

**Syllabus for the post of**

**Associate Professor, Radio-therapy, Class-I (Advt. No. 30/2023-24)**

**Marks – 200**

**Questions – 200**

**Medium - English**

**1. BASIC SCIENCES:**

**I. Applied Anatomy and Physiology**

Applied anatomy of oral cavity, larynx, pharynx, paranasal sinuses, CSF pathways salivary glands, middle ear, external orbit, breast, bronchopulmonary segments, mediastinum, esophagus, liver, spleen, stomach, small and large bowels, pelvic and genitor-urinary organs (bladder, uterus, ovary, testis rectum, anal canal etc.), spinal segments; Lymphatic system and lymphatic drainage pathway of various organs, Relationship of vital structures, Surface Anatomy pertaining to various organs, Cross Sectional Anatomy pertaining to US/CT/MR/PET images, General principles of physiology of respiratory, cardiovascular, nervous, biliary, reproductive and endocrine systems and fluid-electrolyte-metabolic balance.

**II. Various Investigative and Imaging Procedures** including radio-isotope based procedures in Diagnosis, Staging, Treatment Planning and follow up of cancer patients.

**III. Pathology of Benign and Malignant Diseases**

Carcinogenesis-epidemiological studies, molecular studies, genetic basis, oncogenes, tumour growth kinetics; Pre-cancerous conditions, Methods of dissemination of cancer and its biological behavior, Degree of differentiation of cancer; Principles and methods of definite diagnosis: i) Surgical biopsy - various procedures of biopsy, ii) Exfoliative cytology, iii) Fine Needle Aspiration Cytology (FNAC) and biopsy, iv) Tumour markers; General histologic and cytologic features of malignancy including features of special staining, surface markers, intracellular markers, Classification of benign and malignant tumours and their interpretation, Molecular pathology, molecular basis of diagnosis and prognosis of cancers, Radiation pathology.

#### **IV. Staging of various cancers:**

Evolution of different staging systems for various cancers over the years, Clinical Staging, WHO Staging, TNM Staging, AJCC Staging and FIGO staging etc of various cancers, as applicable, with their inter-comparisons.

#### **V. International Coding and classification of various neoplastic disorders:**

ICD-9, ICD-O and ICD-10 system of classification and coding of various tumours.

### **2. RADIATION PHYSICS**

#### **I. Atomic and Nuclear Structure.**

#### **II. Radioactive Decay**

Modes of decay, Mathematics of Radioactive Decay, Natural Radioactivity, Artificial Radioactivity.

#### **III. Production of X-rays**

X-ray tubes, x ray circuits.

#### **IV. High Energy Treatment Machines**

Cobalt units, Van de graaff generators, Linear accelerators, Betatrons, Resonance transformers, Cyclotrons for neutron therapy, Microtron, Synchrocyclotron and Particle Accelerators.

#### **V. Interactions of X - and Gamma-rays**

Attenuation of a beam of x- or gamma-rays: Attenuation and absorption coefficients, Attenuation in the body; Modes of interaction: Photoelectric absorption, Compton scattering, Pair production, Photo-disintegration.

#### **VI. Interactions of Particulate Radiations**

Types of interactions, Properties of particulate radiations, Interactions of heavy charged particles and pions, Interactions of electrons, Neutron interactions, Radioactive sources used in diagnosis and therapy.

## **VII. Measurement of Radiation Exposure**

Photon and energy flux density and fluence; the roentgen; Electronic equilibrium; Ionization chambers, Exposure calibration of an X - or gamma - ray beam.

## **VIII. Radiation Quality**

Measures of quality, Factors influencing quality.

## **IX. Measurement of Absorbed Dose**

Units of radiation dose, dose equivalent, RBE-dose; Calculation of dose from exposure; Measurement of absorbed dose with an ionization chamber: Bragg-Gray cavity theory; Direct measurement of absorbed dose: Film, TLD, Calorimetry, Chemical dosimetry.

## **X. Calibration of High Energy Photon and Electron Beams**

Photons, Electrons.

## **XI. Dose Distribution, External Beam Therapy**

Dosimetric variables, Single and multiple field dose distributions, Dose distribution for rotational therapy; Calculation of dose in large, irregular fields.

## **XII. Dose Distribution, Sealed Source Therapy**

Handling of sealed radioactive sources; Dose distributions for sealed implant sources; Design of sealed source implants; Radium and its substitutes; Special techniques for <sup>192</sup>Ir and <sup>125</sup>Ir; Other sealed sources in therapy.

## **XIII. Computerized Treatment Planning**

External X-and gamma-ray beams, Electron beams, implanted sources.

## **XIV. Radiation Protection from External Sources**

Concepts and units, Treatment room design, sealed source storage, Protection surveys, Personnel monitoring.

## **XV. Radiation Protection from Internal Sources**

Body burdens and critical organs: Effective half-lives for uptake and elimination;  
Internal dose computations: Locally absorbed radiation, Penetrating radiation;  
Handling radionuclide therapy patients; licensing procedure for using radionuclides.

## **XVI. Planning of a Radiotherapy Department**

Building designs; Choice of various equipment and sources; Acceptance and Calibration Tests; Various maintenance steps and procedures.

## **XVII. New Radiation Modalities:**

Protons, Neutrons, Pions, High energy heavy ions.

## **3. RADIOBIOLOGY (RADIOBIOLOGY AND LABORATORY RADIOTHERAPY)**

**I. Mammalian Cell Radiosensitivity:** Apoptosis, Interphase and reproductive death, Cell survival curves in vitro, Characterization of cell survival curves, Critical sites and target theory, Dose response curves in vivo, Quantitative normal tissue reaction based on systems.

**II. Factors that Modify Radiation Response:** The Oxygen effect, The age response function, Potentially Lethal damage, Sublethal damage, Dose-rate, Radiosensitizers, Antibiotics, Radioprotectors.

### **III. Linear Energy Transfer**

Definition, Track and energy average, LET for different types of radiation, OER as a function of LET

### **IV. Relative Biological Effectiveness (RBE)**

Definition, RBE for different cells and tissues, RBE as a function of dose, RBE and fractionation, RBE as a function of LET, Q factor

### **V. Cell and Tissue Kinetics**

The cell cycle, Autoradiography, Constituent parts of the cell cycle, Percent labeled mitoses technique, Growth fraction, Cell loss factor, Growth kinetics of human tumours

## **VI. Tissue Radiosensitivity**

Classification based on radiation pathology, Types of cell population.

## **VII. Time-Dose and Fractionations**

The 4 R's of radiobiology, the basis of fractionation, The Strandquist's plot, Nominal standard dose, Linear Quadrate equation

## **VIII. Hyperthermia**

Methods of heating, Systematic hyperthermia, Localized heating, Cellular response to heat, Repair of thermal damage, Thermotolerance, Hyperthermia combined with ionizing radiations, Time sequence of heat and irradiation, Hypoxic cells and heat, Effect of pH on the response to hyperthermia, Response of transplanted tumours to heat, Response of spontaneous tumours to heat, Response of normal tissues to heat, Heat and the therapeutic gain factor, Hyperthermia and chemotherapy

## **IX. Total Body Irradiation – Acute Effects**

Prodromal radiation syndrome, Central nervous system / cerebrovascular syndrome, gastrointestinal syndrome, Haematopoietic syndrome, Mean lethal dose: (LD50), Treatment of radiation accident

## **X. Late Effects**

Probabilistic/Deterministic (Stochastic/Non-Stochastic) effects, Non-specific life shortening, Carcinogenesis.

## **XI. Mechanisms of Radiation Carcinogenesis**

Genetics of irradiation-Point mutations, Relationship to dose, Chromosome aberrations, Relationship to dose, Doubling dose, genetically significant dose (GSD), Genetic effect in humans, Background radiation in relation to the GSD

## **XII. Radiation Effects in the Developing Embryo and Fetus**

Intrauterine death, Congenital abnormalities including neonatal death, Growth retardation, Dependence of the above effects on dose, dose-rate and stage in gestation, Carcinogenesis following *in utero* exposure, Human experience of pregnant women exposed to therapeutic doses, Occupational exposure of

potentially pregnant women, Elective booking or “10 day rule”, The “Practical threshold” for therapeutic abortion

**4. RADIATION PATHOLOGY:**

**Radiophysiology of Human Tissues:** Effects of irradiation of the skin, bone and cartilage, kidney, lung, nervous tissues, ovary, eye, lymphoid tissues, bone marrow, oral, pharyngolaryngeal and esophageal mucous membrane, salivary glands, Radiation effects observable in clinical radiotherapy, human embryo, SOMA Scales.

**5. BASICS OF CHEMOTHERAPY:**

Classification, mechanisms of action and pharmacokinetics of anti-cancer (cytotoxic) drugs including Biological Response Modifiers, Rationality of using cytotoxic drugs as single agents and as multi-drug protocol in various clinical settings, Dosages/Modes/routes of administration of cytotoxic drugs, Complications/adverse effects of various cytotoxic drugs.

**6. PRINCIPLES OF RADIOTHERAPY ALLIED SPECIALTIES**

Principles of Radiotherapy: General, Teletherapy, Brachytherapy; Techniques of Radiotherapy, Techniques in Brachytherapy, Clinical Practice, Treatment Planning and Presentation, General histologic and cytologic features of malignancy.

**7. CLINICAL MANAGEMENT IN TUMORS OF:**

Head and Neck, Gastro-Intestinal Tract, Chest, Genito-Urinary Tract, Female Genital Tract, Central Nervous System, Soft Tissue Sarcomata and Bone Tumours, Paediatric Tumours, Lymphoproliferative and Myeloproliferative Disorders, Skin, Endocrine, Other tumours and tumour- like conditions, Metastatic cancer in unknown primary.

**8. RADIOTHERAPY FOR BENIGN DISEASE**

The indications for radiotherapy in the treatment of benign conditions, including suitable techniques and dosage schedules, and likely benefits and risks

**9. COMPLICATIONS OF TREATMENT**

The acute and late complications of oncological treatment and their management Including: Skin reactions, Nausea and vomiting, Diarrhoea, Oedema, Bone marrow toxicity, Neutropenic sepsis, Drug reactions, Cytotoxic extravasation, Alopecia, Cataract, Skin atrophy and ulceration, Colitis, proctitis, gut strictures and perforation, Renal effects, Cardiac effects, Pulmonary effects, Fibrosis and lymphedema, Endocrine effects (thyroid, pituitary and salivary gland), Effects on fertility, Incidence of second and radiation induced cancers.

**10. SYMPTOM CONTROL AND CONTINUING CARE**

The available medical and surgical techniques for the control of pain, nausea, vomiting and malignant effusions, Treatment of various cancer related conditions and paraneoplastic syndromes including- Hypercalcaemia, Ectopic hormone production, Raised intra cranial pressure, Anaemia

**11. RESEARCH METHODOLOGY.**

**12. MEDICO LEGAL ASPECTS RELEVANT TO THE DISCIPLINE.**

**13. INDIAN MEDICAL COUNCIL (PROFESSIONAL CONDUCT, ETIQUETTE AND ETHICS) REGULATIONS, 2002.**

**14. CURRENT TRENDS AND RECENT ADVANCEMENTS IN THE FIELD OF RADIOTHERAPY.**