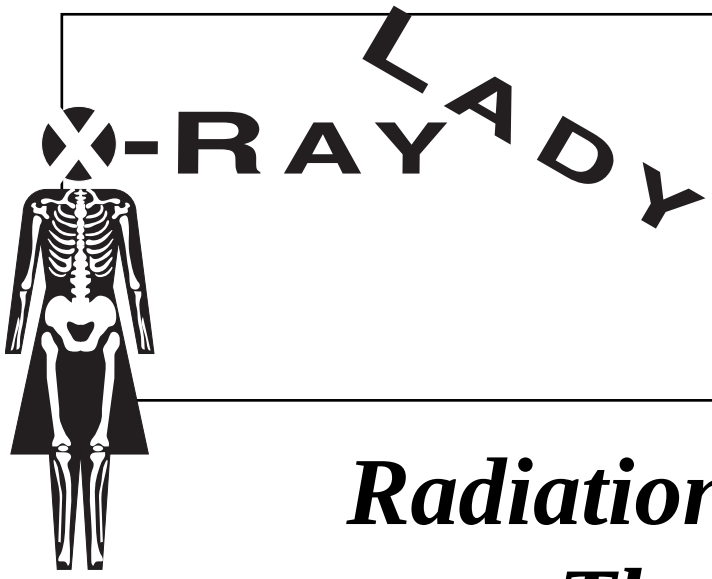

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Radiation Protection: The Basics

Approved for 12 Category A+ Continuing Education Credits

American Society of Radiologic Technologists
Course Approval Start Date 3/1/2011
Course approval End Date 4/1/2013

Florida Radiologic Technology Program
Provider # 3200615
Course Approval Start Date 2/1/2011
Course Approval End Date 1/31/2014

KY Radiation Operator Certification Program
Kentucky Radiation Control Program
Course Approval Start Date 3/1/2011
Course approval End Date 4/1/2013

Iowa Department of Public Health
Bureau of Radiological Health
Course Approval Start Date 2/10/2011
Course approval End Date 2/1/2014

A Continuing Education Course for Radiation Operators

Radiation Protection: The Basics
Homestudy Course

Course Description

The ***Radiation Protection: The Basics*** course provides the most recent information and concepts concerning radiation protection in medical imaging. The information in this course provides an ideal way to review the basics of Radiation Protection and includes the following major topics.

- Concepts of Radiologic Science
- Human Biology
- Fundamental Principles of Radiobiology
- Molecular and Cellular Radiobiology
- Early and Late Effects of Radiation
- Health Physics
- Designing for Radiation Protection
- Patient Radiation Dose Management

Occupational Radiation Dose Management

Course Objectives: Upon completion of this homestudy course, the participant will:

1. Recall facts about radiation and radiation interactions with matter.

2. Correctly identify radiation measurement quantities and units.

3. Recall facts about cell biology and effects of radiation exposure.

4. Discuss the concept of radiation risk versus benefit.

5. Describe universal practice standards in regard to the list of specific procedures listed above.

6. Define ALARA and give five examples of ALARA in action.

7. Identify correct statements regarding structural design for radiation protection, protective apparel, room and equipment design, primary beam limitation, filtration, and selection of technical factors.

8. Discriminate between appropriate and inappropriate statements concerning radiation detection and monitoring.

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Homestudy Course Directions

Directions

- To complete this course read the reference included with your homestudy course.
- We suggest that you read the reference prior to answering the post-test questions.
- Complete the post-test questions. If you have difficulty in answering any question, refer to the reference.

Complete the Answer Sheet and Course Evaluation

- Complete the post-test and record your responses on the answer sheet and complete the course evaluation. You may mail your answer sheet to 6511 Glenridge Park Place, Suite 6, Louisville, KY 40222.

- **If you mail your answer sheet and course evaluation, retain a copy before mailing.**

- **We request that you do not fax your answer sheet unless you are within two weeks of your expiration date. If you fax your answer sheet and course evaluation, obtain verification from the machine that the fax was delivered or call our office for verification.**

  OR

- Use **the Online Answer Sheet** on our website homepage at www.x-raylady.com. After completing the ONLINE Answer sheet, just hit submit to send via email. Remember to also complete the online course evaluation.

Grading and Issuance of a Certificate

Your answer sheet will be scored within 1-2 days of arrival in our office. To obtain continuing education credit, you must have a cumulative average score of at least 75%. **Verification of awarded continuing education for this course will be submitted to the following states: KY, IA, FL**. For ARRT and all other states, please self-report to the state radiation certification agency in your state and the ARRT and any other organizations.

You will be awarded a certificate verifying satisfactory completion of this course, or notification if you do not. **We are now emailing certificates so be sure to include your email address**. Please let us know if you prefer to receive a copy in the mail and allow 4-5 days to receive your copy.

Need Additional Information

You may call our office (502) 425-0651 voice mail. Our office hours are 9 a.m. –6 p.m. Monday through Friday. The office operates on Eastern Standard Time and is closed on major holidays. You may also e-mail us at xraylady@insightbb.com. For information, about courses or to order online, visit our web site at www.x-raylady.com.

The X-ray Lady Refund and Exchange Policy, Certificate Replacement Policy, and other related policies are included in each course.

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Effective 3-1-08: All course certificates will be sent via e-mail unless we are otherwise notified**. Be sure to add our e-mail to your address book so that your certificate is not sent to your junk/bulk mail. If you have a new or different e-mail please notify our office or make note of it on your answer sheet.**

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Radiation Protection: The Basics Post Test

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1. The primary distinguishing characteristic of matter is:

   a. mass
   b. atoms
   c. energy
   d. molecules

2. In radiology, energy is measured in:

   a. joules (J)
   b. kilowatt hour (kWh)
   c. electron volt (eV)
   d. British thermal unit (Btu)

3. In radiology, electrical energy in the x-ray imaging system is used to produce electromagnetic energy (the x-ray), which then is converted to ___ energy in the radiographic film.

   a. nuclear
   b. kinetic
   c. thermal
   d. chemical

4. **All** of the following are forms of electromagnetic radiation with sufficient energy to ionize matter, **except**:

   a. x-rays
   b. radio waves
   c. gamma rays
   d. ultraviolet light

5. When an x-ray passes close to an orbital electron of an atom and transfers sufficient energy to the electron to remove it from the atom, ___ occurs.

   a. ionization
   b. polarization
   c. interference
   d. synchronization

6. Radon emits ___ particles.

   a. beta
   b. x-ray
   c. alpha
   d. gamma

7. The annual average radiation dose due to diagnostic x-rays is ___%.

   a. 10
   b. 11
   c. 13
   d. 15

8. The person that produced the first medical x-ray in early 1896 was:

   a. Michael Pulpin
   b. Thomas Edison
   c. Charles Leonard
   d. Wilhelm Roentgen

9. One kilovolt (kV) is equal to ___ volts (V) of electric potential..

   a. 10
   b. 100
   c. 1,000
   d. 10,000

10. Long exposure time results in image:

    a. blur
    b. clarity
    c. polarization
    d. magnification

11. The person who unveiled his hot-cathode x-ray tube to the medical community in 1913 was:

    a. Michael Pulpin
    b. William Coolidge
    c. Wilhelm Roentgen
    d. Sir William Crookes

12. A/An ___ device reduces scatter radiation and thus improves image contrast.

    a. filtration
    b. collimator
    c. protective barrier
    d. intensifying screen

13. In the Ten Commandments of Radiation Protection, commandment number ___ reminds operators to “Always wear an occupational radiation monitor and position it outside the protective apron at the collar”.

    a. 1
    b. 3
    c. 5
    d. 7

14. If sufficiently intense, x-rays can cause:

    a. cancer
    b. cataracts
    c. skin burns
    d. all of the above

15. The effect of x-rays on humans is the result of interactions at the ___ level.

    a. atomic
    b. cellular
    c. molecular
    d. radioactive

16. **All** of the following are late effects of radiation on humans **except**:

a. leukemia
b. bone cancer
c. thyroid cancer
d. acute radiation syndrome

17. In 1665, Robert Hooke first named the ___ as the biologic building block.

a. cell
b. atom
c. electron
d. molecule

18. There are ___ principle types of molecules found in the body.

a. 4
b. 5
c. 6
d. 7

19. **All** of the following are classes of organic molecules **except**:

a. lipids
b. proteins
c. nucleic acids
d. carbohydrates

20. Water constitutes ___% of the molecular composition of the body.

a. 50
b. 70
c. 80
d. 90

21. Molecules that are necessary in small quantities to allow a biochemical reaction to continue, even though they do not directly enter into the reaction are:

a. lipids
b. glucose
c. enzymes
d. hormones

22. What is present in all tissues of the body and are structural components of cell membranes?

a. lipids
b. antigens
c. enzymes
d. carbohydrates

23. The “engine of the cell” is the:

a. nucleus
b. ribosomes
c. lysosomes
d. mitochondria

24. The period of growth of the cell between divisions is called:

a. mitosis
b. meiosis
c. interphase
d. synthesis

25. The ___ stage of mitosis occurs when chromosomes appear and are lined up along the equator of the nucleus.

a. prophase
b. anaphase
c. telephase
d. metaphase

26. The genetic cell begins meiosis with ___ chromosomes.

a. 23
b. 40
c. 45
d. 46

27. Immature cells may also be called:

a. stem cells
b. pre-cursor cells
c. undifferentiated cells
d. all of the above

28. Mature cells are more sensitive to radiation than stem cells.

    a. True
    b. False

29. **All** of the following have a high level of radiosensitivity **except**:

    a. brain
    b. gonads
    c. bone marrow
    d. lymphoid tissue

30. The tissue that is found throughout the body and is high in protein content is:

    a. muscle
    b. nervous
    c. epithelium
    d. connective

31. The relative biologic effectiveness of diagnostic x-rays is:

    a. 1
    b. 3
    c. 5
    d. 7

32. Tissue is more sensitive to radiation when irradiated in the ___ state.

    a. anoxic
    b. natural
    c. hypoxic
    d. oxygenated

33. Usually ___ radiation responses follow low radiation exposure and appear as a ___ radiation response.

    a. deterministic, late
    b. deterministic, early
    c. stochastic, late
    d. stochastic, early

34. Any dose, regardless of its size, that is expected to produce a response is known as a ___dose-response relationship.

a. linear, threshold
b. linear, non-threshold
c. non-linear, threshold
d. non-linear, non-threshold

35. The suggestion that a “little bit of radiation is good for you” is known as:

a. hormesis
b. protraction
c. extrapolate
d. fractionation

36. When macromolecules are irradiated in solution in vitro, the ___ effect causes breakage of the backbone of the long-chain macromolecule.

a. synthesis
b. point-lesion
c. cross-linking
d. main-chain scission

37. During the ___ portion of interphase, the Deoxyribonucleic (DNA) separates like a zipper and two daughter DNA molecules are formed, each alike and each a replicate of the parent molecule.

a. growth 1
b. growth 2
c. S phase
d. gap zero

38. A principle observable effect that may result from irradiation of DNA is:

a. cell death
b. genetic damage
c. malignant disease
d. all of the above

39. Irradiation of water represents the principle radiation interaction in the body.

a. True
b. False

40. The free radical that can join with a similar molecule to form hydrogen peroxide is:

a. H*
b. H+
c. OH-
d. OH*

41. According to the ___ theory, for a cell to die after radiation exposure, its DNA molecule must be inactivated.

a. target
b. indirect
c. inactive
d. sensitive key

42. The lethal effects of radiation are determined by observing cell:

a. death
b. growth
c. survival
d. reproduction

43. When the radiation dose (D) reaches a level sufficient to kill 63% of the cells (37% survival) it is called:

a. D33
b. D35
c. D37
d. D39

44. At very low radiation doses, cell survival is nearly ___%.

a. 95
b. 98
c. 99
d. 100

45. The capacity to accumulate and recover from sublethal damage is measured by:

a. Do
b. Dq
c. No
d. D37

46. The presence of ___ maximizes the effect of low-LET radiation.

a. carbon
b. oxygen
c. nitrogen
d. hydrogen

47. The ___ syndrome is characterized by increased intracranial pressure, vasculitis, and meningitis.

a. hematologic
b. acute radiation
c. gastrointestinal (GI)
d. central nervous system (CNS)

48. Acute radiation lethality follows a ___ dose-response relationship.

a. linear, threshold
b. linear, non-threshold
c. non-linear, threshold
d. non-linear, non-threshold

49. Acute radiation lethality is approximately ___(rad) for humans.

a. 250
b. 275
c. 300
d. 350

50. It takes a dose of ___(rad) for an irradiated cockroach to die within 60 days.

a. 620
b. 725
c. 2000
d. 10,000

51. Mean survival time is dose dependant with the ___ syndrome.

a. GI
b. CNS
c. hematologic
d. acute radiation

52. The cell layer of normal skin that participates in the response to radiation exposure is:

a. outer
b. intermediate
c. subcutaneous
d. all of the above

53. Skin cells are replaced at a rate of approximately ___% per day.

a. 2
b. 5
c. 7
d. 10

54. The first observed biologic response to skin radiation exposure is:

a. epilation
b. erythema
c. carcinoma
d. desquamation

55. The amount of radiation absorbed dose (rad) to the testes that produces permanent sterility is:

a. 200
b. 300
c. 400
d. 500

56. The cell type that is used to fight bacteria is:

a. granulocytes
b. lymphocytes
c. erythrocytes
d. thrombocytes

57. After radiation exposure, the first cells to become affected are the:

a. granulocytes
b. lymphocytes
c. erythrocytes
d. thrombocytes

58. Radiation cytogenetic studies have shown that nearly every type of chromosome aberration can be radiation induced and that some aberrations may be specific to radiation.

a. True
b. False

59. When the radiation dose exceeds approximately ___ rads, the frequency of multi-hit abberations increases more rapidly.

a. 50
b. 70
c. 90
d. 100

60. Individuals irradiated accidentally with rather high radiation doses continue to show chromosome abnormalities in their peripheral lymphocytes for as long as ___years.

a. 5
b. 10
c. 20
d. 30

61. The dose response relationship for radiation induced cataracts is:

a. linear, threshold
b. linear, non-threshold
c. non-linear, threshold
d. non-linear, non-threshold

62. At worst, humans can expect a reduced life span of approximately ___ days for every rad.

a. 1
b. 3
c. 5
d. 10

63. If one observes a large population for late radiation effects without having any precise knowledge of the radiation dose to which they were exposed, then the concept of ___ risk is used.

a. excess
b. relative
c. absolute
d. frequency

64. ALARA stands for: As low as reasonably acheiveable.

a. True
b. False

65. The greatest wealth of information that has been accumulated regarding radiation-induced leukemia in humans has been drawn from:

a. radiotherapy patients
b. American radiologists
c. atomic bomb survivors
d. children irradiated in-utero

66. The period of time after irradiation during which one might expect the radiation effect to occur is called the ___ period.

a. latent
b. at-risk
c. prodromal
d. manifest illness

67. It is not possible to link any case of cancer to a previous radiation exposure, regardless of its magnitude, because cancer is so common.

a. True
b. False

68. Radon is a radioactive decay product of:

a. sulfur
b. bismuth
c. iridium
d. uranium

69. Lethality from radiation-induced malignant disease is projected at approximately ___%.

a. 20
b. 40
c. 50
d. 60

70. The effect of radiation in utero is:

a. prenatal death
b. genetic effects
c. congenital abnormalities
d. all of the above

71. The relative risk of childhood leukemia after irradiation in utero is 1.4 in the:

a. first 30 days
b. first trimester
c. second trimester
d. third trimester

72. Which of the following responses to radiation in utero is of least concern?

a. mental retardation
b. spontaneous abortion
c. childhood malignancies
d. congenital abnormalities

73. The weakest area of knowledge in radiation biology is the area of:

a. radiation genetics
b. effects on fertility
c. irradiation in utero
d. radiation induced cancer

74. For most of the pre-reproductive life stage women are more sensitive than men to the genetic effects of radiation.

a. True
b. False

75. The radiologic technologist should practice all of the following cardinal principles, except:

a. Keep the exposure to radiation as short as possible.
b. Maintain a large distance as possible between the source of radiation and the exposed person.
c. Insert shielding material between the radiation source and the exposed person.
d. During fluoroscopy remain as close to the patient as practicable.

76. If the distance from the source exceeds ___ times the source diameter, it can be treated as a point source.

a. 2
b. 4
c. 5
d. 10

77. Actual measurements show that protective aprons reduce exposure to approximately ___% because scattered x-rays are incident on the apron at an oblique angle.

a. 10
b. 25
c. 50
d. 75

78. Radiologic technologists receive essentially all of their occupational radiation exposure during:

a. fluoroscopy
b. radiography
c. mammography
d. computed tomography

79. We assume the occupational effective dose to be ___% of the monitor dose.

a. 10
b. 11
c. 12
d. 15

80. The malevolent use of radiologic material by terrorists can be described as a/an ___ device.

a. radiation exposure
b. improvised nuclear
c. radiological dispersal
d. all of the above

81. A radiographic protection feature of x-ray tube housing is:

a. filtration
b. collimation
c. source-to-image receptor distance indicator
d. all of the above

82. **All** general purpose diagnostic x-ray beams must have a total filtration of at least ___ mm Al when operated above 70 kVp.

a. 1.5
b. 2.5
c. 3.5
d. 4.5

83. For any given radiographic technique the variation in x-ray intensity should not exceed ___%.

a. 5
b. 10
c. 12
d. 15

84. A protective ___ is positioned between the fluoroscopist and the patient.

a. tray
b. filter
c. apron
d. curtain

85. Dose area product is a quantity that reflects not only the dose but also the volume of tissue irradiated; therefore, it may be a better indicator of risk than dose.

a. True
b. False

86. The radiation that is the most intense, hazardous, and difficult to shield is:

a. scatter
b. primary
c. leakage
d. secondary

87. During radiography and fluoroscopy, the ___ is the single most important scattering object.

a. table
b. patient
c. Bucky grid
d. image-receptor

88. The percentage of time during which the x-ray beam is on and directed toward a particular protective barrier is know as the:

a. control
b. distance
c. workload
d. use factor

89. Measurements of radiation exposure outside the x-ray examination room always result in radiation levels far less than those anticipated by calculation.

a. True
b. False

90. The earliest radiation detection device was a/an:

a. ionization chamber
b. proportional counter
c. Geiger-Muller counter
d. photographic emulsion

91. **All** of the following are gas filled radiation protection devices **except**:

a. ionization chanbers
b. proportional counters
c. scintillation detection
d. Geiger-Muller detectors

92. **All** of the following are true regarding Geiger counters, **except**:

a. are useful as a dosimeter
b. is an example of an gas-filled detector
c. operate in the fourth region of the voltage response curve
d. are used for contamination control in nuclear medicine laboratories

93. A photocathode is a device that emits ___ when illuminated.

a. images
b. carbon
c. energy
d. electrons

94. Scintillation detectors are sensitive devices for:

a. alpha and beta rays
b. neutrons and electrons
c. x-rays and gamma rays
d. alpha, beta, and gamma rays

95. The most widely used thermo luminescence dosimetry material is:

a. lithium borate
b. calcium sulfate
c. lithium fluoride
d. calcium fluoride

96. The ___ thermoluminescent phosphor's principle use is primarily for research.

a. lithium borate
b. calcium sulfate
c. lithium fluoride
d. calcium fluoride

97. Patient radiation dose is expressed as:

a. gonadal dose
b. bone marrow dose
c. entrance skin exposure (ESE)
d. all of the above

98. The mean marrow dose for an x-ray procedure of the cervical spine is:

a. 2
b. 10
c. 30
d. 50

99. Which of the following is often referred to as the *patient dose*?

a. ESE
b. gonadal dose
c. marrow dose
d. genetically significant dose

100. The genetically significant dose estimated from diagnostic x-ray examinations in the United States is ___ miliradian (mrad).

a. 12
b. 20
c. 22
d. 27

101. The skin dose delivered by a series of contiguous computed tomography (CT) slices is much lower than that delivered by a single radiographic view.

a. True
b. False

102. Glandular dose is approximately ___% of the ESE.

a. 10
b. 15
c. 20
d. 25

103. The ideal x-ray beam for CT would have ___ boundaries.

a. dull
b. zero
c. sharp
d. straight

104. The ___ the multislice value of a CT exam, the ___ the patient dose will be.

a. lower; lower
b. lower; higher
c. higher; lower
d. higher; higher

105. Which of the following situations would be unnecessary for an x-ray exam to be performed?

a. hospital admission
b. pre-employment physical
c. periodic health examination
d. all of the above

106. Gonad shielding should be considered for:

a. men
b. women
c. children
d. all patients

107. The administrative protocol that can be used to ensure that a pregnant patient is not irradiated is:

a. elective booking
b. patient questionnaire
c. posting of caution signs
d. all of the above

108. The occupational radiation exposure of radiologic personnel engaged in general x-ray activity normally should not exceed ___ milliseivert (mSv)/year.

a. 1
b. 10
c. 20
d. 50

109. Radiologists usually receive slightly lower exposures than radiologic technologists.

a. True
b. False

110. **All** of the following result in high occupational exposure **except**:

a. fluoroscopy
b. mammography
c. mobile radiography
d. interventional radiology

111. Dose limits imply that if received annually, the risk of death would be less than 1 in:

a. 100
b. 1,000
c. 10,000
d. 100,000

112. In 1902 the approximate daily dose limit in millirem (mrem) was:

a. 20
b. 100
c. 5,000
d. 10,000

113. Wearing a protective apron reduces radiation dose to many tissues and organs to near zero.

a. True
b. False

114. The tissue weighting factor for the lungs is ___ (Wt).

a. 0.01
b. 0.05
c. 0.12
d. 0.20

115. Protective shielding for the radiologic technologist as well as the radiologist should include:

a. apron
b. curtain
c. buckey slot cover
d. all of the above

116. Exposures less than ___mR are not measured by film badge monitors.

a. 10
b. 20
c. 30
d. 50

117. If the radiologic technologist participates in fluoroscopy, the occupational radiation monitor should be positioned on the:

a. belt
b. chest
c. apron
d. collar

118. **All** of the following periods are acceptable monitoring periods for recording results for an occupational monitoring program **except**:

a. weekly
b. monthly
c. annually
d. biennially

119. A radiation protection program should include:

a. new employee training
b. periodic in-service training
c. counseling during pregnancy
d. all of the above

120. Ultrasound technologists normally are not classified as radiation workers.

a. True
b. False