

Chapter 2

Practice Test #1: Difficulty Level – Easy*

Questions

1. The venous blood returning via the superior vena cava (SVC) and inferior vena cava (IVC) enters the heart at the:
(A) Left atrium (LA)
(B) Right atrium (RA)
(C) Left ventricle (LV)
(D) Right ventricle (RV)
2. The mechanism by which the epithelial cells of the thyroid concentrate iodide is termed:
(A) Diffusion
(B) Hormonogenesis
(C) Active transport
(D) Absorption
3. Flood field nonuniformity in reconstructed SPECT images can result in:
(A) Star artifacts
(B) Ring artifacts
(C) Hot spot artifacts
(D) Cold spot artifacts

*Answers to Test #1 begin on page 54.

4. Tc-99m Sulfur colloid can be used in all of the following types of imaging EXCEPT:
- (A) Bone marrow imaging
 - (B) Gastrointestinal bleeding imaging
 - (C) Liver imaging
 - (D) Brain imaging
5. Figure 2.1 presents the diagrams of end-systolic (dashed line) and end-diastolic (solid line) shape of left ventricle cineangiogram. The drawing “a” represents normal left ventricle wall motion. What left ventricle abnormality corresponds to the drawing “b”?
- (A) Hypokinetic left ventricle
 - (B) Hyperkinetic left ventricle
 - (C) Akinetic left ventricle
 - (D) Dyskinetic left ventricle

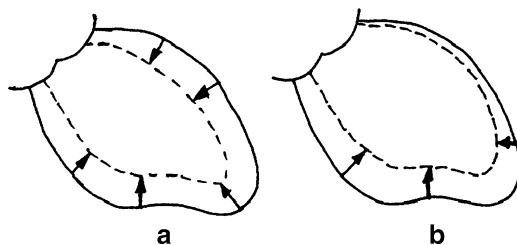


Fig. 2.1 End-systolic (dashed line) and end-diastolic (solid line) shape of left ventricle cineangiogram
(Illustration by Sabina Moniuszko)

6. Popular radiation safety acronym ALARA stands for:
- (A) As Low as Radiologist Approve
 - (B) As Low as Radiation Accepted
 - (C) As Low as Reasonably Achievable
 - (D) As Low as Reasonably Accepted
7. Technetium-99m is used in the majority of all standard nuclear medicine studies because Tc-99m:
- (A) Has a long half-life
 - (B) Produces alpha and beta particles
 - (C) Causes septal penetration
 - (D) Provides good tissue penetration

8. A dose calibrator is used to assay the amount of a radioactivity in a sample before it is administered to a patient. All radiation leaving the source placed in the dose calibrator is detected EXCEPT radiation directed toward:
- (A) The bottom of the chamber
 - (B) The hole at the top
 - (C) The bottom half of the chamber
 - (D) The upper part of the chamber
9. If expected value of the long-lived source is 120 μCi and actual reading obtained from dose calibrator is 122 μCi , what is the percentage error of that reading?
- (A) -2
 - (B) -1.7
 - (C) 1.7
 - (D) 2.0
10. The size of the colloid particles is important in imaging the reticuloendothelial system. Particles smaller than 20 nm tend to accumulate in:
- (A) The bone marrow
 - (B) The liver
 - (C) The spleen
 - (D) The lymph nodes
11. The cardiac measurement defined as the blood volume pumped out by the ventricle over 1 min time period is called the:
- (A) Ejection fraction
 - (B) Stroke volume
 - (C) Cardiac output
 - (D) Systolic
12. Esophageal transit scintigraphy is fast, noninvasive, and easy to perform diagnostic procedure but its widespread use is limited because of:
- (A) High radiation exposure
 - (B) Lack of standardization
 - (C) Labeling difficulties
 - (D) Food allergies
13. The daily quality control for dose calibrator includes a constancy check typically performed with small amounts of Cobalt-57 or Cesium-137. Cs-137 has a half-life of 30 years and produces:
- (A) 133 keV gamma ray
 - (B) 388 keV gamma ray
 - (C) 637 keV gamma ray
 - (D) 662 keV gamma ray

14. Scintigraphy is the gold standard measurement of gastric emptying for diagnosis of gastroparesis. All the following symptoms are common among patients with gastric dysmotility disorders EXCEPT:
- (A) Nausea and vomiting
 - (B) Early satiety
 - (C) Abdominal bloating
 - (D) Tachycardia
15. Figure 2.2 presents the schematic drawing of normal heart conduction system. The label “a” represents:
- (A) The left bundle branch
 - (B) The right bundle branch
 - (C) The sinoatrial node
 - (D) The atrioventricular node

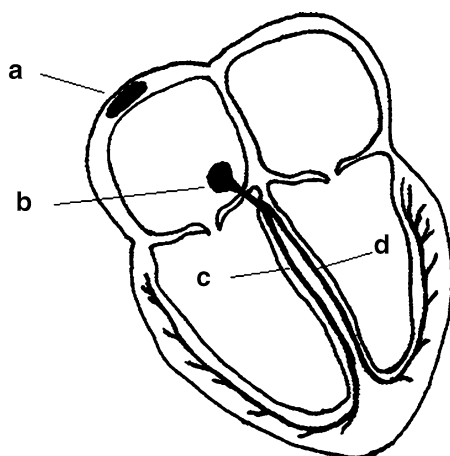


Fig. 2.2 Normal heart conduction system (*Illustration by Sabina Moniuszko*)

16. The Nuclear Regulatory Commission (NRC) has provided complete guidelines for retention of all records generated in a nuclear medicine department. Which of the following documentation should be kept indefinitely?
- (A) Misadministrations records
 - (B) Patient dosage records
 - (C) Personnel monitoring records
 - (D) Sealed-source inventory records

17. The radionuclides emitting β particles should be stored in containers of low Z material to prevent:
- (A) Compton scatter
 - (B) Bremsstrahlung radiation
 - (C) Back injuries
 - (D) Extra expenditures
18. The mathematical process of applying a negative value to both sides of the density histogram of each ray sum is called convolution filtering and is used in reconstruction method called:
- (A) Filtered backprojection
 - (B) Iterative reconstruction
 - (C) Ordered subset expectation maximization
 - (D) Fourier transformation
19. 580 Microcuries (μCi) is equal to:
- (A) 58 curies (Ci)
 - (B) 0.580 curie (Ci)
 - (C) 0.00058 curie (Ci)
 - (D) 0.000058 curie (Ci)
20. Fever of unknown origin (FUO) can be caused by all of the following disorders/factors EXCEPT:
- (A) Stress
 - (B) Infection
 - (C) Neoplasm
 - (D) Drugs
21. When approaching unresponsive victim her/his occasional gasps the rescuer should:
- (A) Give rescue breath
 - (B) Treat the victim gasps as effective breaths
 - (C) Call 911
 - (D) Wait till breathing become more regular
22. Tc-99m methylene diphosphonate (MDP) is the most widely used bone imaging agent. Uptake of the tracer depends on all of the following EXCEPT:
- (A) Local blood flow
 - (B) Osteoblastic activity
 - (C) Extraction efficiency
 - (D) Liver function

23. The extrinsic flood image evaluates the uniformity of:
- (A) Detector only
 - (B) Detector and collimator
 - (C) Collimator only
 - (D) Neither detector nor collimator
24. All of the following structures can be seen on a normal bone scan of the thorax region EXCEPT:
- (A) Sternoclavicular joint
 - (B) Body of scapulae
 - (C) Manubrium sternum
 - (D) Sternal foramina
25. Presented images (Fig. 2.3) are example of what type of nuclear medicine acquisition?
- (A) Dynamic study
 - (B) Static imaging
 - (C) Dual point imaging
 - (D) Flow study

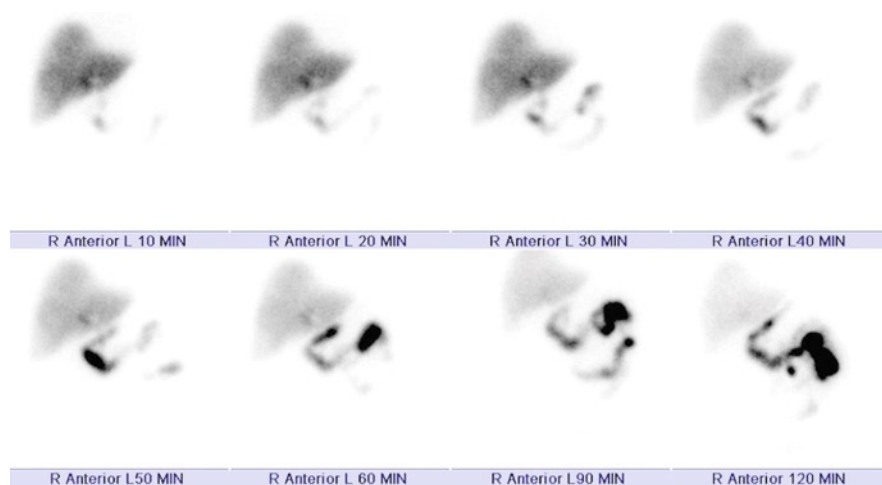


Fig. 2.3 Nuclear medicine acquisition

26. All of the following are recommended means of reducing radiation exposure EXCEPT:
- (A) Use of remote handling devices
 - (B) Applying shielding
 - (C) Wearing film badge
 - (D) Limitation of time

27. One of two or more different nuclides having the same mass number is called:
- (A) Isomer
 - (B) Isotope
 - (C) Isobar
 - (D) Isotone
28. All of the following quality control (QC) tests are performed in nuclear medicine department to assess the reproducibility of radiation counter EXCEPT:
- (A) The relative error
 - (B) The chi-squared test
 - (C) The reliability factor
 - (D) The constancy test
29. A radioactive source produces exposure of 30 millirem per hour (mR/h) at 2-m distance. If the distance is increased to 5-m what is the new exposure rate?
- (A) 4.8 mR/h
 - (B) 5.1 mR/h
 - (C) 5.6 mR/h
 - (D) 6.1 mR/h
30. Excessive free pertechnetate in Tc-99m methylene diphosphonate (MDP) preparation will result in increased tracer accumulation in the:
- (A) Thyroid and stomach
 - (B) Thyroid and kidney
 - (C) Thyroid and bowel
 - (D) Thyroid and liver
31. All of the following symptoms can be related to thyroid dysfunction EXCEPT:
- (A) Weight loss
 - (B) Weight gain
 - (C) Back pain
 - (D) Irregular menstrual cycles
32. Extravasation of the tracer at the site of injection when performing bone scintigraphy may result in visualization of the:
- (A) Thyroid
 - (B) Stomach
 - (C) Kidney(s)
 - (D) Lymph node(s)

33. The basic unit commonly used for expressing amounts of binary-coded information is called:
- (A) The bit
 - (B) The byte
 - (C) The word
 - (D) The sequence
34. Tc-99m-labeled erythrocytes and Tc-99m sulfur colloid are two commonly used techniques to detect:
- (A) Active bleeding
 - (B) Hemangioma
 - (C) Melena
 - (D) Hematemesis
35. Presented images (Fig. 2.4) are example of what type of nuclear medicine acquisition?
- (A) Dynamic study
 - (B) Static imaging
 - (C) Dual point imaging
 - (D) SPECT study

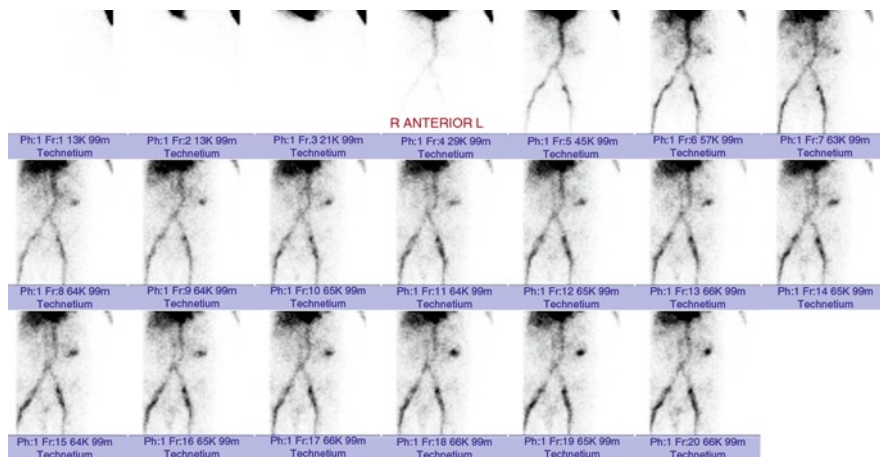


Fig. 2.4 Nuclear medicine acquisition

36. The diagnostic and therapeutic uses of radiopharmaceuticals are dependent on the accumulation of the material in the “organ of interest.” According to the Nuclear Regulatory Commission (NRC) definition, the part of the body that is most susceptible to radiation damage under the specific conditions under consideration is called:
- (A) The critical organ
 - (B) The paired organ
 - (C) The target organ
 - (D) The internal organ
37. A specific radiolabeled molecule that resembles the in vivo behavior of a natural molecule and can be used to provide information about a specific biological process is called:
- (A) Isotope
 - (B) Radiotracer
 - (C) Ligand
 - (D) Pharmaceutical
38. The dose calibrator’s ability to measure accurately a range of low-activity doses to high-activity doses is called:
- (A) Accuracy
 - (B) Constancy
 - (C) Geometry
 - (D) Linearity
39. If cardiac net end-diastolic counts are 65,450 and net end-systolic counts are 31,219, what is the left ventricle ejection fraction?
- (A) 74%
 - (B) 52%
 - (C) 40%
 - (D) 35%
40. All of the following findings on the gastrointestinal bleeding scintigraphy have the potential to reduce the specificity of the test EXCEPT:
- (A) Horse-shoe kidney
 - (B) Dilated abdominal aorta
 - (C) Hepatic hemangioma
 - (D) Foreign body

41. Soaps are detergent-based products and are available in various forms including bar soap, tissue, leaflet, and liquid preparations. Which of the following statements regarding soaps and handwashing is false?
- (A) Handwashing with plain soap can result in increases in bacterial counts on the skin
 - (B) Plain soaps have minimal antimicrobial activity
 - (C) In many studies, handwashing with plain soap failed to remove pathogens from the hands of hospital personnel
 - (D) Plain soaps cannot be contaminated
42. Cinegraphic loop viewing of dynamic images of the gastrointestinal bleeding scintigraphy:
- (A) Help to localize the site of bleeding
 - (B) Eliminate the need of angiography
 - (C) Have prognostic value
 - (D) Is time consuming
43. Calibration, sensitivity/constancy, efficiency, chi-square, and energy resolution are quality control procedures performed to ensure proper operation of the:
- (A) Survey meter
 - (B) Dose calibrator
 - (C) Gamma-camera
 - (D) Well counter and uptake probe
44. Which of the following gastrointestinal structures is more variable in location and more prone to overlap with vascular structures?
- (A) Stomach
 - (B) Small bowel
 - (C) Colon
 - (D) Rectum
45. Images presented in Fig. 2.5 were acquired during routine bone scintigraphy and they should be labeled:
- (A) (a) and (b) – posterior views
 - (B) (a) – anterior and (b) – posterior view
 - (C) (a) – posterior and (b) – anterior view
 - (D) (a) and (b) – anterior views

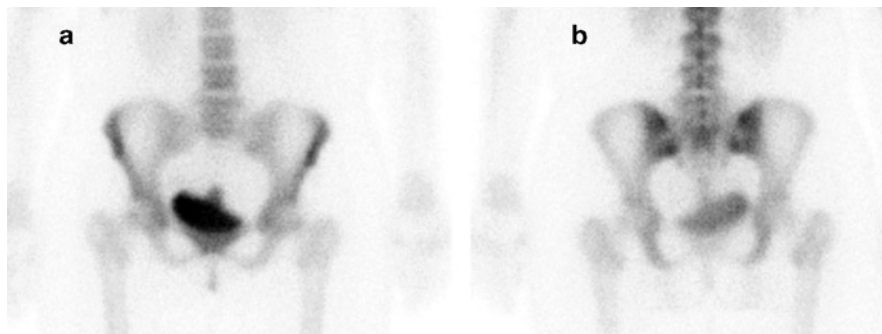


Fig. 2.5 Bone scintigraphy

46. Measurement of radioactive materials present inside a person's body through analysis of the person's blood, urine, feces, or sweat is called:
- (A) Radioconcentration
 - (B) Biodosimetry
 - (C) Biodistribution
 - (D) Bioassay
47. The fraction of total radioactivity present in the form of desired radiopharmaceutical is called:
- (A) Formulation strength
 - (B) Radionuclide purity
 - (C) Integrity of a formulation
 - (D) Radiochemical purity
48. The photons, after passing through the collimator interact with the sodium iodide crystal detector and produce pulses of light that are detected by the:
- (A) Scintillating solution
 - (B) Photomultiplier tubes
 - (C) Pulse height analyzer
 - (D) Amplifier
49. Half-value layer of Tc-99m is 0.27 mm. If an unshielded vial of Tc-99m producing the exposure rate of 225 mR/h is placed in a storage area with lead shield that is 0.8 mm thick, what would be the new exposure rate?
- (A) 75 mR/h
 - (B) 45 mR/h
 - (C) 28 mR/h
 - (D) 18 mR/h

50. Radiolabeled colloidal or macroaggregate particles should have a proper size range for a specific organ uptake. Tc-99m macroaggregated albumin (MAA) particles size from 10 to 100 μm :
- (A) Block the capillaries in lungs
 - (B) Are taken up by the cells of reticuloendothelial system (RES) in liver and spleen
 - (C) Are taken up by the cells of reticuloendothelial system (RES) in bone marrow
 - (D) Block the arterioles in lungs
51. The mixture of thick semifluid mass of partly digested food and secretions that is passed from the stomach to the duodenum is called:
- (A) Bolus
 - (B) Chyme
 - (C) Ganglion
 - (D) Chyle
52. The raw myocardial perfusion projection images are routinely evaluated for all of the following purposes EXCEPT:
- (A) Attenuation artifacts
 - (B) Motion artifacts
 - (C) Wall motion analysis
 - (D) Noncardiac pathology
53. High-count floods performed on gamma-cameras are applied to:
- (A) Static images
 - (B) Static and dynamic images only
 - (C) SPECT images
 - (D) Static, dynamic, and SPECT images
54. In-111 and Tc-99m-labeled white blood cells (WBC) accumulation have been observed in all of the following conditions/sites EXCEPT:
- (A) Gastrointestinal bleeding
 - (B) Debridement sites
 - (C) Vascular access lines
 - (D) Focal seizures
55. Images presented in Fig. 2.6 were acquired during gated equilibrium radionuclide ventriculography and displayed as a splash view of myocardial cycle. How many frames per R–R interval were acquired during the acquisition?
- (A) 4
 - (B) 8
 - (C) 16
 - (D) 32

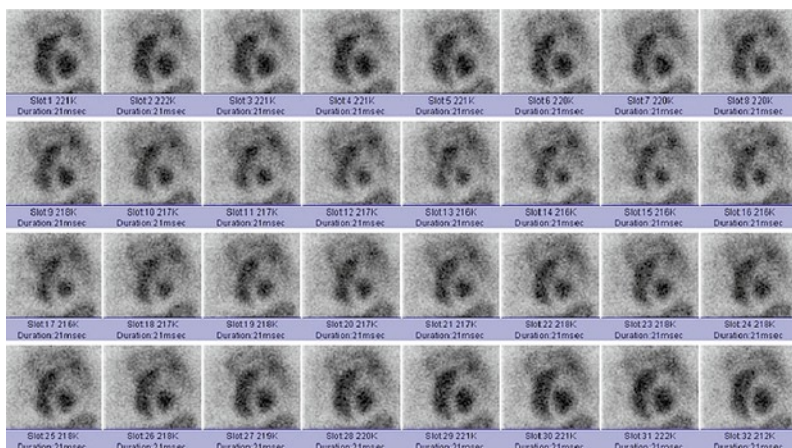


Fig. 2.6 Splash view of myocardial cycle

56. The relationship that states that electromagnetic radiation intensity is inversely proportional to the square of the distance from a point source is called:
 - (A) Inverse square principle
 - (B) Inverse square rule
 - (C) Inverse square law
 - (D) Inverse square protection
57. Tl-201 as thallous chloride at neutral pH with respect to biochemistry and physiology is considered to behave similarly to:
 - (A) Sodium
 - (B) Calcium
 - (C) Potassium
 - (D) Gallium
58. The Pulmonex Xenon System is commonly used to perform lung ventilation studies. Which part of the xenon trap system is responsible for trapping the radioactivity?
 - (A) The Drierite
 - (B) The mask
 - (C) The charcoal filter
 - (D) Soda lime crystals
59. What is the effective half-life of an isotope, that has a physical half-life of 18 h and a biological half-life of 10 h?
 - (A) 2.5 h
 - (B) 6.4 h
 - (C) 7.5 h
 - (D) 9.2 h

60. Tc-99m-labeled leukocytes and Tc-99m sulfur colloid accumulate in the reticuloendothelial cells of the bone marrow. The distribution of marrow activity is similar in all of the following conditions with the exception of:
- (A) Paget's disease
 - (B) Bone fracture
 - (C) Osteomyelitis
 - (D) Shin splint
61. If the medication is injected at a 45-degree angle using a 5/8 in. needle with a 25 gauge, the injection is called:
- (A) Subcutaneous injection
 - (B) Intramuscular injection
 - (C) Intradermal injection
 - (D) Intravenous injection
62. Tc-99m-labeled red blood cells (Tc-99m RBC's) and Tc-99m-labeled sulfur (Tc-99m SC) can be used for the detection of gastrointestinal bleeding. Which of the following statements correctly describe their properties?
- (A) Tc-99m RBC is rapidly cleared from intravascular space
 - (B) Tc-99m RBC do not contribute to observed background activity
 - (C) Tc-99m SC is rapidly cleared from intravascular space
 - (D) Tc-99m SC use is limited for the detection of gastric bleeding only
63. The Positron emission tomography (PET) blank scan should be acquired and checked:
- (A) Daily
 - (B) Weekly
 - (C) Monthly
 - (D) Annually
64. In the radionuclide localization of acute gastrointestinal bleeding, two radiopharmaceuticals – Tc-99m-labeled red blood cells and Tc-99m-labeled sulfur colloid – are commonly used. Tc-99m RBCs have a stable persistence within the blood pool. On the contrary, Tc-99m SC is rapidly cleared from intravascular space with a HALF-TIME of approximately:
- (A) 30–40 min
 - (B) 20–30 min
 - (C) 2–3 min
 - (D) 3–10 s

65. Images presented in Fig. 2.7 were acquired during routine whole body bone scintigraphy after intravenous 25.7 mCi of Tc-99m methylene diphosphonate (MDP) administration. Which of the following statements is most consistent with the finding from the scan?
- (A) Normal scan
 - (B) Ribs fractures
 - (C) Bone metastasis
 - (D) Paget's disease

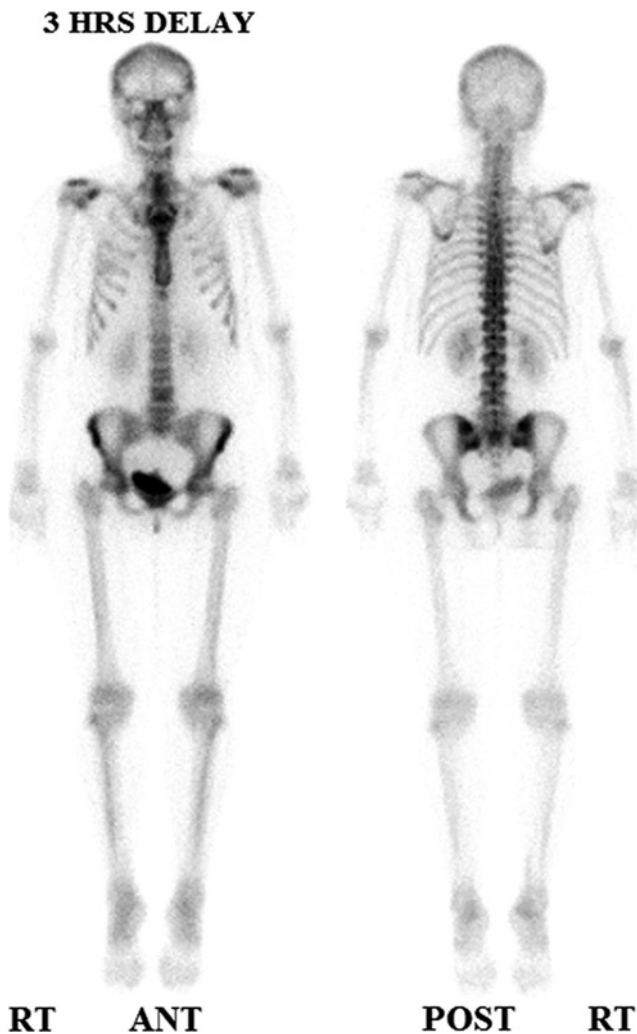


Fig. 2.7 Whole body bone scintigraphy

66. The increasing mean age of the US population and emerging new technologies will likely increase the demand for all of the following nuclear medicine procedures EXCEPT:
- (A) Tumor scans
 - (B) Bone scans
 - (C) Cardiac scans
 - (D) Ventilation/perfusion scans
67. The major types of radiation listed by decreasing mass are:
- (A) γ , α , β
 - (B) α , β , γ
 - (C) α , γ , β
 - (D) γ , β , α
68. The shield and the decay method are two different approaches to evaluate:
- (A) Effective dose measurement
 - (B) γ -Camera linearity
 - (C) Half-value layer thickness
 - (D) Dose-calibrator linearity
69. If a study of 40 frames is acquired in BYTE mode on 128×128 matrix, what is the memory used if the acquisition is stored in WORD mode?
- (A) 327,680 words
 - (B) 655,360 words
 - (C) 655,360 bytes
 - (D) 327,680 bytes
70. Sludge in the gallbladder is a common ultrasonographic finding in patients with chronic understimulation of the gallbladder. Sludge is:
- (A) Lithogenic bile
 - (B) Acid chyme
 - (C) Bile soap
 - (D) Surfactant
71. Measurements used to assess the patient's condition are called the vital signs, and consist of the following vital parameters EXCEPT:
- (A) Blood pressure
 - (B) Respiration rate
 - (C) Temperature
 - (D) Height and weight

72. False-positive cholescintigraphy can be minimized by a familiarity with its common causes. All of the following can elicit false-positive gallbladder scintigraphy results EXCEPT:
- (A) Nonfasting
 - (B) Prolonged fasting
 - (C) Hepatocellular disease
 - (D) Dose extravasation
73. New imaging geometries using cadmium–zinc–telluride (CZT) detectors when compared with the parallel collimated Anger cameras:
- (A) Have the same count sensitivities
 - (B) Have the same energy resolution
 - (C) Have the same spatial resolution
 - (D) Allow greatly reduced injected radioactivity
74. Relevant laboratory tests before performing bone scintigraphy, such as prostate-specific antigen (PSA) in patients with prostate cancer, frequently are performed. Which of the following laboratory blood tests can indicate bone pathology?
- (A) Elevated BUN
 - (B) Elevated alkaline phosphatase
 - (C) Elevated aspartate aminotransferase
 - (D) Elevated troponin
75. Images presented in Fig. 2.8 acquired during routine bone scintigraphy after intravenous 24.1 mCi of Tc-99m methylene diphosphonate (MDP) administration. Which of the following statements is most consistent with the findings from the scan?
- (A) Normal scan
 - (B) Rib fractures
 - (C) Bone metastases
 - (D) Paget's disease

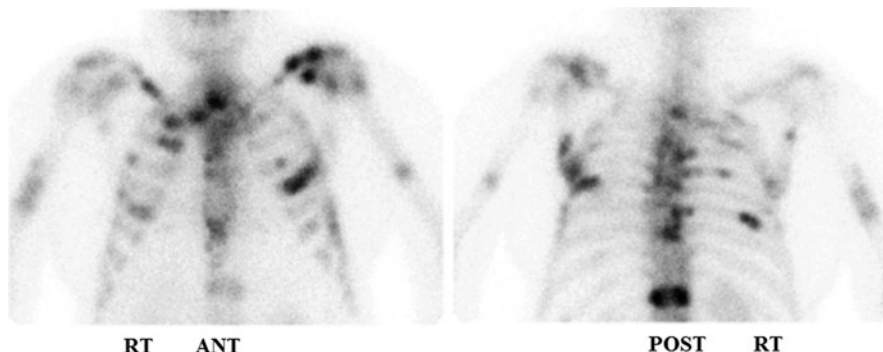


Fig. 2.8 Bone scintigraphy

76. According to the American Society of Nuclear Cardiology (ASNC) recommendations, all of the following can result in reducing radiation exposure and obtaining high-quality diagnostic images EXCEPT:
- (A) Radiopharmaceutical selection
 - (B) Individualized dose adjustment
 - (C) Applying iterative reconstruction
 - (D) Improving report turnaround time
77. The maximum permissible limit of Al^{+3} in Tc-99m eluate is set by:
- (A) U.S. Pharmacopeia
 - (B) Nuclear Regulatory Commission (NRC)
 - (C) Food and Drug Administration (FDA)
 - (D) Society of Nuclear Medicine (SNM)
78. Leak testing on sealed sources, e.g., dose calibrator standards, spot markers, etc. must be performed at intervals not to exceed:
- (A) 1 week
 - (B) 1 month
 - (C) 6 months
 - (D) 12 months
79. When performing a bone scan with Tc-99m methylene diphosphonate (MDP), the technologist sets the pulse height analyzer to 20% window. What is the acceptable energy range in this setting?
- (A) 126–154 keV
 - (B) 112–168 keV
 - (C) 120–160 keV
 - (D) 130–150 keV
80. Abdominal pain during hepatobiliary scintigraphy with sincalide infusion:
- (A) Is predictive of the gallbladder disease
 - (B) Is determined by the method of sincalide infusion
 - (C) Is determined by the dose of radiopharmaceutical
 - (D) Is predictive of the postcholecystectomy complications
81. All of the following organs belong to the urinary system EXCEPT:
- (A) The bladder
 - (B) The urethra
 - (C) The ureters
 - (D) The uterus

82. The presence of a focal defect on rest images that was not seen on stress images, or the presence a focal defect on stress images that appears more severe on rest images is called:
- (A) Reverse redistribution
 - (B) Viability image
 - (C) Pseudo aneurysm
 - (D) Cardiomyopathy
83. Every received package holding radioisotopes must be logged in properly. The incoming package logbook must include all of the following data EXCEPT:
- (A) Product name
 - (B) Date
 - (C) Driver's name
 - (D) Received activity
84. The inferior wall of the left ventricle commonly demonstrates a decreased count density most likely caused by photons attenuation. All of the following can cause attenuation artifacts in the inferior wall of the left ventricle EXCEPT:
- (A) The left diaphragm
 - (B) The right ventricle wall
 - (C) The right ventricle blood pool
 - (D) The right diaphragm
85. Display on the Fig. 2.9 presents reconstruction reoriented single photon emission computed tomography (SPECT MPI) data and created:
- (A) Short axis slices
 - (B) Vertical long axis slices
 - (C) Long axis slices
 - (D) Horizontal long axis



Fig. 2.9 Reconstruction reoriented SPECT MPI slices

86. Which of the following diagnostic examinations will deliver the smallest estimated dose to the fetus?
- (A) Abdomen CT
 - (B) Pelvis X-ray
 - (C) Interventional fluoroscopically guided procedures
 - (D) Lung perfusion scan

87. The distance that the positron passes from its origin to the point of the annihilation is called:
- (A) Positron attenuation
 - (B) Positron range
 - (C) Travel range
 - (D) Annihilation delay
88. Photomultiplier tube (PMT) consists of a photocathode and a series of dynodes in an evacuated glass enclosure. PMT converts:
- (A) The light photons into an electrical signal
 - (B) An electrical signal into light
 - (C) An electrical signal into heat
 - (D) Heat into light
89. 850 milligrays (mGy) are equal to:
- (A) 0.850 rad
 - (B) 85 rads
 - (C) 85,000 rads
 - (D) 8,500,000 rads
90. Attenuation artifacts of tomographic myocardial perfusion imaging may decrease the diagnostic accuracy of the technique, predominantly due to:
- (A) Increase in false negative
 - (B) Increase in false positive
 - (C) Increase in true negative
 - (D) Increase in true positive
91. Kupffer cells of the liver are responsible for the radiopharmaceutical:
- (A) Extraction
 - (B) Excretion
 - (C) Phagocytosis
 - (D) Breakdown
92. If the time between two successive R points is 1 s, a beat length acceptance window of 100% allows accumulation of data from cardiac beats:
- (A) Having a duration 1,000 ms
 - (B) Having a duration 1–1,000 ms
 - (C) Having a duration 500–1,500 ms
 - (D) All duration beats will be accepted
93. Compton scatter from the patient overlaps into the energy levels located:
- (A) Around the energy peak
 - (B) At low energy side of the energy window
 - (C) At high energy side of the energy window
 - (D) At all levels of energy window

94. A defect that is present on stress images, and not seen or present to the lesser degree on resting images is called:
- (A) Reversible defect
 - (B) Reverse defect
 - (C) Fixed defect
 - (D) Transient defect
95. Figure 2.10 presents the schematic diagram of the hepatobiliary tract. What part of the hepatobiliary tree represents label “b”?
- (A) Sphincter of Oddi
 - (B) Cystic duct
 - (C) Common bile duct
 - (D) Common hepatic duct

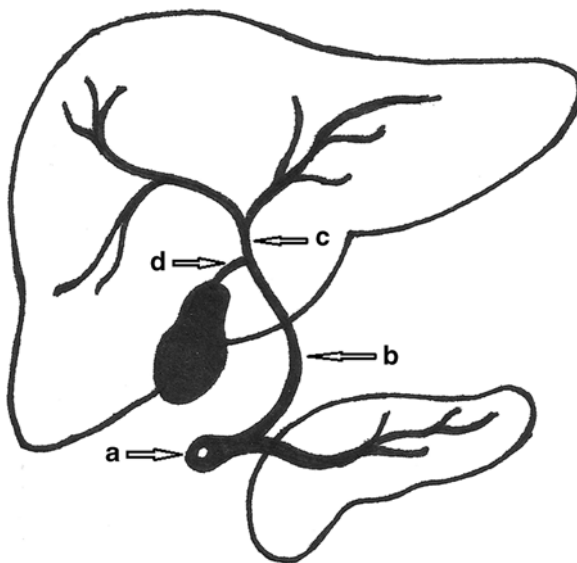


Fig. 2.10 Schematic diagram of hepatobiliary tract (*Illustration by Sabina Moniuszko*)

96. According to Nuclear Regulatory Commission-10 Code of Federal Regulations (NRC-10CFR) Part 20 Section 1201, a maximum permissible dose to extremities for radiation workers should not exceed:
- (A) 0.5 rem/year
 - (B) 5 rem/year
 - (C) 50 rem/year
 - (D) 500 rem/year

97. The increasing distance between the origin of the positron and the location of the point of annihilation results in:
- (A) Attenuation artifact
 - (B) Motion artifact
 - (C) Decreased image resolution
 - (D) Increased image resolution
98. The process of restricting the detection of emitted radiations to a given area of interest is called:
- (A) Attenuation
 - (B) Collimation
 - (C) Scattering
 - (D) Pooling
99. How much activity will be remaining at 2:30 P.M. if the dose of Tc-99m methylene diphosphonate (MDP) is calibrated to contain 25 mCi at 12:00 P.M. on the same day?
- (A) 19.5 mCi
 - (B) 18.7 mCi
 - (C) 17.3.0 mCi
 - (D) 15.7 mCi
100. Which of the following pharmacological stress agents is not approved by the US Food and Drug Administration (FDA) for stress testing in the USA?
- (A) Dobutamine
 - (B) Adenosine triphosphate
 - (C) Adenosine
 - (D) Regadenoson
101. The brain consists of two hemispheres and each hemisphere has four lobes. Which of the following structures is NOT the brain's composition?
- (A) The frontal lobe
 - (B) The lateral lobe
 - (C) The parietal lobe
 - (D) The temporal lobe
102. The methylxanthines competitively inhibit the adenosine receptors and can be a source of:
- (A) False-positive studies
 - (B) False-negative studies
 - (C) True-positive studies
 - (D) True-negative studies

103. All of the following single photon emission computed tomography (SPECT) quality control procedures can be performed by the technologist EXCEPT:
- (A) Center of rotation (COR) calibration
 - (B) Multiple head registration (MHR) validation
 - (C) SPECT phantom
 - (D) Uniformity correction matrix
104. A patient referred for Tc-99m mercaptoacetyltriglycine (MAG3) renal scintigraphy should:
- (A) Stay NPO (nothing per oral) for 6 h
 - (B) Be well hydrated
 - (C) Follow low carbohydrate diet
 - (D) Avoid iodine containing medications
105. Figure 2.11 shows four different I-123 thyroid images where image (a) demonstrates a normal thyroid gland. The findings from image (b) are more consistent with the clinical diagnoses of:
- (A) Hypothyroidism
 - (B) Grave's disease
 - (C) Multinodular goiter
 - (D) Autonomously hyperfunctioning thyroid nodule

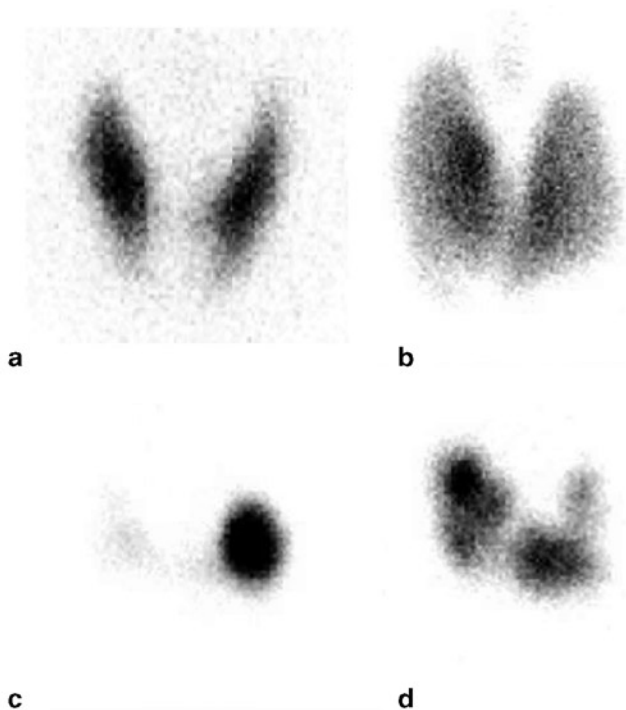


Fig. 2.11 I-123 thyroid scans

106. According to the criteria defining unrestricted areas and listed in Nuclear Regulatory Commission-10 Code of Federal Regulations (NRC-10CFR) Part 20 Section 1301, all licensees must perform procedures so that a dose in any unrestricted area does not exceed:
- (A) 0.001 rem in any 1 h
 - (B) 0.002 rem in any 1 h
 - (C) 0.004 rem in any 1 h
 - (D) 0.005 rem in any 1 h
107. The product of the physical half-life and the decay constant is equal to:
- (A) 0.5
 - (B) 0.693
 - (C) 0.693^2
 - (D) 1
108. The survey meter, also known as the Geiger-Mueller detector or Geiger counter, is a radiation detector filled with:
- (A) Water
 - (B) Gas
 - (C) Lead
 - (D) Scintillation crystals
109. At the time of preparation, a macroaggregated albumin (MAA) kit contained 30.5 mCi of Tc-99m. How much activity will remain after 5 h and 30 min?
- (A) 7.2 mCi
 - (B) 10.5 mCi
 - (C) 16.2 mCi
 - (D) 18.5 mCi
110. Technetium-labeled blood cells can be used in all of the following types of nuclear medicine scintigraphies EXCEPT:
- (A) Hemangioma imaging
 - (B) Osteomyelitis imaging
 - (C) GI bleed scan
 - (D) Meckel's diverticulum scan
111. Obstruction of the passage of food through the mouth, pharynx, or the esophagus is called:
- (A) Dyspepsia
 - (B) Dystrophia
 - (C) Dysphasia
 - (D) Dysphagia

112. Patient preparation for some of the nuclear medicine scintigraphies is essential. For all of the following NM imaging procedures, the patient has to remain NPO (nothing per oral) after midnight EXCEPT for the:
- (A) Gastroesophageal reflux study
 - (B) Gastric empty scan
 - (C) Liver–spleen scan
 - (D) Hepatobiliary scan
113. The battery check, sealed source check, and calibration are three different quality control procedures performed to ensure proper operation of the:
- (A) Geiger-Mueller detector
 - (B) Well counter
 - (C) Thyroid probe
 - (D) Glucose meter
114. The form of targeted radionuclide therapy that uses a monoclonal antibody to deliver localized radiation is called:
- (A) Radioimmunotherapy
 - (B) Radiochemotherapy
 - (C) Radiation therapy
 - (D) Antibody therapy
115. Curves of cortical kidney activity are displayed in Fig. 2.12. Graph (a) presents a normal pattern with a prompt increase in activity and spontaneous wash-out. Curve of cortical kidney activity displayed on graph “B” is described as:
- (A) Dilated nonobstructed pattern
 - (B) Blunted response pattern
 - (C) Obstructed pattern
 - (D) Golden pattern

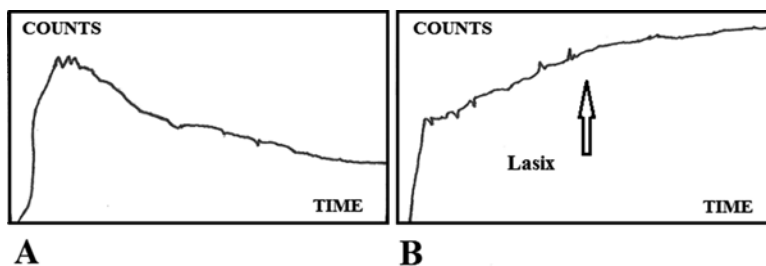


Fig. 2.12 Cortical kidney activity (*Illustration by Sabina Moniuszko*)

116. According to the Nuclear Regulatory Commission (NRC), an adult is defined as an individual:
- (A) 16 or more years of age
 - (B) 18 or more years of age
 - (C) 21 or more years of age
 - (D) 23 or more years of age
117. An atom with an unstable nucleus is called a:
- (A) Radiochemical
 - (B) Radionuclide
 - (C) Radiopharmaceutical
 - (D) Radio wave
118. The quality control procedure known as survey meter calibration is usually performed by:
- (A) The physicist
 - (B) The technologist
 - (C) The lead technologist
 - (D) The radiation safety officer
119. If the net maximum counts of 67,670 and the net minimum counts of 25,659 are obtained from the region of interest (ROI) drawn over the gallbladder (GB) area, what is the calculated GB ejection fraction?
- (A) 22%
 - (B) 32%
 - (C) 52%
 - (D) 62%
120. The general pretreatment requirements for adult qualifying for therapy with I-131 metaiodobenzylguanidine (MIBG) include the following EXCEPT:
- (A) A diagnostic MIBG scan or previous posttreatment I-131 MIBG scan
 - (B) Reviewing potential interfering medications
 - (C) Blocking thyroid uptake of free radioiodine
 - (D) Performing pulmonary function tests

121. The most proximal part of the conduction system of the heart that exhibits the most automaticity is called:
- (A) The Purkinje fibers
 - (B) The bundle of His
 - (C) The sinus node
 - (D) The atrioventricular node
122. All generic names for monoclonal antibodies end with the suffix “mab.” Most frequently, the monoclonal antibodies are derived from:
- (A) Mouse
 - (B) Fish
 - (C) Rat
 - (D) Human
123. To ensure the proper operation of the dose calibrator, all of the following quality control procedures must be performed on the unit EXCEPT:
- (A) Accuracy
 - (B) Constancy
 - (C) Battery check
 - (D) Geometry
124. Human antimurine antibody (HAMA) is being produced when:
- (A) A murine immunoglobulin is injected into a mouse
 - (B) A murine immunoglobulin is injected into a human
 - (C) A humane immunoglobulin is injected into a mouse
 - (D) A human immunoglobulin is injected into a human
125. Figure 2.13 displays the images obtained from 15-year-old-child 3-h post injection of Tc-99m methylene diphosphonate (MDP). What is the cause of the activity shown by the arrow?
- (A) Growth plate
 - (B) Sports injury
 - (C) Bad tagging
 - (D) Osteoporosis

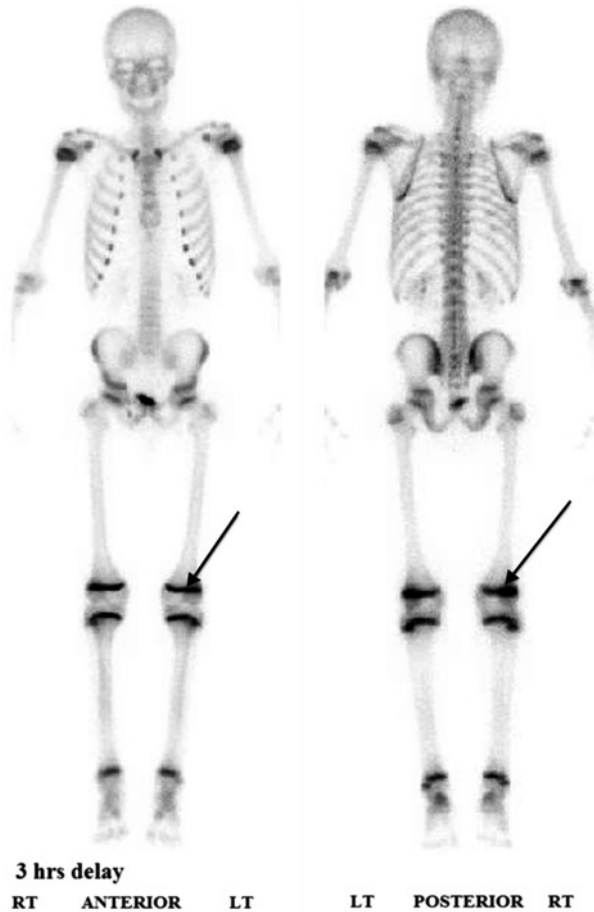


Fig. 2.13 Bone scan images obtained 3 hrs post injection of Tc 99m MDP

126. How often every organization is responsible for notifying each employee of his cumulative radiation dose?
- (A) Every week
 - (B) Every month
 - (C) Every 6 months
 - (D) Once a year
127. When comparing the mass of an atom to the sum of the individual pieces of the atom, there will always be:
- (A) Less mass than expected
 - (B) More mass than expected
 - (C) No difference
 - (D) Impossible to estimate

128. The quality control procedure performed on the dose calibrator with all the dose configurations used in the nuclear medicine department is called:
- (A) Accuracy
 - (B) Linearity
 - (C) Geometry
 - (D) Constancy
129. If a 15 mCi of F-18 fluorodeoxyglucose (FDG) dose is needed for positron emission tomography (PET) scan at 1:00 P.M., how much activity should be prepared at 10 A.M.?
- (A) 4.8 mCi
 - (B) 11 mCi
 - (C) 21.2 mCi
 - (D) 46.6 mCi
130. The hematologic toxicity of Y-90 Zevalin therapy is common. All of the following can be a sign of hematologic toxicity EXCEPT:
- (A) Fever
 - (B) Bruising
 - (C) Anemia
 - (D) Arrhythmia
131. Pulmonary embolism (PE) usually is due to embolism of a thrombus (blood clot). The other possible embolic materials include all of the following EXCEPT:
- (A) Air
 - (B) Globules of fat
 - (C) Amniotic fluid
 - (D) Saliva
132. The summed difference score (SDS) is derived as the difference between summed stress score (SSS) and summed rest score (SRS) and represents:
- (A) The reversibility of perfusion defects
 - (B) The myocardial viability
 - (C) The extend of the scar tissue
 - (D) The left ventricle (LV) dilatation
133. The measure obtained by taking the counts per minute detected by the instrument and dividing them by the actual disintegrations per minute from the same source is called:
- (A) Counter accuracy
 - (B) Counter efficiency
 - (C) Counter reliability
 - (D) Counter reproducibility

134. Many sulfur colloid kits contain ethylenediaminetetraacetic acid (EDTA), the chelating agent that binds the Al^{+3} ions and prevents:
- (A) The disintegration of the colloidal particles
 - (B) The aggregation of the colloidal particles
 - (C) The phagocytosis of the colloidal particles
 - (D) The migration of the colloidal particles
135. The myocardial perfusion defect can be estimated by analyzing the stress-label (a) and the rest-label (b) images. The bull's eye polar plot images presented in Fig. 2.14a,b indicate the presence of:
- (A) Irreversible defect
 - (B) Reversible defect
 - (C) Scar tissue
 - (D) Apical thinning

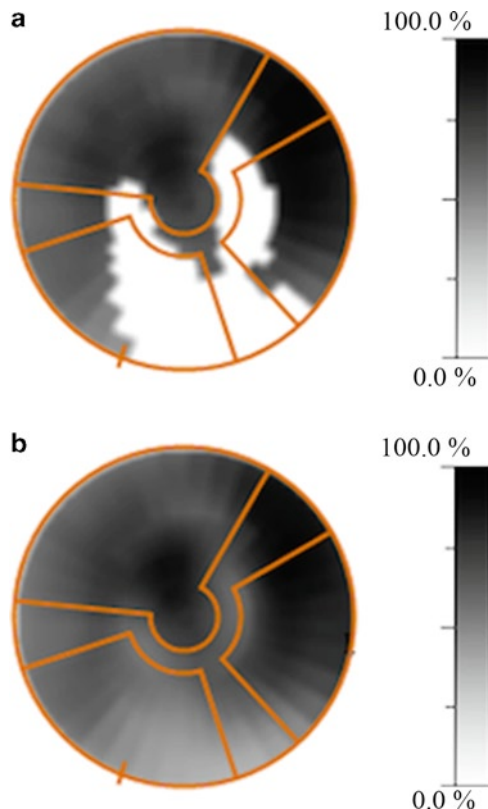


Fig. 2.14 Bull's-eye polar plot

136. Different level of radioactivities are handled in different areas of the nuclear medicine departments. Radioactivity in the range of microcurie levels are carried out in the section of NM department designated as:
- (A) Warm area
 - (B) Hot area
 - (C) Lukewarm area
 - (D) Cold area
137. The minimum amount of energy needed to overcome the forces holding the atom together is called:
- (A) Holding energy
 - (B) Binding energy
 - (C) Kinetic energy
 - (D) Thermal energy
138. The center of rotation (COR) of gamma-cameras is a key quality control procedure performed to assess capability of the nuclear medicine cameras to perform:
- (A) SPECT imaging
 - (B) Planar imaging
 - (C) Dual phase scanning
 - (D) Dynamic scanning
139. A voiding cystogram is scheduled to be performed on a 5 year old child. Approximately how much saline (0.9% NaCl) should be infused into the patient's bladder during the procedure?
- (A) 330 ml
 - (B) 270 ml
 - (C) 240 ml
 - (D) 210 ml
140. Regadenoson is an A_{2A} adenosine receptor agonist that dilates the coronary arteries. Lexiscan is supplied as a single use pre-filled syringe containing regadenoson:
- (A) 0.04 mg/ml
 - (B) 0.08 mg/ml
 - (C) 0.4 mg/ml
 - (D) 0.8 mg/ml

141. The part of the large intestine, on the right side of the abdomen that extends from the cecum to the transverse colon, is called:
- (A) Sigmoid
 - (B) Appendix
 - (C) Ascending colon
 - (D) Descending colon
142. Dose misadministration reports sent to the Nuclear Regulatory Commission (NRC) must include:
- (A) Patient name, age, gender
 - (B) Patient name, age, gender diagnosis
 - (C) Patient name, age, gender diagnosis, address
 - (D) Information whether the patient or a relative was notified
143. The xenon trap machine and aerosol nebulizer are employed to perform lung ventilation studies. Which of the following quality control procedures are performed on the Xenon trap machine?
- (A) The Drierite freshness test
 - (B) Soda lime crystals hygroscopic test
 - (C) Charcoal filter consistency test
 - (D) Xenon leak test
144. According to the “TechneScan MAG3” package, filtered air added to the reaction vial immediately following the addition of Tc-99m pertechnetate:
- (A) Oxidizes excess stannous ion
 - (B) Reduces excess stannous ion
 - (C) Evens out the pressure inside the reaction vial
 - (D) Speeds up the formation of Tc-99m mertiatide
145. Figure 2.15 displays the images obtained during bone scintigraphy and shows arrow-excessive bladder activity, which can obscure underlying bone pathology. To obtain better quality images, technologist should:
- (A) Repeat images after voiding
 - (B) Take lateral views
 - (C) Use masking technique to exclude bladder from the image
 - (D) Use lead plate to shield the bladder

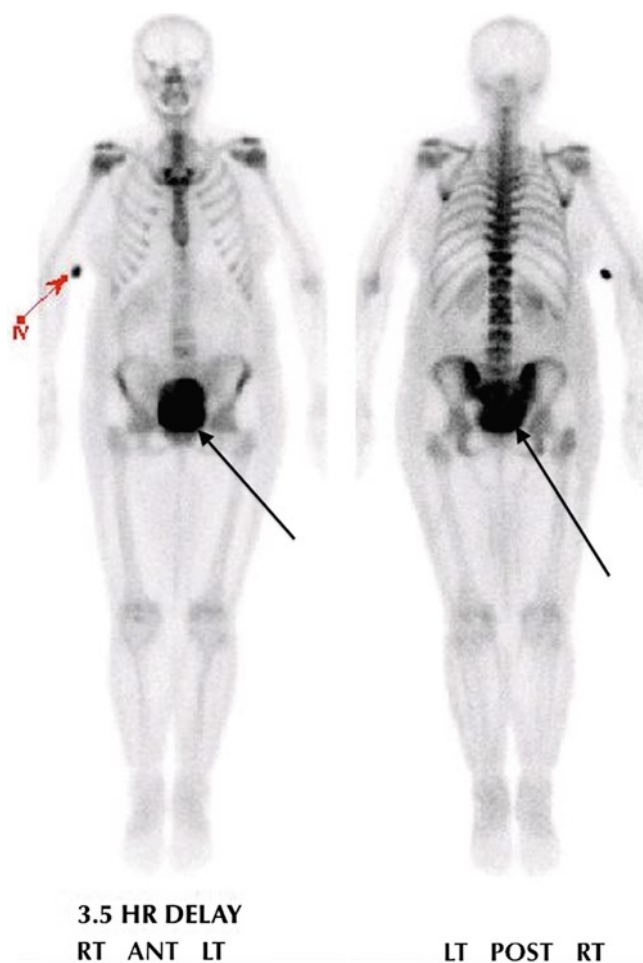


Fig. 2.15 Bone scintigraphy

146. Different levels of radioactivities are being handled in different areas of nuclear medicine departments. Radioactivities in the range of millicurie levels are carried out in the section of NM department designated as:
- (A) Warm area
 - (B) Hot area
 - (C) Lukewarm area
 - (D) Cold area

147. Technetium-99m and technetium-99 are:
- (A) Isotones
 - (B) Isobars
 - (C) Isomers
 - (D) Isotopes
148. When performing daily intrinsic floods, a point source of Tc-99m is placed five crystal dimensions away and centered over the detector. A point source should produce a measured counting rate not greater than:
- (A) 5,000 cps
 - (B) 15,000 cps
 - (C) 25,000 cps
 - (D) 35,000 cps
149. A bone scan is scheduled to be performed with 25 mCi of Tc-99m methylene diphosphonate (MDP) at 12:30 P.M. How much Tc-99m MDP should be placed in the syringe at 8:00 A.M. on the same day?
- (A) 42 mCi
 - (B) 37.4 mCi
 - (C) 35 mCi
 - (D) 33 mCi
150. Several materials for everyday use in the Nuclear medicine department have the expiration date listed on the package. Which of the following packages, with provided expiration dates, can be used safely on July 30, 2011?
- (A) Package with expiration date June 30, 2011
 - (B) Package with expiration date May 30, 2011
 - (C) Package with expiration date August 1, 2011
 - (D) Package with expiration date July 1, 2011
151. The anatomical structure dividing the heart into two functionally separate and anatomically distinct units and separates left atrium and ventricle from the right atrium and ventricle is called:
- (A) Atrioventricular septum
 - (B) Tricuspid valve
 - (C) Bicuspid valve
 - (D) Ventricular septum
152. Tc-99m and I-123 are the most commonly used agents for thyroid imaging. Thyroid imaging with technetium administration:
- (A) Cannot be performed with pinhole collimator
 - (B) Requires 6 h delay evaluation
 - (C) Doesn't require anti thyroid medications withholding
 - (D) Does not evaluate true thyroid function

153. Co-57, Ge-68, and Ba-133 are sometimes called “mock” isotopes. Which of the following trios of isotopes do they imitate?
- (A) Tc-99m, I-131, Co-60
 - (B) Tc-99m, F-18, I-131
 - (C) Co-60, Xe-133, F-18
 - (D) Xe-133, Ga-67, Sm-153
154. A lone “cold” nodule in an otherwise normal thyroid gland warrants:
- (A) Surgical removal
 - (B) Fine needle aspiration biopsy
 - (C) Radiation therapy
 - (D) Chemotherapy
155. The images shown in Fig. 2.16 are acquired during routine bone scintigraphy. What is wrong with these pictures?
- (A) Wrong labels
 - (B) Bad tag
 - (C) Wrong radiopharmaceutical
 - (D) There is nothing wrong with these images

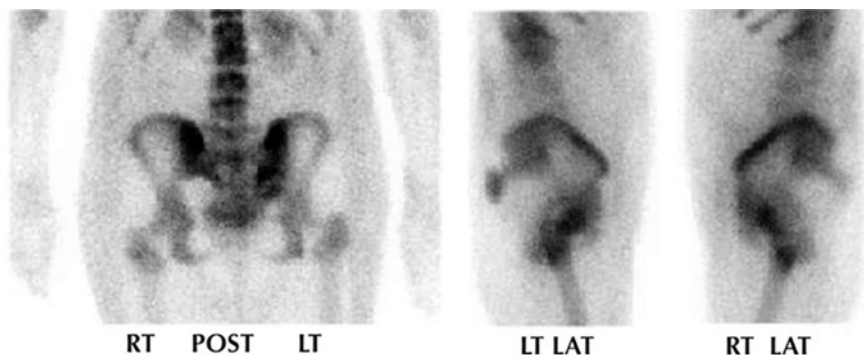


Fig. 2.16 Bone scintigraphy

156. Oxygen radiosensitizes human cells to the damaging effects of radiation by:
- (A) Promoting cellular growth
 - (B) Promoting cellular division
 - (C) Promoting free radical production
 - (D) Promoting cellular healing

157. In Compton scattering, the incoming photon scatters off an electron that is initially at rest. The electron gains energy and the scattered photon possess:
- (A) Lower energy, shorter wavelength
 - (B) Lower energy, longer wavelength
 - (C) Higher energy, shorter wavelength
 - (D) Higher energy, longer wavelength
158. The gamma-camera is the most widely used imaging piece of equipment in nuclear medicine. The performance parameters of a routine gamma-camera quality control (QC) program include all of the following EXCEPT:
- (A) Spatial resolution
 - (B) Peaking linearity
 - (C) Energy resolution
 - (D) Flood uniformity
159. A nuclear medicine department receives 375 mCi of Tc-99m in 4.5 ml bulk vial. If the macroaggregated albumin (MAA) kit is to be reconstituted with 30 mCi in 3 ml, how much saline should be added to the kit?
- (A) 1.64 ml
 - (B) 2.64 ml
 - (C) 3.0 ml
 - (D) 3.6 ml
160. Esophageal activity can mimic ectopic thyroid tissue on a thyroid scan. To avoid misinterpretation:
- (A) Perform imaging with low energy, all purpose (LEAP) collimator
 - (B) Repeat images after water ingestion
 - (C) Repeat images with two markers
 - (D) Repeat the scan in 2 weeks
161. The mediastinum is the space in the thoracic cavity behind the sternum and in between the two pleural sacs that contains all of the following anatomical structures EXCEPT:
- (A) Thyroid
 - (B) Aorta
 - (C) Trachea
 - (D) Esophagus
162. To reduce radiation exposure to the patient undergoing radioactive iodine (RAI) treatment, all of the following recommendations will be helpful EXCEPT:
- (A) Patient should be well hydrated
 - (B) Patient should urinate frequently
 - (C) Patient laxatives
 - (D) Patient should use antiperspirant medications

163. Spatial resolution and spatial linearity of a gamma-camera is assessed with a 4-quadrant bar phantom which consists of four sectors of lead bars and intervening plastic strips:
- (A) 1, 2, 3, and 4 mm in width
 - (B) 2, 2.5, 3, and 4 mm in width
 - (C) 2.5, 3, 4, and 4.5 mm in width
 - (D) 3, 4, 5, and 6 mm in width
164. Ultrasound and radionuclide cholescintigraphy are commonly used in the process of evaluation of gallbladder disease. The main advantage of performing a hepatobiliary imino-diacetic acid (HIDA) scan over ultrasound is:
- (A) HIDA scan allows assessment of gallbladder function
 - (B) HIDA scan takes less time to complete
 - (C) HIDA scan allows gall stones measurements
 - (D) HIDA scan can be performed during pregnancy
165. Figure 2.17 presents the images acquired during the first 4 h of the ventriculo-peritoneal shunt patency study. What is the radiopharmaceutical most commonly used in this type of scintigraphy?
- (A) In-111 hexamethylpropyleneamine oxime
 - (B) Tc-99m sulfur colloid
 - (C) Tc-99m mercaptoacetyltriglycine
 - (D) Tc-99m hydroxyiminodiacetic acid

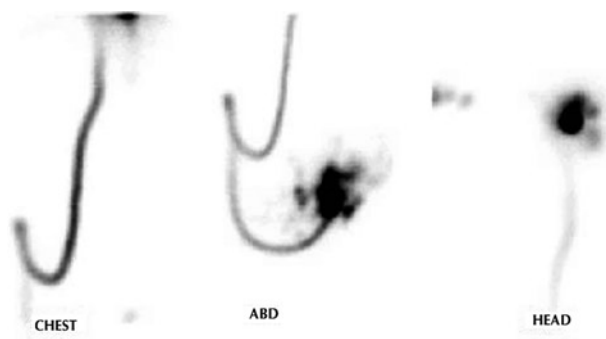


Fig. 2.17 Ventriculoperitoneal shunt patency study

166. Iodine-131 is considered to be the treatment of choice in many patients with Graves' disease. The most common side effect of radioactive iodine (RAI) treatment is:
- (A) Hyperthyroidism
 - (B) Hypothyroidism
 - (C) Thyroid carcinoma
 - (D) Thyroiditis

167. Phosphorus-33, copper-67, iodine-131, and yttrium-90 are examples of:
- (A) Alpha-particle emitters
 - (B) Beta-particle emitters
 - (C) Alpha- and beta-particle emitters
 - (D) Pure gamma emitters
168. Basic algorithms for reconstruction of tomographic images from projection figures include two analytic techniques known as:
- (A) Filtered backprojection and volume rendering techniques
 - (B) Filtered backprojection and iterative techniques
 - (C) Inverse Fourier transform and filtering techniques
 - (D) Filtering and volume rendering techniques
169. If 300 μCi of I-123 is used for an adult dose, what is the pediatric dose according to Young's formula for a child who is 14-year old and weighs 65 lbs?
- (A) 250 μCi
 - (B) 185 μCi
 - (C) 173 μCi
 - (D) 162 μCi
170. The period of time required for the concentration or amount of drug in the body to be reduced by 50% (percent) is known as:
- (A) Absorption time
 - (B) Half-life
 - (C) Therapeutic index
 - (D) Potency
171. Slowed or stopped intravenous (IV) infusion, swelling, pain, and coldness around the needle site indicate:
- (A) Infiltration
 - (B) Inflammation
 - (C) Infection
 - (D) Infraction
172. The most prevalent modes of myocardial perfusion imaging (MPI) tomographic acquisition are the "step-and-shoot" and "continuous technique." Small amount of blurring is present if the images are acquired by:
- (A) Step and shoot
 - (B) Both methods
 - (C) Continuous
 - (D) Neither method

173. The reduction of image noise by reducing high-frequency information is called:
- (A) Fourier transform
 - (B) Filtered backprojection
 - (C) Filtering
 - (D) Expectation maximization
174. Which of the following medications can be used as an adjunct to myocardial perfusion imaging (MPI) pharmacological stress testing?
- (A) Digoxin
 - (B) Atropine
 - (C) Coumadine
 - (D) Aspirin
175. Images presented in Fig. 2.18 are acquired during routine liver–spleen scintigraphy. What is wrong with these images?
- (A) Wrong label
 - (B) Bad tag
 - (C) Wrong radiopharmaceutical
 - (D) There is nothing wrong with these images

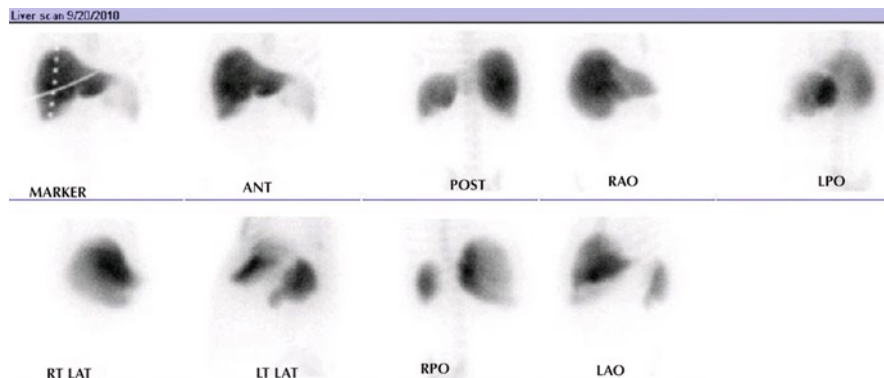


Fig. 2.18 Liver-spleen scintigraphy

176. All of the following are types of radioactive material licenses EXCEPT:
- (A) Specific
 - (B) Broad
 - (C) Wide
 - (D) General

177. The nucleus is composed of two types of particles called:
- (A) Protons and electrons
 - (B) Electrons and quarks
 - (C) Neutrons and protons
 - (D) Quarks and protons
178. References used to inform chemical users of the hazards associated with chemicals, and to advise users of the appropriate precautions, are known as:
- (A) Material Safety Data Sheet (MSDS)
 - (B) Code of Federal Regulations (CFR)
 - (C) Listing of United States Pharmacopeia (USP)
 - (D) Regulations of United States Nuclear Regulatory Commission (U.S. NRC)
179. Xe-133, used during a ventilation/perfusion (VQ) scan has a physical half-life of 5.3 days and biological half-life is 0.37 min. What is the effective half-life of Xe-133?
- (A) 5.3 min
 - (B) 3.7 min
 - (C) 0.37 min
 - (D) 5 s
180. All of the following radioisotopes have been approved in the USA for use in the treatment of bone metastases EXCEPT:
- (A) Strontium chloride Sr-89
 - (B) Phosphorus P-32
 - (C) Radium Ra-223
 - (D) Samarium Sm-153
181. The liver is divided into four lobes based on surface features. Which of the following lobes is not the part of the liver?
- (A) The right lobe
 - (B) The left lobe
 - (C) The medium lobe
 - (D) The caudate lobe
182. In which of the following causes of fever of unknown origin (FUO) diagnostic leukocyte scintigraphy may be especially valuable?
- (A) Systemic rheumatic disease
 - (B) Infection
 - (C) Neoplasm
 - (D) Granulomatous disorder

183. The short axis cardiac tomogram is displayed with the orientation as if the viewer was observing the heart from the:
- (A) Base
 - (B) Apex
 - (C) Lateral wall
 - (D) Inferior wall
184. All of the following can cause erroneous standardized uptake value (SUV) measurements EXCEPT:
- (A) Patient size
 - (B) Injected dose
 - (C) Plasma glucose level
 - (D) Time of measurement
185. Presented below images were acquired 25 min after intravenous administration of 19.9 mCi of Tc-99m sestamibi. What type of nuclear medicine scintigraphy is displayed in Fig. 2.19?
- (A) Thyroid scan
 - (B) Parathyroid scan
 - (C) Salivary scan
 - (D) Brain scan

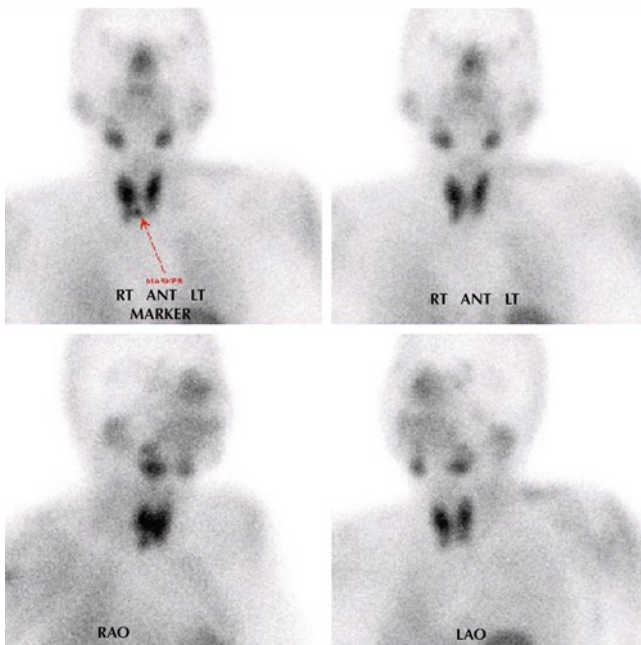


Fig. 2.19 Nuclear medicine scintigraphy obtained after intravenous administration of Tc-99m sestamibi

186. An individual responsible for the daily implementation of the radiation safety program in accordance with directives from the Radiation Safety Committee (RSC), license provisions, and regulatory requirements is named:
- (A) Senior Technologist
 - (B) The Radiation Safety Officer (RSO)
 - (C) Nuclear Medicine Physician
 - (D) Chief Executive Officer (CEO)
187. Samarium-153 (Quadramet) is a therapeutic radiopharmaceutical used to treat:
- (A) Polycythemia vera
 - (B) Medullary thyroid carcinoma
 - (C) Dyspnea in lung Ca
 - (D) Pain in bony metastases
188. Increasing the thickness of the scintillation detector will result in the detector:
- (A) Increased sensitivity and increased resolution
 - (B) Increased sensitivity and decreased resolution
 - (C) Decreased and increased resolution
 - (D) Decreased and decreased resolution
189. If generator elute contains 635 mCi of Tc-99m, what is the maximum amount of Mo-99 allowed? (0.15 μ Ci Mo-99 per mCi Tc-99m)
- (A) 95.3 μ Ci
 - (B) 64.2 μ Ci
 - (C) 0.54 μ Ci
 - (D) 0.15 μ Ci
190. Dual time-point imaging (DTPI) can improve accuracy of positron emission tomography (PET) imaging. DTPI technique is a specialized protocol in which:
- (A) Flow study is performed followed by static imaging
 - (B) Two days delay imaging is performed
 - (C) Dual-isotope technique is applied
 - (D) Delay imaging is performed
191. Most patients with overt hyperthyroidism have an assemblage of symptoms which include all of the following EXCEPT:
- (A) Anxiety
 - (B) Tremor
 - (C) Weight loss
 - (D) Decreased appetite

192. What is the predominant toxicity of radioisotopes used in the treatment of bone metastases?
- (A) Myelosuppression
 - (B) Leukemia
 - (C) Gastritis
 - (D) Radiation pneumonitis
193. All of the following components of the scintillation camera are housed on the camera head EXCEPT:
- (A) Photomultiplier tubes
 - (B) Touch pad
 - (C) Display monitor
 - (D) Amplifiers
194. Image representation of raw data obtained from projections of the object for image reconstruction is called:
- (A) Sinogram
 - (B) Star artifact
 - (C) Uniformity projections
 - (D) Blank scan
195. Figure 2.20. A 57-years-old man with sudden onset of tachycardia and dyspnea and referred for lung scintigraphy. Displayed images were acquired after intravenous administration of 4.1 mCi of Tc-99m macroaggregated albumin (MAA). Which lung perfusion view demonstrates greatest cardiac shadow?
- (A) Posterior
 - (B) Anterior
 - (C) LPO
 - (D) Left lateral

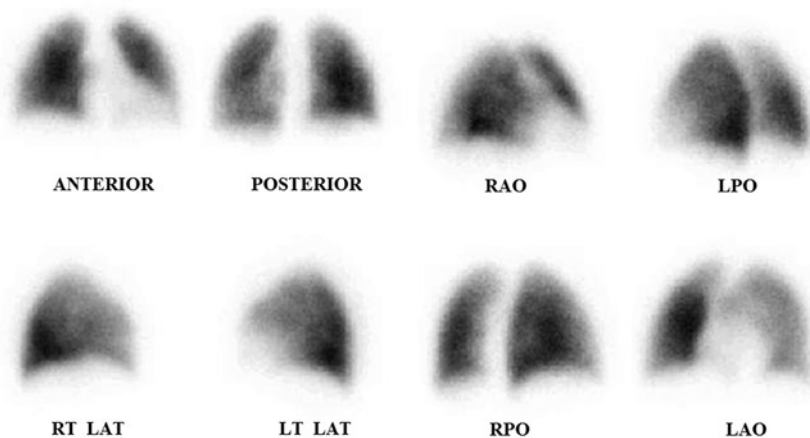


Fig. 2.20 Nuclear medicine lung perfusion scintigraphy

196. Dose equivalency is being measured in units called:
- (A) Curies
 - (B) Rads
 - (C) Rems
 - (D) Becquerels
197. An alpha particle is identical to the nucleus of a helium atom. Alpha particles:
- (A) Are not charged
 - (B) Travel unlimited distances
 - (C) Are used for radionuclide therapy
 - (D) Are smaller than beta particles
198. If the sample volume of a given activity is increased, the counting efficiency of the well counter will:
- (A) Decrease
 - (B) Increase
 - (C) Not change
 - (D) Approach 0
199. Patient received 200 μCi of I-123 for thyroid uptake and scan. If the data shown below were obtained 6 h post administration of I-123, what is the percentage thyroid uptake at 6 h?
- | | | | |
|---------------------------------------|-------------|----------------|-----------|
| 200 μCi I-123 capsules cts | 135,890 cpm | Background cts | 109 cpm |
| Thyroid cts | 45,534 cpm | Thigh cts | 2,109 cpm |
- (A) 25%
 - (B) 28%
 - (C) 32%
 - (D) 68%
200. A significant enlargement in left ventricular (LV) size on the stress myocardial perfusion imaging (MPI) as compared to the rest images is called:
- (A) Transient Ischemic Dilation
 - (B) Cardiomegaly
 - (C) Hypertrophy
 - (D) Hibernation

201. Blood pressure is expressed in units of:
- (A) Millimeters of mercury
 - (B) Centimeters of mercury
 - (C) Millimeters of blood
 - (D) Centimeters of blood
202. In order to correctly calculate gallbladder ejection fraction, the GB must be:
- (A) Free of superimposition
 - (B) Distended
 - (C) Free of stones
 - (D) Dyskinetic
203. Which of the following quality control procedures is NOT performed to ensure proper operation of the survey meter?
- (A) Battery check
 - (B) Sealed source check
 - (C) Accuracy
 - (D) Calibration
204. If a patient has an irregular heart rate, the total number of cardiac cycles acquired for each projection will be the same if each projection is acquired for:
- (A) The same length of time
 - (B) The same number of beats
 - (C) The same number of counts
 - (D) The same acceptance window
205. A 48-year-old woman with an abnormal treadmill stress test result, and a history of abdominal surgery, referred for a myocardial perfusion study. Figure 2.21 displays the resting raw projections of SPECT obtained after 3.2 mCi of Tl-201 administration. The images are consistent with the patient's surgical history of:
- (A) Splenectomy
 - (B) Right nephrectomy
 - (C) Left nephrectomy
 - (D) Hysterectomy



Fig. 2.21 Myocardial perfusion study-resting raw projections after Tl-201 administration

206. Which of the following patients undergoing diagnostic medical procedures are considered as a radioactive source?
- (A) Patient undergoing MRI study with gadolinium administration
 - (B) Patient undergoing CT scan with iodine administration
 - (C) Patient undergoing NM study with radiopharmaceutical administration
 - (D) Patient undergoing X-ray study
207. In isomeric transition decay, the extra energy in the nucleus is released by the emission of:
- (A) X-rays
 - (B) Electrons
 - (C) Gamma photons
 - (D) Neutrons
208. When only image quality is considered, the best possible distance between the collimator and the patient's body for a gamma-camera equipped with HRES collimator is:
- (A) 10 cm
 - (B) Half the collimator diameter
 - (C) Contact
 - (D) 1 in.

209. Large I-131 therapy dose stored in a nuclear medicine department produces an exposure of 80 mR/h. What thickness of lead is required to reduce the exposure rate to less than 1 mR/h? HVL for I-131 is 0.21 mm.
- (A) 1.0 mm
 - (B) 1.5 mm
 - (C) 2.0 mm
 - (D) 2.1 mm
210. The primary route of excretion of Tc-99m hexakis 2-methoxy isobutyl isonitrile (Sestamibi) is:
- (A) Skin
 - (B) Hepatobiliary tract
 - (C) Urinary tract
 - (D) Respiratory tract
211. The myocardium, in a typical fasting state, primarily uses as a substrate:
- (A) Glucose
 - (B) Free fatty acids
 - (C) Proteins
 - (D) Aminoacids
212. "Single isotope dual phase technique" commonly applied in parathyroid imaging is based on the observation that:
- (A) Tl-201 washes out more rapidly from the thyroid than from abnormal parathyroid
 - (B) Tl-201 washes out more rapidly from the abnormal parathyroid than from thyroid
 - (C) Tc-99m MIBI washes out more rapidly from the thyroid than from abnormal parathyroid
 - (D) Tc-99m MIBI washes out more rapidly from the abnormal parathyroid than from thyroid
213. The usefulness of F-18 FDG PET in infection imaging is based on the fact that granulocytes and macrophages in infectious foci:
- (A) Have high glucose consumption
 - (B) Have high insulin production
 - (C) Have high mitotic rate
 - (D) Have short life span

214. Before FDG administration, the patient relaxes in a waiting room to minimize muscular activity, and in so doing minimizes any physiological uptake of FDG in the muscles. Hyperventilation may cause increased uptake in the:
- (A) The diaphragm
 - (B) Leg muscles
 - (C) Arm muscles
 - (D) The peritoneum
215. Radioactive decay is the process by which an unstable atomic nucleus loses energy by emitting ionizing radiation. The emission is described as spontaneous meaning:
- (A) The nucleus decays without collision with another particle or atom
 - (B) The nucleus decays after collision with another particle or atom
 - (C) The nucleus decays without collision with shielding material
 - (D) The nucleus decays after collision with shielding material
216. Brain natriuretic peptide (BNP) is 32 amino acid polypeptide secreted by the:
- (A) Brain
 - (B) Heart
 - (C) Kidney
 - (D) Thyroid
217. A two-dimensional illustration of a three-dimensional allocation of the radiotracer in the myocardium which allows visualization of perfusion defects in a compressed format is known as:
- (A) Short axis display
 - (B) Counts profile
 - (C) Volume curve
 - (D) Polar map
218. Side effects of the antithyroid medications include all of the following EXCEPT:
- (A) Agranulocytosis
 - (B) Granulocytopenia
 - (C) Aplastic anemia
 - (D) Thrombocytosis

219. When tested Tc-99m sulfur colloid kit with TLC for free Tc-99m, the technologist noted: strip with free Tc-99m migrated to the solvent front reads 650 cpm, and strip containing Tc-99m sulfur colloid remaining at the point of origin reads 18350 cpm. What is the radiopharmaceutical impurity of this sulfur colloid kit?
- (A) 3%
 - (B) 5%
 - (C) 95%
 - (D) 97%
220. The dose for cardiac first pass imaging studies must be contained in a volume not exceeding:
- (A) 0.5 ml
 - (B) 1 ml
 - (C) 2 ml
 - (D) 3 ml

Answers

1. D – Right atrium (RA)

Blood received by the right ventricle from the right atrium is propelled into the pulmonary artery and the pulmonary circulation. Oxygenated blood is returned by the pulmonary veins to the left atrium. The left ventricle ejects blood into systemic circulation.

(Early and Sodee 1995)

2. C – Active transport

Thyroid concentrates iodine from the blood stream in a gradient 20:1. The trapping mechanism operates through the Na^+/K^+ pump.

(Early and Sodee 1995)

3. B – Ring artifacts

If the counts in one pixel of the image are falsely decreased, then information at that location will be back-projected at the decreased level. The result in the reconstructed image will be a ring artifact, with the radius of the ring equal to the distance of that pixel from the COR.

(O'Connor 2010)

4. D – Brain imaging

Tc-99m sulfur colloid can also be used in esophageal transit time, gastroesophageal reflux, and gastric empty study.

(Shackett 2008)

5. A – Hypokinetic left ventricle

Hypokinesis – seen there on the anterior and apical surfaces – refers to decreased contractile function of the left ventricle, e.g., during a severe ischemia. The heart muscle in the distribution of the involved vessels is often hypokinetic due to the diminished blood supply.

(Zaret and Beller 2005)

6. C – As Low as Reasonably Achievable

It indicates making every reasonable attempt to maintain exposures to *ionizing radiation* as far below the dose limits as practical.

(Saha 2004)

7. D – Provides good tissue penetration

Tc-99m is a pure gamma emitter so no particle radiation is being produced; Tc-99m half-life is so long that body efficiently excretes it before it can have any real negative *health* effects.

(Christian et al. 2004)

8. B – The hole at the top

The dose calibrator is an ionization chamber used to determine the activity of radiopharmaceuticals. Once activity is detected (in a syringe or vial), the dose calibrator converts it – based on the radionuclide's gamma constant – to units of activity in curie or becquerel (Ci or Bq).

(Early and Sodee 1995)

9. C – 1.7

(Appendix A, Formula 10A)

10. A – The bone marrow

Larger particles >100 nm accumulate in the liver and spleen.

(Saha 2004)

11. C – Cardiac output

The cardiac output (CO) is the stroke volume (SV) multiplied by the heart rate (HR) or $CO = SV \times HR$.

(Early and Sodee 1995)

12. B – Lack of standardization

Also, it is not an easy test, since the patient has to dry swallow for 10 min. The main indications for performing ES are to evaluate esophageal emptying and reflux in patients with esophageal dysmotility.

(Odunsi and Camilleri 2009)

13. D – 662 keV gamma ray

In larger amounts, Cs-137 is used in medical radiation therapy devices for treating cancer and in industrial gauges for detecting the flow of liquid through pipes.

(Consultants in Nuclear Medicine)

14. D – Tachycardia

Tachycardia is a rapid heart rate, usually defined as greater than 100 beats per minute.

(Odunsi and Camilleri 2009)

15. C – The sinoatrial node

Acting as the heart's natural pacemaker, the SA node (also commonly spelled sinuatrial node, abbreviated SA node or SAN, also called the sinus node) produces impulses at regular intervals to cause the heart to contract with a rhythm of about 60–70 beats per minute for a healthy, resting heart.

(Podrid 2008)

16. C – Personnel monitoring
Misadministrations and sealed source inventory documentation should be kept for 5 years; 3 years of storage is required for patient dosage records.
(Early and Sodee [1995](#))
17. B – Bremsstrahlung radiation
Beta emitting substances should be shielded with low density materials, e.g., Plexiglas, plastic, wood because the rate of deceleration of the electron is slower and the radiation given off has a longer wavelength (less penetrating).
(Saha [2006](#))
18. A – Filtered backprojection
In the filtered backprojection (FBP) method – based on direct inversion of the Radon transform – the limited number of projections introduces streak artifacts in the image reconstructions.
(Christian 2004)
19. C – 0.00058 Ci
(Appendix A, Formula 9A)
20. A – Stress
Noninfectious inflammatory disease (NIID) e.g., vasculitis syndrome, granulomatous disorders, rheumatic fever can also induce fever.
(Bleeker-Rovers et al. [2009](#))
21. A – Give rescue breath
Occasional gasps, which can occur in the first minutes after sudden cardiac arrest (SCA), are not effective breaths.
(AHA Guidelines 2005)
22. D – Liver function
A Tc-99m methylene diphosphonate (Tc-99m MDP) is adsorbed onto the hydroxyapatite crystals on the mineralizing bone surfaces and kidney is the major route of radionuclide elimination.
(Gnanasegaran et al. [2009](#))
23. B – Detector and collimator
Extrinsic floods are performed with a collimator in place which allows evaluation of the particular collimator on the flood field.
(Early and Sodee [1995](#))

24. B – Body of scapulae
Tip of scapulae, acromioclavicular joint, and costochondral uptake are normal variants of the Tc-99m MDP bone scan of thoracic region.
(Gnanasegaran et al. 2009)
25. B – Static imaging
The specific imaging parameters, e.g., collimator type, time of acquisition, number of counts, matrix, etc. for a given exam will vary depending on the desired clinical information.
(Early and Sodee 1995)
26. C – Wearing film badge
Time, distance, and shielding are the three primary means of eliminating or reducing radiation exposures.
(Saha 2004)
27. C – Isobar
Isobars differ in *atomic number* (or number of *protons*) but not in *mass number*.
(Early and Sodee 1995)
28. D – The Constancy Test
The relative error test is used if only two observations are available; the chi-squared test is used with 10, 20, or more observations; the reliability factor is equal to the ratio of the sample standard deviation to the square root of the mean and is used with more than two observations.
(Lombardi 1999)
29. A – 4.8 mR/h
(Appendix A, Formula 16)
30. A – Thyroid and stomach
Other artifacts can be related to the patient, e.g., motion, prosthesis, radiotherapy, belt buckle, etc.
(Gnanasegaran et al. 2009)
31. C – Back pain
Some of the other symptoms of thyroid disease are: tachycardia, sensitivity to cold or heat, increased bowel movements or constipation, muscle weakness or spasms, moist or dry skin, irritability, sleep disturbances, fatigue, depression, and memory problems.
(Christian et al. 2004)

32. D – Lymph node(s)

It is important to document the site of injection in all patients to avoid confusion with bone abnormality.

(Gnanasegaran et al. [2009](#))

33. B – The byte

If the sequence contains eight bits, the word is referred to as a byte.

(Christian et al. [2004](#))

34. A – Active bleeding

Melena refers to the black, smelly, and tarry stool; hematemesis is the vomiting of blood and both conditions are signs of gastrointestinal bleeding.

(Howarth [2006](#))

35. A – Dynamic study

The time per frame should be decided on the temporal resolution needed for the study being performed. Quantitative studies require imaging time being sufficient enough with obtaining adequate statistics. For purposes of imaging only, longer times are generally preferred in order to provide sufficient image details.

(Early and Sodee [1995](#))

36. A – The critical organ

Target organ is the organ intended to receive the therapeutic dose of a radioactive substance.

(U.S. NRC Glossary [2010](#))

37. B – Radiotracer

One of the most important characteristics of a true radiotracer is the ability to study the components of a homeostatic system without disturbing their function.

(Vallabhajosula et al. [2010](#))

38. D – Linearity

The linearity test is performed at installation and quarterly. Actual measurements are matched up to expected measurements to determine if the instrument is linear throughout the activity range used in nuclear medicine department.

(Early and Sodee [1995](#))

39. B – 52%

(Appendix A, Formula 33)

40. D – Foreign body

Foreign body will be seen as a photopenic area and will not cause false-positive results.

(Howarth 2006)

41. D – Plain soaps cannot be contaminated

Nonantimicrobial soaps may be associated with substantial skin irritation and dryness. Trials have studied the effects of handwashing with plain soap and water vs., e.g., a chlorhexidine-containing detergent on healthcare-associated infection rates. Studies showed that healthcare-associated infection rates were lower when antiseptic handwashing was performed by personnel.

(CDC Guideline 2002)

42. A – Help to localize the site of bleeding

Static images may show blood in the gut that has already moved away from the actual site of bleeding.

(Howarth 2006)

43. D – Well counter and uptake probe

In the statistics of counting the chi-square test is used to find out whether there is a significant difference between the expected and the observed values in one or more categories.

(Early and Sodee 1995)

44. B – Small bowel

The small bowel is the longest portion of the gastrointestinal tract. It is much thinner when compared with the “large” bowel (colon), but it is much longer than the large bowel (14 ft on average).

(Howarth 2006)

45. B – (a) – anterior and (b) – posterior view

(Frohlich 2001)

46. D – Bioassay

Bioassays are also conducted to measure the effects of a given substance on a living *organism* and are crucial in the development of new *drugs* and in monitoring environmental *pollutants*.

(Saha 2004)

47. B – Radionuclide purity

The most common example radionuclide impurity is Mo-99 contaminant in Tc-99m radiopharmaceuticals.

(Saha 2006)

48. B – Photomultiplier tubes

PMTs are light detectors: high internal gain makes the PMTs very sensitive devices.

(Early and Sodee 1995)

49. C – 28 mR/h

(Appendix A, Formula 17)

50. A – Block the capillaries in lungs

Diameter of average capillary is 7 μm and the number of capillaries occluded compared to the total of 280 billion is almost negligible.

(Saha 2004)

51. B – Chyme

Chyle is a fluid consisting of a mixture of lymphatic fluid and chylomicrons that has a milky appearance.

(Frohlich 1985)

52. C – Wall motion analysis

Wall motion analysis is performed on processed single photon emission computed tomography (SPECT) myocardial perfusion images.

(Zaret and Beller 2005)

53. D –Static, dynamic, and SPECT, images

High count floods create uniformity correction matrix which is applied to all type of acquisitions performed on any given camera. Should be performed on monthly basis for at least 100 Mcts for each isotope used (vendor dependant).

(Early and Sodee 1995)

54. D – Focal seizures

Leukocytes are components of the blood. Changing patterns of bowel activity on delay images usually indicate distal passage of labeled granulocytes, or at times, bleeding within the bowel lumen.

(Love and Palestro 2010)

55. D – 32

A minimum of 16 frames per R–R interval are required for an accurate assessment of ventricular wall motion and assessment of ejection fraction. A higher framing rate (32–64 frames per R–R) allows for more precise end-systolic frame localization and is preferred for detailed measurement of diastolic filling parameters.

(Zaret and Beller 2005)

56. C – Inverse square law

The inverse-square law applies not only to the physics of radiation – it is any *physical law* stating that some physical *quantity* or strength is *inversely proportional* to the *square* of the *distance* from the source of that physical quantity. (Early and Sodee 1995)

57. C – Potassium

Potassium is an essential dietary *mineral* and *electrolyte* and plays a key role in skeletal and smooth muscle contraction and is crucial to heart function. (Saha 2006)

58. C – The charcoal filter

Exhaled xenon is pulled through lead shielded traps filled with activated charcoal. Expanded “U” shaped traps prolong the life of charcoal and provide a lengthy path for xenon runoff, allowing greater decay and absorption before exhaustion. Averaging 30–50 studies per month, the charcoal trap will last approximately 1 year. (Biodex 2010)

59. B – 6.4 h

(Appendix A, Formula 18)

60. C – Osteomyelitis

Osteomyelitis stimulates the uptake of leukocytes but suppresses the uptake of sulfur colloid. (Love and Palestro 2010)

61. A – Subcutaneous injection

Subcutaneous injections are given in small doses of 0.5–1 ml. Examples of subcutaneous administered medications include heparin, narcotics, allergy shots, etc. (Perry and Potter 2006)

62. C – Tc-99m SC is rapidly cleared from intravascular space

The Tc-99m tagged red blood cells (RBCs) have a stable presence within the blood pool, while the Tc-99m sulfur colloid (SC) as a blood pool agent is rapidly cleared-T_{1/2} of approximately 2–3 min – from intravascular space. As a result by 10–15 min after administration, SC has completely cleared from the blood pool into the liver, spleen, and, to a lesser degree, the bone marrow, while RBC activity is practically unchanged. (Howarth 2006)

63. A – Daily

The blank scan has been compared with the daily uniformity flood used for the gamma-camera.

(Saha [2005](#))

64. C – 2–3 min

As a result of rapid intravascular clearance 10–15 min after administration, SC has completely cleared from the blood pool into the liver, spleen, and, to a lesser extent, the bone marrow.

(Howarth [2006](#))

65. A – Normal scan

In normal circumstances, the regions of high stress, e.g., sacro-iliac joints or active growth appear as a “hot areas” when compared with the neighboring areas.

(Early and Sodee [1995](#))

66. D – Ventilation/perfusion scans

The advent of the new faster computed tomography (CT) scanners is responsible for shifting from nuclear medicine V/Q scans to the use of multidetector CT scans which are easier to read and are more specific.

(Mettler et al. [2008](#))

67. B – α , β , γ

The alpha particle consists of two protons and two neutrons, a beta particle is a high-velocity electron, and gamma rays are photons, not particles but the postemission products.

(Saha [2006](#))

68. D – Dose-calibrator linearity

In the decay method, 100–200 mCi of Technetium-99m in the glass vial is assayed. The time the measurement is taken and the activity are recorded. This same procedure is repeated at various time intervals for the next 36 h after the initial assay.

In the shield method, 100–200 mCi of Technetium-99m in the glass vial is assayed and the activity is recorded. In the next steps, the activity of the source vial is assayed in tube/tubes combinations and the measured activity is multiplied by the calibration factor for each of the tube/tubes combinations.

(Early and Sodee [1995](#))

69. A – 327,680 words

(Appendix A, Formula 24)

70. A – Lithogenic bile

Lithogenic bile favors gallstones production and may be associated with conditions like, e.g., increased secretion of *cholesterol* in the bile in obesity, high-caloric diets, etc.

(Wikipedia)

71. D – Height and weight

Many sources in the USA use blood glucose level and oxygen saturation as vital signs in addition to temperature, pulse, respiratory rate, and blood pressure. The other agencies include pupil size, equality, and reactivity to light or pain perceived by the patient to be vital sign as well.

(Kowalczyk and Donnett 1996)

72. D – Dose extravasation

The other mechanism other than cystic or common duct obstruction can be responsible for nonvisualization of gallbladder and resulting in false-positive studies, and include: parenteral nutrition (absence of oral intake), hepatocyte damage, decreased gallbladder contractility, etc.

(Ziessman 2009)

73. D – Allow greatly reduced injected radioactivity

The new imaging geometries using cadmium–zinc–telluride (CZT) detectors have higher sensitivity, higher energy, and higher spatial resolution which allow lowering the administered doses to the patient.

(ASNC Information Statement 2010)

74. B – Elevated alkaline phosphatase

The primary importance of measuring aspartate aminotransferase alkaline and alanine aminotransferase is to check the possibility of liver disease.

(Gnanasegaran et al. 2009)

75. C – Bone metastases

When cancer cells break away from a primary tumor, they can travel through the blood stream or lymph vessels to other parts of the body and lodge in an organ at a distant location (secondary tumor). Secondary tumors in the bone are called bone metastases.

(Christian et al. 2004)

76. D – Improving report turnaround time

(ASNC Information Statement 2010)

77. A – U.S. Pharmacopeia

(Saha 2006)

78. C – 6 months

The wipe sample must be taken from the nearest accessible point to the sealed source where contamination might accumulate.
(NRC 2000)

79. A – 126–154 keV

(Appendix A, Formula 22A)

80. B – Is determined by the method of sincalide infusion

Rapid sincalide infusions often cause nausea and cramps.
(Ziessman 2009)

81. D – The uterus

The uterus is a part of the genitourinary system or urogenital system which includes the *reproductive organs* and the *urinary system*.
(Frohlich 2001)

82. A – Reverse redistribution

(Zaret and Beller 2005)

83. C – Driver's name

A record of each shipment of licensed material should be kept for a period of 3 years after shipment.
(NRC 2004)

84. D – The right diaphragm

In patients diagnosed with Situs inversus totalis, the right diaphragm can cause the inferior wall defect.
(Zaret and Beller 2005)

85. B – Vertical long axis slices

In this view, the heart is in horizontal position and the apex of the heart is to the viewer's right. The tomogram is displayed with slices beginning at the septum and progressing to the lateral wall of the left ventricle.
(Zaret and Beller 2005)

86. D – Lung perfusion scan

Interventional fluoroscopically guided procedures may give fetal doses in the range of 10–100 mGy, X-ray of pelvis 1–4 mGy, CT of 8–49 mGy, and lung perfusion of 0.9 mGy.
(ICRP 2010)

87. B – Positron range

Greater path length results in a slight mispositioning of the annihilation event from the actual location of the positron-producing atom.

(Christian et al. 2004)

88. A – The light photons into an electrical signal

When a photon of sufficient energy hits the photocathode, it ejects a photoelectron which is accelerated toward dynodes. The amplification depends on the number of dynodes and the accelerating voltage; amplified electrical signal can be measured.

(Christian et al. 2004)

89. D – 8,500,000 rad

(Appendix A, Formula 9C)

90. B – Increase in false positive

Attenuation objects or structures can decreased counts density simulating presence of perfusion defect.

(Zaret and Beller 2005)

91. C – Phagocytosis

Phagocytosis is the process by which specialized macrophages, e.g., Kupffer cells, engulf and destroy microorganisms, and foreign bodies.

(Frohlich 2001)

92. C – Having a duration 500–1,500 ms

(Zaret and Beller 2005)

93. B – At low energy side of the energy window

Scattering of photons in matter results in a decrease in *energy* (increase in *wavelength*) of an *X-ray* or *gamma ray photon*.

(Early and Sodee 1995)

94. A – Reversible defect

(Zaret and Beller 2005)

95. C – Common bile duct

The common bile duct (CBD) is formed by the connection of the cystic duct that comes from the gallbladder and the common hepatic duct that comes from the liver. The CBD carries bile from the gallbladder and liver into the duodenum.

(Christian et al. 2004)

96. C – 50 rem/year
(Consultants in Nuclear Medicine [2010](#))
97. C – Decreased image resolution
(Christian et al. [2004](#))
98. B – Collimation
A collimator consists of a lead (Pb) plate containing a large number of small holes and is used to improve the spatial resolution of a gamma-camera.
(Early and Sodee 1999)
99. B – 18.7 mCi
(Appendix A, Formula 25)
100. B – Adenosine triphosphate
Adenosine triphosphate (ATP) is considered by biologists to be the energy currency of life. It is the high-energy molecule that stores the energy we need to do just about everything we do.
(Zaret and Beller [2005](#))
101. B – The lateral lobe
(Early and Sodee [1995](#))
102. B – False-negative studies
Methylxanthines is a common, naturally occurring group of stimulants. Caffeine, theophylline, and theobromine – the active ingredients of coffee, tea, cocoa, and cola beverages are in this group.
(Zaret and Beller [2005](#))
103. A – COR calibration
COR validation, not COR calibration, can be performed by the technologist.
(Halama [2010](#))
104. B – Be well hydrated
The patient should be well hydrated orally: 10 ml/kg of water or juice 30 min before imaging is recommended.
(Sfakianakis et al. [2009](#))

105. B – Grave’s disease

Graves’ disease – the most common cause of hyperthyroidism in the USA – is an autoimmune disorder in which the immune system makes thyroid-stimulating immunoglobulin that attaches to thyroid cells and mimics the action of thyroid-stimulating hormone (TSH).

(Early and Sodee 1995)

106. B – 0.002 rem in any 1 h

(Consultants in Nuclear Medicine 2010)

107. B – 0.693

$$\lambda = 0.693/T_{1/2}$$

(Early and Sodee 1995)

108. B – Gas

A gas-filled tube usually with helium, neon, or argon briefly conducts an electrical current when a particle or photon of radiation temporarily ionizes the gas.

(Early and Sodee 1995)

109. C – 16.2 mCi

(Appendix A, Formula 25)

110. D – Meckel’s diverticulum scan

A *Tc-99m* pertechnetate scan is the procedure of choice to diagnose Meckel’s diverticulum. Labeled white blood cells can be used in differential diagnosis of osteomyelitis.

(Early and Sodee 1995)

111. D – Dysphagia

Dyspepsia is defined as an uncomfortable feeling of epigastric discomfort, fullness, heartburn, bloating, etc. felt after eating.

(Mosby 1998)

112. C – Liver–spleen scan

No NPO required. A liver-spleen scintigraphy is useful in the diagnosis of hepatomegaly, splenomegaly, bone marrow shifting, tumors, lacerations, cysts, etc.

(Christian 2004)

113. A – Geiger-Mueller detector

The battery check and the sealed source check are performed daily by the nuclear medicine technologist to assess the sufficiency of the battery powering and the instrument sensitivity and consistency accordingly.

(Early and Sodee 1995)

114. A – Radioimmunotherapy

Radiotherapy and concurrent *chemotherapy* is called radiochemotherapy.

(Goldsmith 2010)

115. C – Obstructed pattern

Kidneys show gradually increasing activity with no response after Lasix administration.

(Christian 2004)

116. B – 18 or more years of age

(Nuclear Medicine Tutorials 2010)

117. B – Radionuclide

Radiopharmaceuticals have been defined as radioactive drugs that, when used for the purpose of diagnosis or therapy, typically elicit no physiological response from the patient.

(Early and Sodee 1995)

118. A – The physicist

Calibration is usually performed by the physicist who places the meter in front of a high-activity cesium sealed source producing exposure of at least 30 mR/h at 1 m. The exposure reading of the survey meter is calculated using the inverse square law and it should be adjusted to read the same ($\pm 10\%$) as the calculated value.

(Eradimaging 2010)

119. D – 62%

(Appendix A, Formula 34)

120. D – Performing pulmonary function tests

Medications interfering with MIBG uptake, e.g., reserpine, calcium channel blockers, or sympathomimetics have to be withdrawn in time.

(Grünwald and Ezziddin 2010)

121. C – The sinus node

Action potential from the sinus node spreads through the right and left atrium, reaches A–V node and after transmission through the bundle of His passes into the ventricular septum.

(Podrid 2008)

122. A – Mouse

“Ximabs” are the chimeric molecules and “zumabs” are the humanized molecules.

(Goldsmith 2010)

123. C – Battery check

Linearity, done quarterly, is also quality control procedure performed on the dose calibrator to assess the instrument’s ability to measure accurately a range of low to high activities.

(Early and Sodee 1995)

124. B – A murine immunoglobulin is injected into a human

A mouse antibody injected to a human is recognized by the human *immune system* as a foreign protein (antigen). The human immune system then produces its own antibodies to fight the introduced mouse antibody (the HAMA response).

(Goldsmith 2010)

125. A – Growth plate

This uptake in epiphysis of the long bone is caused by hyperactive osteoblast due to child’s growth. The quality of the bone scan can be judged by the sharpness of the appearance of the epiphyseal plates of the femora, tibiae, and fibulae.

(Christian et al. 2004)

126. D – Once a year

Although film badge readings are routinely posted on a monthly basis, every employer is responsible for informing each *employee* on an annual basis of his cumulative radiation dose.

(Nuclear Medicine Tutorials 2010)

127. A – Less mass than expected

(Early and Sodee 1995)

128. C – Geometry

Geometry warrants the ability of the instrument to accurately measure activities in different configured containers such as a syringes, vials, or pills.

(Early and Sodee 1995)

129. D – 46.6 mCi
(Appendix A, Formula 25)
130. D – Arrhythmias
Since a Y-90 Zevalin administration results in serious and prolonged cytopenias, the Zevalin therapeutic regimen should not be used to patients with significant marrow involvement and/or impaired bone marrow reserve.
(Goldsmith 2010)
131. D – Saliva
Most thromboemboli originate in the deep veins of the thigh. Stasis, hypercoagulable state, and intimal injury are important factors in the development of thrombosis.
(Thompson and Hales 2010)
132. A – The reversibility of perfusion defects
(Zaret and Beller 2005)
133. B – Counter efficiency
 $\text{Counter efficiency} = \text{cpm/dpm} \times 100$. The disintegrations per minute are calculated based on the activity of the source.
(Early and Sodee 1995)
134. B – The aggregation of the colloidal particles
A chelating agent (chelator) is a chemical that form complex molecules with certain metal ions so as to prevent ions from reacting with other ions or elements.
(Vallabhajosula et al. 2010)
135. B – Reversible defect
A defect that is present on the stress images and is not seen on the resting images is called reversible defect. Defect reversibility usually is a sign of myocardial ischemia. In our case, polar plot display indicates the presence of myocardial ischemia of the infero-basal wall.
(Christian et al. 2004)
136. C – Lukewarm area
The thyroid uptake room, the radioassay laboratory, and the computers room are examples of lukewarm areas. The cold areas are open to the public since no radioactivity is handled in these areas.
(Lombardi 1999)

137. B – Binding energy
(Early and Sodee 1995)
138. A – SPECT imaging
SPECT data can be acquired using step-and-shoot, continuous motion, or a hybrid technique, depending on the camera design and the type of study to be done and the COR is critical for this type of acquisition.
(Early and Sodee 1995)
139. D – 210 ml
(Appendix A, Formula 36A)
140. B – 0.08 mg/ml
A single-use vial or a single-use prefilled syringe injection solution containing regadenoson 0.4 mg/5 ml (0.08 mg/ml).
(Astellas 2010)
141. C – Ascending colon
The colon consists of four sections: the *ascending colon*, the *transverse colon*, the *descending colon*, and the *sigmoid colon*. The colon, the *cecum*, and the *rectum* make up the *large intestine*.
(Frohlich 1993)
142. D – Information whether the patient or a relative was notified
The licensee's name, the referring the brief description of the event, and the preventive action plan must be submitted. The patient's name must not be included in the report.
(Saha 2004)
143. D – Xenon leak test
The nebulizer does not necessitate any quality control procedure, but should be visually inspected for damage and cleaned when necessary.
(Early and Sodee 1995)
144. A – Oxidizes excess stannous ion
(Covidien 2010)
145. A – Repeat images after voiding
Having patient urinate reduces the bladder activity. If visualization of the pelvis is essential and patient is unable to void, bladder catheterization is indicated.
(Christian et al. 2004)

146. A – Warm area

The scanning room is an example of the warm area. The hot lab is an example of the hot area in the NM department where activities up to a few hundred millicuries may be stored and handled.

(Lombardi [1999](#))

147. C – Isomers

Isomer is any of two or more nuclides that consist of the same *number* of protons and the same number of neutrons but differ in energy.

(Saha [2004](#))

148. C – 25,000 cps

A point source centered over the detector guarantees a close to uniform photon flux striking on the detector.

(Zanzonico [2008](#))

149. A – 42 mCi

(Appendix A, Formula 25)

150. C – Package with expiration date August 1, 2011

(Early and Sodee [1995](#))

151. A – Atrioventricular septum

Atrioventricular septal defects are typically present in the fetal or neonatal period and are an important source of cardiac morbidity and mortality in this age group.

(Frohlich 1993)

152. D – Does not evaluate true thyroid function

Tc-99m although is being trapped by the thyroid cells is not being further organified as I-123.

(Christian et al. [2004](#))

153. B – Tc-99m, F-18, I-131

Energies of Co-57, Ba-133, and Ge-68 are 122 keV, 356 keV, and 511 keV, respectively. Compare their energies to that of Tc-99m (140 keV), ¹³¹I (364 keV), and ¹⁸F (511 keV).

(Zanzonico [2008](#))

154. B – Fine needle aspiration biopsy

A solitary “cold nodule” has a 5–10% probability of malignancy. Colloid cyst, abscess, nonfunctioning adenomas can also appear as a cold spots.

(Smith and Oates [2004](#))

155. A – Wrong labels

The first image on the left displays posterior view of pelvic, so it should be labeled “Lt Post Rt” not “Rt Post Lt.” The second image from the left should be labeled “Lt Lat” and the third image should be labeled as “Rt Lat.”
(Christian et al. 2004)

156. C – Promoting free radical production

Free radical damage may involve mitochondria, lysosomes, peroxisomes, nuclear endoplasmic reticulum, and plasma membranes. All of them are vital to the normal metabolic functions of the cell.
(Kassis 2008)

157. B – Lower energy, longer wavelength

Since the scattered X-ray photon has less energy, it has a longer wavelength and is less penetrating than the incident photon.
(Early and Sodee 1995)

158. B – Peaking linearity

The energy peak should be verified at least once a day to make sure that the photopeak is centered in the energy windows currently set.
(Early and Sodee 1995)

159. B – 2.64 ml

Answer of Formula 29 should be subtracted from the volume needed (3 ml) to get desired volume.
(Appendix A, Formulas 28A, 29)

160. B – Repeat images after water ingestion

(Smith and Oates 2004)

161. A – Thyroid

The heart, thymus, large vessels, lymph nodes, and connective tissue are also part of the mediastinum.
(Frohlich 1993)

162. D – Patient should use antiperspirant medications

A patient must also be instructed on how to reduce radiation exposure to the family and public members.
(SNM Guideline 2002)

163. B – 2, 2.5, 3, and 4 mm in width

The minimum perceptible bar spacing in a transmission image is used as an index of camera spatial resolution. All bars should appear straight (spatial linearity).
(Zanzonico 2008)

164. A – HIDA scan allows assessment of gallbladder function

A HIDA scan can be used to measure the rate at which bile is released from the gallbladder (gallbladder ejection fraction). Cholecystokinin (CCK) administration or standardized fatty meal consumption are the most commonly used interventions.

(Early and Sodee 1995)

165. B – Tc-99m sulfur colloid

Cerebral shunts are commonly used to treat *hydrocephalus*, due to excess buildup of *cerebrospinal fluid*. Shunt patency studies are performed to determine whether shunt revision surgery is needed in malfunctioned ventriculo-peritoneal shunt.

(Christian et al. 2004)

166. B – Hypothyroidism

The only definite complication of RAI is a 1% incidence of radiation thyroiditis.

(Ross 2008)

167. B – Beta-particle emitters

(Kassis 2008)

168. B – Filtered backprojection and iterative techniques

(Christian et al. 2004)

169. D – 162 μCi

(Appendix A, Formula 31C)

170. B – Half-life

The biological half-life or elimination half-life of a substance is the time it takes for a *metabolite*, *drug*, radionuclide or other substance to lose half of its pharmacologic, physiologic, or radiologic activity.

(Mycek and Harvey 2008)

171. A – Infiltration

(Kozier and Erb 1993)

172. C – Continuous

The smaller the arc used for each projection, the less blurring from the camera motion.

(Christian et al. 2004)

173. C – Filtering

(Christian et al. 2004)

174. B – Atropine

Administration of atropine at the end of dobutamine infusion helps in achieving of 85% of aged predicted target heart rate (THR).

(Zaret and Beller 2005)

175. D – There is nothing wrong with these images

Liver–spleen images in Fig. 2.18 show normal homogeneous uptake of radiotracer in liver and spleen. Minor uptake of Tc-99m sulfur colloid is commonly seen in vertebrae and ribs during liver–spleen scan.

(Christian et al. 2004)

176. C – Wide

A specific license is given to the named persons for specific use of radioactive materials. General and broad licenses applied to, e.g., some laboratories and large medical centers accordingly.

(Halama 2010)

177. C – Neutrons and protons

A nucleon is a collective name for two particles: the *neutron* and the *proton* and they are components of the *atomic nucleus*. The nucleons are made of three *quarks*.

(Christian et al. 2004)

178. A – Material Safety Data Sheet (MSDS)

In the USA, the *Occupational Safety and Health Administration* (OSHA) requires that MSDS be available to employees for potentially harmful substances handled in the workplace.

(OSHA 1994)

179. C – 0.37 min

When there is huge difference between the biological half-life and the physical half-life, shorter of both becomes the effective half-life.

(Appendix A, Formula 18)

180. C – Radium 223

The alpha emitter radium-223 is a bone-seeking radionuclide studied as a novel treatment for patients with bone metastases. Ra-223 showed minimal toxicity in a phase 1 study.

(Saha 2004)

181. C – The medium lobe

The right lobe, the left lobe, the caudate lobe, and the quadrate lobe are the four lobes of the liver.

(Frohlich 1993)

182. B – Infection

An infection is defined as an invasion and multiplying of pathogens – certain bacteria, viruses, fungi, and parasites – in the body tissues in which they are not usually present.

(Bleeker-Rovers et al 2009)

183. B – Apex

The apical slices are displayed first with progression toward the cardiac base with the superior plane at the top and the inferior at the bottom.

(Zaret and Beller 2005)

184. B – Injected dose

(Lin and Alavi 2009)

185. B – Parathyroid

Note the uptake in salivary glands and the heart visualization – lower left corner – due to Tc-99m sestamibi uptake in the myocardium.

(Christian et al. 2004)

186. B – The Radiation Safety Officer (RSO)

(Radiologyinfo.org 2010)

187. D – Pain in bony metastases

Two radiopharmaceuticals: strontium-89 (Metastron) and samarium-153 (Quadramet) can be used for the treatment of painful skeletal metastases (e.g., bone metastases from prostate cancer, breast cancer, or any other cancer that metastasizes to the bone).

(Christian et al. 2004)

188. B – Increased sensitivity and decreased resolution

Increase the thickness of the scintillation detector will increase γ -ray absorption; however, increased thickness will result in more Compton scattering causing degradation of resolution.

(Saha 2006)

189. A – 95.3 μCi

(Appendix A, Formula 30A)

190. D – Delay imaging is performed
(Lin and Alavi [2009](#))
191. D – Decreased appetite
The blend of weight loss and increased appetite is a characteristic finding in patients with evident hyperthyroidism; however, some patients gain weight, especially younger ones due to the excessive appetite stimulation.
(Andreoli et al. [2001](#))
192. A – Myelosuppression
P-32 therapy has not been accepted commonly because of its known bone marrow toxicity.
(Saha [2004](#))
193. C – Display monitor
(Early and Sodee [1995](#))
194. A – Sinogram
A sinogram has all the projection information necessary to reconstruct a single slice of the original activity allocation.
(Christian et al. [2004](#))
195. B – Anterior
Since the heart is located anterior to the lung, it projects greatest shadow in the anterior view.
(Christian et al. [2004](#))
196. C – Rems
The curie and becquerel measure the amount of radioactivity; the rad is the measure of absorbed dose.
(Early and Sodee [1995](#))
197. C – Are used for radionuclide therapy
(Kassis [2008](#))
198. A – Decrease
An increased volume of the sample will result in more count “escaping” the detector through the well counter opening.
(Saha [2006](#))
199. C – 32%
(Appendix A, Formula 38A)

200. A – Transient Ischemic Dilation

TID is most likely caused by stress-induced ischemia to the innermost layer of the ventricle.

(Zaret and Beller 2005)

201. A – Millimeters of mercury

(Kowalczyk and Donnett 1996)

202. A – Free of superimposition

(Ziessman 2009)

203. C – Accuracy

(Early and Sodee 1995)

204. B – The same number of beats

(Zaret and Beller 2005)

205. B – Right nephrectomy

Unusual findings might be nonsignificant or incidental, such as dextrocardia, liver cysts, postmastectomy changes but occasionally these findings may require further evaluation as they may indicate an unexpected malignancy, e.g., breast or lung carcinoma. The raw projection images should always be reviewed for any unusual findings, as well as for potential causes of image artifacts.

(Zaret and Beller 2005)

206. C – Patient undergoing NM study with radiopharmaceutical administration

(Early and Sodee 1995)

207. C – Gamma photons

(Early and Sodee 1995)

208. C – Contact

(Early and Sodee 1995)

209. B – 1.5 mm

Simple way to solve this type of problem is by dividing the given exposure rate by 2 until desired exposure rate is achieved. Each division by 2 represents one HVL, since exposure is reduced to half. If you divide initial exposure rate by two 7 times, then you have gone through 7 HVLs to achieve desired exposure rate. To obtain answer just multiply the amount of HVLs by the HVL of a given isotope (7×0.21).

(Appendix A, Formula 17)

210. B – Hepatobiliary tract

Thirty-three percentage of the injected dose is excreted through the hepatobiliary tract and 25% through the kidneys.

(Christian 2004)

211. B – Free fatty acids

The myocardium can use different substrates according to their availability, hormonal status, and other factors. In a typical fasting state, the myocardium primarily utilizes free fatty acids, but after a meal or a glucose load, it prefers glucose.

(Christian 2004)

212. C – Tc-99m MIBI washes out more rapidly from the thyroid than from abnormal parathyroid

The retention of tracer in abnormal parathyroid is related to the presence of rich in mitochondria oxyphil cells.

(Palestro et al. 2005)

213. A – Have high glucose consumption

High spatial resolution and rapid accumulation into inflammation foci are major benefits of PET FDG over conventional imaging.

(Lin and Alavi 2009)

214. A – The diaphragm

(Lin and Alavi 2009)

215. A – The nucleus decays without collision with another particle or atom

(Wikipedia 2010)

216. B – *Heart*

BNP belongs to a family of protein hormones called natriuretic peptides. BNP acts on blood vessels, causing them to widen and on the kidneys promoting salt and water excretion.

(Family Health Guide 2010)

217. D – Polar map

Circumferential profiles generated from the short axis slices are normalized to the reference area in the rest or stress study. The rest or stress is subtracted from the normalized data, and then displayed as a polar bull's-eye plot so that positive values show areas that have “reverse” or “improved.” Patient profiles are compared with means and standard deviations of reversibility for all pixels determined from the database of normal files.

(Zaret and Beller 2005)

218. D – Thrombocytosis

Thrombocytosis is the presence of high *platelet* counts in the *blood* – often symptomless but it can predispose to *thrombosis* in some patients.

(Andreoli et al. 2001)

219. A – 3%

(Appendix A, Formula 32B)

220. B – 1 ml

(Zaret and Beller 2005)

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