

# **RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER**

## **SYLLABUS OF COMPETITIVE EXAMINATION FOR THE POST OF ASSISTANT PROFESSOR (Broad Speciality) NUCLEAR MEDICINE MEDICAL EDUCATION DEPARTMENT**

### **Unit-I - Radiation Physics and Instrumentation:**

- Structure of atom, Natural and artificial radioactivity.
- Modes of Radioactive decay.
- Interaction of radiation with matter.
- Principles of radiation detection and detectors.
- Basic principles of production of radionuclides by reactors and cyclotrons.

### **Unit-II - Nuclear Medicine Instrumentation:**

- Nuclear Medicine Instrumentation: Gamma Cameras, Single Photon Emission Computed Tomography (SPECT), Positron Emission Tomography (PET), Hybrid Imaging Systems like SPECT/CT, PET/CT, PET/MR, respiratory gating devices and PET/CT guided robotic positioning system.
- Counting Systems: Well counters, liquid scintillation counters, spectrometers, Radioactive Iodine Uptake (RAIU) probe, gamma probe and radiation monitoring devices,
- Quality control of Instruments used in Nuclear Medicine.
- Collimation of radiation detectors and the characteristics of various collimators, their response to point, line and plane sources.
- Electronic instruments, such as pulse amplifiers, pulse height analyser, count rate meters and computer interfaces including gating devices.
- Software and hardware fusion technology, Digital Imaging and Communications in Medicine (DICOM) technology and Picture Archiving and Communication System (PACS).
- System specific software applications in Nuclear Medicine: Neurology, cardiology etc.

### **Unit-III - Mathematics, Statistics and Computer Sciences:**

- Basic Mathematical concepts, counting statistics, probability distribution, Bayesian and McNemar statistics, parametric and non-parametric statistics, survival analysis, receiver operating characteristics (ROC), forest plot and waterfall plots etc.
- Compartmental analysis and mathematical models of physiologic systems.

- Basic aspects of computer structure, function and programming.
- Computer applications with emphasis on digital image acquisition, analysis, processing and enhancement, tomographic reconstruction, display and recordings of findings.
- Fundamental of filters, their applications and uses.

#### **Unit-IV - Radiation Biology:**

- The biological effects of radiation exposure with emphasis on the effects of low level exposure.
- Basics of radiobiology: Physics and Chemistry of Radiation Absorption, Molecular Mechanisms of DNA and Chromosome Damage and Repair, Cell Survival Curves, Radiosensitivity and Cell Age in the Mitotic Cycle, Fractionated Radiation and the Dose-Rate Effect, Oxygen Effect and Reoxygenation, Linear Energy Transfer and Relative Biologic Effectiveness
- Methods of reducing unnecessary radiation exposure to patients, personnel and environment.
- ICRP recommendations and their amendments from time to time and other international recommendations, environmental regulations- regarding limits of radiation exposure, handling of radioactive patients, transport of radioactivity material and disposal of radioactive wastes.
- The diagnosis, evaluation and treatment of radiation over exposure in any form.
- Regulatory process/requirements for establishing Nuclear Medicine diagnostic and therapy facilities

#### **Unit-V - Diagnostic Radiopharmaceuticals:**

- Physical and chemical characteristics of radionuclide used in diagnostic Nuclear Medicine.
- Criteria for selection of radionuclide for diagnostic purposes.
- Biological behaviour of radiopharmaceuticals.
- Quality control.
- Mechanism of localization.
- Positron Emitting radionuclides, target reactions and their radiopharmaceuticals chemistry, various synthetic modules.
- Specific topics on Radiopharmaceuticals: Bone seeking, hepatobiliary, brain and cerebrospinal fluid (CSF), renal, thyroid, parathyroid, infection imaging, Tumor seeking, cardiac imaging, pulmonary, lymphatics & Gastrointestinal system etc.

- Good Manufacturing Practice (GMP) and Laws pertaining to in-house manufacturing of Radiopharmaceuticals.
- Radiopharmaceuticals for Research.

#### **Unit-VI - In vivo Diagnostic Imaging:**

- General clinical indications for organ imaging; normal and altered anatomy, physiology, biochemistry and metabolism of various organs. Technical aspects of performing the procedures including proper patient preparation and patient management before, during and after the procedure.
- In vivo imaging and functional studies including brain Single Photon Emission Computed Tomography (SPECT), tracing of cerebrospinal fluid pathways, thyroid imaging, salivary glands, lungs, heart, gastrointestinal, hepatobiliary system, spleen, kidney, prostate, adrenal, bone and joints, bone marrow evaluation, lymphatics etc.
- The use of physiologic gating techniques for functional studies and patient monitoring during intervention, both physical exercise and using pharmacological stress agents.
- Cellular kinetics, absorption and excretion analysis, nuclear hematology and metabolic balance studies using radiotracers.
- Comparative analysis of Nuclear Medicine procedures with X-ray, Ultrasound, Echo, MRI, CT and angiography etc.
- Nuclear Cardiology: Stress and redistribution studies using Thallium<sup>201</sup>, technetium<sup>99m</sup> labelled & PET based myocardial perfusion agents, myocardial viability, Gated SPECT & PET myocardial studies, etc.
- Neurology: SPECT & PET studies dementia, movement disorders, epilepsy, encephalitis etc
- Positron Emission Tomography (PET) : All indications for use of PET imaging in oncology, cardiology, infection, neurosciences and psychiatric disorders.

#### **Unit-VII - In vitro Studies:**

- Principles of Radioimmunoassay (RIA), immunoradiometric assay (IRMA), quality control and data analysis for various hormones and drugs assays.
- Glomerular Filtration Rate (GFR) estimation, Red Cell Survival, Red Cell Mass using chromium and C<sup>14</sup> urea Breath test.

### **Unit-VIII - Basics of Radionuclide therapy:**

- Principles of Internal Dosimetry: Calculation of the radiation dose from internally administered radionuclide.
- Characteristics of Radionuclides/Radiopharmaceuticals for radionuclide therapy (alpha and beta therapy).

### **Unit-IX - Radiation protection in therapeutic set up:**

- Design of Isolation ward as per the norms of Atomic Energy Regulatory Board (AERB).

### **Unit-X – Radionuclide Therapy and metabolic interventions:**

- Thyrotoxicosis.
- Thyroid cancer, Prostate cancer, Neuroendocrine tumor.
- Radiosynovectomy.
- Peptide receptor radionuclide therapy.
- Bone pain palliation.
- Radioimmunotherapy.
- Locoregional internal radiationnuclide therapy: Intravascular /Intracavitary /Interstitial and Epidermal Radionuclide Therapy
- PET guided metabolic interventions.

### **Unit-XI – Recent Advances in areas of Nuclear Medicine:**

Instrumentation, Radiopharmaceuticals, Diagnostic Nuclear Medicine, Procedures/interventions, Therapeutic Nuclear Medicine Procedures, Artificial intelligence and machine learning in Nuclear Medicine.

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#### **Pattern of Question Papers:**

- 1. Objective Type Paper**
- 2. Maximum Marks: 150**
- 3. Number of Questions: 150**
- 4. Duration of Paper: 2.30 Hours**
- 5. All Questions carry equal marks**
- 6. There will be Negative Marking.**

(For every wrong answer one-third of the marks prescribed for that Particular question shall be deducted.)