

Nuclear Medicine Handbook1 Test Questions

(hint: print questions & circle answers before starting online test)

Chapters 1 to 10

Chapter 1

- Who discovered natural radioactivity?
 - Röntgen
 - Newton
 - Becquerel
 - Tesla
- A _____ is defined as a quantity that can be used in mathematical equations of science and technology.
 - physical quantity
 - kilogram
 - radiation
 - x-ray quality
- The currently used metric system of units is known as the _____.
 - Tesla
 - Gauss
 - Traditional Radiation units
 - International System of Units (SI)
- Which of the following are examples of ionizing radiation?
 - X rays and γ rays
 - energetic neutrons, electrons and protons
 - heavier particles
 - All of the above
- Ionizing radiation can be categorized into which of the following types?
 - directly ionizing radiation
 - indirectly ionizing radiation
 - ultrasonic waves
 - Both A and B
- Indirectly ionizing photon radiation consists of which of the following main categories?
 - ultraviolet
 - X ray
 - γ ray
 - All of the above
- Gamma rays typically have energies above _____ keV and wavelengths less than 0.1 \AA .
 - 1
 - 10
 - 100
 - none of the above
- _____ is defined as energy absorbed per unit mass of medium.
 - Absorbed dose
 - Exposure X*
 - Kerma K*
 - Effective dose E*
- _____ of a radioactive substance is defined as the number of nuclear decays per time.
 - Absorbed dose
 - Activity A*
 - Kerma K*
 - Effective dose E*
- Atomic number symbolized by letter _____ is the number of protons and number of electrons in an atom.
 - A
 - Z
 - K
 - E
- _____ is a spontaneous process by which an unstable parent nucleus emits a particle or electromagnetic radiation and transforms into a more stable daughter nucleus that may or may not be stable.
 - MRI
 - Electricity
 - Radioactivity
 - none of the above

12. The SI unit of radioactivity is the _____.
- A. becquerel (Bq)
 - B. rad
 - C. *kerma K*
 - D. *effective dose E*
13. In ____ Frédéric Joliot and Irène Curie-Joliot discovered artificial radioactivity.
- A. 1895
 - B. 1900
 - C. 1915
 - D. 1934
14. _____ is important in production of radionuclides used for external beam radiotherapy, brachytherapy, therapeutic nuclear medicine and nuclear medicine imaging also referred to as molecular imaging.
- A. proton activation
 - B. *Neutron activation*
 - C. *Magnet activation*
 - D. *Sonowave*
15. Naturally occurring α particles have kinetic energies between _____ MeV.
- A. 1 and 1.5
 - B. 2 and 2.7
 - C. 4 and 9
 - D. 50 and 76
16. A large number of radionuclides used in nuclear medicine (e.g. ^{99m}Tc , ^{123}I , ^{201}Tl , ^{64}Cu) decay by electron capture and/or internal conversion.
- A. TRUE
 - B. FALSE
17. Coulomb interactions between the incident electron or positron and nuclei of the absorber atom result in _____.
- A. proton activation
 - B. *particle scattering*
 - C. *Magnet activation*
 - D. *ghost image*
18. _____ is defined as the thickness of a homogeneous absorber that attenuates the narrow beam intensity $I(0)$ to one half (50%) of the original intensity.
- A. Detective Quantum Efficiency (DQE)
 - B. Inverse Square Law
 - C. PACS
 - D. Half Value Layer (HVL)
19. Which of the following are considered as photon interactions with atoms of the absorber?
- A. Compton and Photoelectric effect
 - B. Nuclear and Electronic pair production
 - C. Photonuclear reactions
 - D. All of the above
20. The Compton effect is also called by which of the following?
- A. Incoherent scattering
 - B. Compton scattering
 - C. Rayleigh scattering
 - D. Both A and B

Chapter 2

21. _____ is the study (both qualitative and quantitative) of the actions of ionizing radiations on living matter.
- A. Radiobiology
 - B. Radiology
 - C. *Cardiology*
 - D. *Anthropology*
22. In nuclear medicine, which of the following types of radiation play a relevant role in tumor and normal tissue effects?
- A. gamma (γ) radiation
 - B. beta (β) radiation
 - C. alpha (α) particles and Auger electrons
 - D. All of the above
23. _____ is emitted when heavy, unstable nuclides undergo decay.
- A. Solar radiation
 - B. *Alpha radiation*

- C. *Ultraviolet radiation*
D. *Microwave radiation*
24. _____ occur when a cell which has not been traversed by a charged particle is damaged as a result of radiation interactions occurring in neighboring cells.
- A. Scatter radiation
B. Photoelectric effect
C. Bystander effects
D. Lethal dose
25. _____ damage is the **primary** cause of cell death caused by radiation.
- A. Muscle
B. Red blood cells
C. DNA
D. Skin
26. _____ is a form of cell death associated with loss of cellular membrane activity.
- A. Necrosis
B. Alopecia
C. *Erythema*
D. *Cataract*
27. _____ is a measure of the linear rate at which radiation is absorbed in the absorbing medium by the secondary particles.
- A. LET
B. DQE
C. *HVL*
D. *LD*
28. Targeted radionuclide therapy normally involves irradiation of the tumor/normal tissues at a dose rate which is not constant but which reduces as treatment proceeds, as a consequence of the combination of radionuclide decay and biological clearance of the radiopharmaceutical.
- A. TRUE
B. FALSE
29. _____ damage in which the cellular DNA is irreversibly damaged to such an extent that the cell dies or loses its proliferative capacity.
- A. Sublethal
B. *Lethal*
C. *Reversible*
D. *Minor*
30. The _____ of a particular radiation treatment is a measure of the resultant damage to the tumor vs the damage to critical normal structures.
- A. lethal index
B. toxicity
C. therapeutic index
D. none of the above
- Chapter 3**
31. Medical exposure is the largest human-made source of radiation exposure, accounting for more than _____ of radiation exposure.
- A. 50%
B. 66%
C. 73%
D. 95%
32. _____ is the exposure of workers incurred in the course of their work.
- A. Occupational exposure
B. Medical exposure
C. *Public exposure*
D. *Hazard exposure*
33. The ICRP system has which of the following fundamental principles of radiological protection?
- A. The principle of justification
B. The principle of optimization of protection (ALARA)
C. The principle of limitation of doses
D. All of the above
34. According to table 3.1, what is the maximum recommended occupational dose to lens of the eye?
- A. 10 *mSv*
B. 20 *mSv*
C. 500 *mSv*
D. 900 *mSv*

35. The International System of Units (SI) unit of mean organ dose is joules per kilogram (J/kg) which is termed _____.
- A. *rem*
 - B. *gray (Gy)*
 - C. *rad*
 - D. *becquerel*
36. Regarding internal exposure from radionuclides, the equivalent dose and the effective dose are not only dependent on the physical properties of the radiation but also on which of the following?
- A. biological turnover
 - B. retention of the radionuclide
 - C. NM equipment
 - D. Both A and B
37. The relationship between the probability of stochastic effects and equivalent dose is found to depend on the _____.
- A. organ or tissue irradiated
 - B. step-up transformer
 - C. *anode*
 - D. *cathode*
38. Which of the following have key roles and responsibilities in implementing radiation protection in a nuclear medicine facility?
- A. nuclear medicine physician and medical physicist
 - B. nuclear medicine technologist and radiopharmacist
 - C. radiation protection officer (RPO)
 - D. All of the above
39. Which of the following are important tasks for the medical physicist for nuclear medicine staff and other health professionals?
- A. quality assurance (QA)
 - B. continuing education in radiation protection
 - C. teaching pharmacology
 - D. Both A and B
40. Which of the following is a special concern in a nuclear medicine facility?
- A. scatter radiation
 - B. toxicity
 - C. risk of contamination
 - D. high magnetic area
41. With regard to occupational exposure, the basic safety standards (BSS) require the classification of workplaces as controlled areas or as supervised areas.
- A. TRUE
 - B. FALSE
42. In a nuclear medicine facility, which of the following are controlled areas?
- A. the rooms for preparation
 - B. storage (including radioactive waste)
 - C. injection of the radiopharmaceuticals
 - D. All of the above
43. The final disposal of the radioactive waste produced in the nuclear medicine facility includes which of the following options?
- A. storage for decay and disposal as cleared waste into the sewage system (aqueous waste)
 - B. through incineration or transfer to a landfill site (solid waste)
 - C. transfer of sources to the vendor or to a special waste disposal facility outside of the hospital
 - D. All of the above
44. High equivalent dose to the _____ can be received in preparation and administration of radiopharmaceuticals, even if proper shielding is used.
- A. feet
 - B. fingers
 - C. gonads
 - D. none of the above
45. It is generally accepted that the unborn child should be afforded the same protection level as a member of the general public, meaning that a dose limit of _____ should be applied once pregnancy is declared.
- A. 0 mSv
 - B. 1 mSv
 - C. 10 mSv
 - D. 100 mSv

46. In order to minimize external exposure, which of the following fundamental measures of protection should be applied?
- A. time
 - B. distance
 - C. shielding
 - D. All of the above
47. _____ should be used to reduce the radiation exposure by increasing the distance between the source and the hands.
- A. Gonadal shielding
 - B. Thyroid cover
 - C. Forceps or tongs
 - D. Dosimeter
48. Which of the following can be used during examinations, when the distance to the patient is short?
- A. low kVp
 - B. personal dosimeter
 - C. movable transparent shield
 - D. curtain
49. ____ should **not** be subject to therapy with a radioactive substance unless the application is life-saving.
- A. Pregnant women
 - B. Elderly patients
 - C. *Cancer patients*
 - D. *Pediatric patients*
50. For children or young patients, _____ should always be measured and the adult administered activity should then be scaled down.
- A. height
 - B. body weight
 - C. age
 - D. none of the above

Chapter 4

51. All matter in the universe has its origin in an event called the _____, a cosmic explosion releasing an enormous amount of energy about 14 billion years ago.
- A. theory of relativity
 - B. big bang
 - C. atomic theory
 - D. gravity theory
52. _____ was the first person to apply the radioactive tracer technique in biology when he investigated lead uptake in plants (1923) using ^{212}Pb .
- A. Röntgen
 - B. Newton
 - C. De Hevesy
 - D. Becquerel
53. Before the second world war, the ____ was the main producer of radionuclides since the neutron sources at that time were very weak.
- A. cyclotron
 - B. Fuji
 - C. *Kodak*
 - D. *GE*
54. Which of the following contains constant number of protons?
- A. Isotones
 - B. Isotopes
 - C. Isobars
 - D. none of the above
55. The stability of the nucleus is determined by which of the following competing forces?
- A. strong force that binds the nucleons (protons and neutrons) together
 - B. Coulomb force that repulses particles of like charge
 - C. electromagnetic force
 - D. Both A and B
56. There are two major ways to produce radionuclides: using reactors (neutrons) or particle accelerators (protons, deuterons, α particles or heavy ions).
- A. TRUE
 - B. FALSE
57. Many reactor produced radionuclides emit high energy _____ that contribute to the absorbed dose (but not the imaging signal) to patients, which is a drawback in diagnostic procedures.

- A. x-ray
- B. magnetic force
- C. β particles
- D. solar radiation

58. Which of the following are used in radionuclide therapy that emits high energy β radiation?

- A. ^{90}Y
- B. ^{131}I
- C. ^{177}Lu
- D. All of the above

59. _____ is not only used as fuel in a nuclear reactor but it can also be used as a target to produce radionuclides.

- A. Barium sulfide
- B. Uranium-235
- C. Gadolinium
- D. Isovue 500

60. According to table 4.2, accelerated particles of <10 MeV proton energy are used for _____.

- A. MRI
- B. PET
- C. Radiography
- D. Ultrasound

61. _____ is produced by deuteron bombardment of natural nitrogen through the $^{14}\text{N}(d, n)^{15}\text{O}$ nuclear reaction.

- A. Oxygen-15
- B. Helium
- C. *Carbon dioxide*
- D. *Calcium*

62. When the _____ is hit by an energetic particle, a complex interplay between physical and statistical laws determines the result.

- A. nucleus
- B. electrons
- C. *cell membrane*
- D. *protons*

63. Whenever a radionuclide (parent) decays to another radioactive nuclide (daughter), this is called a_____.

- A. ionization
- B. photoelectric effect
- C. radionuclide generator
- D. magnetization

Chapter 5

64. Which of the following are sources of errors in Nuclear Medicine measurement?

- A. blunders
- B. systematic errors or accuracy of measurements
- C. random errors or precision of measurements
- D. All of the above

65. When an incorrectly calibrated ionization chamber is used for measurement of radiation dose, it is an example of _____ error.

- A. regular
- B. systematic
- C. routine
- D. normal

66. Systematic errors can be detected by using _____.

- A. reference standards
- B. H & D curve
- C. *pie chart*
- D. *histograms*

67. Random errors are rarely present when radiation measurements are performed because the measured quantity, namely the radionuclide decay, is a random varying quantity.

- A. TRUE
- B. FALSE

68. The random error as a result of the measured quantity, namely radionuclide decay, will significantly influence the _____ of the image.

- A. collimation
- B. absorption
- C. visual quality

D. magnification

69. Random errors are always present and play a significant role in which of the following?

- A. radiation counting
- B. imaging
- C. radio frequency signals
- D. Both A and B

70. A _____ of the relative frequency distribution of the fluctuations in the measurements can be constructed by plotting the relative frequency of the measured counts (Fig. 5.3(b)).

- A. histogram
- B. radio frequency signals
- C. T_2 signal
- D. magnification

71. Most procedures in nuclear medicine involve multiple nuclear measurements and imaging procedures for the calculation of which of the following results on which clinical diagnosis is based?

- A. thyroid iodine uptake
- B. ejection fraction and renal clearance
- C. blood volume or red cell survival time
- D. All of the above

72. In imaging, when scatter or background correction is performed by _____, image quality deteriorates as a result of the increased uncertainty in the pixel values.

- A. collimation
- B. subtraction
- C. filtration
- D. magnification

73. The background counts during sample counting consist of which of the following?

- A. electronic noise and detection of cosmic rays
- B. natural radioactivity in the detector
- C. down scatter radioactivity from non-target radionuclides in the sample
- D. All of the above

74. The plasma volume (PV) is measured by using the _____.

- A. collimation
- B. subtraction
- C. dilution principle
- D. magnification

75. A _____ determines the energy resolution of a detector or the uncertainty associated with the energy measurement of a detected photon.

- A. IP process
- B. analog to digital converter
- C. statistical process
- D. flux gain

76. Which of the following is widely used in nuclear medicine for sample counting and imaging?

- A. scintillation detectors
- B. radio frequency signals
- C. T_2 signal
- D. step up transformer

Chapter 6

77. A _____ is a sensor that upon interaction with radiation produces a signal that can preferably be processed electronically to give the requested information.

- A. x-ray tube
- B. radiation detector
- C. transformer
- D. mA meter

78. Charged particles, such as α particles, transfer their energy directly by which of the following method?

- A. ionization
- B. excitation
- C. magnetic signal
- D. Both A and B

79. The quality of a radiation detector is expressed in terms of which of the following characteristics?

- A. sensitivity, energy and time
- B. position resolution
- C. counting rate a detector can handle
- D. All of the above

80. In radiation detection, the sensitivity depends on which of the following?
A. the solid angle subtended by the detector
B. the efficiency of the detector for interaction with the radiation
C. magnet size
D. Both A and B
81. In Nuclear Medicine, _____ depends primarily on two factors, the rise time and the height of the signal pulses.
A. IP process
B. filtration
C. time resolution
D. flux gain
82. In nuclear medicine, _____ is an issue in γ ray detection in the gamma camera and in single photon emission computed tomography (SPECT) and PET detection systems.
A. ghost images
B. position resolution
C. metal artifacts
D. blurring
83. The mode of operation of a gas filled detector depends strongly on the applied _____.
A. voltage
B. radio frequency signals
C. mAs
D. contrast
84. A semiconductor detector is also called a _____.
A. capacitor
B. step-up transformer
C. anode
D. cathode
85. Which of the following semiconductor detector material is **primarily** of interest for (position sensitive) detection of low energy X rays, β particles and light quanta?
A. Lead
B. Tungsten
C. Silicon
D. Wood
86. _____, with its higher density and atomic number, is the basic material for high resolution γ ray spectroscopy.
A. Lead
B. Tungsten
C. Germanium
D. Wood

Chapter 7

87. Nuclear medicine imaging is generally based on the detection of X rays and γ rays emitted by _____ injected into a patient.
A. barium sulfide
B. radionuclides
C. iodine
D. gadolinium
88. Photon counting places a heavy burden on the electronics used for nuclear medicine imaging in terms of _____.
A. electronic noise and stability
B. ghost images
C. blurring
D. magnification
89. The methods used for the detection of X ray and γ ray photons fall into which of the following categories?
A. scintillation counter
B. gas filled detectors
C. semiconductors
D. All of the above
90. Gas filled imaging systems convert the energy deposited by a γ ray photon directly into _____.
A. digital signal
B. analog signal
C. ion pairs
D. scatter radiation

91. Which of the following produces images from signals by ionizing radiation detection processes in nuclear medicine?
- A. gamma camera
 - B. positron camera
 - C. imaging plates (IP)
 - D. Both A and B
92. The gamma camera was invented by _____.
- A. Hal Anger
 - B. Fuji
 - C. *Kodak*
 - D. *GE*
93. The amplified signal from the photo-multiplier can be converted to a digital pulse train using an _____.
- A. analogue to digital converter (ADC)
 - B. digital to analogue converter (DAC)
 - C. *step-up transformer*
 - D. *ionization chamber*
94. _____ is based on the use of radioactive labels to determine the microscopic distribution of pharmaceuticals in tissues excised from humans or animals.
- A. Radiobiology
 - B. Autoradiography
 - C. Cardiology
 - D. Oncology
95. _____ is a problem when an amplifier produces a pulse that either oscillates before reaching its maximum value or where the tail oscillates before reaching the baseline.
- A. Artifact
 - B. Ghost image
 - C. Ringing
 - D. Scatter radiation
96. Analogue signals are converted into _____ that are subsequently used to provide spatial and temporal information about each detected event.
- A. electric signal
 - B. x-ray signal
 - C. digital signals
 - D. radio-frequency signal

Chapter 8

97. The **first stage** of a generic nuclear medicine imager is the _____ emitted by the radionuclide.
- A. detection of the γ rays
 - B. capture of scattered radiation
 - C. *elimination of signals*
 - D. *none of the above*
98. _____ reflect the performance of a sub-part of the imager under ideal conditions.
- A. Statistic counting
 - B. Intrinsic measurements
 - C. QA
 - D. QC
99. The _____ is an intrinsic measure of detector performance.
- A. magnification
 - B. energy resolution
 - C. flux gain
 - D. histogram
100. The _____ of a nuclear medicine imager characterizes the system's ability to resolve spatially separated sources of radioactivity.
- A. grid lines
 - B. DQE
 - C. spatial resolution
 - D. none of the above

Chapter 9

101. The instrument that is used in nuclear medicine to measure radioactivity is the calibrated re-entrant ionization chamber, commonly known by which of the following name?
- A. radionuclide calibrator
 - B. dose calibrator
 - C. imaging plates (IP)
 - D. Both A and B

102. The calibrated re-entrant ionization chamber is typically shielded by the manufacturer with 6 mm of _____ to ensure low background readings.

- A. lead
- B. wood
- C. *plastic*
- D. *concrete*

103. _____ measure the current output from the ionization chamber ranging from tens of femtoamperes up to micro-amperes.

- A. Electrometers
- B. Sensitometer
- C. *Densitometer*
- D. *kVp meter*

104. The dose calibrator response from β particles will be almost entirely from _____.

- A. Compton and photoelectric effect
- B. nuclear and electronic pair production
- C. bremsstrahlung radiation
- D. magnetic source

105. The proportion of the total radioactivity that is present as a specific radionuclide is defined as the radionuclide purity.

- A. TRUE
- B. FALSE

106. Acceptance tests for dose calibrators should include measurements of which of the following?

- A. accuracy
- B. reproducibility and linearity
- C. geometry response
- D. All of the above

107. Children are approximately three times more radiosensitive than adults, so determining the appropriate activity to be administered for pediatric procedures is essential.

- A. TRUE
- B. FALSE

108. Surface contamination with radioactivity could lead to contamination of a radiation worker and/or external irradiation of the _____ of the worker.

- A. eyes
- B. skin
- C. thyroid
- D. none of the above

109. Internal contamination could arise from inhalation and/or ingestion of the radionuclide.

- A. TRUE
- B. FALSE

110. Systematic studies of the dose to the hands of staff working in radio-pharmacies have shown that finger doses may approach or exceed the annual dose limit of _____ mSv to the extremities.

- A. 5
- B. 50
- C. 500
- D. 5,000

111. The ICRP has recommended that ____ dose monitoring be undertaken for any person handling more than 2 GBq/d and regular monitoring should be carried out if doses to the most exposed part of the hand exceed 6 mSv/month.

- A. eye
- B. finger
- C. gonad
- D. thyroid

112. A _____ mounted in a plastic ring is usually the most convenient type of monitor that is worn on the finger.

- A. ionizing pen
- B. film-badge dosimeter
- C. G M monitor
- D. thermoluminescent dosimeter chip

113. The ICRP recommends that the ring monitor be worn on the middle finger with the element positioned on the palm side, and that a factor of three should be applied to derive an estimate of the dose to the tip.

- A. TRUE
- B. FALSE

114. A _____ is an enclosed workplace designed to prevent the spread of fumes to the operator and other persons.

- A. dark room
- B. fume cupboard
- C. processing room
- D. lead curtain

115. During radiopharmaceutical preparation, dispensing and administration to the patient, the activity is usually manipulated in _____.

- A. cups
- B. bottles
- C. syringes
- D. spoons

116. The radiopharmacy should be located in an area that is not accessible to members of the public.

- A. TRUE
- B. FALSE

117. Radioactive waste generated within a nuclear medicine facility usually consists of radionuclides with half-lives of less than _____.

- A. one day
- B. one month
- C. one year
- D. none of the above

Chapter 10

118. In scintillation detectors, radiation interacts with and deposits energy in a scintillator, most commonly, a crystalline solid such as _____.

- A. thallium-doped sodium iodide (NaI(Tl))
- B. mercury
- C. *helium*
- D. *sodium bromide*

119. Among ionization detector survey meters, so-called _____ are relatively low sensitivity ionization chambers that are designed for use where relatively high fluxes of X rays and γ rays are encountered.

- A. ionizing pen
- B. film-badge dosimeter
- C. G M monitor
- D. cutie-pies

120. Well counters are used for high sensitivity counting of radioactive specimens such as blood or urine samples or 'wipes' from surveys of removable contamination (i.e. 'wipe testing').

- A. TRUE
- B. FALSE