CHAPTER 6

Practice Test 1
Questions

1. Radiation therapy is a treatment that utilizes
   (A) drugs to treat cancer that may have spread
   (B) high-energy radiation to destroy cancer cells
   (C) radioactive tracers to track the path of cancer to the lymph nodes
   (D) potent pain medication to treat the severe pain from cancer

2. Between ages 20 and 30 years, an asymptomatic woman should be undergoing mammography every
   (A) year
   (B) 2 years
   (C) 3 years
   (D) none of the above

3. Medical history may include questions on hormone use because
   (A) treatment with synthetic hormones, such as hormone replacement therapy (HRT), will always cause breast cancer
   (B) the use of reproductive hormones can increase risk factors for breast cancer
   (C) family history of hormone use predisposes a woman to cancer
   (D) personal history of hormone use decreases a woman’s risk for breast cancer

4. In imaging implants, some of the projections taken will include an image of the implant. In these projections, compression is used
   (A) to allow a uniform tissue density
   (B) for immobilization only
   (C) to separate the breast tissue
   (D) to separate and spread out the implant

5. The glandular dose is a measure of
   (A) the radiation dose to the skin of the breast
   (B) the dose to the radiosensitive cells of the breast
   (C) the significant background dose recorded in the US
   (D) the radiation dose to the gonads

6. In digital imaging, “high detective quantum efficiency” means that
   (A) the system is more efficient in converting input x-ray signals and/or the system needs higher exposure factors to create an image
   (B) the system needs higher exposure factors to create an image and/or the system has a high fill factor on the TFT array
   (C) the system is more efficient in converting input x-ray signals and/or the system has a high fill factor on the TFT array
   (D) all of the above
7. In digital imaging, a graph of the optical density range to the log of relative exposure is a
   (A) shallow sloping curve
   (B) steep sloping curve
   (C) linear response
   (D) curvilinear response

8. In the new 2016 American College of Radiology (ACR) Digital Mammography Quality Control Manual, the approved accreditation phantom has a total of
   (A) 5 fibers, 5 speck groups, and 5 masses
   (B) 5 fibers, 6 speck groups, and 5 masses
   (C) 6 fibers, 5 speck groups, and 5 masses
   (D) 6 fibers, 6 speck groups, and 6 masses

9. The circular pigmented area around the nipple is called the
   (A) skin
   (B) areola
   (C) Montgomery gland
   (D) ampulla

10. Keratosis is demonstrated mammographically as a
    (A) sharply outlined multilobulated lesion
    (B) sharply outlined lesion with a halo
    (C) mixed radiolucent and radiopaque circular lesion with a radiolucent center
    (D) mixed radiolucent and radiopaque oval lesion

11. Figure 6–1 indicates
    (A) mammographically benign calcifications
    (B) malignant calcifications
    (C) keratosis
    (D) fibroadenomas

12. The advantages of a quality assurance program, such as the Mammography Quality Standards Act (MQSA), includes all of the following except
    (A) increased efficiency
    (B) cost-effectiveness
    (C) permission for manipulation of the final image
    (D) improved patient satisfaction

13. In magnification, what immediate role does the large object-to-image receptor distance (OID) play in reducing scattered radiation?
    (A) It allows the use of lower peak kilovoltage (kVp) values.
    (B) There is increased source-to-object distance (SOD), which allows for absorption of the scattered radiation.
    (C) Most of the scattered radiation misses the detector.
    (D) The larger OID utilizes a smaller source-to-image receptor distance (SID).
14. Using a small focal spot size is recommended for magnification
   (A) to reduce the resultant loss of image detail
   (B) because of increased patient dose
   (C) to compensate for the small OID
   (D) to compensate long exposure times

15. What is the best placement for the needle wire during needle localization?
   (A) The needle wire should pass immediately below the lesion.
   (B) The needle wire should pass immediately above the lesion.
   (C) The needle wire should pass through the lesion.
   (D) The needle wire should pass immediately beside the lesion.

16. Although it may mean losing some of the lateral breast tissue, in imaging for the cranio-caudal (CC) projection, most experts agree that all efforts should be made to maximize imaging of the medial breast tissue. Why?
   (A) Medial breast is imaged best on CC.
   (B) Medial breast is imaged only on CC.
   (C) Most cancers are found in the medial breast.
   (D) The lateral breast is generally distorted on CC.

17. Which is true when positioning for all tangential (TAN) projections?
   (A) The patient is always in the CC position.
   (B) The central ray is always directed vertically.
   (C) The central ray is always parallel to the plane of the breast.
   (D) The central ray is always parallel to the skin surface.

18. In the rolled medial (RM) position, the inferior (lower) surface of the breast is rolled in which direction?
   (A) lateral
   (B) medial
   (C) inferior
   (D) superior

19. A radiopaque implant that is used in breast reconstruction and can be adjusted for cup size after surgical placement in the breast is the
   (A) silicone gel implant
   (B) flap implant
   (C) silicone liquid implant
   (D) saline implant

20. In addition to the routine CC and mediolateral oblique (MLO) projections, a routine series after mastectomy could also include
   (A) axillary tail (AT)
   (B) mediolateral (ML)
   (C) TAN
   (D) lateromedial oblique (LMO)

21. Men with a family history of breast cancer will
   (A) have a greater risk for breast cancer
   (B) have a minor risk for breast cancer
   (C) have no significantly increased risk for breast cancer
   (D) always get breast cancer

22. The dynamic range is
   (A) the detector’s ability to respond to different exposure levels
   (B) a measure of the image quality
   (C) an indication of how efficient the detector is at converting the remnant beam to useful data
   (D) the ability of the detector to record lower exposure factors
23. The absorbed dose in mammography is generally ______ the entrance skin exposure (ESE).
   (A) significantly higher than  
   (B) significantly lower than  
   (C) about the same as  
   (D) slighter higher than

24. In the compression test required by the MQSA, the maximum compression for the initial power drive should not exceed
   (A) 100 newtons (N)  
   (B) 200 N  
   (C) 400 N  
   (D) 500 N

25. Collimation should not extend beyond any edge of the detector by more than
   (A) 1% of the SID  
   (B) 2% of the SID  
   (C) 3% of the SID  
   (D) 4% of the SID

26. Inherent filtration will include filtration by all of the following except
   (A) exit port of the tube  
   (B) compression paddle  
   (C) molybdenum filters  
   (D) mirror assembly

27. The MQSA was enacted
   (A) because mammography was overregulated  
   (B) to address the inconsistent quality of mammography  
   (C) to enforce continuing education for the radiologic technologist  
   (D) to enforce continuing education for the radiologist

28. Grids are utilized in mammography
   (A) during normal imaging  
   (B) during magnification imaging only  
   (C) only if requested by the radiologist  
   (D) to reduce radiation dose to the patient

29. Breast tissue can extend medially to the
   (A) latissimus dorsi muscle  
   (B) mid-sternum  
   (C) retromammary space  
   (D) inframammary fold (IMF)

30. Which of the following hormones has the most influence on the normal physiological changes of the breast?
   (A) estrogen and prolactin  
   (B) estrogen and progesterone  
   (C) prolactin and estrogen  
   (D) progesterone and prolactin

31. Which of the following are considered first-degree relatives?
   (A) mother and aunt  
   (B) first cousin and mother  
   (C) aunt and sister  
   (D) sister and mother

32. Image compression is often required to allow
   (A) teleradiography  
   (B) Digital Imaging and Communication in Medicine (DICOM) interpretation  
   (C) Picture Archiving and Communication System (PACS) transmission  
   (D) digital imaging

33. Network limited to a small geographical area (e.g., can be interhospital) is called
   (A) wide area network (WAN)  
   (B) local area network (LAN)  
   (C) personal area network (PAN)  
   (D) PACS

34. In the low kVp range using a molybdenum target tube, what type of photon interaction predominates?
   (A) photoelectric  
   (B) Compton  
   (C) Bremsstrahlung  
   (D) coherent
35. In digital imaging, a repeat analysis test is
   (A) unnecessary—digital imaging automatically corrects exposure mistakes
   (B) necessary—digital imaging cannot correct for overexposure
   (C) unnecessary—digital imaging corrects unsharpness by altering the spatial display
   (D) necessary—digital imaging cannot correct factors such as motion unsharpness

36. The same technologist should view the phantom images because
   (A) subjective judgment about images is always difficult
   (B) it is not wise to have different individuals handling the phantom
   (C) not all mammographers know the MQSA regulations
   (D) given different images, different mammographers will calculate the optical densities differently

37. The from-below (FB) projection utilizes a beam directed
   (A) perpendicular to the detector
   (B) horizontally
   (C) tangentially
   (D) parallel to the detector

38. Changes in the breast as a result of radiation therapy include
   (A) erythema
   (B) edema
   (C) hardening
   (D) all of the above

39. Scanning the breast to locate a cancer based on the vast amount of glucose/sugar utilized by cancer cells is the technique used in
   (A) scintigraphy
   (B) positron emission mammography (PEM) imaging
   (C) magnetic resonance imaging (MRI)
   (D) lymphoscintigraphy

40. Which of the following projections could be used to replace MLO in patients where MLO is not possible?
   (A) ML
   (B) lateromedial (LM)
   (C) rolled lateral (RL)
   (D) AT

41. Which of the following does not describe mammography filtration?
   (A) It shapes the emerging beam by absorbing low-energy x-rays that would only be absorbed by the superficial tissue and contribute to patient dose.
   (B) It will affect the half-value layer (HVL) of the emerging x-ray beam.
   (C) Filtration makes the emerging beam compatible with the characteristics of the breast.
   (D) The filtration used in mammography is never aluminum.

42. An artifact caused by dust is more common in
   (A) flat panel detector systems
   (B) computer radiography systems
   (C) indirect flat panel detector systems
   (D) scintillator-based systems

43. Evaluations, such as the mammography equipment evaluation (MEE), is performed by the
   (A) radiologic assistant
   (B) technologist
   (C) medical physicist
   (D) radiologist

44. The test pattern used to ensure that the acquisition workstation monitors are clean and free of dust, fingerprints, and other artifacts is
   (A) signal-to-noise ratio (SNR)
   (B) SMPTE (Society of Motion Picture and Television Engineers)
   (C) contrast-to-noise ratio (CNR)
   (D) modulation transfer function (MTF)
45. According to the 2016 American College of Radiology (ACR) Digital Quality Control Manual, which of the following test is performed monthly?

- (A) phantom check
- (B) repeat/reject analysis
- (C) compression thickness indicator check
- (D) compression force check

46. On a reject/repeat analysis, the rate was <5%, but one category of the reject/repeat analysis is significantly higher than others. What should be done?

- (A) Although the rate is <5%, that one area should be targeted for improvement.
- (B) If the other categories are within normal limits, that area can be disregarded.
- (C) Because the rate was >2%, the entire department needs to be reassessed.
- (D) With an overall rate <5%, one high rate is statistically meaningless.

47. Typically, grid ratios in mammography range from

- (A) 7:1 to 8:1
- (B) 6:1 to 7:1
- (C) 4:1 to 6:1
- (D) 3:1 to 5:1

48. Positron emission tomography/mammography (PET or PEM) imaging is useful in staging tumors because

- (A) the positron emitting isotopes are radioactive
- (B) PET or PEM imaging can display the extent and location of the tumor
- (C) the positron emitting isotopes will destroy the tumor bed
- (D) PET or PEM imaging tracks the increased blood flow from the cancerous tumor

49. Medical history is important in

- (A) assessing risk factors for breast cancer
- (B) preventing breast cancer
- (C) evaluating treatment options
- (D) more than one of the above

50. Unlike general radiography x-ray tubes, some mammography tubes are tilted 6 to 24 degrees from the horizontal. The effect of this is to

- (A) allow the use of smaller focal spot size
- (B) minimize the heel effect
- (C) increase resolution
- (D) all of the above

51. The term “retromammary space” describes the area

- (A) between the breast and pectoral muscle
- (B) separating the skin of the breast from the deep fascia
- (C) separating the skin from the superficial fascia
- (D) between the glandular tissue and the IMF

52. In which of the following are breast cysts least common?

- (A) young women in their early 20s
- (B) premenopausal women
- (C) postmenopausal women on estrogen therapy
- (D) women aged 70 years

53. The CC projection shows a circumscribed oval radiolucent lesion. There is a definite halo surrounding the lesion. It is most likely to be a

- (A) fibroadenoma
- (B) galactocele
- (C) cyst
- (D) hematoma
54. The indirect effect of breast compression on Compton interaction is
   (A) the absolute number of Compton interactions increases
   (B) the absolute number of Compton interactions decreases
   (C) compression has no effect on Compton interactions
   (D) compression affects Compton interaction only above 70 kVp

55. One disadvantage of lossless compression is
   (A) it does not provide exact measurement for fine detail on reconstruction
   (B) it provides exact reconstruction of the original image
   (C) transmission times can be too long
   (D) it does not support teleradiography

56. Grids with strips that are linear but slanted to match the divergence of the x-ray beam are _____ grids.
   (A) parallel
   (B) crossed
   (C) focused
   (D) moving

57. Fatty tissue is generally radiolucent and will show on the mammogram as
   (A) glandular areas
   (B) high-optical density areas
   (C) low-optical density areas
   (D) white or gray areas

58. The mammogram of a woman who is age 50 years and has recently started estrogen replacement therapy is likely to show a breast that is
   (A) more fibroglandular than in her previous mammograms
   (B) more fatty than in her previous mammograms
   (C) less fibrous and less glandular than in her previous mammograms
   (D) unchanged from her previous mammograms

59. The mammogram shows an oval-shaped lesion with mixed radiolucent and radio-opaque content. The lesion has a central radiolucent area and is freely movable. This lesion is most likely to be a
   (A) fibroadenoma
   (B) hematoma
   (C) lymph node
   (D) galactocele

60. The method of locating the lymph node(s) through which cancer is spreading from the breast is called
   (A) scintigraphy
   (B) PEM
   (C) MRI
   (D) lymphoscintigraphy

61. The change in OID could cause loss of image detail in magnification mammography. What factors help compensate for this loss of image detail?
   (A) decreased OID and breast compression
   (B) increased focal spot size and breast compression
   (C) decreased focal spot size and compression of the part
   (D) increased OID and compression of the part

62. What does the actual focal spot size measure?
   (A) the area on the anode exposed to electrons
   (B) the area projected on the patient
   (C) the area projected on the detector
   (D) the nominal focal spot size

63. The mammography report has an assessment score of 0, according to the BIRAD (Breast Imaging Reporting and Data) system. This means that
   (A) the mammography result is negative
   (B) there is a high probability of a benign finding
   (C) additional imaging is needed
   (D) the findings are suspicious
64. Differentiate between repeat and reject images.
   (A) Repeat is the percentage of repeats from a specific cause. Reject is the percentage of repeats from multiple causes.
   (B) Rejects are all images that are discarded. Repeats are images that resulted in extra radiation doses to the patient.
   (C) Repeats are all images that are discarded. Rejects are images that resulted in extra radiation doses to the patient.
   (D) Rejects are images discarded after any quality control (QC) testing. Repeats are any images discarded.

65. What is epithelial hyperplasia?
   (A) a calcified hematoma resulting from trauma
   (B) an oil cyst within the breast
   (C) an overgrowth of cells in the ducts or lobules
   (D) an epidermoid cyst on the skin of the breast

66. Figure 6–2 shows a(n)
   (A) ruptured implant
   (B) encapsulated implant
   (C) herniated implant
   (D) implant removal

67. After four-projection mammography, calcifications are visualized superior to the nipple but only on the MLO projection. What additional projection would be used to best locate the position of the lesion?
   (A) exaggerated craniocaudal (XCCL)
   (B) cleavage (CV)
   (C) ML
   (D) AT

68. Approximately how much contrast agent is injected into the breast during ductography?
   (A) approximately 1 cc
   (B) 15–25 cc
   (C) 30–40 cc
   (D) approximately 50 cc

69. What does the glandular dose measure?
   (A) the average dose to the patient’s skin
   (B) the absorbed dose to the skin
   (C) the absorbed dose at the tissue level
   (D) the same as the entrance skin dose

70. Which of the following relationships does not change when moving from routine to magnification mammography?
   (A) OID
   (B) focal spot size
   (C) SID
   (D) SOD

71. Who performs the compression device check for mammography QC?
   (A) physicist
   (B) any staff technologist
   (C) radiologist
   (D) technologist
72. A galactocele is
   (A) a lesion associated with trauma to the breast
   (B) a benign milk-filled cyst
   (C) associated with eggshell-like calcification
   (D) associated with a central radiolucent hilus

73. Instead of using a grid, what does magnification mammography use to reduce scatter during normal imaging?
   (A) lead shielding
   (B) increased OID
   (C) a low milliampere second (mAs) technique
   (D) increased SID

74. Most of the glandular tissue is arranged in the breast around the
   (A) medial and upper–inner quadrants
   (B) lateral and lower–inner quadrants
   (C) central and upper–outer quadrants
   (D) medial and upper–outer quadrants

75. A beryllium (Be) window on the x-ray tube enhances contrast by
   (A) increasing the output of the x-ray tube
   (B) reducing production of scattered radiation
   (C) transmitting more low-energy photons
   (D) transmitting more high-energy photons

76. Proper compression of the breast is indicated when the
   (A) patient is in pain
   (B) compression paddle stops
   (C) breast is taut
   (D) breast feels soft

77. Which factors cause increased skin dose in magnification?
   (A) larger OID and smaller focal spot size
   (B) increased mAs and larger SOD
   (C) increased OID and decreased SOD
   (D) smaller OID and larger SID

78. In radiology, according to the line–focus principle, the effective focal spot is
   (A) larger than the actual focal spot
   (B) smaller than the actual focal spot
   (C) the same as the actual focal spot
   (D) decreased as the target angle increases

79. Figures 6–3A and 6–3B are mammograms of the same patient. Figure 6–3B was taken 6 months after Figure 6–3A. These mammograms have the characteristic appearance of a
   (A) resolving oil cyst
   (B) galactocele
   (C) resolving postsurgical scar
   (D) hematoma

80. When using the air-gap technique in magnification mammography, what additional step is necessary?
   (A) grid use
   (B) decreased SID
   (C) increased OID
   (D) increased SID

81. Which of the following projections would best separate superimposed 12-o’clock and 6-o’clock masses?
   (A) MLO
   (B) XCCL
   (C) CC
   (D) AT

82. In positioning terminology, CV means
   (A) compressed position
   (B) cranial view
   (C) cleavage view
   (D) compression view
83. Malignant casting-type calcifications can appear on the mammogram as
   (A) granulated-sugar or crushed-stone calcifications
   (B) eggshell-like calcifications
   (C) elongated, branching, and needle-like calcifications
   (D) fragmented, linear branching calcifications

84. The functional milk-producing units of the breast are contained within the
   (A) lactiferous sinuses
   (B) lobules
   (C) ampulla
   (D) areola

85. What is the grid ratio?
   (A) the height of the lead strips divided by the distance between each strip
   (B) the height of the lead strips multiplied by the distance between each strip
   (C) twice the height of each lead strip
   (D) the distance between each strip divided by the height

86. The AT projection best demonstrates the
   (A) subareolar area
   (B) medial aspect of the breast
   (C) axillary aspect of the breast
   (D) lower–inner quadrant of the breast

87. The lesion seen on Figure 6–4 has the characteristic appearance of a(n)
   (A) oil cyst
   (B) stellate lesion
   (C) galactocele, calcified
   (D) fibroadenoma

88. The patient had trauma to the breast 1 month ago and has developed a lump. Such an injury may show mammographically as a
   (A) galactocele
   (B) hematoma
   (C) lymph node
   (D) fibroadenoma
91. Which of the following types of breast imaging methods will fall under the category of nuclear imaging?
   (A) PEM  
   (B) MRI  
   (C) ultrasonography  
   (D) digital tomosynthesis

92. The area of low optical density in the upper part of Figure 6–5 best represents
   (A) a pacemaker  
   (B) the patient’s chin  
   (C) a hematoma  
   (D) port-a-cath (Infusaport)

89. A device used to convert light to a digital signal is a(n)
   (A) film digitizer  
   (B) DICOM  
   (C) analog-to-digital converter (ADC)  
   (D) digital-to-analog converter (DAC)

90. If too much of the upper axilla and shoulder are under the compression paddle when imaging for MLO, the effect is to
   (A) inhibit proper compression of the upper breast  
   (B) inhibit proper compression of the lower breast  
   (C) ensure equal compression of the upper and lower breast  
   (D) ensure proper compression of the lower breast
93. A rolled projection can be performed to
   (A) separate superimposed tissues
   (B) identify microcalcifications
   (C) localize a skin lesion
   (D) determine the location of a finding seen only on one of the standard projections

94. Ideally, in an open surgical biopsy, when should a breast tissue specimen be imaged?
   (A) immediately after surgery
   (B) within 24 hours of the surgery
   (C) just prior to the surgery
   (D) after the lesion is removed but before the surgical site is closed

95. Which projection gives a mirror image of MLO?
   (A) ML
   (B) LM
   (C) LMO
   (D) AT

96. The nominal focal spot size of the mammography unit is 0.3. This means that the
   (A) actual focal spot size is 0.3
   (B) effective focal spot size is 0.3
   (C) both effective and actual focal spot sizes are 0.3
   (D) actual focal spot is smaller than 0.3

97. After lumpectomy, patients could have magnified images of the tumor bed taken to
   (A) confirm the removal of the cancer
   (B) check calcium deposits that may result from radiation and surgical changes
   (C) all of the above
   (D) none of the above

98. Figure 6–6 shows a routine screening mammogram, CC projection. What projection could best image the missed area?
   (A) XCCL
   (B) CV
   (C) ML
   (D) AT

99. Where is the grid placed?
   (A) above the breast
   (B) between the breast and the image plate or detector
   (C) below the image plate
   (D) between the breast and the x-ray tube

100. Which of the following statements is true of both the photostimulable phosphor (PSP) and the flat-panel mammography systems?
    (A) The imaging plates (IPs) used can be damaged or dropped during transport.
    (B) The system has a wide latitude and dynamic range.
    (C) PSP is very sensitive to radiation.
    (D) The imaging system is susceptible to scratches.
101. The purpose of the mammography certification and accreditation process is to
(A) provide legal mammography services
(B) enforce minimum national quality standards for mammography
(C) ensure that all women have access to a certified mammography facility
(D) authorize certain states to certify mammography facilities and conduct inspections

102. A facility has a sign posted advising patients to contact a designated person within the organization with comments. This facility is meeting the US Food and Drug Administration (FDA)’s
(A) medical outcome audit program
(B) record-keeping program
(C) patient communication of results program
(D) customer complaint program

103. A hamartoma is
(A) a malignant tumor of the breast
(B) a benign tumor of the breast
(C) associated with trauma of the breast
(D) associated with nursing

104. During lactation, the contraction of which cells help eject milk from the alveoli?
(A) epithelial cells
(B) myoepithelial cells
(C) basement cells
(D) superficial cells

105. A finding of BIRAD 2 on the mammogram means that
(A) it cannot aid in accurate evaluation of the breast
(B) the findings are benign
(C) the findings are suspicious
(D) it is suggestive for malignancy

106. Erythema of the breast is an indication
(A) of inflammatory breast cancer
(B) of a breast abscess
(C) of a breast infection
(D) that further testing of the breast is necessary

107. Which of the following is used as a treatment for estrogen-dependent tumors in postmenopausal and premenopausal women?
(A) radiation therapy
(B) chemotherapy
(C) tamoxifen
(D) antibody therapy

108. In flat-panel detector systems, the spatial resolution of the system is controlled by the
(A) pixel number
(B) detector element (DEL) size
(C) matrix size
(D) thin-film transistor (TFT) number

109. A thin supportive layer located between the basal surface of the epithelium and the connective tissue layer of the lobule is called
(A) chief cells
(B) myoepithelial
(C) basement membrane
(D) superficial A cells

110. The appearance of a “camel’s nose” breast contour in the MLO projection can be prevented by
(A) including all of the breast under the compression paddle
(B) angling the detector parallel to the pectoralis muscle
(C) properly supporting the anterior breast during compression
(D) ensuring that the nipple remains in profile during compression
111. The superoinferior oblique (SIO) projection will best demonstrate the
(A) outer–upper quadrant and the lower–outer quadrant of the breast
(B) lower–inner quadrant and the upper–inner quadrant of the breast
(C) upper–inner quadrant and lower–outer quadrant of the breast
(D) lower–inner quadrant and the outer–upper quadrant of the breast

112. The basic premise of a medical audit is that
1. all positive mammograms should be followed up
2. the pathology results of all biopsy procedures performed should be collected
3. all pathology results should be correlated with the radiologist's findings
   (A) 1 and 2 only
   (B) 2 and 3 only
   (C) 1 and 3 only
   (D) 1, 2, and 3

113. Under the MQSA, how long are facilities required to maintain the records of a patient who died shortly after her first mammography?
(A) 5 years
(B) 10 years
(C) 20 years
(D) permanently

114. Under which of the following circumstances would the triangulation technique be necessary?
(A) to locate an abnormality visualized on one projection only
(B) during routine mammography screening
(C) when performing spot magnification
(D) to locate a palpable lesion

115. A dimpled skin condition seen in cases of lymphatic edema of the breast is called
(A) inflammatory carcinoma
(B) ductal ectasia
(C) plasma cell mastitis
(D) peau d’orange
1. **(B)** Many women are choosing conservation therapy, in which the tumor is removed with wide margins (lumpectomy, quadrectomy, or segmental mastectomy) and includes radiation therapy. Treatment starts 3 to 8 weeks after surgery and includes about 5 to 6 weeks of daily treatments. Nuclear medicine uses radioactive tracers (also called radioactive isotopes or radiopharmaceuticals). Treatment may include hormonal therapy (estrogen therapy) with drugs, such as tamoxifen, or chemotherapy.

2. **(D)** Annual mammography is generally not recommended for asymptomatic women age 40 years and below. At any age, breast imaging can be recommended by a physician on the basis of clinical findings. However, mammography is not an effective screening tool for younger women.

3. **(B)** Studies have suggested that synthetic hormones, used in hormone replacement therapy (HRT), or reproductive hormones influence breast cancer risk and promote cancer growth. Early menarche (<12 years), late menopause (≥55 years), oral contraceptive use, and fewer pregnancies will all increase a woman’s risk by affecting estrogen levels in the body. Hormones or hormone use, however, are not known to always cause breast cancer, and the use of hormones by another family member will not increase a woman’s breast cancer risks.

4. **(B)** When imaging implants, the standard projections are used for immobilization purposes only; full compression is not applied. The implant is then displaced, and four additional compression projections are taken. The result is an eight-projection series (Fig. 6–7).

5. **(B)** Radiation dose is often the calculation of the entrance skin exposure (ESE), which is the dose received at the skin. However, in mammography, glandular dose, which is a record of the dose to the glandular and more radiosensitive cells and tissues of the breast, is considered more significant. The American College of Radiology (ACR) recommends a glandular dose of 3 mGy (0.3 rad) with a grid and 1 mGy (0.1 rad) without a grid.

6. **(C)** Detective quantum efficiency (DQE) is the product of absorption and conversion efficiency. It is the percentage of energy that strikes a detector that results in a useful output signal. DQE measures how efficiently a digital detector can convert the remnant beam to useful data. High DQE means lower patient dose when imaging. The thin-film transistor (TFT) is a complex circuit device that collects electrons emitted from either amorphous selenium (a-Se) or amorphous silicon (a-Si). Within that assembly are areas referred to as detector elements (DELs). DELs collect the electrons that represent individual components of a digital image. Each square in the TFT matrix has sensitive and nonsensitive areas. The sensitive area represents the DELs that collect the electron charge. The fill factor is the ratio of the sensitive area to the entire detector area and is usually expressed as a percentage. The fill factor will affect the spatial resolution and signal-to-noise ratio (SNR). A typical fill factor is 80%. A system with a high fill factor is more efficient.

7. **(C)** Digital imaging systems have a linear response to x-ray intensity (Fig. 6–8). This means that regardless of the intensity of the x-ray beam, a small change in the intensity is recorded as the same change in the electronic
Figure 6–7. (A–D) MLO and CC imaging with limited compression; and (E–H) MLO and CC implant-displaced (ID) images. (Reproduced with permission from Peart O: Mammography and Breast Imaging PREP: Program Review and Exam Prep, 2nd ed. New York, NY: McGraw-Hill Education; 2018.)
image. In digital imaging, this is possible because there are different devices for acquisition and display, and each can be separately optimized. Digital imaging, therefore, has a much wider latitude compared with analog imaging. Digital imaging can enhance the contrast resolution of the final image.

8. (D) The 2016 ACR Digital Mammography Quality Control Manual has a new digital phantom. The phantom now has six fibers, six speck groups, and six masses. The phantom represents a 4.2 cm-thick compressed breast consisting of 50% glandular tissue and 50% adipose tissue. The phantom is designed to cover the majority of the digital detector area and provides the same attenuation as the previous screen-film ACR phantom. The method of scoring is the same. However, the fiber score must be ≥2.0, the speck group score must be ≥3.0, and the mass score must be ≥2.0. Artifacts should not be clinically significant. There is no subtraction of the score for artifacts; however, if the artifact is located in an area that could impact interpretation, then the test fails. The artifact must be resolved before imaging any patients. The 2016 ACR Digital Mammography Quality Control Manual is now recommended for use with all digital units with standard features. Facilities with three-dimensional (3D) units or those with contrast enhancement features must follow the manufacturer’s QC guidelines (Fig. 6–9).

9. (B) The areola is the smooth, darkened area that surrounds the nipple. The skin covers the entire breast tissue, and the Montgomery glands are specialized sebaceous glands on the areola. Ampulla is another name for the lactiferous sinus, a part of the ductal system in the internal breast anatomy.

10. (A) Keratosis forms on the skin surface of the breast. On the mammogram, it is seen as a multilobulated lesion with sharply outlined borders. An example of a mixed optical density lesion with a radiolucent center is a lymph node. Other mixed optical density circular or oval lesions are hematomas, galactoceles, or fibroadenolipomas. Halos are narrow radiolucent rings or ring segments typically seen around the periphery of benign circular or oval lesions. (See Fig. 3–18.)

11. (A) Plasma cell mastitis, periductal mastitis, or ductal ectasia is an inflammatory reaction characterized by the presence of plasma cells surrounding a dilated duct. It is a benign condition. Intraductal and/or periductal calcifications are the final results of this condition. The calcifications can be located around or inside the dilated ducts. Most are elongated and sharply outlined with smooth borders; some are needle-like and have high optical density or a lucent central area. The fibroadenoma is an oval lesion that may contain calcifications. Keratosis rarely calcifies and mammographically appears as lobulated lesions. Mammographically, malignant calcifications often appear in clusters. (See Fig. 6–1.)

12. (C) The Mammography Quality Standards Act (MQSA) is legislation for quality assurance and involves overall management of actions needed to ensure the highest quality images and to enhance patient care. It mandates regular quality control tests and the collection and evaluation of data. The benefits of MQSA include reduction of unnecessary

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**Figure 6–8.** Characteristic curve for digital imaging. A graph of the optical density signal and the relative exposure for a digital imaging detector will have a linear response to x-ray. This is unlike the curvilinear response of a screen-film system.
thus improving contrast. Positioning the breast away from the detector takes advantage of the inverse square law: The intensity of the scattered radiation is reduced because the distance between the detector and the object is increased. Mammography uses a fixed source-to-image receptor distance (SID), and it does not change in magnification. With increased object-to-image receptor (OID), radiation to patients by reducing repeats, improved overall efficiency of service, improved patient satisfaction, consistency of image production, and cost-effectiveness. Image manipulation is an advantage of digital imaging systems.

13. (C) In magnification, the large air gap acts like a grid and reduces scattered radiation, thus improving contrast. Positioning the breast away from the detector takes advantage of the inverse square law: The intensity of the scattered radiation is reduced because the distance between the detector and the object is increased. Mammography uses a fixed source-to-image receptor distance (SID), and it does not change in magnification. With increased object-to-image receptor (OID),
there is decreased source-to-object distance (SOD). However, this will affect the dose to the patient but not reduce scatter. With the patient’s breast closer to the radiation source, there is increased skin dose, although the glandular dose remains low (Fig. 6–10).

14. (A) Magnification uses a large OID with a constant SID. To compensate for the distortion, a small focal spot size is used to allow fine-detail imaging. As the focal spot size decreases, the sharpness of detail will increase. Grids are not used in magnification radiography because the large OID serves as an air gap to reduce scatter to the detector. (See Fig. 6–10.)

15. (C) The localization needle wire should be positioned to pass just through the lesion. Most surgeons feel for the tip of the wire before making an incision in the patient’s breast. Because the tip is being used as a locator, it should pass through the lesion, not above, below, or beside it (Fig. 6–11).

16. (A) Including the medial breast is very important in the CC projection. The other routine projection, MLO, will not image the medial breast clearly because it is an oblique projection, and the medial tissue will be distorted. Cancer can develop anywhere in the breast but most often in the upper–outer quadrant. Additional projections that can be used to image the medial breast include cleavage view (CV) and exaggerated cranio-caudal medial (XCCM) (Fig. 6–12).

17. (D) In the tangential (TAN) projection, the x-ray beam just skims the area of interest. The beam is always tangential or parallel to the skin surface. This projection demonstrates the area of interest free of superimposition. TAN is possible in any direction or projection (Fig. 6–13).

18. (A) In the rolled medial (RM) position, the breast is first positioned for the craniocaudal (CC) projection. The top surface of the breast is rolled medially and the bottom surface laterally (Fig. 6–14).

19. (D) The saline implant can be inserted as an expandable sac, where the fluid content can be adjusted, as needed, during surgery and...
even after surgery. Saline implants are actually silicone shells filled with a saline solution. Silicone implants are silicone shells filled with silicone gel. The silicone implants are already filled with silicone gel when inserted; therefore, the desired size must be
known prior to the surgical procedure. The only radiolucent implant available is the autologous myocutaneous flap implant. Flap surgery removes skin and fat from the abdomen, back, or buttocks to form a new breast. Flap techniques can either leave the flap attached to its original blood supply and tunnel the flap under the skin to the breast area or remove the flap completely, which would involve microsurgery to recreate blood supply to the flap when it is in position. Mammographically, the flap implant has a fatty or muscular appearance, depending on the type of flap technique performed (Fig. 6–15).

20. (B) After mastectomy, a three-projection series, including CC, MLO, and ML, is often recommended because without the other breast for comparison, this series gives the radiologist a better opportunity to diagnose any new malignancy. AT images the axilla, and TAN images skin lesions. LMO is the true reverse of MLO.

21. (A) Even though men generally have a low risk of developing breast cancer, they should be aware of the risk factors, especially family history, which could be associated with genetic changes. However, a family history of breast cancer does not mean breast cancer will develop. Slightly over 1% of males in the US develop breast cancer each year.

22. (A) The term “dynamic range” refers to the detector’s ability to respond to different exposure levels. Digital systems have a wide dynamic range. For the technologist, quantum noise is the only visual cue that indicates when the digital detector is underexposed. When an image is overexposed, the image contrast is decreased because of the reduced signal difference reaching the detector. If the exposure is >100% of the normal exposure, the detector will reach the saturation point, and the visual cue will be a black image, indicating massive overexposure (Fig. 6–16).

23. (B) Because of the low x-ray energies used in mammography, the dose to the skin may be high, but the dose falls off rapidly as the beam penetrates the breast. The dose to the skin may be as high as 8 to 12 mGy per projection (800–1200 mrad); the dose to the midline of the breast (the average radiation dose to the glandular tissue or glandular dose) will be only about 1 mGy (100 mrad). The final rule for mammography, as dictated by the MQSA, states that a single projection mammogram (digital or screen-film) should not give average glandular dose of >3 mGy (300 mrad) per projection when a grid is used and should not exceed 1 mGy (100 mrad) per projection without a grid.

24. (B) The actual compression applied to the breast is always under the discretion of the technologist. However, to ensure that the equipment is working properly, the MQSA requires a compression force of at least 111 newtons (N) (25 lb) and a maximum of 200 N (20 daN or 45 lb) for the initial power drive. This is an MQSA requirement, which is important to follow to avoid causing injury to patients.
25. (B) The collimation standard is an MQSA requirement to avoid excess radiation dose to the patient. All units should have a beam-limiting device that allows the entire chest wall edge of the x-ray field to extend to the chest wall edge of the detector and should not extend beyond any of the edges on the detector by >2%.

26. (C) The radiation leaving the mammography tube is filtered by everything in its path. This is the inherent filtration and includes the oil in the tube, the window of the tube, the mirror of the collimation assembly, and the compression paddle. To reduce the lower energy photons that would only contribute to skin dose, added filtration is need. Added filtration can be molybdenum, rhodium, silver, or aluminum.

27. (B) The MQSA was enacted in 1992, and enforcement started in 1995 to address the need for ensuring high-quality mammograms. Under the MQSA, all mammography units in the US must be accredited, certified, and inspected regularly. The Act also includes education and continued education requirements for physicists, radiologists, and radiographers.

28. (A) Grids absorb scatter and increase visibility of image detail and are necessary during normal mammography. The use of a grid typically requires increased dose. Grids are placed between the patient's breast and the detector. Grids are not used in magnification radiography or Hologic tomosynthesis imaging. In magnification mammography, the large OID serves as an air gap to reduce scatter to the detector. In tomosynthesis, high contrast is achieved by reconstruction of the tomographic image. Grids are also not used in photon counting systems. These systems employ slit scanning with a small detector. They have slot collimation before and after the x-ray passes through the breast tissue, which all serve to provide a high contrast image with lower radiation dose to the patient (Fig. 6–17).

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Figure 6–16. (A) Contrast refers to the minimum optical density difference between two tissues that can be detected in the image as different densities. Contrast is dependent on pixel size. Larger pixels = better contrast. High contrast = few data values between black and white. Low contrast = many data values between black and white; and (B) noise is the random background information resulting from constant flow of current in the circuit. Noise does not contribute to image quality. On the digital image, noise looks like quantum mottle.

Figure 6–17. Schematic diagram showing the cross-section of a grid. (Reproduced with permission from Peart O: Lange Q&A: Mammography Examination. 3rd ed. New York, NY: McGraw-Hill Education; 2015.)
29. (B) The breast can reach superiorly to the clavicle (level of the second or third rib), inferiorly to meet the abdominal wall at the level of the sixth or seventh rib (at the inframammary fold or crease), laterally to the edge of the latissimus dorsi muscle, and medially to the mid-sternum.

30. (B) The most prominent hormones active in the breast are estrogen and progesterone. Estrogen is mostly responsible for ductal proliferation, and progesterone is responsible for lobular proliferation and growth. Studies have shown that the two actually work together to produce full ductal–lobular–alveolar (terminal ductules) development. Prolactin is present in the breast during initial breast growth, pregnancy, and lactation.

31. (D) First-degree relatives are members of the immediate family, such as mother, sister, or daughter.

32. (A) Transmitting digital mammography signals involve the transmission of huge data files that are typically as much as 32 MB in size for a single projection, and the transmission must often occur without timeout to avoid compromising the signal. Four-series mammography could therefore involve transmitting a 125-MB file; if the patient had prior studies, the total could easily exceed 0.5 GB per patient—just for a basic screening study. (In comparison, a typical MRI consisting of over 100 images will need about 6.5 MB.) Computer-aided detection (CAD) can also add approximately 0.2 GB to the data load. This needs a lot of network bandwidth, and this can be very expensive, especially because the ACR requirement is that only lossless compression be used on mammography images intended for interpretation. Mammography compression algorithms that allow compression of data at the site of origin and decompression at the interpretation site have been developed. Digital Imaging and Communications in Medicine (DICOM) is one of the most widely deployed health care messaging standards in the world. It is used for handling, storing, printing, and transmitting information in medical imaging. The picture archiving and communication system (PACS) is a complete integrated system that offers the conveniences viewing images from multiple modalities, such as mammography, ultrasonography, and MRI, all at one workstation.

33. (B) Local area network (LAN) is a limited computer network. A LAN network would interconnect computers to a server within a small geographical area, such as within a school or a hospital. Computers and other mobile devices using a LAN connection can share resources, such as printers or network storage. Wide area network (WAN) is a computer network that covers a large geographical area and generally involves major telecommunication or Internet links. PACS is a complete integrated system that offers the conveniences in viewing images from multiple modalities, such as mammography, ultrasonography, and MRI, all at one workstation.

34. (A) For mammography tubes made with molybdenum, the most prominent x-rays are characteristic x-rays. Characteristic x-rays are produced after a photoelectric interaction. If the target is filtered with molybdenum, the characteristic energy of 19 kiloelectron volts (keV) from the K-shell interaction will be prominent. This is within the range of energies that are most effective for mammographic imaging. If the outer shell electron fills the void in the K-shell, the x-ray emissions are termed K-characteristic x-rays. Bremsstrahlung x-rays are produced when an outer projectile electron is slowed by the electric field of the target atom nucleus. This interaction is common in tungsten targets. Coherent or classic scattering describes the interaction between low-energy electrons and atoms. The x-ray loses no energy but changes direction slightly. In Compton scattering, moderate-energy x-rays interact with an outer-shell electron and eject the electron from the atom. The ejected electron is the Compton electron (Fig. 6–18).
35. (D) The 2016 ACR Digital Mammography Quality Control Manual is now recommended for use with all digital units with standard features. Facilities with 3D units or units with contrast enhancement features must follow the manufacturer’s QC guidelines. Tests of the mammography unit are required, as well as additional tests on the display, laser printer if used, and imaging system. Repeat analysis is still needed to monitor repeats caused by patient positioning, patient motion, noisy images, or equipment failure. Digital imaging can correct for overexposure, although excessive overexposure increases the patient dose. In digital imaging, correcting for extreme underexposure is more difficult, and a noisy image (similar to quantum mottle) is created. Digital imaging can enhance the spatial display by enhancing the edges of spiculations or calcifications, making them more visible. In digital imaging, unsharp images cannot be corrected, especially unsharpness caused by motion. See Box 1 (Sample Reject Analysis Reasons)

36. (A) To ensure consistency and the effectiveness of the mammography QC program, the ACR recommends that a single technologist be the primary QC technologist. This technologist would be responsible for overseeing all tests but could delegate responsibility to other individuals. The facility should have a backup plan to ensure continuity when the primary QC technologist is not available, and other technologists should be familiar with the QC protocols. However, if tasks are performed by someone other than the primary QC technologist, these tasks should be reviewed by the primary QC technologist as soon as possible. The optical density on the image can be

![Diagram of x-ray interactions]

Figure 6–18. Schematic diagram showing (A) characteristic radiation; (B) Compton; (C) Bremsstrahlung; and (D) coherent scattering.
measured using a densitometer. This reading would not be influenced by subjective judgment. All mammographers should be at least familiar with the basic MQSA guidelines.

37. **(A)** The from-below (FB) projection is the reverse craniocaudal (CC) projection. The beam is directed craniocaudally to form an angle of 90 degrees (perpendicular) with the detector (Fig. 6–19).

38. **(D)** After radiation therapy, the breast may appear red and swollen and may gradually get tighter or harden. The breast may also get smaller and can become distorted after radiation therapy and the surgical procedure. These changes are a result of the radiation, and although with newer radiation treatment adverse effects on the breast are reduced, the technologist should still exercise care in handling patients because the skin of the breast may be delicate and the patient may have tender or painful areas.

39. **(B)** Positron emission mammography (PEM) technology utilizes the fact that cancerous tissue uses vast amounts of sugar. PEM is similar to positron emission tomography (PET) but uses an organ specific high-resolution gamma detector. After intravenous injection of fluorodeoxyglucose (FDG), the patient sits or relaxes for about 60 to 90 minutes, giving the body time to absorb the radioactive tracer. Next, each breast is scanned separately with the gamma detector. The pair of detectors is placed above and below the breast to apply mild compression during the scanning process, which takes about 10 minutes. Typically, two scans per breasts are taken. The radioactive tracer that is introduced into the body is metabolized in the body in a manner similar to the metabolism of sugar. The tracer will go to the tissues that are most active—normally the cancerous tissue. Before any PEM scan, the patient is required to fast, and no vigorous exercise is allowed 48 hours prior to the PEM scan. Scintigraphy, breast-specific gamma imaging (BSGI), and scinti-mammography use the radioactive tracer technetium-99m (Tc-99m) sestamibi. The tracer accumulates in malignant lesions. In lymphoscintigraphy, or sentinel node mapping,
the radiopharmaceutical is injected into the subareolar lymphatic plexus (or lesion). The tracer travels to the sentinel node and identifies that node for dissection, thus eliminating the need for extensive lymph node dissection (Fig. 6–20).

40. (B) LMO provides a mirror image of MLO. The next best position is the LM projection, which can replace MLO when imaging patients with difficult body habitus. LM cannot be used as a routine imaging projection because it does not image the deep posterior breasts. LM will also image medially located lesions that are high on the chest wall or in the inferior half of the breast. ML, although a true lateral projection, cannot be used because it does not image the posterior breast well enough. AT best images the tail of Spence, and RL has the breast positioned for CC, with the upper surface rolled laterally and the lower surface rolled medially (see Fig. 5–9).

41. (D) Filtration removes lower-energy photons that would only contribute to the skin dose. With filtration, the average energy of the beam will increase, but the maximum energy remains the same. With proper filtration, the x-ray beam entering the breast will have fewer photons above or below the preferred mammographic energy range. Generally, x-ray tubes use aluminum filtration. Mammography units can use molybdenum, rhodium, silver, or aluminum as the filtration material (Fig. 6–21).

Figure 6–20. Radiograph showing (A) radiation therapy unit; and (B) whole-body gamma camera.

Unfiltered Mo beam
100%

Filtered Mo beam
(through, breast, thick compression device, or glass tube window)

Figure 6–21. Filtration of the x-ray beam. (Reproduced with permission from Peart O: Mammography and Breast Imaging PREP: Program Review and Exam Prep. 2nd ed. New York, NY: McGraw-Hill Education; 2018.)
42. (B) The photostimulable phosphor (PSP)-based digital mammography system is referred to as computed mammography (CM) by some, and the digital systems using flat panel technology is sometimes referred to as digital mammography (DM) or full-field digital mammography (FFDM). There are two types of DM systems. The indirect system uses scintillators, and the direct system uses amorphous selenium (a-Se), which is a photoconductor. All DM systems have built-in detectors. The CM system uses radiation-sensitive PSP, which is kept in rigid imaging plates (IPs). The IPs are scanned, read, and erased in computer readers (CRs) and can be damaged during transport. The IPs used in CM are susceptible to scratches and dust in the CR. DM systems have no plates to drop or damage and no plates to be transferred.

43. (C) The 2016 ACR Digital Mammography Quality Control Manual is now recommended for use with all digital units with standard features. Facilities with 3D units or units with contrast enhancement features must follow the manufacturer’s QC guidelines. The mammography equipment evaluation (MEE) is performed by the physicist. This evaluation is used to determine whether new or changed equipment meets the MQSA requirements. Under the MQSA guidelines, the technologist, the physicist, and the radiologist have specific duties. The technologist is responsible for patient positioning, compression, image production, image processing, infection control, and general QC, including daily, weekly, monthly, and semi-annual tests. The interpreting radiologist is responsible for image interpretation, medical audits, and patient communication. The radiologist should also take corrective action or call the technologist’s attention to issues related to image quality or artifacts. It is the physicists’ responsibility to evaluate the mammography unit, conduct appropriate tests on all new installations and reassembled equipment, review all tests, records, and charts, as well as policies and procedures, and provide a written report of corrective recommendations (Table 6–1).

Table 6–1

<table>
<thead>
<tr>
<th>Digital Mammography Quality Control Tests – Physicists</th>
<th>Minimum Frequency</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mammography Equipment Evaluation (MEE) – MQSA Requirements</td>
<td>MEE and annual</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>2. ACR DM Phantom Image Quality</td>
<td>MEE and annual</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>3. Spatial resolution</td>
<td>MEE and annual</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>4. Automatic Exposure Control System Performance</td>
<td>MEE and annual</td>
<td>Within 30 days</td>
</tr>
<tr>
<td>5. Average Glandular Dose</td>
<td>MEE and annual</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>6. Unit Checklist</td>
<td>MEE and annual</td>
<td>Critical items: before clinical use less critical items: within 30 days</td>
</tr>
<tr>
<td>7. Computed Radiography (if applicable)</td>
<td>MEE and annual</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>8. Acquisition Workstation (AW) Monitor QC</td>
<td>MEE and annual</td>
<td>Within 30 days; before clinical use for severe defects</td>
</tr>
<tr>
<td>9. Radiologist Workstation (RW) Monitor QC</td>
<td>MEE and annual</td>
<td>Within 30 days; before clinical use for severe defects</td>
</tr>
<tr>
<td>10. Film Printer QC (if applicable)</td>
<td>MEE and annual</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>11. Evaluation of Site’s Technologist QC Program</td>
<td>Annual</td>
<td>Within 30 days</td>
</tr>
<tr>
<td>12. Evaluation of Display Device Technologist QC Program</td>
<td>Annual</td>
<td>Within 30 days</td>
</tr>
<tr>
<td>MEE or Troubleshooting – Beam Quality (Half-Value Layer) Assessment</td>
<td>MEE or troubleshooting</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>MEE or Troubleshooting – kVp Accuracy and Reproducibility</td>
<td>MEE or troubleshooting</td>
<td>MEE: before clinical use troubleshooting: within 30 days</td>
</tr>
<tr>
<td>MEE or Troubleshooting – Collimation Assessment</td>
<td>MEE or troubleshooting</td>
<td>MEE: before clinical use troubleshooting: within 30 days</td>
</tr>
<tr>
<td>Troubleshooting – Ghost Image Evaluation</td>
<td>Troubleshooting</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>Troubleshooting – Viewbox Luminance</td>
<td>Troubleshooting</td>
<td>NA</td>
</tr>
</tbody>
</table>
44. **(B) SMPTE (Society of Motion Picture and Television Engineers) is a test pattern that can be used to ensure that the monitor is calibrated correctly with brightness and contrast settings. This pattern is also used to check that the monitors are clean and free of dust, fingerprints, and other marks that could interfere with clinical interpretation. The 2016 ACR Mammography Digital Quality Control Manual recommends using the AAPMTG-18-QC test pattern, which can be installed on the computer. Some also have manufacturer’s test programs installed. Modulation transfer function (MTF) is a check of the ability of the detector system to produce an exact image of the object. Contrast measures the minimum density difference between two tissues that can be detected in the image as different densities. The contrast-to-noise (CNR) ratio is a check of how well a system will image microcalcifications and distinguish mass or densities from their background density. Signal-to-noise ratio (SNR) is a check of the image noise, the random background information—resulting from constant flow of current in the circuit—which can obscure the digital image. Noise does not contribute to image quality. On the digital image, noise looks like quantum mottle (Fig. 6–22).**

45. **(C) The 2016 ACR Mammography Digital Quality Control Manual outlines the standard test details for all 2D digital mammography units. These standards do not apply to units with advanced imaging capabilities, such as tomosynthesis and contrast enhancement. Facilities with units with advanced imaging capabilities must follow the manufacturer’s guidelines. Table 6–2 shows test frequency and corrective action. The frequency of the repeat/reject analysis can depend on the volume of work. To be meaningful, a patient volume of at least 250 patients is needed. However, some facilities may choose to conduct routine repeat analysis.**

**Table 6–2**

<table>
<thead>
<tr>
<th>Digital Mammography Quality Control Tests –Technologists</th>
<th>Minimum Frequency</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ACR DM Phantom Image Quality</td>
<td>Weekly</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>2. Computed Radiography (CR) Cassette Erasure (if applicable)</td>
<td>Weekly</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>3. Compression Thickness Indicator</td>
<td>Monthly</td>
<td>Within 30 days</td>
</tr>
<tr>
<td>4. Visual Checklist</td>
<td>Monthly</td>
<td>Critical items: before clinical use less critical items: within 30 days</td>
</tr>
<tr>
<td>5. Acquisition Workstation (AW) Monitor QC</td>
<td>Monthly</td>
<td>Within 30 days; before clinical use for severe defects</td>
</tr>
<tr>
<td>6. Radiologist Workstation (RW) Monitor QC</td>
<td>Monthly</td>
<td>Within 30 days; before clinical use for severe defects</td>
</tr>
<tr>
<td>7. Film Printer QC (if applicable)</td>
<td>Monthly</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>8. Viewbox Cleanliness (if applicable)</td>
<td>Monthly</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>9. Facility QC Review</td>
<td>Quarterly</td>
<td>Not applicable</td>
</tr>
<tr>
<td>10. Compression Force</td>
<td>Semiannual</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>11. Manufacturer Detector Calibration (if applicable)</td>
<td>Mfr. recommendation</td>
<td>Before clinical use</td>
</tr>
<tr>
<td>Optional – Repeat Analysis</td>
<td>As needed</td>
<td>Within 30 days after analysis</td>
</tr>
<tr>
<td>Optional – System QC for Radiologist</td>
<td>As needed</td>
<td>Within 30 days; before clinical use for severe artifacts</td>
</tr>
<tr>
<td>Optional – Radiologist Image Quality Feedback</td>
<td>As needed</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>
46. (A) Ideally, the rate should not exceed 2%, but a rate of 5% is acceptable once a QC program has been established. Too low or no repeat rate may indicate that poor image quality is being tolerated. An analysis of the number of repeated mammograms and rejected images identifies ways to improve efficiency and reduce cost and patient exposure. Because the main purpose of the reject/repeat analysis is to determine problem areas within the department, one high-rate area should be targeted for improvement. The rates should be based on a volume of at least 250 patients to be meaningful.

47. (D) The linear-type grids used in mammography typically have a very low ratio because even with the common grid ratio of 4:1, patient exposure doubles (grid ratio = the height of the lead strips/the distance between the strips; ratio = h/d). Most grids are focused to the source-to-image receptor distance (SID) to increase contrast. Grids in mammography typically have a frequency of 30 to 50 lines per centimeter (Fig. 6–23).

48. (B) The staging of breast cancer is useful to determine the extent of the spread of cancer.

49. (D) During the documentation of the patient’s medical history, the physician collects information on the patient’s risk factors for benign or malignant breast conditions and any other health problems. Information about past mammographic examinations is also collected because of the importance of comparative evaluation. Although the medical history does not prevent breast cancer, it is the first step in evaluating both symptomatic and asymptomatic women and an important step in evaluating treatment options.

50. (D) The smaller the focal spot size, the greater the resolution. Mammography units use a “half-field” geometry system, where the central axis of the x-ray beam will run perpendicular to the plane of the detector at the chest wall. The target of the anode is then angled between 6 and 16 degrees (line-focus principle). The large target angle would force the use of larger focal spot sizes and increase the heel effect (Fig. 6–23). However, to reduce the heel effect, an effective anode angle >22 degrees is maintained either by using a 0-degree anode angle matched with a 24-degree tube tilt or a 16-degree anode...
a woman’s genetic predisposition. Younger women, premenopausal women, and postmenopausal women taking estrogen are likely to have higher hormonal levels and therefore have an increased possibility of having cysts.

53. (C) By the process of elimination, the best choice is that the lesion is a cyst. The halo often surrounds cysts. Although fibroadenoma, hematoma, and galactocele are all oval or circular lesions, they are of mixed density (radiolucent and radiopaque). (See Fig. 3–18.)

54. (B) As the peak kilovoltage (kVp) increases, the relative number of x-rays undergoing Compton interaction also increases. With compression, the part is thinner, less kVp is needed to penetrate the part, and therefore there is less Compton scatter.

55. (C) In information technology, lossy compression reduces a file by permanently eliminating certain information, especially redundant information. For example, JPG compression analyzes images in blocks of $8 \times 8$ pixels in size and selectively reduces the detail within each block. When the file is uncompressed, only a part of the original information remains. These techniques are used to reduce data size for purposes of storage, handling, and transmission of content. Well-designed lossy compression technology often reduces file sizes significantly before degradation is noticed by the end user. Lossless compression is a class of data compression algorithms that allow the original data to be perfectly reconstructed from the compressed data. Lossless compression is used in mammography because it is vital that the original data and the decompressed data be identical. Image broken into smaller blocks of data at the origin are put back together at the destination. With lossless compression, every single bit of data that was originally in the file remains after the file is uncompressed. The disadvantage is that the transmission time is longer.

56. (C) Focused grids have linear lead strips that are slanted to match the divergence angle matched with a 6-degree tube tile. The result is 24- and 22-degree effective anode angles, respectively (actual anode angle plus the physical tube tilt). As a result, small focal spots are possible, resulting in increased resolution.

51. (A) The retromammary space separates the breast from the pectoral muscle. This space is filled with a layer of adipose or fatty tissue as opposed to the supporting and connective tissue (stroma), blood vessels, and various ductal structures that make up the glandular and fibrous tissues of the breast.

52. (D) Cysts occur in the terminal ductal lobular units when the extralobular terminal duct becomes blocked. Fluid accumulates faster than it can be reabsorbed. Cysts vary in size and respond to hormonal fluctuations, but the development of a cyst also depends on...
of the x-ray beam. A focused grid must be used at the correct SID, and correct side of grid must be facing the x-ray tube to prevent grid cutoff. Parallel grids have strips arranged in straight lines in one direction (also called linear grids). They can be used with varying SIDs. Crossed grids are, in effect, two linear grids, one placed on top of the other, with the grid lines perpendicular to each other. They offer more efficient scatter cleanup but greater risk of grid cutoff and can result in increased radiation dose to the patient. In mammography, the high-transmission cellular (HTC) grid is similar to a crossed grid. It uses air as the interspace material and copper instead of lead as the strips to avoid increased patient dose. (See Fig. 6–17.)

57. (B) Fibrous and glandular tissues are together referred to as fibroglandular densities. X-rays pass more easily through fatty tissue than through fibrous or glandular tissue. Fatty areas are more radiolucent and will appear as black on the mammogram. Fibroglandular tissue is more radiopaque than fatty tissue and results in areas of lower optical density on the mammogram (white areas).

58. (A) Estrogen and progesterone are two of the many hormones responsible for the physiological changes that occur in the breast. Estrogen is responsible for ductal proliferation and progesterone for lobular proliferation. Once a woman starts taking any of these hormones, for example, in HRT, the changes to the breast can be spotty, causing lumps or increased interstitial fluids (cysts), but will generally result in an overall increase in glandular tissue.

59. (C) By the process of elimination, the lesion is likely to be a lymph node. Lymph nodes are lesions with mixed density and generally have a radiolucent center corresponding to the hilus. Fibroadenoma, hematoma, and galactocele are all mixed-density, oval, or circular lesions, but none has the lucent center typical of the lymph nodes. (See Fig. 3–19.)

60. (D) In lymphoscintigraphy, or sentinel node mapping, the radiopharmaceutical is injected into the subareolar lymphatic plexus (or lesion). The tracer travels to the sentinel node—identifying that node for dissection and eliminating the need for extensive lymph node dissection. PEM technology utilizes the fact that cancerous tissue uses vast amounts of sugar. PEM is similar to PET but uses an organ-specific high-resolution gamma detector. After intravenous injection of FDG, the patient sits or relaxes for about 60 to 90 minutes, giving the body time to absorb the radioactive tracer. Next, each breast is scanned separately using the gamma detector. The pair of detectors is placed above and below the breast to apply mild compression during the scanning process, which takes about 10 minutes. Typically, two scans per breasts are taken. The radioactive tracer that is introduced into the body is metabolized in the body in a manner similar to the metabolization of sugar. The tracer will go to the tissues that are most active—normally the cancerous tissue. Before PEM, the patient is required to fast, and no vigorous exercise is allowed 48 hours prior to PEM. Breast-specific gamma imaging (BSGI), or scintimammography, uses the radioactive tracer technetium-99m (Tc-99m) sestamibi. The tracer accumulates in malignant lesions.
smaller than the actual area of electron interactions. The effective focal spot is the area projected onto the patient and the detector. The nominal focal spot size is a measure of the effective focal spot size and is the value determined by manufacturers to identify large or small focal spots (Fig. 6–25).

63. (C) The MQSA governs final assessment findings in the evaluation of mammographic images. In an effort to guide referring physicians and radiologists in the decision making process, the ACR came up with the BIRAD (Breast Imaging Reporting and Data) system, which is a standardized mammographic reporting system that can be used as a coding and assessment system (Table 6–3). To ensure recognition of the system, the ACR collaborated with the National Cancer Institute (NCI), the Center for Disease Control and Prevention (CDC), the US Food and Drug Administration (FDA), the American Medical Association (AMA), the American College of Surgeons (ACS), and the American College of Pathologists (ACP). The BIRAD system is now well recognized and used by radiologists, physicians, and surgeons across the United States, Canada, and much of Europe and Asia. The MQSA also has a category assessment; however, the ACR assessment categories were in existence even before the publication of the final regulations of the MQSA. Because the assessment categories developed by the ACR are so widely recognized, the FDA accepts the ACR’s BIRAD categories; however, to avoid confusion, in addition to category names (e.g., BIRAD 1), the report must include the word identifier, for example, “BIRAD 1: negative.”

64. (B) Rejects are all discarded images. Repeats are images that resulted in a dose to the patient. The causal repeat rate is the percentage of repeats from a specific cause. It is equal to the number of repeats of a specific cause divided by the total number of repeats, times 100. The total repeat rate is the number of repeated images divided by the total number of images taken, times 100. In mammography, the department repeat rates should not exceed 2%.

65. (C) Epithelial hyperplasia, also known as proliferative breast disease, is an overgrowth of cells that line either ducts or lobules. When hyperplasia involves ducts, it is called ductal hyperplasia or duct epithelial hyperplasia. When it affects lobules, it is referred to as lobular hyperplasia. Depending on how it looks under the microscope, it may be classified as “usual” or “atypical.” An epidermoid cyst, often incorrectly referred to as a sebaceous cyst, is a pimple-like cyst that occurs in the oil glands of the skin, and hematoma is a pooling of blood as a result of trauma or surgery. Over time, a hematoma may slowly calcify, resulting in the formation of an oil cyst and later a calcified hematoma.
66. (A) This is a ruptured implant. In an implant rupture, the silicone may leak into the fibrous capsule or may escape from the capsule, leaking into the surrounding breast tissue and muscle and causing pain or discomfort. In the encapsulated implant, the implant hardens or calcifies but does not rupture. A herniated implant shows the implant pushing out of the fibrous capsule but does not indicate a silicone leak. Patients who had their implants removed may have traces of residual silicone in the breast. (See Fig. 6–2.)

67. (C) The first step is to determine the location of the lesion by applying the rules for lesion movement. When comparing the MLO projection to ML, a lateral abnormality will move down from its position on MLO. A medial abnormality will move up from its position on MLO. A centrally located lesion and lesions at the areola will show little or no movement. Once the location of the lesion is determined, XCCl for a lateral lesion or CV or XCCM for medial lesions will locate the lesion in the CC position. AT images only the axilla of the breast and is not needed.

68. (A) During ductography, a collecting duct that ends at the nipple is cannulated, and a small amount of contrast agent is injected. Generally, about 1 cc of the agent is enough to fill the duct.

69. (C) The glandular dose is used in mammography because the biological effects of radiation are most likely to be related to the total energy absorbed by glandular tissue. The glandular dose is the average radiation dose to the glandular tissue in the middle of the breast. The other measure of dose is the ESE. The ESE is most often referred to as the patient dose. It is the exposure at the skin’s surface. In mammography, the ESE may be very high because of low-energy x-rays, but the dose falls quickly as the x-rays penetrate the breast.

70. (C) The SID of mammography units does not change. Obtaining a magnified image requires increasing OID while maintaining a constant SID. Any change in OID will result in a corresponding change in SOD. To maintain a sharp image, a smaller focal spot must be used in magnification. (See Fig. 6–10.)

71. (D) QC testing should always be performed by the dedicated QC personnel or the same individual. Here, the technologist would be the most obvious person.

72. (B) Galactoceles are small, milk-filled cysts with a high fat content. These are associated with lactation, may be of mixed density, and are circular/oval in shape, with sharply defined contours. A hematoma is associated with breast trauma or surgery, and the oil cysts appear mammographically as eggshell-like calcifications. Lymph nodes typically have a central radiolucent area corresponding to the hilus.

73. (B) Using increased OID or the air-gap technique is effective in reducing scatter to the detector. The air-gap technique provides a large OID increase, which allows the scatter to be dissipated in the air before reaching the detector. An OID of at least 6 in (10–15 cm) is required to be effective. (See Fig. 6–10.)

74. (C) In descriptive terminology, the four quadrants of the breast are the upper–outer quadrant, the upper–inner quadrant, the lower–outer quadrant, and the lower–inner quadrant. The exact locations within the quadrant are represented by viewing each breast separately as a clock face. The upper–outer quadrant, which extends toward the axilla, is known as the axillary tail, tail of the breast, or tail of Spence. Most glandular tissue is found centrally and extends laterally toward the axilla in the upper–outer quadrant. This distribution increases or decreases with hormonal fluctuations, but generally mirrors the opposite breast (Fig. 6–26).

75. (C) Mammography uses very low-energy kVp, and it is very important to ensure that the x-ray tube window does not attenuate the low-energy photons. Most mammography units use the beryllium window as the port
window. With a low atomic number of 4, it is ideal and provides an inherent filtration of approximately 0.1 mm Al (aluminum). The material of the glass window has no effect on scattered radiation, nor can it increase or decrease the output of the x-ray tube.

76. (C) Compression is important in mammography to reduce the thickness of the breast tissue, the radiation dose, and motion unsharpness. Compression also separates the superimposed areas of the breast tissue and brings abnormalities closer to the detector. Unfortunately, compression is painful for some women. In general, the breast should be compressed until taut to ensure adequate compression. Compression, however, should not be applied to cause severe pain to the patient.

77. (C) In magnification mammography, OID is increased, SOD is decreased, but SID remains fixed. Magnification factor = SID/SOD or image size/object size. The greater the magnification factor, the greater the OID, and the smaller the SOD, the greater is the skin dose to the patient. In magnification, the patient’s skin dose increases because the breast is closer to the source. The small focal spot size used to maintain a sharp image requires that the milliamperc second (mAs) be reduced with a corresponding increase in exposure time. (See Fig. 6–10.)

78. (B) The actual focal spot size is the area on the anode target that is exposed to the electrons from the tube current. As the size of the focal spot decreases, the heating of the target is concentrated into a smaller area. In the design based on the line-focus principle, the target is angled, allowing a larger area for heating while maintaining a small effective focal spot. Because the target is angled, the effective focal spot is made much smaller than the actual area of electron interactions. The effective focal spot is the area projected onto the patient and the detector. As the target angle is made smaller, the effective focal spot decreases. (See Fig. 6–24.)

79. (C) Postsurgical scarring is a benign process, and the surgical scar can mimic a radial scar. It follows a surgical intervention and can appear as an area of architectural distortion or an irregular-shaped lesion with spiculated margins. It may or may not be associated with calcifications. Typically, the surgical scar will resolve spontaneously over time. A benign surgical scar has no central tumor, although there may be long spicules radiating from the center of the lesion. Regardless of the size of the spicules in the surgical scar, there is no associated skin thickening, dimpling, or nipple reaction. As shown on the radiograph (see Fig. 6–3), the lesion is resolving. A galactocele is a benign, milk-filled cyst with a high fat content. These lesions are generally associated with lactation. They are usually circular, have sharply
defined borders, and have densities that are both radiolucent and radiopaque. They are often left alone, but if painful, they can be drained by using needle puncture. Often they yield a yellow fluid. Oil cysts are generally seen mammographically as eggshell-like calcifications. Hematomas are generally associated with trauma. They are mixed-density, oval, or circular lesions and can calcify to become high-density calcifications. (See Fig. 3–16.)

80. (C) When the air-gap technique is used, OID must increase to allow the scatter to be dissipated in the air before reaching the detector. An OID of at least 6 inches (10–15 cm) is required to be effective. (See Fig. 6–10.)

81. (A) According to clock-face terminology, there are four main clock positions (12 o’clock, 3 o’clock, 6 o’clock, and 9 o’clock). In XCCL and CC, the central rays are directed superior to inferior; therefore, 12 o’clock and 6 o’clock lesions will be superimposed. AT images the axilla and would miss any 6 o’clock lesion. In MLO, the beam is directed medial to lateral separating the upper aspect of the breast (12 o’clock position) from the lower aspect (6 o’clock position). (See Fig. 6–26.)

82. (C) The cleavage view (CV) is the standard term adopted by the ACR. All projections in mammography are compression or compressed projections. (See Fig. 5–9 (8).)

83. (D) Malignant casting calcifications are produced when carcinoma in situ fills ducts and their branches. The shape of the cast is determined by the uneven production of calcification and the irregular necrosis of the cellular debris. The contours of the cast are always irregular in density, width, and length, and the cast is always fragmented. A calcification is seen as branching when it extends into adjacent ducts. The width of the ducts determines the width of the castings. Eggshell-like and needle-like, sharply outlined, or elongated branching calcifications on mammography are typically benign. “Granulated sugar” or “crushed stone” calcifications are termed pleomorphic or granular-type calcifications and are often malignant. (See Fig. 3–19.)

84. (B) Starting at the terminal ductal lobular unit (TDLU), the collecting ductal system gradually widens like tree branches, forming segmental ducts. Immediately behind the nipple, it further distends to form an ampulla, also called the lactiferous sinus. This is a pouch-like structure immediately behind the nipple. The ducts again narrow to end at the nipple (Fig. 6–27).

85. (A) The grid ratio is equal to the height of the lead strips divided by the distance between each lead strip (or width of interspace material). (See Fig. 6–23.)

86. (C) The AT projection best demonstrates the AT of the breast. The medial and subareolar areas are not visualized on the AT projection. The upper–outer quadrant, which extends toward the axilla, is known as the axillary tail, tail of the breast, or tail of Spence. (See Fig. 5–9 (9).)

87. (D) Fibroadenoma is generally a mixed-density lesion (radiolucent and radiopaque). Galactoceles are small, milk-filled cysts with a high fat content associated with lactation. Over time, a galactocele can calcify to form a high optical density lesion. If a hematoma calcifies, it slowly becomes a mixed optical density oil cyst, with typical eggshell-like calcifications, and then eventually a high optical density radiopaque lesion. Stellate lesions are high optical density lesions with spiculated margins. (See Fig. 3–19.)

88. (B) A hematoma is associated with breast trauma or surgery. Generally, the result is a pooling of blood, which can show mammographically as a low-density radiopaque lesion. If the hematoma calcifies, it slowly becomes a mixed-density oil cyst, with typical eggshell-like calcifications, and then eventually a high-density radiopaque lesion. Galactoceles are small, milk-filled cysts with a high fat content associated with lactation.
Fibroadenomas are benign tumors common in women of any age, and intramammary lymph nodes can be found in any quadrant of the breast and are not related to injury. (See Fig. 3–19.)

89. (C) The analog-to-digital converter (ADC) converts the analog signal (light or electronic) from the image receptor or detector to a digital signal for computers to manipulate for processing, display, and storage. The ADC assigns each picture element or pixel a value that corresponds to a level of brightness. The entire image is divided into a matrix of pixels based on the brightness of each pixel. The digital-to-analog converter (DAC) converts digitally manipulated data back to an analog (electronic) signal, and the
film digitizer converts an analog-produced radiograph (film) to a digital version via a scanning device. DICOM is a set of computer software standards that permit a wide range of digital imaging programs to communicate with each other.

90. (B) Generally, when the patient’s shoulders are not relaxed or if the height of the detector is too high, most of the axilla and shoulders will fall into the compression area. The thick area of the axilla and shoulder can stop the compression paddle before adequate compression is applied to the lower or anterior breast.

91. (A) Digital breast imaging, including digital tomosynthesis, ultrasonography, and MRI, all image the structure and anatomy of the breasts. Molecular imaging looks at biological activity and shows what the cells are doing or how they are functioning. Nuclear imaging studies use radioactive tracers or radiopharmaceuticals. These include PET or PEM imaging, breast-specific gamma imaging (BSGI) or scintimammography, and lymphoscintigraphy.

92. (D) In this case, the circular lucency in the center suggests a port-a-cath (Infusaport). (See Fig. 3–21.) A pacemaker generally presents as a low-optical-density object with wirings. A hematoma is generally associated with trauma or surgery. They are mixed-density, oval, or circular lesions possibly with calcifications. The patient’s chin would present as a uniform area of low optical density.

93. (A) The rolled positions are helpful when dense breast tissue is superimposed on a lesion. The dense tissue is rolled off the lesion.

94. (D) The specimen must be imaged after biopsy to ensure that the lesion was completely removed. In imaging the specimen, it should be compressed and magnified to prevent the appearance of pseudomasses and to assess calcifications. The specimen should also be compared with the initial mammograms. Imaging the specimen before the open surgical biopsy is completed will allow the surgeon to take an additional biopsy specimen, if indicated.

95. (C) LMO is useful in patients who have had prior chest surgery or in those with pacemakers, which prevent compression to the medial breast. The LMO projection is an inferolateral to superomedial projection. The x-ray tube is angled approximately 125 degrees. The detector is positioned at the medial aspect of the breast, and compression is applied from the lateral aspect. AT images the tail of the breast (tail of Spence); LM and ML are both 90-degree lateral projections. (See Fig. 5–9.)

96. (B) The actual focal spot size is the area on the anode target that is exposed to the electrons from the tube current. Because the target is angled, the effective focal spot is made much smaller than the actual area of electron interactions. The effective focal spot is the area projected onto the patient and the detector. The nominal focal spot size is a measure of the effective focal spot size and is the value used when identifying large or small focal spots. (See Fig. 6–25.)

97. (C) Radiation and surgical treatment can cause changes in the breast and can cause calcium formation. After any breast surgery, including lumpectomy, magnification can be useful for preassessment and postassessment of any calcifications. Magnification imaging can also be used to confirm complete removal of malignant calcifications.

98. (A) The posterior lateral breast tissue is missing on this CC projection, and XCCL is the best option to image the missed area. CV shows the medial breast. AT images the axillary tail, and ML is a 90-degree lateral projection that will best image the medial breast. (See Fig. 5–9.)

99. (B) Grids absorb scatter and increase visibility of image details. Grids are thin, rectangular devices made of alternating strips of radiopaque materials (usually lead) and...
authorize individual states to certify mammography facilities, conduct inspections, and enforce the MQSA quality standards. After October 1994, the MQSA required all legal providers of mammography services to be accredited by an approved accreditation body and certified by the FDA. The FDA, however, cannot ensure that all women have access to a certified mammography facility.

100. (B) Mammography imaging systems using PSP, referred to as computed mammography (CM), and those using flat panel technology, referred to as digital mammography (DM) or full-field digital mammography (FFDM), both have a wide latitude and a dynamic range. The advantages of CM include a wide latitude and a dynamic range; faster imaging compared with screen-film imaging; reduced repeats and no lost films; and increased workflow. The disadvantages of CM include lower spatial resolution (all digital imaging can manipulate the pixel value after the exposure, which compensates for the lower spatial resolution in digital imaging systems; however, CM is not as effective as DM in compensating for the lower resolution of digital imaging systems); use of IPs, which can be damaged during transport; susceptibility of IPs to scratches in the CR; low exposure, which can create a noisy image; and the extreme sensitivity of PSP to radiation, which can contribute to a noisy image. The advantages of DM include no plates to drop or damage; no plates to be transferred; and increased detective quantum efficiency (DQE, which describes how efficient the system is in converting x-ray input signals into a useful image) over CM. The disadvantages of DM include image lag or memory effect because the charge is trapped in the metastable band and is released slowly over time. Image lag time varies and is shorter for flat-panel digital detectors based on indirect conversion. Low exposure can create a noisy image.

101. (B) The MQSA was enacted in the United States on October 27, 1992, to enforce minimum national standards for mammography. Under the MQSA requirements, the FDA can authorize individual states to certify mammography facilities, conduct inspections, and enforce the MQSA quality standards.

102. (D) The MQSA final regulations require facilities to have a written and documented policy of resolving consumer complaints. The facility may select its own format. Medical outcome audit is required by the MQSA to follow up positive mammographic assessments and to correlate pathology results with the radiologist’s findings. "Record keeping" refers to the section of MQSA standards dealing with the maintenance of mammograms and reports in a permanent file (for not less than 5 years, or not less than 10 years if no additional mammograms of the patient are performed at the facility, or longer if required by state or local laws). To satisfy the communication-of-results section of the standards, all mammographic facilities must send each patient a summary of the report, written in lay terms, within 30 days of the mammographic examination. If assessments are suspicious or highly suspicious for malignancy, the facility should contact the patient as soon as possible with the results.

103. (B) A harmartoma is a benign tumor. It is considered self-limiting because it consists of an overgrowth of normal tissue and the tumor cells do not reproduce. Breast lesions associated with trauma and nursing are hematomas and galactoceles, respectively. (See Fig. 3–19.)

104. (B) Parturition is the process of giving birth. In the immature breast, a two-layer epithelium of cells lines ducts and alveoli. After puberty, this epithelium proliferates, forming three alveolar cell types—superficial (luminal) A cells, basal B cells (chief cells), and myoepithelial cells forming the innermost layer or basal surface of the epithelium. The radiolucent materials. The radiolucent material allows x-ray photons traveling in a straight line to pass through to the detector, and the lead strips absorb scatter radiation photons before they reach the detector. Grids are placed between the patient and the detector. Grids are not used in magnification radiography. The large OID serves as an air gap to reduce scatter to the detector. (See Fig. 6–23.)
myoepithelial cells are arranged in a branching, star-like fashion located around the alveoli and excretory milk ducts. Contraction of the myoepithelial cells helps propel milk toward the nipples. Beneath the epithelium is connective tissue that helps keep the epithelium in place. Between the epithelium and the connective tissue is a layer called the basement membrane. The basement membrane provides support and acts as a semi-permeable filter under the epithelium. (See Fig. 6–27.)

105. (B) A benign finding means that although something was seen, it is considered totally benign. When using the BIRAD system (see Table 3), the verbal identifier must be used to avoid confusion with the MQSA assessment. The MQSA categories number 1 to 7, with all mammographic findings placed in categories similar to the BIRAD system, but MQSA categories are rarely used today.

106. (D) Erythema is redness or inflammation of the skin. Although it can indicate inflammatory breast cancer, it can also be an indication of breast abscess or other infectious changes. Further evaluation and testing, including mammography, would be necessary to determine the cause.

107. (C) Tamoxifen is a nonsteroidal antiestrogen drug given to patients with breast cancer. It is considered an antiestrogen drug because it prevents estrogen from latching onto tumor cell receptors and shrinks or stops the recurrence of breast cancer. Tamoxifen lowers the risks of breast cancer recurrence in postmenopausal women. Treatment with tamoxifen is considered palliative treatment because it will not cure the disease. The drug has serious side effects, including increased risk of endometrial cancer, uterine cancer, pulmonary embolism, stroke, deep vein thrombosis, and blood clots, and causes increased menopausal symptoms. Because of these risks, tamoxifen is often not given for >5 years. However, some studies have suggested that the benefits of tamoxifen outweigh the risks and that the drug can be taken and will be effective for longer periods. Other similar drugs with less dangerous side effects are now on the market. Radiation therapy may be used to destroy cancer cells remaining after surgery or to reduce the size of a tumor before surgery. Chemotherapy uses a combination of drugs to kill undetected tumor cells that may have migrated to other parts of the body. Antibody therapy works by blocking the effect of the protein HER-2—important in regulating the growth of breast cancer cells.

108. (B) The detector elements (DELS or dexels) are located within the thin-film transistor (TFT). DEL size controls the recorded detail, or spatial resolution, for the flat-panel device. DEL size also contributes to the image blur present in a flat-panel detector systems. The larger DELs in a flat-panel detector cause more image blur. The DEL is a part of the complex circuit device of the TFT and is the sensitive component of the TFT, which collects electrons emitted from either amorphous selenium (a-Se) or amorphous silicon (a-Si); these electrons represent individual components of a digital image. Each square in the TFT matrix can have sensitive and nonsensitive areas. The fill factor is the ratio of the sensitive area to the entire detector area and is usually expressed as a percentage. The fill factor will affect spatial resolution and the signal-to-noise ratio (SNR). A typical fill factor is 80%. The technologist cannot change the size of the DEL, which is fixed. The DEL size is determined by individual manufacturers. Once the DELs are read, the flat-panel detector automatically erases them and is ready for another exposure. The actual digital image produced is a matrix of picture elements (pixels). Each cell corresponds to a specific location in the image. The matrix is therefore a box of cells with numeric values arranged in rows and columns. The image resolution is controlled by the number of pixels; the greater the number of pixels, the greater is the image resolution.

109. (C) After puberty, the epithelium of the lobules proliferates, becoming multilayered and forming three alveolar cell types, superficial (luminal) A cells, basal B cells (chief cells),
and myoepithelial cells. The innermost layer or basal surface of the epithelium consists of myoepithelial cells. Beneath the epithelium is connective tissue that helps to keep the epithelium in place. Between the epithelium and the connective tissue is a layer called the *basement membrane*. The basement membrane provides support and acts as a semi-permeable filter under the epithelium.

110. (C) The “camel’s nose” contour refers to the sloping of the anterior breast in the MLO projection, caused by insufficient compression. The result is poor separation of the breast tissues. Preventing “camel’s nose” involves pulling the anterior breast up and out and supporting it during the initial stage of compression. The technologist should use one hand to maintain support of the breast until enough compression is achieved to keep the breast in position (Fig. 6–28).

111. (C) In the four quadrants terminology, the breast can be described as upper–outer quadrant, upper–inner quadrant, lower–outer quadrant, and lower–inner quadrant. The exact locations within the quadrant are represented by viewing each breast separately as a clock face. SIO best demonstrates the upper–inner quadrant and the lower–outer quadrant of the breast, free of superimposition. This projection can be used to demonstrate these quadrants free of the implant, especially when using the implant-displaced (ID) or Eklund compression techniques. (See Fig. 6–26.)

112. (D) The medical audit is used to check the reliability of the mammographic image. As mandated by the MQSA, each facility must establish and maintain a system to track positive mammographic findings and to correlate such findings with the biopsy results that the facility obtains on an annual basis. At a minimum, the system must track all positive mammographic findings, which can include “suspicious” or “highly suggestive of malignancy.” Each facility can set up and maintain a tracking system that works best for it, but the system must include a set of procedures to track mammograms; determine whether biopsy was performed and whether the biopsy specimen was benign or malignant; and report this information back to the interpreting physician. The system must also include patients with cancers not initially detected by the mammogram. The audit analysis must be initiated within 12 months after the date the facility becomes certified and must be conducted and reviewed by the interpreting physician at least once every 12 months.

113. (B) For each patient, the MQSA requires facilities to maintain records of the original mammograms and reports for a period of not less than 5 years and not less than 10 years if no additional mammography is performed at the facility. Some state and local laws may require longer storage times. Facilities are also allowed to permanently or temporarily transfer a patient’s records to another medical institution, physician, or health care provider, if requested by the patient.
114. (C) Triangulation is used to determine the location of a nonpalpable lesion seen mammographically. After triangulation, the lesion can be spot compressed or magnified. Triangulation could also be used to determine the shortest skin-to-abnormality distance for the purpose of stereotactic biopsy. To determine the location of the lesion relative to the nipple, the technologist should measure (1) the distance from the nipple to the level of the lesion posteriorly on the CC or MLO projection; (2) from that level to the lesion in the superior-to-inferior (as on MLO) or medial-to-lateral direction (as on CC); and (3) from the lesion to the skin surface (Fig. 6–29).

115. (D) The term peau d’orange describes breast skin that is thickened and resembles an orange. The condition occurs secondary to obstruction of the axillary lymphatics and may be a result of either benign or malignant conditions, such as inflammatory carcinoma. Plasma cell mastitis or ductal ectasia are both inflammatory conditions. Plasma cell mastitis calcifications follow the course of the ducts. Some may be elongated and branching, some needle-like, and some ring-like or oval, but all are sharply outlined, are of high density, and have smooth borders. If they are periductal, they have central lucencies. Ductal ectasia involves the lactiferous ducts and may or may not cause nipple discharge or inversion. Both conditions are characterized by the presence of plasma cells surrounding a dilated duct. (See Fig. 3–16.)

Bibliography