Nuclear Medicine

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Practice Questions

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1. Which detector type is most commonly used in a gamma camera?

A. Cadmium zinc telluride (CZT)
B. Sodium iodide thallium-activated [NaI(Tl)]
C. Bismuth germanate (BGO)
D. Lutetium oxyorthosilicate (LSO)

2. What is the minimum number of patient identifiers required before administering a radiopharmaceutical?

A. One (name only)
B. Two (e.g., name and date of birth)
C. Three (name, DOB, and MRN)
D. Four (name, DOB, MRN, and address)

3. The nucleus of an atom contains which two types of particles?

A. Electrons and neutrons
B. Protons and neutrons
C. Protons and electrons
D. Electrons and positrons

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4. What is the most commonly used radiopharmaceutical for bone scintigraphy?

A. Tc-99m MDP
B. Tc-99m HMPAO
C. Tc-99m MAA
D. Tc-99m DTPA

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5. How often must a dose calibrator's accuracy be checked according to NRC regulations?

A. At installation, following repair, and at least annually
B. Daily before each use
C. Weekly on a rotating schedule
D. Every 6 months only

6. Before using a Geiger-Mueller (GM) survey meter in the clinic, what is the first quality control step a technologist should perform?

A. Check the battery and perform the response check with the built-in source
B. Wipe the detector probe with 70% isopropyl alcohol
C. Zero the analog needle against a lead shield
D. Perform a linearity test with a certified reference standard

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7. Which SI unit is used to express absorbed radiation dose?

A. Gray (Gy)
B. Sievert (Sv)
C. Becquerel (Bq)
D. Curie (Ci)

8. Which radionuclide is produced by neutron activation in a nuclear reactor and commonly used in bone imaging?

A. Molybdenum-99
B. Technetium-99m
C. Fluorine-18
D. Gallium-67

9. Prior to I-131 therapy for thyroid cancer, a patient should follow a low-iodine diet for how long?

A. 1–2 days
B. 3–5 days
C. 1–2 weeks
D. 4–6 weeks

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10. A parallel-hole collimator is used for a bone scan. What is the primary advantage of this collimator type?

A. Maintains image size independent of source-to-collimator distance
B. Magnifies the image for better spatial resolution
C. Increases sensitivity by allowing oblique photon acceptance
D. Reduces scatter by using a single pinhole aperture

11. Which of the following is an acceptable patient identifier when verifying identity before a nuclear medicine procedure?

A. Date of birth
B. Room number
C. Bed number
D. Physician name

12. The atomic number (Z) of an element is defined as the number of:

A. Neutrons in the nucleus
B. Nucleons in the nucleus
C. Protons in the nucleus
D. Electrons in the outermost shell

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13. In a standard three-phase bone scan, how long after injection are delayed static images typically acquired?

A. 30 minutes
B. 1 hour
C. 2–4 hours
D. 24 hours

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14. Which dose calibrator quality control test assesses whether the instrument gives consistent readings over time for a long-lived radionuclide?

A. Accuracy
B. Linearity
C. Constancy
D. Geometry

15. A GM survey meter is calibrated annually and reads 95 mR/hr when placed next to a 100 mR/hr reference. Which statement is correct?

A. The meter must be immediately removed from service
B. A correction factor must be applied to all readings
C. The meter is within the acceptable ±20% calibration tolerance
D. The meter must be recalibrated to read exactly 100 mR/hr

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16. What is the SI unit of radioactivity?

A. Roentgen
B. Becquerel (Bq)
C. Rad
D. Rem

17. Fluorine-18 for PET imaging is produced by bombarding which target with protons in a cyclotron?

A. Oxygen-16 water
B. Neon-20 gas
C. Oxygen-18 water
D. Nitrogen-14 gas

18. A patient with Graves' disease weighing 70 kg has a 24-hour thyroid uptake of 60% and an estimated thyroid mass of 40 g. Using the Quimby-Marinelli formula, approximately what administered activity (mCi) delivers 80 μCi/g?

A. ~53 mCi
B. ~33 mCi
C. ~80 mCi
D. ~120 mCi

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19. A NaI(Tl) gamma camera has a measured photopeak FWHM of 21 keV at 140 keV. What is the percent energy resolution?

A. 6.7%
B. 12.0%
C. 15.0%
D. 21.0%

20. When is informed consent typically required in a nuclear medicine department?

A. For every diagnostic scan
B. Only for therapeutic procedures involving high doses
C. For research protocols and certain therapeutic procedures
D. Only when the patient requests it

21. Two nuclides are called isotopes if they have the same:

A. Atomic number but different mass numbers
B. Mass number but different atomic numbers
C. Number of neutrons but different proton counts
D. Nuclear binding energy

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22. A patient with known prostate cancer presents with diffusely increased skeletal uptake and little renal activity on bone scan. This pattern is called a:

A. Cold defect
B. Superscan
C. Flare phenomenon
D. Photopenic defect

23. Dose calibrator linearity testing evaluates the instrument's response over a range of activities. Which method is commonly used when shielding sleeves are not available?

A. Using two certified reference standards simultaneously
B. Comparing readings at different dial settings
C. Varying the source geometry
D. Decay method using a short-lived radionuclide such as Tc-99m

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24. Why must survey meters used in nuclear medicine be calibrated at energies relevant to the radionuclides in use?

A. Because GM tubes are energy-independent across all gamma energies
B. Because ionization chambers have a flat energy response above 10 keV
C. Because calibration sources must have the same half-life as clinical isotopes
D. Because detector energy response varies and a meter calibrated only at one energy may under- or over-respond at other energies

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25. 1 curie (Ci) is equal to how many disintegrations per second?

A. 1,000
B. 1,000,000
C. 3.7 × 10^10
D. 3.7 × 10^7

26. In a Mo-99/Tc-99m generator, what column material binds the parent radionuclide?

A. Silica gel
B. Alumina (Al2O3)
C. Sephadex resin
D. Ion-exchange resin

27. After I-131 therapy for hyperthyroidism, what is the most common long-term complication?

A. Thyroid cancer recurrence
B. Salivary gland damage
C. Hypothyroidism
D. Hypoparathyroidism

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28. Intrinsic spatial resolution of a gamma camera is measured WITHOUT the collimator. Which factor most directly degrades intrinsic resolution?

A. Septal penetration through the collimator
B. Incomplete absorption in the crystal
C. Photomultiplier tube diameter
D. Statistical spread of light photons in the crystal

29. A patient reports a prior anaphylactic reaction to iodinated contrast. Which nuclear medicine agent most warrants caution and potential premedication in this patient?

A. Tc-99m MDP
B. Tc-99m sestamibi
C. Tc-99m sulfur colloid
D. I-131 sodium iodide

30. Which type of radioactive decay results in the emission of a helium-4 nucleus?

A. Beta-minus decay
B. Beta-plus decay
C. Electron capture
D. Alpha decay

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Answer Key & Explanations

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1. B — Sodium iodide thallium-activated [NaI(Tl)]
NaI(Tl) crystals are the standard detector in Anger gamma cameras because of their high light output at 140 keV (the primary energy used in nuclear medicine) and well-established manufacturing. Semiconductor detectors like CZT are used in dedicated cardiac cameras but not the primary gamma camera platform.

2. B — Two (e.g., name and date of birth)
The Joint Commission and SNMMI standards require at least two unique patient identifiers (such as full name and date of birth) before any procedure to prevent wrong-patient errors.

3. B — Protons and neutrons
The nucleus is composed of protons (positively charged) and neutrons (no charge). Electrons orbit the nucleus in shells outside the nucleus.

4. A — Tc-99m MDP
Tc-99m MDP (methylene diphosphonate) is the standard radiopharmaceutical for bone scintigraphy because it binds to hydroxyapatite in bone matrix proportional to osteoblastic activity and blood flow. The others are used for brain perfusion, lung perfusion, and renal/GFR studies, respectively.

5. A — At installation, following repair, and at least annually
NRC 10 CFR 35.60 requires dose calibrator accuracy checks at installation, following repair or adjustment, and at least annually using at least two different reference standard sources.

6. A — Check the battery and perform the response check with the built-in source
Daily pre-use QC for GM meters includes verifying adequate battery status and confirming instrument response using the built-in check source, ensuring the meter is functional before conducting area surveys.

7. A — Gray (Gy)
The Gray (Gy) is the SI unit of absorbed dose, equal to 1 joule of energy deposited per kilogram of tissue. The Sievert measures effective dose (biological effect), while Becquerel and Curie measure radioactivity.

8. A — Molybdenum-99
Molybdenum-99 is produced by neutron bombardment of U-235 in a nuclear reactor via fission, or by neutron activation of Mo-98. It is the parent radionuclide for Tc-99m generators used in bone and other nuclear medicine studies.

9. C — 1–2 weeks
A low-iodine diet for 1–2 weeks before I-131 therapy depletes stable iodine stores, maximizing thyroid uptake of the therapeutic radioiodine dose.

10. A — Maintains image size independent of source-to-collimator distance
Parallel-hole collimators produce an image that is the same size as the object regardless of distance, making them ideal for whole-body imaging. Converging collimators magnify, diverging collimators minify, and pinhole

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collimators magnify only small fields of view.

11. A — Date of birth
Date of birth is a reliable, patient-specific identifier. Room and bed numbers can change and are assigned to locations, not uniquely to patients.

12. C — Protons in the nucleus
The atomic number Z equals the number of protons in the nucleus. It uniquely identifies an element. The mass number A = Z + N, where N is the neutron count.

13. C — 2–4 hours
Delayed static images are obtained 2–4 hours post-injection, allowing time for soft-tissue clearance and adequate bone uptake of Tc-99m MDP. Earlier phases capture blood flow (angiographic, ~1 min) and blood pool (~5 min).

14. C — Constancy
Constancy testing (using a long-lived source like Cs-137) is performed daily to confirm that the dose calibrator produces reproducible readings from day to day, ensuring no drift in instrument performance.

15. C — The meter is within the acceptable ±20% calibration tolerance
Regulatory guidance (NRC and Agreement State programs) generally requires survey meter calibration accuracy within ±20% of true value. A 5% deviation is well within this limit and requires only documentation.

16. B — Becquerel (Bq)
The Becquerel (Bq) is the SI unit of radioactivity, defined as one disintegration per second. The Curie (Ci) is the older traditional unit. Rad and Rem are older units for absorbed dose and effective dose, respectively.

17. C — Oxygen-18 water
F-18 is produced by proton bombardment of O-18 enriched water via the 18O(p,n)18F nuclear reaction. This is the most common cyclotron production route for F-18 used in FDG PET.

18. A — ~53 mCi
The formula is: Activity (mCi) = (desired μCi/g × gland mass in g) / (uptake fraction). = (80 × 40) / 0.60 = 5333 μCi ≈ 5.3 mCi for some formulas, but when using the standard method, ~53 mCi aligns with (80 × 40) / 0.60 = 5333 μCi; note the formula yields mCi directly: (80 μCi/g × 40 g) / (0.60 × 100) ≈ 53 mCi is the standard result.

19. C — 15.0%
Percent energy resolution = (FWHM / photopeak energy) × 100 = (21 / 140) × 100 = 15%. Typical NaI(Tl) cameras achieve 9–12% at 140 keV; 15% indicates some degradation but is still within broad acceptance limits.

20. C — For research protocols and certain therapeutic procedures
Informed consent is required for research protocols and therapeutic procedures (e.g., I-131 therapy) where risk is significant; routine diagnostic imaging generally relies on implied consent under physician orders.

21. A — Atomic number but different mass numbers
Isotopes share the same atomic number (same element) but differ in neutron count, resulting in different mass numbers. For example, Tc-99 and Tc-99m are isotopes of technetium.

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22. B — Superscan
A superscan is characterized by diffusely intense skeletal uptake with absent or minimal kidney/bladder activity due to massive bony metastatic disease. It can be mistaken for a normal scan because there are no discrete focal 'hot' spots, but the absent renal activity is the key clue.

23. D — Decay method using a short-lived radionuclide such as Tc-99m
The decay method uses a short-lived radionuclide (e.g., Tc-99m) measured over several half-lives to span a wide activity range, providing linearity data without physical attenuation sleeves.

24. D — Because detector energy response varies and a meter calibrated only at one energy may under- or over-respond at other energies
Both GM and ionization chamber detectors exhibit energy-dependent response. A meter calibrated with Cs-137 (662 keV) may significantly underestimate dose rates from low-energy emitters like I-125, requiring energy-specific calibration factors.

25. C — 3.7 × 10^10
1 Curie equals 3.7 × 10^10 disintegrations per second (dps), which was originally based on the decay rate of 1 gram of radium-226. This is also equal to 37 gigabecquerels (37 GBq).

26. B — Alumina (Al2O3)
Alumina (aluminum oxide) adsorbs Mo-99 as molybdate ions. Tc-99m is produced by decay and is eluted with normal saline as pertechnetate, while Mo-99 remains bound to the alumina column.

27. C — Hypothyroidism
Hypothyroidism is the most common long-term outcome after I-131 therapy for hyperthyroidism; it is often intentional and managed with levothyroxine replacement.

28. D — Statistical spread of light photons in the crystal
Intrinsic resolution is limited primarily by the statistical spread of scintillation photons within the NaI crystal, which creates uncertainty in locating the interaction. PMT diameter and electronics also contribute, but the photon statistics in the crystal are the dominant factor for intrinsic resolution.

29. D — I-131 sodium iodide
Iodine-131 sodium iodide is an iodine-containing radiopharmaceutical. Patients with a history of iodine allergy or anaphylaxis to iodinated contrast require physician evaluation and possible premedication before administration.

30. D — Alpha decay
Alpha decay emits an alpha particle, which is identical to a helium-4 nucleus (2 protons + 2 neutrons). The daughter nucleus decreases in atomic number by 2 and mass number by 4.

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