions to be followed in MRI the room.
e. Principles of operation of SPECT.
- 6. Write very short answers on the following:** 5 x 3 = 15
- a. What is Doppler shift?
b. List few contraindications for MRI
c. What is USG Elastography?
d. What is the use of Shimming in MRI?
e. What is Time of Repetition and Time of Echo?

Model Question paper**Phase III - Paper III: Radiation safety and Regulatory requirements in diagnostic radiology**

Maximum marks: 100 Maximum duration: 3 hours
Answer all the questions. Draw suitable diagrams where necessary

Section A

- 1. Answer the following question in detail:** 1 x 10 = 10
- a. Explain the quality assurance test performed in diagnostic x-ray unit
- 2. Write short notes on the following:** 5 x 5 = 25
- a. Explain H&D curve
b. Explain the principles of radiation protection.
c. Role of licensee in diagnostic radiology
d. How to perform phantom related QA in mammography?
e. List the QA tests performed in CT scan unit.
- 3. Answer the following questions briefly:** 5 x 3 = 15
- a. Minimum room requirements for x-ray unit and CT facilities.
b. What are the types of survey meters available for radiation survey?
c. What is type approval?
d. Name any three personnel monitoring devices.
e. What is customer acceptance test?

Section B

- 4. Write essay answer on the following:** 1 x 10 = 10
- a. Draw a neat model room layout of CT. Enumerate the basic regulatory requirement for CT
- 5. Write short notes on the following:** 5 x 5 = 25
- a. Acute radiation effects due to whole body exposure.
b. Radiation weighting factor.
c. Prenatal effect.
d. Deterministic and Stochastic effects.
e. Explain the formula to derive reduction factor in shielding calculation.
- 6. Write very short answers on the following:** 5 x 3 = 15
- a. Cellular level damage.
b. Molecular level damage.
c. Recommended wall thickness for a CT room.
d. What is eLORA?
e. Write few steps to controls external radiation hazards.
