Chapter 33

1. Which of the following is a real difference between DR and CR:
   1. Only CR uses phosphors
   2. For DR, the image receptor is electrically or electromagnetically connected to the processing unit
   3. Only DR is truly digitized
   4. DR detector plates always have a cable attached, CR cassettes do not
2. To allow some flexibility in centering of the anatomy over different portions of the receptor

plate, most fixed DR units have detector cells in the plate for automatic exposure

control (AEC):

a. 1

b. 3

c. 5

d. 6

3. When compared to CR, which of the following is *not* a disadvantage of DR:

a. Tendency to use the bucky grid for distal extremities

b. Less flexibility in positioning

c. Bulky and cumbersome receptor plates

d. Less consistency in image quality

4. In the 1980s, the first clinically useful DR system consisted of a bar of large detectors

connected to photomultiplier tubes, which swept across the field area during exposure.

This system was called:

a. computed tomography

b. conventional tomography

c. linear positron emission tomography

d. scanned projection radiography

e. direct-scan radiography

5. For DR, the size of the individual detector elements (dels) currently used is closest to:

a. 1 cm

b. 1 mm

c. 100 microns (1/10th mm)

d. 1 micron (1/1000th mm)

6. Which of the following terms, all contractions, most accurately describes the individual hardware elements of a DR receptor plate that detect radiation in the remnant x-ray beam?

a. the pixel

b. the del (or dexel)

c. the voxel

d. the rexel

7. To a computer expert, a true pixel is a numerical value assigned to a(n):

a. small square area in the image

b. small circular area in the image

c. small square detector surface

d. small circular detector surface

e. point with no dimensions

8. In a DR image receptor, most of the square area of each del is dedicated to what portion of

the detector element:

a. the thin-film transistor

b. the semiconductor layer

c. the capacitor

d. the gate lines

9. In a DR image receptor, smaller dels have a:

a. lower fill-factor

b. higher fill-factor

c. the same fill-factor

d. smaller capacitors

e. smaller TFTs

10. In a DR image receptor, which electronic devices directly account for the plate’s ability to

*hold onto* a latent image until it is sent into the computer?

a. the semiconductor layers

b. the gate lines

c. the data lines

d. the capacitors

e. the TFTs

11. In the active matrix array of a DR image receptor, what device controls the order in which

the dels are read out by sending a bias voltage down the gate lines to each TFT:

a. the address driver

b. the top electrode

c. the amplifier

d. the data lines

12. In an individual DR detector element (del), the electronic charge built up on the capacitor

is *positive charge* because it is generated by drifting downward through the

semiconductor layers to the capacitor:

a. x-rays

b. electrons

c. charge holes

d. molecules of amorphous selenium

e. top electrodes

13. In indirect-conversion DR systems, the dispersion of light emitted from molecules of cesium iodide is reduced by using:

a. light guides

b. crystalline tubular phosphor structure

c. amorphous phosphor structure

d. scintillation optics

14. For both direct-conversion and indirect-conversion DR image receptors, the elements of

the active matrix array, (semiconductor layers, TFTs capacitors and lines), are supported

on a substrate made of:

a. amorphous silicon

b. amorphous selenium

c. metal

d. plastic

e. glass

15. For indirect-conversion DR systems, why is amorphous *silicon* used rather than amorphous

*selenium* for the semiconductor layers of the detector elements (dels)?

a. silicon is a better electrical conductor

b. the molecule must be suited to absorbing light rather than x-rays

c. silicon binds better to the cesium iodide layer above

d. silicon is easier to coat into very thin layers

16. Which of the following is a primary advantage of direct-conversion DR receptors over

indirect-conversion systems?

a. improved resolution

b. lowered patient exposure

c. increased image contrast

d. increased system processing speed

17. Computed radiography (CR) is a digital imaging technique that acquires image data from:

a. an electrostatic image receptor scanned by a CCD

b. a magnetic tape that has been scanned by a magnetic recorder

c. a rare earth intensifying screen scanned by a PM tube

d. a photostimulable phosphor plate scanned by a laser beam

18. Throughout the entire imaging sequence for a CR system, how many times is the

photostimulable phosphor plate caused to glow?

a. Once

b. Twice

c. Three times

d. A CR plate does not give off light, but conducts electricity

19. For a CR image receptor plate, which of the following chemicals makes a good

photostimulable phosphor:

a. gadolinium oxysulfide

b. lanthanium oxybromide

c. calcium tungstate

d. barium fluorobromide

e. silver nitrate

20. The CR cassette must be structured so as to protect the phosphor plate inside it from:

a. light

b. primary x-rays

c. static electricity

d. heat

21. In the structure of a photostimulable phosphor plate, the anti-halo layer prevents:

a. back-scattered x-rays from reaching the phosphor layer

b. external light from creating artifacts within the phosphor layer

c. laser light from penetrating through to the reflective layer

d. emitted light from excessive diffusion

22. In the CR reader, the release of trapped energy from a meta-stable F-center in a phosphor

crystal is triggered by exposure to visible light in the spectrum:

a. red

b. violet

c. green

d. ultraviolet

23. A photomultiplier tube is incorporated into the CR reader in order to:

a. amplify and convert visible light into a measurable electronic signal

b. convert laser light into a usable electric signal

c. store the exit radiation in multiple conduction bands of the crystal lattice

d. convert analog information into a digital signal

24. Photostimulated light emission refers to the process by which:

a. the laser beam is converted into a usable electronic signal

b. radiation is absorbed into the lattice of a fluorescent crystal

c. the photomulitplier tube converts the electronic signal into a laser image

d. the trapped energy of the electronic latent image is released as visible light

25. During x-ray exposure of a CR phosphor, within its molecular structure what do the meta-stable F centers do?

a. absorb x-ray energy

b. trap excited electrons

c. give off visible light

d. conduct electrical current

26. After a photostimulable phosphor plate has been scanned in the CR reader, it is then exposed

to high-intensity white light in order to:

a. clean the transport system of leftover positive ions

b. clear any of the remaining latent image from the phosphor layer

c. realign the low density laser mirror to the PM tube

d. amplify the electronic signal from the PM tube before it goes to the computer system

27. A flat panel containing rows and columns of thousands of detector elements defines a(n):

a. Phosphor plate

b. Active matrix array

c. CR reader

d. CR cassette

28. During the reading process, the intensity of light emitted by the CR plate phosphor is directly

proportional to:

a. the amount of quantum mottle present in the image

b. the voltage applied to the photomultiplier (PM) tube

c. the amount of x-ray energy absorbed in the plate

d. the original kVp used for the radiographic technique

29. During the CR reading process, the direction in which the photostimulable phosphor plate

moves as it is scanned is called the:

a. slow scan or sub-scan direction

b. fast scan direction

c. interlaced or alternating scan direction

d. detection axis direction

30. Which of the following types of lasers is most commonly used in CR processors?

a. helium-neon

b. chlorine-argon

c. xenon-sodium

d. hydrogen-krypton

31. When a photostimulable phosphor plate is stimulated by a laser beam, the color of light

emitted from a barium fluorohalide crystal is:

a. yellow-green

b. blue-violet

c. ultraviolet

d. orange

32. A CR phosphor plate should be erased prior to use if it has been in storage and accumulating

background radiation for more than:

a. 1 day

b. 2 days

c. 3 days

d. 5 days

33. “Pre-fogging” a CR cassette prior to use adds to the overall amount of \_\_\_\_\_\_\_ fed into the

computer, which can cause rescaling or gradation errors if it becomes overwhelming.

1. CNR
2. Data
3. Noise
4. Signal intensity

34. For a DR receptor plate, if the width of the individual detector elements could be reduced

to 0.0625 mm (del pitch = 0.0625 mm), what spatial resolution could be achieved?

a. 4 LP/mm

b. 5 LP/mm

c. 6 LP/mm

d. 8 LP/mm

35. For CR systems, an upper limit on spatial resolution is imposed by the:

a. sampling frequency of the CR reader

b. size of crystals in the photostimulable phosphor plate

c. geometry of the x-ray beam

d. size of the focal spot in the x-ray tube

36. Which of the following is calculated as 2 times the highest frequency within a digital image:

a. Larmour frequency

b. Nyquist frequency

c. fast-scan frequency

d. aliasing frequency

37. The formula relating the field-of-view (FOV) to the pixel size of “soft” pixels is: *For a given*

*physical area:*

1. FOV = PS/M
2. FOV = M/PS
3. PS = FOV/M
4. PS = M/FOV

38. What is the “soft” pixel size for a 205 mm (FOV) image displayed on a monitor screen with

a 1024 X 1024 matrix of hardware pixels?

1. 0.2 mm
2. 2 mm
3. 5 mm
4. 0.5 mm

39. For different applications, the *field-of-view (FOV)* can be determined by the:

a. physical size of a display monitor

b. physical size of an image receptor

c. size of the collimated x-ray field, if smaller than the image receptor

d. level of magnification (zoom) applied at a display monitor

e. any of the above

40. Because they are NOT subject to change, the pixel size formula is *invalidated* for:

a. the dels (detector elements) in a DR detector plate

b. the pixels in a *fixed sampling* CR reader

c. the hardware pixels of a display monitor

d. all of the above

41. A particular DR detector has dels measuring 100 microns in width. During exposure, if the

x-ray field is collimated to a size smaller than the DR detector plate, the *inherent*

sharpness (spatial resolution) for the DR detector will:

1. Increase
2. Decrease
3. Remain the same

42. Smaller image receptor plates will result in higher sharpness only IF the system is a(n):

a. Fixed matrix CR system

b. Fixed sampling CR system

c. Direct-conversion DR system

d. Indirect-conversion DR system

43. On a liquid-crystal display (LCD) monitor, each intersection of two flat, transparent wires

constitutes a:

1. Hardware del
2. Hardware pixel
3. “Soft” pixel
4. “Soft” del

44. For a display monitor, which of the following is constant or fixed:

a. The displayed field-of-view (FOV)

b. The size of the displayed light image pixels

c. The size of the hardware pixels

d. The matrix size for the displayed light image

45. Magnification of the displayed light image using monitor controls can be accomplished only

by:

1. Spreading out a single pixel value across several hardware monitor pixels
2. Increasing the size of the hardware monitor pixels
3. Increasing the displayed image matrix size
4. Increasing the displayed image field-of-view (FOV)

46. Changing the field-of-view (FOV) can affect the spatial resolution (sharpness) of an image

ONLY if it results in:

1. Changing the matrix size
2. Changing the pixel size
3. Changing the pixel value
4. Maintaining the matrix size

47. At the display monitor, as the light image in magnified more and more, the *matrix size* for the

light image itself is:

1. Unchanged
2. Increasing
3. Decreasing

48. Which of the following is the most likely cause for a “pixelly” digital image:

a. overexposed

b. over-magnified

c. aliased

d. over-brightened

49. A reflective backing in a CR phosphor plate improves its:

a. absorption efficiency

b. conversion efficiency

c. emission efficiency

d. k-edge effect

50. Which of the following increase the absorption efficiency of a CR phosphor plate:

a. thicker phosphor layer

b. phosphor compounds with high atomic numbers

c. compounds that take advantage of the k-edge effect

d. all of these

e. none of these

51. Which of the following affect the conversion efficiency of a CR phosphor plate:

a. thickness of the phosphor layer

b. the chemical compound used as a phosphor

c. size of the phosphor crystals

d. all of these

e. none of these

52. Generally, phosphor elements with higher atomic numbers absorb more x-rays; However, an

exception to this rule can occur if lowering the atomic number better matches the of

the phosphor element to the typical energies in a diagnostic x-ray beam:

a. physical density

b. electron density

c. binding energy of the k-shell

d. atomic mass

53. An active matrix array panel converts \_\_\_\_\_\_\_ energy to \_\_\_\_\_\_\_\_ energy:

a. X-ray or light to electrical

b. X-ray to light

c. Light to x-ray

d. Electrical to light

54. When compared to direct-conversion DR systems, a major reason that indirect-conversion

DR systems can save patient dose is that they have higher:

a. absorption efficiency

b. conversion efficiency

c. emission efficiency

d. electronic efficiency

55. When the signal-to-noise ratio of the output image from a receptor is divided by the signal-

to-noise ratio of the signal coming into the receptor, (with both numbers squared), we

obtain the overall for the system:

a. emission efficiency

b. detective quantum efficiency

c. contrast-noise ratio

d. modulation transfer function

56. Which of the following has the highest DQE, at 77%:

a. conventional screens and film

b. CR phosphor plates

c. direct-conversion DR plates

d. indirect-conversion DR plates

57. For CR, the most common source of image artifacts is the:

a. patient

b. phosphor plate

c. reader (processor)

d. computer

58. Whenever there is an insufficient sampling rate for a high-frequency digital image, \_\_\_\_\_\_

artifacts may be created:

a. pixel drop-out

b. halo

c. reticulation

d. aliasing

59. The *Nyquist criterion* states that to prevent aliasing, the sampling rate must be \_\_\_\_\_ the

spatial frequency of the image:

1. Equal to
2. At least twice
3. One-half
4. Four times

60. Which of the following would be caused by fluctuations in the electrical current passing

through the image acquisition system or digital processing system:

1. Electronic aliasing
2. Grid aliasing
3. Electronic mottle
4. Material mottle

61. In digital imaging, missing lines or pixels can be caused by problems with:

a. computer memory

b. digitization

c. communication between the image acquisition system and the computer system

d. all of the above

e. b & c only

62. In any digital image, the distance from the center of one pixel to the center of the next

adjacent pixel is the:

a. pixel pitch

b. pixel span

c. spatial frequency

d. average detail size

63. For direct-conversion DR systems, the detection surface of each del is made of:

a. Cesium iodide

b. Gadolinium oxysulfide

c. Amorphous selenium

d. Amorphous silicon

64. For indirect-conversion DR systems, the phosphor plate may be made of:

a. Silicon compounds

b. Selenium compounds

c. Barium fluorohalide compounds

d. Cesium or gadolinium compounds

65. For indirect-conversion DR systems, why is amorphous silicon used rather than amorphous

selenium for the semiconductor layers of the detector elements (dels)?

a. silicon is a better electrical conductor

b. the molecule must be suited to absorbing light rather than x-rays

c. silicon binds better to the cesium iodide layer above

d. silicon is easier to coat into very thin layers

66. Chemicals used for the detection surface of dels must be in powder form. The term for a

“shapeless,” granular powder is:

a. Heterogeneous

b. Amorphous

c. Nematic

d. Silicate

67. In the AMA, which of the following acts as a switching gate to release the built-up electrical

charge when each del is “read out”:

a. The TFT

b. The top electrode

c. The capacitor

d. The detection surface

68. Within the detection surface of a del, ionization of molecules by x-rays or light creates

electron/hole pairs. A hole consists of:

a. An ionized molecule with a negative charge

b. An ionized molecule with a positive charge

c. An orbital electron with a positive charge

d. A free electron with a negative charge

69. On read-out of an exposed DR detector plate, what causes the TFT “gates” to open in

sequence and dump their stored electric charge into a data line:

a. X-ray exposure

b. Light exposure

c. A sudden surge of electricity

d. Change of a “bias” voltage from negative to positive

70. Which of the following is the first item listed out of order for the flow of electronic data

through a DR system:

a. Data line

b. ADC

c. Amplifier

d. Computer

71. On read-out of a DR detector, electronic charge is “dumped” from each del into:

a. A data line

b. A gate line

c. An address driver

d. A capacitor

72. For indirect-conversion DR, which of the following best represents the sequence of energy

conversions:

a. X-rays, electrical signal

b. X-rays, light, electrical signal

c. X-rays, electrical signal, light

d. Light, electrical signal

73. The greater the stored electric charge in each del, the \_\_\_\_\_\_ the pixel will be upon display:

a. Darker

b. Lighter

c. Higher contrast

d. Lower contrast

74. Since DR units use a flash electronic exposure to purge any residual charge between

exposures, it is not susceptible (like CR is) to:

a. Anode heel effect

b. Mottle

c. Scatter radiation during exposure

d. Background radiation

75. The ability of a whole image acquisition system or any of its components to detect and

measure small amounts of radiation defines its:

a. Sensitivity

b. Dynamic range

c. Brightness

d. Contrast resolution

76. Dynamic range is the range of pixel values made available to build up a displayed image, and

is best applied to describe:

a. the image receptor only

b. the computer and display hardware only

c. the computer software only

d. the whole image acquisition system

77. Which of the following best describes the ability of an entire imaging system to reproduce

the differences between tissues within the body in the final displayed image:

a. Sensitivity

b. Dynamic range

c. Spatial resolution

d. Contrast resolution

78. The sensitivity of an image acquisition system depends upon:

a. the inherent sensitivity of the image receptor

b. the speed setting of the computer processing system

c. both of the above

d. neither of the above

79. The smaller the del or pixel size, the:

a. Higher the spatial resolution

b. Lower the spatial resolution

c. Higher the contrast resolution

d. Lower the contrast resolution

80. An image matrix that can be changed in size within the physical area of the display is

referred to as “\_\_\_\_\_\_”:

a. Active

b. Fixed

c. Soft

d. Hard

81. For a fixed-matrix CR unit, the pixels are:

a. Well defined, with a fixed area

b. Well-defined, not with a fixed area

c. Poorly-defined, with a fixed area

d. Poorly-defined, not with a fixed area

82. For CR, pixel size can be changed by effectively “collimating” the:

a. X-ray beam

b. Laser beam

c. Light image

d. Light guide

83. If the physical area of the displayed image is fixed, the only way to fit more pixels into the

physical area is to make the:

a. Pixels smaller

b. Pixels larger

c. Matrix smaller

d. Field-of-view (FOV) smaller

84. For a displayed light image, the larger the matrix, the:

a. Higher the efficiency

b. Lower the efficiency

c. Higher the spatial resolution (sharpness)

d. Lower the sharpness

85. For a displayed image in a fixed physical area, the smaller the field-of-view (the more zoom

applied), the:

a. Higher the brightness

b. Lower the magnification

c. Lower the spatial resolution (sharpness)

d. Higher the spatial resolution (sharpness)

86. Most modern CR systems are \_\_\_\_\_\_ systems:

a. Fixed matrix

b. Fixed sampling

c. Direct-conversion

d. Indirect-conversion

87. The pixel size formula can only be applied when the image consists of:

a. Soft pixels

b. Hard pixels

c. Large pixels

d. Small pixels

88. The types of efficiency for any x-ray image receptor system include all of the following

EXCEPT:

a. Electromagnetic

b. Absorption

c. Conversion

d. Emission

89. Which of the following is a primary advantage of direct-conversion DR receptors over

indirect-conversion systems?

a. improved spatial resolution

b. lowered patient exposure

c. increased image contrast

d. increased system processing speed

90. Compared to indirect-conversion DR systems, even though direct-conversion DR systems

result in increased patient dose, they continue in use because of their higher:

a. Gray scale

b. Spatial resolution (sharpness)

c. Density

d. Contrast

91. For the electronic active matrix array, the conversion of light or x-ray energy into an

electronic signal is:

a. About 30%

b. About 67%

c. About 77%

d. Nearly 100%

92. \_\_\_\_ imaging system(s) can achieve a perfect DQE (detective quantum efficiency) of 100%:

a. No

b. Some

c. Most

d. All

1. For CR systems, in the PSP plate, *barium fluoro-halide* compounds are most commonly used for the:
   1. Base
   2. Anti-halo layer
   3. Active phosphor layer
   4. Reflective layer
2. For a CR cassette, which of the following must be made of a low-absorption carbon fiber material:
   1. Phosphor layer
   2. Front panel
   3. Back panel
   4. Phosphor support base
3. In a CR PSP plate, the small percentage of electrons trapped in F centers form a(n) \_\_\_\_\_\_\_\_ image stored by the phosphor plate:
   1. X-ray
   2. Electronic
   3. Primary
   4. Latent
4. During exposure, a CR phosphor fluoresces when \_\_\_\_\_ of the electrons ejected out of their atoms fall *immediately* back into their shells:
   1. All
   2. Most
   3. A few
   4. None
5. In the CR reader, when a PSP plate is re-stimulated by the laser beam, it emits a very:
   1. Dim light image
   2. Bright light image
   3. Dim electronic image
   4. Bright electronic image
6. In the CR reader, which of the following best describes the process the PSP plate undergoes:
   1. Fluorescence
   2. Phosphorescence
   3. Delayed phosphorescence
   4. Luminescence
7. Within the CR reader, the *fast scan direction* relates to the:
   1. Laser beam
   2. Rollers
   3. Suction cups
   4. White light beam
8. The maximum size of CR pixels is defined by the size of the:
   1. Phosphor crystals
   2. X-ray beam
   3. Detector elements
   4. Laser beam
9. In the CR reader, the bundle of optic fibers that picks up emitted light from the

PSP plate is the:

* 1. Photocathode
  2. Light channeling guide
  3. Active matrix array
  4. Photomultiplier tube

1. All of the following are components of a photomultiplier (PM) tube EXCEPT:
   1. Collector
   2. Photocathode
   3. PSP plate
   4. Dynodes
2. For CR, the photostimulable phosphor must be made one of a small number of

barium fluoro-halide compounds that possess the ability to temporarily \_\_\_\_\_\_\_

a latent image:

* 1. Emit
  2. Expose
  3. Store
  4. Ionize

1. In a CR reader, the photomultiplier (PM) tubes used are especially sensitive to:
   1. White light
   2. Blue-violet light
   3. Red light
   4. X-rays
2. Each CR cassette has a unique identifying number that can be accessed by a(n):
   1. Flasher
   2. Bar code reader
   3. Active matrix array
   4. PSP
3. A CR phosphor plate should be erased prior to use if it has been in storage and

accumulating background radiation for more than:

a. 1 day

b. 2 days

c. 3 days

d. 5 days

1. The distance from the center of one del or pixel to the cente4r of an adjacent del

or pixel defines their:

* 1. Value
  2. Width
  3. Pitch
  4. Height

1. In a CR reader, the only way to increase the sampling frequency is to:
   1. Increase the sample value
   2. Decrease the sample value
   3. Increase the distance between samples
   4. Decrease the distance between samples
2. In a row of image pixels, the number of resolvable details is \_\_\_\_\_ the number of

available pixels:

* 1. Equal to
  2. 2 times
  3. One-half
  4. One-quarter

1. *Spatial frequency* is measured in:
   1. Pixels per line
   2. mm
   3. LP
   4. LP/mm
2. A typical 100-micron (0.1 mm) del produces a spatial frequency of about:

a. 0.2 LP/mm

b. 0.5 LP/mm

c. 5 LP/mm

d. 10 LP/mm

1. The percentage of a del’s square area devoted to the semiconductor detection

layer is called the del’s:

* 1. Absorption factor
  2. SNR factor
  3. DQE factor
  4. Fill factor

1. Because the TFT and capacitor cannot be further miniaturized, smaller dels result

in:

* 1. Increased patient dose
  2. Decreased patient dose
  3. Increased sharpness
  4. Decreased sharpness

1. The Moire artifact is a form of image:
   1. Signal
   2. Mottle
   3. Fog
   4. Noise
2. To avoid aliasing artifact, *each* \_\_\_\_\_ of the digital signal must be sampled:
   1. Cycle
   2. Pulse
   3. Wave
   4. Detail
3. Which of the following act as “sampling devices” and can thus contribute to the

risk of aliasing artifacts:

a. Display monitors

1. Grids
2. CR readers
3. All of the above

117. Entire line or column drop-out can result from malfunction of the CR:

a. roller system

b. PM tube

c. eraser section

d. PSP plate

118. Artifacts can result from:

a. del drop-out

b. improper application of digital processing features

c. segmentation failure

d. all of the above

119. For CR, aliasing can be caused by display monitor having lower \_\_\_\_\_\_\_\_\_\_\_ than the

acquired image:

1. Dynamic range
2. Resolution
3. Distortion
4. Contrast

120. What is the size of each pixel for a 1024 matrix using a 30 cm field of view:

a. 3 cm

b. 30 cm

c. 3 mm

d. 0.3 mm

121. Which of the following artifacts is related to the Nyquist frequency?

a. grid lines

b. aliasing artifact

c. heat blur

d. mottle