Jawaharlal Institute of Postgraduate Medical Education & Research

(JIPMER)

Puducherry

BSc Radiotherapy Technology

CURRICULUM

2021

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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) – Radiotherapy 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.

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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 Radiation Oncology

The Department of Radiation Oncology was previously known as Radiotherapy. The department offer services to effectively evaluate, diagnose, test, and treat cancer patients compassionately with the best possible evidence-based care while striving towards producing advancements in the science of oncology. The department is located in the Regional Cancer Centre building and has all the necessary infrastructure and state-of-the-art equipment to give excellent care to patients and to provide high standards of training to students. Some of the treatment facilities available in the department include external beam radiotherapy with cobalt unit, linear accelerator, intensity modulated radiotherapy, brachytherapy, and image-guided radiotherapy.

COURSE DETAILS

Nomenclature: BSc (Allied Health Sciences) – Radiotherapy Technology

Introduction:

Radiation Oncology is a broad speciality that deals with the non-surgical management of cancers primarily comprising of solid tumours, using therapeutic radiation such as X-rays, γ-rays, protons, etc., anti-cancer systemic therapy such as chemotherapy, hormones, molecular targeted therapies, immunotherapies, etc., and supportive cancer care. The advanced equipment that deliver radiation therapy require skilled technologists for implementing the treatment plans accurately.

Objectives of the course:

The aim of the course is to impart appropriate knowledge and skills to work closely with Medical Physicists and Radiation Oncologists and contribute to the essential care to cancer patients in a department of Radiation Oncology. At the completion of this course, the student will be able to:

- execute all routine radio therapeutic procedures as per prescription and direction of Radiation Oncologist.
- operate the radiotherapy equipment used in treatment of cancer patient independently and maintain the equipment under the guidance of Medical Physicist.
- assist the Radiation Oncologist and Medical Physicist in treatment of cancer patients, radiotherapy planning & procedures, and implementation of new equipment/ technology
- demonstrate and apply adequate knowledge about the safe handling of medical radiation sources, keeping in mind the radiation protection of staff, patients and public.
- demonstrate patient management skills.
- transfer knowledge and skills to students as well as younger professionals, actively participate and also independently work in research in the field of radiotherapy delivery / clinical research/ trials and related areas.

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, Radiation Physics, mathematics, and statistics.

Second phase: one year

In the Second phase, the students will learn the concepts of radiation physics and the concepts behind treatment planning. This includes gaining knowledge about basic instrumentation of radiotherapy equipment such as teletherapy unit, brachytherapy unit and simulators. They will learn about the operational procedures of the units

They will be trained to do basic QA tests of the radiotherapy equipments. The students will learn about the effects of radiation on human body and how radiation exposure can be kept to a minimum.

Third phase: one year

In the Third phase, the students will learn to operate various imaging and therapeutic techniques. They will also be trained in preparation and handling various immobilization accessories and safe handling of the radiation generating equipments as per regulatory requirements

Internship: one year

Internship of one year is compulsory. The interns will be given hands-on training in diagnostic and therapeutic procedures. They will also take part in the quality assurance and quality control related activities of the department. They will have two weeks posting in Radiodiagnosis and one week in Nuclear Medicine.

Expectations from the future graduate

A radiotherapy team consists primarily of radiation oncologists, medical physicists and technologists. The members should work as a team and function in a coordinated manner to achieve productive results. Technologists form an integral and indispensable part of the team and work in union alongside radiation oncologists and medical physicists.

Below mentioned principles exemplify the role and the duties of a Radiotherapy Technologist graduate:

Principle 1 The radiotherapy technologist will provide services with compassion and respect for the dignity of the individual and with the intent to provide the highest quality of patient care.

Principle 2 The radiotherapy technologist will provide care without discrimination regarding the nature of the illness or disease, gender, race, religion, sexual preference, or socioeconomic status of the patient.

Principle 3 The radiotherapy technologist will maintain strict patient confidentiality in accordance with state and federal regulations.

Principle 4 The radiotherapy technologist will comply with the laws, regulations, and policies governing the practice of radiotherapy.

Principle 5 The radiotherapy technologist will continually strive to improve his or her knowledge and technical skills.

Principle 6 The radiotherapy technologist will not engage in fraud, deception, or criminal activities.

Principle 7 The radiotherapy technologist will be an advocate for his or her profession.

Available postgraduate programmes in India

Master of Science in Radiotherapy Technology courses is available in few institutions including PGIMER, Chandigarh, Ayush and Health Sciences University of Chattisgarh, Raipur and Cancer Institute Adyar under Dr.MGR University, Chennai. Complete list of radiotherapy Technology courses is available at https://aerb.gov.in/images/PDF/ Radiotheraphy/RSD5.pdf

Job profile

A qualified Radiotherapy Technologist typically performs the following roles (but not limited to) in a department of Radiation Oncology:

1. Ensuring correct identification of the patient and counsel them regarding the treatment procedure,
2. Preparation of immobilization devices and simulating of the patient,
3. Assist the Radiation Oncologist and Medical Physicist in the planning,
4. Delivering the treatment,
5. Protect the patients, attender, other staffs and themselves from unwanted exposure to radiation,
6. Monitoring the patient during treatment for unusual reactions and other health complication and report the same to the Radiation Oncologist,
7. Maintain the treatment records of all the patients,
8. Assist the Medical Physicist in QA, QC and dosimetry programmes,
9. Share their working knowledge with students and other staffs comfortably,
10. Maintain excellent professional behaviour with the patients and the working team,
11. Work and coordinate efficiently in the multi-disciplinary oncology team resulting in the best possible and compassionate patient care.

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	Basics of Radiation Physics (T & P)
II	I	Radiobiology and Oncology (T & P)
	II	Radiation Quantities, Units and Measurement (T & P)
	III	Radiotherapy Treatment Planning (T & P)
III	I	Imaging Techniques (T & P)
	II	Radiotherapy Techniques (T & P)
	III	Radiation Safety and Regulatory Requirements (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		
	Basics of Radiation Physics	60	280	
	Self-study/Library			60
	Total			**1080**
II	Radiobiology and Oncology	60	280	
	Radiation Quantities, Units and Measurement	60	280	
	Radiotherapy Treatment Planning	60	280	
	Self-study/Library			60
	Total			**1080**
III	Imaging Techniques	60	280	
	Radiotherapy Techniques	60	280	
	Radiation Safety and Regulatory Requirements	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 Heath 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 under-graduate 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'sergography

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: Basics of Radiation Physics

Theory:

Basics of Radiation Physics

Nuclear Physics

- Fundamental Units, Derived Units, Basic Radiation Units
- Atoms, Protons, Electrons and Neutrons
- The Nucleus- Mass Number, Isotopes Atomic masses.
- Elemental Particles Extra nuclear structure
- Atomic Energy Levels
- Nuclear Energy Levels
- Isotopes and isobars – Radioactivity - Radioactive decay - Particle radiation- Specific Activity – Half Live & Effective Half Life.
- Electromagnetic Radiation
- Elementary Nuclear Physics- Nuclear Structure - Binding Energy - Nuclear Forces
- Quantum nature of Radiation
- The Electromagnetic Spectrum-
- Radiation of Energy from an Atom – Mass and energy
- Exponential behaviour - Exponential decay of a radioactive isotope-half life – Transformation constant - Exponential attenuation
- Theory of Alpha Decay- Alpha Decay –- Alpha-Particle Spectra
- Beta Decay – Electron Capture
- Nuclear Isomers
- Internal Conversion
- Nuclear Reactions Transmutation Reaction Nuclear Forces, Nuclear Fission, Nuclear Fusion.

Diagnostic Radiology

- A.C. and D.C. power supply
- Circuit breakers – earthing-main voltage drop and remedy-cables low tension and high tension.
- Rectification - Self-Rectified X-Ray Circuit, Three phase unit
- Thermionic emission – frequency-energy-wave length-velocity.
- Production of X- Rays with simplified circuit

- Continuous X-ray spectrum - Bremsstrahlung Radiation - Characteristic X-rays
- Filters - Quality of X-rays - Effect of voltage and current on the intensity of X-rays
- Properties of X-rays.
- KRAMERS'S Equation.
- Anode – Stationary and rotating. Anode and Focal Spot, Anode Angle, Focal Spot size, Line Focus Principle, Anode angle and field coverage.
- Focal spot size and imaging geometry, Anode heel effect
- Cathode structures – Focusing cup – Small and large cathode.
- Space Charge Effect
- X-Ray Production- Effect of kVp(Tube Voltage), Effect of Target material, Effect of Filters, Effect of Generators
- Ratings of diagnostic tubes, Heat loading capacities, X-Ray tube rating chart, Anode cooling chart
- X-Ray spectra
- Target material
- Characteristic and bremsstrahlung radiation (filtered and unfiltered x-rays)
- The Angular distribution of X Rays
- X-Ray generators
- Attenuation – Filters.
- X-Ray beam restrictors
- Various types of Grids
- Focal spot of x-ray tube

Radiation Therapy

- Basics of radiation safety
- Historical developments in Radiotherapy.
- Physical components of Telecobalt units, Radioactive source, Shutter systems.
- Collimators
- Trimmers
- Penumbra,
- Optical Distance Indicator
- Source housing

- Control Panel
- Couch,
- T-Rod and its function
- Lasers
- Wedge
- Beam modifiers, accessory tray, shielding blocks, wedges, compensators, bolus.
- Linear Accelerator unit, electron gun, wave guide, magnetron, klystron, bending magnet, target material, beam flattening filters, sealed ion chambers, scattering foil, carousal.
- Gamma Knife unit.
- Mould room and Simulator

Miscellaneous

Basics of Heat – Conduction-Convection-Radiation. Introduction/ Orientation to the science of Radiation Oncology and the applications of radiation in the field of oncology.

Practical:

Basics of Radiation Physics

1. Observation
    a. Beam modifying devices, Immobilization devices
    b. Safety devices and emergency procedures
    c. Personal and area monitoring devices
    d. Treatment plan parameters
    e. Switch “ON” and “OFF” procedures.
2. Communication and record keeping
    a. Patient identification
    b. Enter RT chart dose delivered details
    c. Explain the treatment procedure
    d. Communicate between patients, doctors and medical physicists.
3. Patient Counselling
    a. Pre and post radiotherapy counselling
    b. Special protocols and procedures.

Recommended Textbooks (latest edition):

1. The Physics of Radiology Harold Elford Johns John Robert Cunningham.
2. The Essential Physics of Medical Imaging. JT Bushberg, JA Seibert, EM Leidholdt, JM Boone.
3. Radiation Oncology Physics: A Handbook for Teaches and Student E.B. Podgorsak.
4. Physics of Radiation Therapy Faiz M. Khan

Phase II

Paper I: Radiobiology & Oncology

Theory:

Section A – (Radiobiology)

- Cell injury –Etiopathogenesis, Cellular Adaptations and Cell Death. Body Fluid and Electrolyte imbalance. Inflammation & Healing – Acute & Chronic inflammation, Hypersensitivity disorders.
- Diseases and disease types-communicable and non-communicable diseases, common diseases of all major organ systems: Digestive system, Respiratory system, Renal excretory system, Reproductive systems including breast, Male & Female genitalia, Nervous system, Musculo-Skeletal system, Special sense Organs like eye-ear-nose, Endocrine system, cardiovascular system, Blood related diseases, Immunological diseases and diseases of other systems.
- Neoplasia - Definition, terminologies, differences between benign and malignant tumours, biologic properties of tumours, hematogenous and lymphatic metastases and local invasion and metastasis - Genetic predisposition to cancer including geographic & environmental factors, tumour genetics and tumour markers.
- Ionising Radiation-related cell & tissue injury and toxicities, Radiation-Induced diseases like Liver disease (RILD), cardiomyopathy, encephalopathy, radiation necrosis, enteropathy, nephropathy etc. Radiation-Induced Second Malignancies.

Etio-pathogenesis of tumours –local and general effects, spread and clinical features:

Sub types of different cancer cells and Histopathological differentiations-Gross specimen identification – Etiopathogenesis, clinical presentations (signs and symptoms) and brief description of clinical management options for all the following cancers,

- Cancer of Head and Neck - Origin of cancer at different sites – Oral cavity & Pharyngeal cancers which includes nasopharynx, oropharynx, and hypopharynx – Larynx.
- Thoracic cancers - - Sites - Cancer of Lung & Mediastinum-Mediastinum tumour – germ cell tumours – lymphomas – thymoma
- Breast Cancer
- Female genito-urinary Cancer - Sites - Carcinoma cervix and Endometrium - Vesicular mole, choriocarcinoma - Ovarian tumour-

- Male genito-urinary Cancer - Sites – Prostate cancer, Renal carcinoma - Bladder carcinoma - Carcinoma Penis.
- Bone Cancer & Soft Tissue Sarcomas.
- Central Nervous System cancer - Sites – Brain and spinal cord tumours.
- Cancer of Gastro Intestinal tracts - Sites – Oesophagus – stomach – gall bladder – liver – pancreas – small and large intestine – rectum & anal canal.
- Other cancers

Carcinogenesis:

Steps of carcinogenesis, Colo-rectal cancer model, physical/chemical and biological carcinogens.

Cancer-associated syndromes & Co-morbid conditions:

Hereditary Breast & Ovarian Cancer Syndrome, Cowden Syndrome, Familial Adenomatous Polyposis (FAP), Lynch Syndrome, Li-Fraumeni Syndrome, von Hippel Lindau Disease, AIDS-associated cancers. Co-Morbid condition commonly found in cancer patients – Hypertension, Diabetes Mellitus and its relevance in cancer management.

Epidemiology:

Distribution of cancers in India and the world, Incidence and Prevalence of cancers, GLOBOCAN, Cancer registries – HBCR-PBCR.

Genetics:

Oncogenes, Tumour-Suppressor genes involved in carcinogenesis, hereditary cancers, Gene assays and manipulation related to cancer care.

Basic Cell Biology & Radiobiology:

Cell Biology – Cell theory and structure – Cell division – Cell cycle – Molecular biology

Principles of Radiobiology - Radiation effect at cellular level - Radiation effect on human tissue - Radiation effect on organs - Radiation effect on malignant cells and tissues- Fractionation and its effects - Concepts of tolerance doses, Biological modifiers (includes chemotherapy agents commonly used) – Chromosomal aberration and its application for biological dosimetry – Somatic effects – Hereditary effect – Stochastic effect – Deterministic effect – Acute and Chronic exposure – LD50/60

Radiobiological basis of cancer treatment:

Factors influencing tumour control – Relative Biological Effectiveness (RBE) & Oxygen Enhancement Ratio (OER)- Hypo and Hyper fractionation – CHART – Haemostatic

Radiotherapy - Linear Energy Transfer (LET) - 4R's of Radiobiology – Basics of Cell survival curves – Established cell lines- Time Dose Fractionation (TDF) – Overview of different radiobiological models – Ellis curves – Calculations based on TDF - Biological Effective Dose (BED) - Linear Quadratic model, Alpha Beta concepts - Tumour control probability (TCP) - Normal Tissue complication probability (NTCP)- Worked out examples – Unintended treatment Gaps -Gap Correction calculation using TDF and LQ model and comparison - Avoidance of Gap in Radiotherapy - Multi treatment combinations – Tolerance Dose to organ – Radiobiological basis of LDR- HDR

Section B – (Oncology)

- Basic Clinical examination & Performance status

  General observation of a patient including various objective scoring - Karnofsky Performance Score, ECOG score, Glasgow-Coma-Scale, Quality of Life score (EORTC, RTOG), body weight, height, body surface area, food intake abilities and stomas.
- Biopsy

  Invasive tissue retrieval methods for diagnosis like biopsy (core-needle, punch, wedge, excision), FNAC, liquid biopsy etc.
- Imaging methods & other diagnostic, staging and prognostic testing

  Imaging using CT, MRI, PET, Ultrasound etc. and tumour biomarkers
- Tumour Staging and grading

  AJCC-TNM staging, FIGO and other commonly used systems. Tumour grading
- Non-malignant diseases

  Radio-therapeutic management of Keloids, Meningiomas, Craniopharyngiomas, Fibrotic tumours and other benign tumours
- Primary management of malignancy

  The epidemiology, aetiology, detection, diagnosis, patient condition, treatment and prognosis of tumours of the thorax, gynaecologic cancer, lymphomas, breast, paediatric Neoplasms, genitourinary tract, gastrointestinal tract, and leukaemia, skin cancer, endocrine system, head and neck cancer, eye and orbit, central nervous system, bone and soft tissue tumours will be discussed.
- Treatment Modalities

External beam Radiotherapy, Brachytherapy, Anti-cancer systemic drug therapy, Surgery, Palliative Treatment, Radionuclide therapy, Treatment Intent- Radical, Adjuvant, radiation dose-volume prescription for common cancers, Palliative & Supportive therapy.

- Acute & late toxicities of cancer treatment
  Side effects related to radiation and dose - Acute and Late side effects - Monitoring of side effects - Information and Communication - Documentation of side effects – Concepts of reirradiation. Radiation-induced second malignancies- Role of Nutrition.
- National Programmes against cancer.
  National Cancer Control Programme, NCPCDS, ICMR Cancer Registry
- Cancer prevention
  Primordial-Primary – Secondary – Tertiary prevention, Screening programme - Breast - Prostate - Colorectal - Skin – Cervix cancers, Signs and symptoms, Public awareness on early signs and symptoms
- High risk groups
  Population at high risk of developing cancer especially preventable cancers like cervical cancer, Head & Neck Lung cancers, Liver cancers.
- Patient handling & Care
  General of the patient, Handling patients and assisting in their body movements for simulation, treatment setup and verification, preparation for patient setup and treatment delivery, Skin care, Nutrition, Dietary Advice, Care of body tubes like Nasogastric tube-stomas-wound care, handling special situations like unconscious patient, mobility issues etc.

Recommended Textbooks (latest edition):

1. Radiobiology for the radiologist. Eric J Hall; Amato J Giaccia; Publisher: Philadelphia : Wolters Kluwer Health/Lippincott Williams & Wilkins, ©2012. ISBN 1608311937 9781608311934

2. Basics of Oncology, Fred Stephens; K Aigner; Publisher: Cham, Springer International Publishing, ISBN 9783319233680 3319233688

Paper II: Radiation Interaction, Quantities and Measurement

Theory:

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.

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

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. Daily Quality Assurance (QA) Tests of Simulator
2. Daily QA Tests of Tele-Cobalt Unit
3. Daily QA Tests of Linear Accelerator
4. Daily QA Tests of CT
5. Daily QA Tests of HDR Brachytherapy Unit
6. Personnel Monitoring Services – TLD
7. Radiation Measuring Instruments
8. Measurement of HVT of Shielding Materials
9. Measurement of Wedge Factor
10. Measurement of Tray Factor
11. Measurement of Couch Attenuation
12. Calibration of Tele-Cobalt Unit
13. Radiation Survey of Simulator
14. Radiation Survey of Tele-Cobalt Unit
15. Ionization Chambers and Dosimeters

Recommended Textbooks (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. Radiation Dosimetry –Hine & Brownell
11. Radiation Dosimetry - Attix F. H. and Roesch. W. C.

Paper III: Radiotherapy Treatment Planning

Theory:

Immobilization procedure:

General principle-Mould room- Material- Procedures followed -Safety issues

Pre-treatment workup for Head & Neck , Thoracic, Abdomen, Pelvis, Extremities

Patient positioning in Radiotherapy-Plaster of Paris mould- Acrylic mould-Vacuum Immobilization cushion and Stereotactic body frame-Aquaplast- Taping-Belly board – Breast Slant Board-Wing Board-Angles Sponges-Immobilization mask for Stereotactic radiation therapy.

Beam modifying devices-Tissue compensators-Conformal/Secondary beam shaping blocks.

Imaging in Radiotherapy:

Patient data acquisition- Patient and organ movement-Localization of Target volume-Gross Tumor Volume- Clinical Target Volume- Planning Target volume-Organ at Risk (OAR)- ICRU Dimensions-Principle of treatment planning

Physics of Phantom Materials:

Dose Calculation parameters-Isocentre- Build-up – Field Size –Depth of maximum dose-Percentage depth dose- Tissue Air Ratio (TAR) – Off-axis ratio- Tissue Maximum Ratio (TMR)- Tissue Phantom Ratio (TPR)- Properties of TMR- Practical application and basic calculation -Back scatter factor- Scatter Air Ratio-Collimator scatter factor-Phantom scatter factor- Total Scatter Factor

Beam Therapy:

Functions used in dose calculation-PDD- Dependence on Beam quality and depth- Initial dose build-up-Effect of field size and shape-Dependence on source to surface distance- Relationship with PDD and TAR-Isodose charts- Measurement of Isodose curves- Dependence on Beam quality, Source Size, Source to surface distance, Source to diaphragm distance- Penumbra effect-Collimation and flattening filter- Wedge systems - Wedge factor-Wedge isodose-Wedge angle – Effect on beam Quality-Tray factor- Determination of tray factor-Beam attenuation and compensation- Electron Applicators-Electron cutouts

Electron Therapy:

Conventional and Conformal Radiotherapy

Manual and Computerized Planning -Single field- Parallel opposed- Multiple fields two dimensional planning-Three dimensional Conformal planning- Head &Neck-Thoracic-Abdomen-Pelvis-Extremities-Other sites(Lymphomas-Sarcoma etc.,) -Beam's eye view- Dose volume histogram.

Basic calculations- Tumor dose- Mean, Maximum, Minimum- Number of fractions- Treatment time-Monitor Unit (Photon & Electron)

Errors in Radiotherapy- Geometrical uncertainties.

Basics of Brachytherapy planning:

Low Dose Rate – Medium Dose Rate- High Dose Rate – Pulsed Dose Rate- Intracavity- Intraluminal- Interstitial- Surface Mould Brachytherapy. Radioactive sources used in Brachytherapy.

Treatment planning algorithms in Teletherapy and Brachytherapy:

Manual and computerized planning: 3DCRT- IMRT- IGRT- VMAT- Tomotherapy

Quality Assurance test and operational procedure:

Daily QA test and operational procedures of Telecobalt unit, Simulator, CT Simulator, HDR Brachytherapy unit and Linear accelerator

Practical:

1. Operational Procedure of Simulator
2. Operational Procedure of Tele-Cobalt Unit
3. Operational Procedure of Linear accelerator
4. Operational Procedure of CT
5. Operational Procedure of HDR Brachytherapy Unit
6. Preparation of Mould for Head and Neck
7. Preparation of Mould for Thorax
8. Preparation of Mould for Abdomen and Pelvis
9. 2D Simulation Procedure of Head and Neck
10. 2D Simulation Procedure of Thorax
11. 2D Simulation Procedure of Abdomen and Pelvis
12. 2D Treatment Procedure of Head and Neck
13. 2D Treatment Procedure of Thorax
14. 2D Treatment Procedure of Abdomen and Pelvis
15. RT Chart and Other Records
16. Optional: Recent advanced immobilisation devices, imaging devices and their practice

Recommended Textbooks (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. Treatment planning in Radiation Oncology Faiz M. Khan.
6. Cancer Principles & Practice of Oncology Devita, Hellman and Rosenberg's
7. The Discipline of Radiation Oncology-Edward C.Halperin,Carlos A, Perez, Luther W.Brady
8. Radiation Treatment Planning-Richard F Mould
9. Practical Radiotherapy Planning-Jane Dobbs, Ann Barrett, Daniel Ash
10. Text of Radiotherapy- G.K. Rath
11. The Principles & Practice of Radiation Therapy-Washington Lever
12. Text of Radiotherapy- Walter Miller.

Phase III

Paper I: Radiotherapy Techniques

Theory:

Radiotherapy Equipment

Simulator, CT simulator, Tele-Cobalt units, HDR Brachytherapy Units - Linear Accelerator - Tomotherapy - Cyberknife - Gammaknife – MRI Linac – TPS – Phantoms – Dosimeters - Pre-Treatment QA Devices – Radiation Detectors

Immobilization Devices and Accessories

Adaptive 3D Printing – Patient Marking System – SBRT, SRS and SRT Accessories – Vac-Lock Cushions – Fiducial Marker – MR and Proton Compatible Accessories – Bolus and Shielding

Special Techniques in Tele-therapy

Telecobalt Rotation therapy – Arc therapy – Skip & Arc therapy - Mantle Fields – Inverted Y – Craniospinal Fields – Adjacent Field Separation Calculation - Haemostatic Radiotherapy - Total Body Irradiation (TBI) - Total Skin Electron Therapy (TSET) - Stereotactic Radiotherapy (SRT) - Stereotactic Radiosurgery (SRS) –Intraoperative Radiotherapy (IORT) - Extracorporeal Irradiation - Blood Irradiation

Advanced Techniques in Tele-therapy

Intensity Modulated Radiotherapy (IMRT) - Volumetric Modulated Arc Therapy (VMAT) – Image Guided Radiotherapy (IGRT) – Adaptive Radiotherapy - Proton & Ion Therapy

Brachytherapy

Applicators – Templates - Intravascular Brachytherapy – Ophthalmic Applicators – Permanent Implant – Temporary Implant – Prostate Implant - Beta Applicators - Integrated Brachytherapy Unit

Practical:

1. Preparation of Mould with Three, Four and Five Clamp
2. Preparation of Thermoplastic Cast
3. Preparation of Customized Block for Photon and Electron
4. Immobilization Devices
5. Beam Modifying Devices
6. 3D Treatment Procedure of Head and Neck
7. 3D Treatment Procedure of Thorax

8. 3D Treatment Procedure of Abdomen and Pelvis
9. Treatment Procedure of CSI
10. Treatment Procedure of IMRT
11. Treatment Procedure of VMAT
12. Applicators of HDR Brachytherapy
13. Treatment Procedure of HDR Brachytherapy
14. Preparation of Brachytherapy Mould
15. Optional: Recent advanced teletherapy and brachytherapy techniques as well as Treatment Procedure of SRS and SRT

Recommended Textbooks (latest edition):

1. The Physics of Radiation Therapy Faiz M. Khan.
2. Radiation Oncology physics A Handbook for Teachers and Students – E.B. Podgorsak.
3. Treatment planning in radiation oncology Faiz M. Khan
4. Brachytherapy applications and Techniques – Philip M Devlin
5. Radiotherapy Treatment Planning – Richard F Mould
6. Practical Radiotherapy planning - Jane Dobbs, Ann Barrett, Daniel Ash
7. IMRT IGRT SBRT Advances in the Treatment planning and delivery of radiotherapy – John L. Meyer
8. Textbook of Radiotherapy- G.K.Rath
9. Principles and practice of Radiation Therapy - Washington Lever
10. Image Guided IMRT – T.Bortfield

Paper II: Imaging Techniques

Theory:

- Radiography - Fluoroscopy - Interventional Radiography - Computerized Radiography and Digital Radiography systems. Post-processing of digital images. Digital Imaging and Communication in Medicine (DICOM)/DICOM RT. Patient Archiving and Communication Systems (PACS) and networking topologies. Image data security. Errors in medical imaging.
  Image Quality – Factor affecting quality – Artefacts – Contrast media – ALARA principle
- Mammography - Magnetic Resonance Imaging – Ultrasonography – SPECT – SPECT CT - PET – PET CT
- Computed Tomography - Simulator – Virtual simulator – CT simulator – Simulator CT – CBCT – KVCBCT – MVCBCT
- Imaging Protocol and decision making – Verification - EPID and Portal imaging - EPID Protocol and decision – Documentation
  Image reviews – Offline corrections – Matching / Co-registration Methodology - Online corrections – Setup Errors –Geometric uncertainties.
- 2D (radiography, fluoroscopic, USG), 3D (CT, MRI) and functional (PET/SPECT) imaging and their application in radiotherapy planning
  Understand Gross Tumour Volume (GTV), Clinical Target Volume (CTV), Internal Target Volume (ITV), Planning Target Volume (PTV), Organs at Risk (OAR) delineation with respect to different imaging modalities
  Conduct image fusion at the treatment machine console
  To do bony matching, to do soft tissue matching for estimating the preliminary data for applying shifts.
  To prepare documentation
  Imaging requirement for Four-dimensional(4D) planning (MOTION MANAGMENT) /SRS/SRT/SBRT/TBI/TSET (recent advances)

Practical:

1. Image acquisition for planning (and/or verification)
2. Modalities for image acquisition for External beam radiotherapy planning
3. Modalities for image acquisition for Brachytherapy planning

4. Simulation- Conventional Simulation, CT Simulation, Virtual Simulation
5. Image processing and archiving
6. Treatment verification with MV Imaging
7. Treatment verification with kV-kV Imaging
8. Treatment verification with Cone beam Imaging
9. Protocols- Imaging protocols: development and implementation,
    Non-action levels (NAL)
    On-line/off-line corrections
    Matching/co-registration procedures
    Geometric uncertainties
    Documentation
    Adaptive radiotherapy
    Information management
10. Online verification of patient set-up by EPID (Head & Neck)
11. Online verification of patient set-up by EPID (Thorax)
12. Online verification of patient set-up by EPID (Abdomen).
13. Online verification of patient set-up by EPID (Pelvic).
14. Study of Record and Verify system in External Radiotherapy.
15. Tattooing patients for patient set-up
16. Shell markings
17. CT Localization
18. Optional: Advanced Imaging & Motion management techniques

Recommended Textbooks (latest edition):

1. "On Target 2: Updated guidance- Image guided radiotherapy, Royal College of Radiologists, (RCR, London, UK).

2. "On Target: ensuring geometric accuracy in radiotherapy" A Joint RCR/IPEM/SCoR Report, Royal College of Radiologists, 2008 (RCR, London, UK).

3. Skarin, A.T., (Ed), Dana-Faber Cancer Institute, Atlas of Diagnostic Oncology, Mosby Elsevier (2002).

4. Bushong, S.C., Radiological Sciences for Technologists, Mosby Elsevier (2009).

5. Practical Radiotherapy Physics and Equipment, Pam Cherry and Angela Duxbury

6. Handbook of MRI technique, Catherine Westbrook

7. MRI in practice, Catherine Westbrook

8. Pocket atlas of sectional anatomy, Computed tomography and Magnetic Resonance Imaging, T.B.Moeller and E.Reif

9. Nuclear Medicine Physics, A Hand book for Teachers and Students, IAEA, D.L.Bailey

Paper III: Radiation Safety & Regulatory Requirements

Theory:

- Radiation Hazard evaluation and control

  Natural background radiation – Dose limits – Occupational & public exposure limits Principles of radiation protection, Effect of Time, Distance and Shielding, Calculation of workload, Calculation of Weekly dose to the radiation worker and general public, good work practices in diagnostic radiology and/or radiotherapy practices (including teletherapy and Brachytherapy), Planning consideration for radiology and/or radiotherapy installation including work load, use factor & occupancy factors, effect of different shielding material.
- Radiation Emergency Preparedness

  Safety and security of radiation sources, case histories of emergency situations and preparedness, equipment's and tools including role of Gamma Zone Monitor, Regulatory requirements and prevention of emergency, Preventive maintenance and Safety Culture, Role of RTT in handling radiation emergencies (Brachytherapy, Cobalt, Linear Accelerator, other equipment). Incident reporting
- Regulatory requirements

  National Regulatory Body, Responsibilities, organization, Safety Standards, Codes and Guides, Responsibilities of licensees, registrants and employers and Enforcement of Regulatory requirements.
- Quality Assurance

  Accessories and tools used for QA tests in Radiotherapy such as Front pointer, Back pointer, Laser Alignment etc. Optical and radiation field congruence, Beam shaping blocks, Beam shaping jaws, Delineator/Diaphragm movements, Isocentre alignment, Patient support system, Beam on and off mechanisms, Technologist's role in QA tests on telecobalt /Linear Accelerator / Brachytherapy/ Gamma knife/Simulator/CT Simulator machines.

Practical:

1. Practice principles of Time, Distance, Shielding
2. Calculate workload, use, and occupancy factors
3. Quality Assurance in Telecobalt unit – Technologist Perspective
4. Quality Assurance in Medical Linear Accelerator unit - Technologist Perspective

5. Quality Assurance in Remote After loader Brachytherapy Unit - Technologist Perspective
6. Quality Assurance in Remote After loader Brachytherapy Unit - Technologist Perspective
7. Quality Assurance in Simulator - Technologist Perspective
8. Familiarization of Radiation survey meters and their function performance checks.
9. Radiological Protection Survey of Medical Linear Accelerator, Telecobalt, Simulator and CT Simulator and HDR Brachytherapy Installations
10. Technologist perspective in handling radiation emergencies in Telecobalt
11. Technologist perspective in handling radiation emergencies in HDR Brachytherapy unit
12. Technologist perspective in handling radiation emergencies in Medical Linear Accelerator unit
13. Radiation warning signage/beam indicators for Teletherapy, Brachytherapy and Simulators
14. Optional: Quality Assurance of and Handling any newer and advanced equipment and radiation measurement devices safely and accurately.

Recommended Textbooks (latest edition):

1. Principles of Radiation Protection – K. Z. Morgan and J. E. Turner.
2. Physics for Radiation Protection – James E. Martin
3. ICRP Report 103
4. Radiation protection in Medical radiography – Mary Alice
5. An introduction to Radiation Protection – Allen Martin & Samuel
6. Practical Radiotherapy- Physics and equipment – Pam Cherry and Angela Duxbury
7. The Physics of Radiotherapy- F.M.Khan
8. Washington/Leaver: Principles & Practice of Radiation Therapy,
9. Latest reports on AERB safety code: Safety code for Medical diagnostic x-ray
10. Safety code for Radiation Therapy Sources, Equipment and Installations

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 4^{th} 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

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

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

5. 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.

6. 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.

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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. Answer the following questions briefly: 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.

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

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

a. Define anaemia. Give any two causes of anaemia.
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. Answer the following questions briefly: 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

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Model Question paper

Phase I - Paper IV: Basics of Radiation Physics

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 radioactive decay processes with indicative diagrams

2. **Write short notes on the following:** 5 x 5 = 25
   a. Define half-life of a radioactive source.
   b. What is specific activity of radioactive source?
   c. What is Heel effect? How do you overcome this effect practically during imaging?
   d. What is Transformer? Explain different types of transformers used in diagnostic x-ray equipment.
   e. Explain exothermic reaction in Nuclear Physics

3. **Answer the following questions briefly:** 5 x 3 = 15
   a. What is Mass defect?
   b. What is the equation for radioactive decay?
   c. What is the half-life for Cobalt-60, and Iridium-192 isotopes?
   d. What are the differences between stationary and rotating anode?
   e. What is thermionic emission?

Section B

4. **Answer the following question in detail:** 1 x 10 = 10
   a. With a neat diagram explain the modern x-ray tube and the production of x-rays.

5. **Write short notes on the following:** 5 x 5 = 25
   a. Name the different types of generators?
   b. Explain the self-induction principle
   c. What is meant by “Binding Energy” of an atom?
   d. Define Kramer’s equation.
   e. What are Grids? Give its significance in x-ray imaging?

6. **Answer the following questions briefly:** 5 x 3 = 15
   a. Name any two electro-magnetic radiation.
   b. Differentiate CT and conventional x-ray imaging.
   c. Give two differences between x-rays and gamma rays.
   d. Define frequency.
   e. Define Heat Unit (HU).

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Model Question paper

Phase II - Paper I: Radiobiology & Oncology

Maximum marks: 100 Maximum duration: 3 hours

Answer all the questions. Draw suitable diagrams where necessary.

Section A (Radiobiology)

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

a. Discuss the 4 R's of Radiobiology in detail.

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

a. Radio-sensitizers
b. Radiation induced second malignancy.
c. Describe the cell survival curve with respect to ionising radiation induced cell injury.
d. Radiobiological differences between HDR versus LDR brachytherapy
e. Linear-Quadratic Model

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

a. Describe carcinogens with example.
b. Describe LET with example.
c. Define Stochastic and Deterministic Effects
d. LD50/60
e. Clinical utility of hypo-fractionated radiotherapy schedules.

Section B (Oncology)

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

a. Discuss all the options currently available in the treatment of cancer with clinical examples.

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

a. Describe the various types of diagnostic tissue tests for cancer.
b. Describe the common treatment intent in oncology. Give one example in each.
c. What are the acute toxicities of radiation treatment in head and neck cancer
d. What are the high risk etiologic factors for breast cancer?
e. Radiation-Induced Second Malignancies.

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

a. Describe the utilities of PET-CT in oncology.
b. Compare benefits of CT vs MRI in tumor identification
c. What is Primordial prevention? Give one example.
d. What are the diagnostic and screening tests available for cervix cancer?
e. What is palliative care and when is it initiated in the course of cancer management?

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Model Question paper

Phase II - Paper II: Radiation Quantities, Units and Measurement

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 basic, operational and protection quantities with neat flow chart.

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

a. What are Mass attenuation coefficient and Mass energy transfer coefficient?
b. What are Linear Energy Transfer (LET) and mass stopping power?
c. What are decay constant and activity?
d. Explain the working principle of ionization chamber
e. Explain the GM counter.

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

a. What is relative biological effectiveness (RBE) and quality factor?
b. Convert 10Ci in to Becquerel
c. What is radiation weighting factor and tissue weighting factor?
d. What is gamma zone monitor and pocket dosimeter?
e. What are Flux and Fluence?

Section B

4. Answer the following question in detail: 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. What are KERMA and CEMA?
b. What are fluorescence and phosphorescence?
c. Discuss about scintillation detectors
d. Explain the different types of survey meters
e. What is the working principle of diode detectors?

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

a. What is cross section?
b. What is contamination monitor?
c. What is exposure?
d. What is in-vivo dosimeter?
e. What is specific energy?

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Model Question paper

Phase II - Paper III: Radiotherapy Treatment Planning

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. Define Percentage Depth Dose (PDD) and explain the factors that affect PDD.

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

a. Write about immobilization devices.
b. Write about conventional radiotherapy.
c. Define i) Buildup ii) Depth of Maximum Dose iii) Wedge Angle.
d. Explain in detail about Dose Volume Histogram (DVH).
e. Define GTV, CTV and PTV as per ICRU50.

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

a. What are the advantages of an asymmetric jaw?
b. What is the total scatter factor, and where it is used?
c. Define SSD and SAD.
d. Why are immobilization devices used and the significance of it?
e. Define geometric field size.

Section B

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

a. Explain in details about different algorithms used in external beam radiotherapy.

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

a. What are isodose lines? Explain the factors that affect isodose lines.
b. Define TPR and TMR.
c. Write briefly about Three-Dimensional Conformal Radiotherapy(3DCRT)
d. Derive the relation between PDD and TAR.
e. Estimate the treatment time to deliver 180 cGy at 8 cm depth for a 16 cm thick patient using Co60 of Field Size 12 x 6 cm2. Planned for two opposing fields. (Output for 8x8 cm2 is 172 cGy/min and TAR at 8 cm depth for 8x8 cm2 is 0.729).

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

a. Define tissue air ratio with a diagram.
b. Define the equivalent square field and it is requirements
c. Write briefly about ICRU 83.
d. Give the values of Dmax for Co-60, 4 MV, 6 MV, 10 MV and 15MV X-rays.
e. Why is TAR not used other than Co 60 beam?

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Model Question paper

Phase III - Paper I: Imaging Techniques

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 typical flow chart for the process of geometric verification.

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

a. Principle of Magnetic Resonance Imaging (MRI)
b. Ultrasonic Transducers
c. Positron Emission Tomography (PET)
d. Types of modes in Ultrasonography
e. Draw the diagram of mammography equipment

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

a. Name any three differences between KVCT and MVCT
b. What is Larmour Frequency?
c. Name the contrast agents used in MRI
d. What are the safety measures to be taken in MRI?
e. What is the action level in imaging?

Section B

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

a. Explain the applications of digital radiography in radiotherapy.

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

a. Computed Radiography
b. Single Photon Emission Computed Tomography (SPECT)
c. How to manage adverse reactions due to contrast agents?
d. Explain setup errors in imaging.
e. Importance of imaging protocol.

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

a. What is the compression technique in mammography?
b. What is online image verification?
c. Type of flat panel detector using direct and indirect method in DR imaging.
d. What are the differences between PET and SPECT?
e. What is concomitant exposure?

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Model Question paper

Phase III - Paper II: Radiotherapy Techniques

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 VMAT technique with workflow chart.

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

a. Explain Proton therapy.
b. What is Image Guided Radiotherapy?
c. What are cone-beam and fan-beam CT?.
d. Compare CyberKnife with Gamma Knife.
e. What are the types of Brachytherapy? Explain with applicators and sites

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

a. What are the types of wedges used in radiotherapy?
b. What is forward planning and inverse planning?
c. What are the usages of fiducial markers and lasers?
d. What is Extracorporeal Irradiation (ECI)?
e. Write short notes on radioisotopes used in Brachytherapy

Section B

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

a. Discuss various treatment positions used during Total Body Irradiations (TBI) with diagrams.

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

a. Explain in detail about step & shoot and dynamic MLC.
b. What is 4D in radiotherapy?
c. Discuss Tomotherapy treatment technique.
d. Explain the TSET treatment techniques.
e. What is Intensity Modulated Radiotherapy (IMRT)? Differentiate with VMAT

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

a. What is Dose Volume Histogram (DVH)?
b. What is Spread Out Bragg's Peak (SOBP)?
c. Write few image verification instruments in radiotherapy.
d. What is normalization in radiotherapy planning?
e. Define hot-spot and cold-spot in radiotherapy planning.

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Model Question paper

Phase III - Paper III: Radiation Safety and Regulatory Requirements

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. Draw the room layout of High Energy Linear Accelerator bunker and explain the various radiation safety features to be incorporated in the bunker design. How will you calculate the wall thickness for primary and secondary barrier?

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

a. What is TLD inter-comparison? Discuss the procedure involved
b. List out the responsibilities related to radiation safety of an employer as per RPR 2004?
c. Briefly explain the regulatory process to safe guard a pregnant female staff from radiation?
d. Describe the various radiation protection devices that are to be used in X-ray room?
e. Describe in detail the transportation process of radioactive sources?

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

a. What is eLORA?
b. What is the minimum lead equivalence of bucky-grid in the X-ray machine?
c. Name the three main pillars or areas of work underpin the IAEA's mission?
d. Describe any four modes of transporting radioactive materials?
e. What is the minimum thickness for wall and lead lined door in a conventional simulator room?

Section B

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

a. What are the three primary components to achieve radiation safety? Explain in detail the various factors involved to maintain radiation safety for staff working in a radiotherapy department.

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

a. Morning check out in a telecobalt unit.
b. Name any two Personal dosimeters and explain the working principle.
c. What is the distance required to reduce the dose rate from a ceasium-137 source of activity with 50 GBq to 0.1 mSv/hr?
d. How to handle an emergency source struck in a tele-cobalt unit and what is the role of technologist during such procedure?
e. What is the necessity of radiation weighting factor and tissue weighting factor.

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

a. Give the dose limits for radiation staff and normal public as per ICRP-103?
b. Give the abbreviations of the following
c. AERB, b. ICRU, c. ICRP, d. IAEA, d. NCCN.
d. Convert 578 Bq in terms of curies.
e. Name any three stochastic effect.

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