Radiopharmaceuticals

Q1. Define radiopharmaceuticals. Give the ideal characteristics of radiopharmaceuticals.

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Radiopharmaceuticals are medicinal formulations containing radioisotopes which are used in major clinical areas for diagnosis and treatment.

Ideal Characteristics of Radio Pharmaceuticals

- 1. It should have relatively short half-life
- 2. It should emit gamma particles
- 3. It should be able to localize on target site before being metabolized
- 4. The energy of radiopharmaceuticals should range from 30 to 300 kiloelectron volts (keV)
- 5. It should excrete from the body.
- 6. It should be easily available and should be expensive.

Q2. Write in brief about "storage of radiopharmaceuticals".

Storage of Radiopharmaceuticals

- Radiopharmaceuticals should be kept in well-closed containers and stored in an area assigned for the purpose.
- Storage conditions must fulfil radiation protection requirements and protect the product from deterioration.
- Radiation protection guidelines will specify the maximum permissible dose rate and may give special requirements such as fire precautions and safety against theft.
- The storage area must be a dry, clean place.
- Storage at 2° to 5°C will often be required.
- All labellings of pharmaceuticals should clearly show the expiry date.
- The storage condition should be such that the maximum radiation dose rate to which person may be exposed is reduced to an acceptable level.

- Necessary care should be taken to comply with national regulation for protection against ionizing radiations.
- Radiopharmaceuticals preparation intended for parenteral use should be kept in a glass vial, ampoule or syringe that is sufficiently transparent to permit the visual inspection of the contents. Glass containers may get darkened under the effect of radiation.
- The period for use of each radiopharmaceuticals is normally fixed with regard to radiochemical purity, radionuclide purity or similar parameters.

Q3. How are radiopharmaceuticals dispensed?

OR	
Explain process of dispensing radiopharmaceuticals.	

Dispensing of Radiopharmaceuticals

- The dispensing area should be separate, dedicated and secure area.
- The dispensing room should be closed to the imaging and injection areas.
- The operational area should be in a good condition and hygiene must be ensured.
- All work surfaces should be smooth and impermeable and should permit easily cleaning and decontamination.
- Dispensing should be safe, straightforward and reliable.
- Radiopharmaceutical dispensing has been the production of ready to use kits or cold kits which provide individual or multiple doses and can be reconstituted by the addition of radionuclide at the time of intended use.
- Chemical reagents are prepared in a sterile environment using pyrogen free raw materials and dispensed into single or multiple unit dose containers. The preparation of individual doses can be carried out rapidly and safely when required with minimum manipulation.
- The cold kit preparation should be subjected to terminal sterilization preferably by autoclaving or if not by membrane filtration.
- Radiopharmaceuticals are never dispensed directly to patients, they are provided to trained healthcare professionals at the hospital or clinics and then administered to the patients.
- Recommended dosage level is calculated on the basis of patient history, age, weight, surface area and other factors.
- Dispensing of prescription is done as per applicable pharmacy law and appropriate records are maintained.

- Policies and procedures are developed in a way that the correct drug in correct dosage and dosage form is received by the correct patient at the correct time via the correct route of administration.
- Good radiation practices (GRP) should be strictly followed for operations with unrelated sources to reduce the unwanted and avoidable radiation exposure.

Q4. How the radiopharmaceuticals are disposed of?

OR What are different methods of disposal of radiopharmaceuticals?

Disposal of Radiopharmaceuticals

- The radiopharmaceuticals which are of no more use must be disposed to avoid any hazard to environment.
- The disposal has to be taken local regulations for both contamination sources into account. It is useful to segregate short half-life waste from long half-life radionuclides.
- The practices that produce large volume of radioactive waste must be avoided.
- The radioactive waste generated in radiopharmacy laboratory includes syringes, elusion vials, pharmaceutical vials, needles and swabs. All such waste should be primarily stored into waste bin built into the contained workstation.
- Other items such as gloves, paper waste may be deposited in shielded waste bin in the pharmacy. The waste bins should be closed marked as radioactive, dated and removed to radioactive waste store. Once the waste radioactivity decayed to background level, it should be disposed of, for which the hospital waste disposal policy should be followed.

Methods of Disposal

- 1. Dilute and disperse
- 2. Delay and decay
- 3. Concentrate and buried
- 4. Dump to sanitary sewer
- 5. Incineration
- 6. Shift to disposal site
- 7. Dispose of as if not radioactive
- 8. Waste disposal tag

- 1. Dilute and disperse: The low activity solid articles may be disposed of as ordinary hospital waste provided the activity of the articles does not exceed 1.35 μ Ci. Such articles include vials, syringes, cotton swabs. Similarly, liquid radioactive waste with activity less than microcurie level can be disposed of into the sanitary sewerage system with adequate flushing with water following the disposal.
- **2. Delay and decay:** The radioactive waste should be stored for a minimum period of about 10 half lives when after decay only 0.1% of the initial activity remains.

The waste is then monitored for the residual activity and if the dose limit is low, it is disposed of as similar to solid or liquid waste. The radiation safety officer can hold waste with half-lives up to 100 days.

- **3. Concentrate and buried:** Radioactive waste is collected in suitably designed and labelled containers and the buried in exclusive burial sites approved by the competent authority.
- **4. Dump to sanitary sewer:** Water soluble radioactive materials should be checked by radiation safety officer and with his permission it is dumped into sanitary sewers.
- **5. Incineration:** Insoluble liquid waste such as that from the liquid scintillation systems may be disposed of by incineration.
- **6.** Shift to disposal site: Sealed gauges, detectors or counters, and check sources are sent to approved disposal site for disposal.
- 7. Dispose of as if not radioactive: Scintillation cocktail containing not more than $0.05 \ \mu$ Ci per ml of H-3 or C-14 be discarded as if it is not radioactive.

Q5. What precautions are to be taken while handling and storage of radiopharmaceuticals/radioactive materials?

Handling of Radiopharmaceuticals

- Radioactive substances should never be touched with hand but handled with forceps.
- Activities like smoking, drinking, eating should be avoided in the area where radioactive substances are kept.
- Sufficient protective clothing should be used during handling of radioactive substances.
- Area where the radioactive materials are kept should be tested regularly for the presence of fluorescence.
- There should be proper disposal of radioactive materials.
- Radioactive materials may be kept in a suitable, labelled container.

- They should be kept in remote area.
- All surfaces of the containers should be smooth, nonporous, nonwetting, and heat resistant.
- Fluorescence should be removable.
- The wall finishes should be hard and smooth and should not easily get contaminated.
- The amount of wood material should be minimum.
- The benches, cupboards should be made up of plastics.
- There should be minimum movement of workers.
- Workers should wear protective clothes while entering the area where radioactive materials are stored.

+ Objective Questions with Answers in Bold Letters +

- 1. GM counter is used for the measurement of radioactivity.
- 2. Radiopharmaceuticals should have a **short half-life**.
- 3. GRP stands for good radiation practices.
- 4. Sodium rose Bengal (I-131) is used in liver scanning.
- 5. Radiopharmaceuticals should emit gamma particles/rays.
- 6. Xenon-133 gas (Xe-133) is used for pulmonary scanning.
- 7. The compounds or substances which exhibit radioactivity and which are used in medicine for various purposes are called as **radiopharmaceuticals**.
- 8. The hospital radioactive waste is mostly composed of **low level waste**.
- 9. Incineration reduces the bulk of waste.
- 10. Radiopharmaceuticals should be stored at about **2°C to 5°C** temperature.