

COMPREHENSIVE MOCK EXAM 5

Supplemental to: Ultrasound Physics Board Review 2026-2027

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ARDMS SPI (Sonography Principles & Instrumentation) Examination, Inteleos — 110 questions, single-best-answer, four options (A-D), domain-weighted per official ARDMS SPI Content Outline (v17.3)

Board-Review Questions

1. Tissue Doppler Imaging (TDI), as referenced in the New Technologies subdomain, is optimized to detect which type of signal?
 - A. High-velocity blood flow signals
 - B. Static structures with no motion
 - C. Low-velocity, high-amplitude tissue motion
 - D. Cavitation bubble formation

2. Elastography imaging, as a newer ultrasound technology, displays which physical property of tissue?
 - A. Tissue perfusion (blood volume)
 - B. Relative tissue stiffness
 - C. Tissue attenuation coefficient
 - D. Tissue propagation-speed variance

3. The mechanism by which ultrasound contrast agents (microbubbles) enhance signal is best described as:
 - A. Absorption of ultrasound energy
 - B. Nonlinear oscillation generating harmonic echoes
 - C. Alteration of local propagation speed
 - D. Emission of an independent acoustic signal

4. Fusion (hybrid) imaging, per the SPI content outline, specifically refers to which capability?
 - A. Combining B-mode and color Doppler display
 - B. Blending two different transducer frequencies
 - C. Merging images from two ultrasound systems
 - D. Real-time co-registration of ultrasound with a prior CT/MRI dataset

5. The statistical parameter describing a test's ability to correctly identify patients who truly have a condition is called:
- A. Specificity
 - B. Positive predictive value
 - C. Sensitivity
 - D. Overall accuracy
6. An element-integrity test performed during transducer QA is designed to detect which specific problem?
- A. Incorrect system TGC calibration
 - B. Excessive ambient room temperature
 - C. Operator error in preset selection
 - D. Individual nonfunctioning or degraded elements
7. Knowledge of what 'contributes to degradation of image' is a listed skill under the Clinical Safety domain because it directly supports which task?
- A. Evaluating transducer integrity during QA
 - B. Selecting the correct exam protocol
 - C. Calculating patient body mass index
 - D. Determining ideal room lighting
8. Correlating a patient's clinical history and prior imaging studies with the current ultrasound findings serves which primary purpose?
- A. Satisfying a billing requirement only
 - B. Improving diagnostic accuracy and exam relevance
 - C. Reducing the total exam time
 - D. Replacing the need for a physician read

9. Acquiring information from other imaging findings, such as a prior CT or MRI, before or during a sonographic exam is valuable primarily because it:

- A.** Helps focus the exam on relevant anatomy or pathology
- B.** Is required for legal documentation only
- C.** Eliminates the need for a sonographic report
- D.** Determines which transducer frequency is legally required

10. Verifying a patient's identity using two independent identifiers (e.g., name and date of birth) before beginning an exam is a practice primarily intended to prevent which error?

- A.** Exceeding the recommended exam duration
- B.** Selecting an incorrect transducer frequency
- C.** Performing the wrong exam on the wrong patient
- D.** Failing to obtain informed consent

11. An established escalation pathway for communicating a critical or urgent sonographic finding exists primarily to ensure:

- A.** The finding stays out of the patient's chart
- B.** The sonographer alone decides on notification
- C.** Physicians are notified promptly on urgent findings
- D.** The finding waits for the next routine visit

12. Lateral resolution is best defined as the ability to distinguish which type of structures?

- A.** Two reflectors at different depths along the beam
- B.** Two moving structures over time
- C.** Two structures of different echogenicity
- D.** Two side-by-side reflectors at the same depth

- 13.** Elevational (slice-thickness) resolution describes the beam's dimension in which direction?
- A.** Along the beam axis (depth)
 - B.** Within the scan plane, side-to-side
 - C.** Perpendicular to the scan plane
 - D.** Along the time axis of acquisition
- 14.** Contrast resolution refers to the system's ability to:
- A.** Distinguish two closely spaced reflectors
 - B.** Detect rapidly moving structures
 - C.** Penetrate to maximum depth
 - D.** Distinguish subtle echo-amplitude differences
- 15.** The inverse-square law, as it applies to an unfocused ultrasound beam, describes which relationship?
- A.** Intensity decreases in proportion to the square of the increasing distance
 - B.** Intensity increases in proportion to the square of the distance
 - C.** Frequency decreases in proportion to the square of the distance
 - D.** Propagation speed decreases in proportion to the square of the distance
- 16.** Among common tissues, which propagation-speed relationship is generally correct?
- A.** Fat transmits sound faster than bone
 - B.** Air transmits sound faster than soft tissue
 - C.** Bone transmits sound faster than fat
 - D.** All tissues transmit sound at an identical speed
- 17.** Constructive and destructive interference of overlapping sound waves results in which observable effect?

- A. A permanent increase in overall frequency
- B. Localized regions of increased or decreased amplitude
- C. Complete cancellation of the beam everywhere
- D. A uniform increase in propagation speed

18. The half-value layer of a tissue describes:

- A. The thickness of tissue that reduces beam intensity by half
- B. The thickness that doubles beam intensity
- C. The midpoint depth of the entire field of view
- D. The point where axial and lateral resolution are equal

19. The effective radiating area (ERA) of a transducer refers to:

- A. The total physical footprint including housing
- B. The area of tissue imaged at maximum depth
- C. The actual active surface area transmitting ultrasound energy
- D. The area covered by the acoustic lens only

20. The total measured attenuation of a beam as it passes through tissue differs from the backscattered signal received by the transducer because:

- A. Attenuation includes absorption plus scattering losses
- B. Backscatter always exceeds attenuation
- C. Attenuation occurs only in fluid
- D. Backscatter and attenuation are identical

21. The nonlinearity parameter (B/A) of a tissue is relevant to ultrasound physics primarily because it influences:

- A.** Baseline propagation speed at low intensity
- B.** Degree of harmonic frequency generation
- C.** The transducer's resonant frequency
- D.** The system's frame rate calculation

22. The acoustic wave equation relating pressure, impedance, and particle velocity in a medium is generally expressed as:

- A.** Pressure equals impedance divided by particle velocity
- B.** Impedance equals pressure divided by frequency
- C.** Pressure equals impedance multiplied by particle velocity
- D.** Particle velocity equals impedance divided by density

23. A hydrophone is used in ultrasound physics QA primarily to:

- A.** Directly measure acoustic output parameters such as pressure and intensity
- B.** Measure the electrical impedance of the transducer cable
- C.** Calibrate the system's on-screen depth markers
- D.** Test the disinfectant concentration of high-level solutions

24. As a beam travels through a uniform attenuating medium, its intensity decreases with distance in which characteristic pattern?

- A.** A linear (straight-line) decrease
- B.** An exponential decay curve
- C.** A stepwise decrease at fixed intervals only
- D.** An increasing curve before eventually decreasing

25. The backscatter coefficient of a tissue describes:

- A.** The total fraction of energy absorbed as heat
- B.** The fraction of the beam that continues forward unaffected
- C.** The fraction of energy reflected at a specular interface only
- D.** The fraction of scattered energy redirected specifically back toward the source

26. In a dispersive medium, the concept of phase velocity differing from group velocity refers to which phenomenon?

- A.** Different frequency components of a complex pulse traveling at slightly different speeds
- B.** The beam traveling faster in the near field than the far field
- C.** Sound traveling faster toward the transducer than away from it
- D.** A difference between transmitted and received frequency

27. The wavelength of sound measured inside a transducer's piezoelectric crystal differs from the wavelength of the same frequency in soft tissue primarily because:

- A.** Frequency changes as the sound crosses the crystal-tissue boundary
- B.** Wavelength is a fixed universal constant, unaffected by medium
- C.** The crystal absorbs all sound below a threshold wavelength
- D.** Propagation speed within the crystal material differs from propagation speed in soft tissue

28. A two-dimensional (2D) matrix array transducer enables which capability not readily achieved with a standard 1D array?

- A.** A higher maximum operating frequency than any 1D array
- B.** Elimination of the need for an acoustic lens
- C.** Doppler-only operation without B-mode capability
- D.** Real-time volumetric (true 3D/4D) acquisition

29. Element manufacturing yield, evaluated during transducer production QA, refers to:

- A.** The total number of elements physically fitting on the array
- B.** The frequency range achievable by the finished probe
- C.** The proportion of elements in a batch that meet functional specifications
- D.** The expected clinical lifespan of the transducer

30. Multiplexing, in the context of transducer channel design, refers to:

- A.** Doubling the number of piezoelectric crystals used
- B.** Combining two separate transducers into one housing
- C.** Sharing a limited number of electronic channels across a larger number of elements
- D.** Switching automatically between B-mode and Doppler modes

31. Synthetic aperture imaging is a technique in which:

- A.** Combining smaller apertures into one synthetic large aperture
- B.** One large physical aperture every pulse
- C.** Physically expanding the housing mid-exam
- D.** Two probes mechanically fused together

32. A row-column addressed (RCA) array transducer design achieves 2D-equivalent imaging capability using which approach?

- A.** Addressing rows for transmit, columns for receive
- B.** A conventional 1D array rotated mechanically
- C.** A fixed acoustic lens shaping the beam
- D.** Two separate 1D arrays stacked physically

33. PVDF (polyvinylidene fluoride) is notable as a transducer material because it is:

- A.** Identical in structure and properties to PZT ceramic

- B.** A metal alloy used only for transducer housings
- C.** A material used exclusively for backing, never as an active element
- D.** A flexible polymer with piezoelectric properties, unlike rigid ceramic PZT

34. A piezocomposite material with 1-3 connectivity refers to a design in which:

- A.** One crystal type is layered atop three different crystal types
- B.** Piezoelectric ceramic rods are embedded within a polymer matrix
- C.** Three separate frequencies are generated from a single rod
- D.** One backing layer supports three separate matching layers

35. Single-crystal piezoelectric material (such as PMN-PT) generally offers which advantage over conventional polycrystalline PZT?

- A.** Substantially lower manufacturing cost
- B.** Complete immunity to Curie-point depoling
- C.** No need for any backing layer
- D.** Higher coupling efficiency and bandwidth

36. The concept of a 'virtual apex' or virtual source in phased-array beamforming refers to:

- A.** The physical center of the housing
- B.** A real focal point in front of the array
- C.** A computed focal point behind the array face
- D.** The location of the power supply

37. True time delay beamforming differs from analog delay-line beamforming primarily in that true time delay:

- A.** Usable only with narrowband transducers

- B.** Eliminates the need for beamforming
- C.** A receive-only technique, never on transmit
- D.** Frequency-independent, accurate across bandwidth

38. Electrical impedance matching within a transducer's circuitry serves which purpose?

- A.** Maximizing electrical power transfer between the system's electronics and the crystal
- B.** Matching the crystal's acoustic impedance to skin, as the matching layer does
- C.** Physically aligning the transducer housing to the probe cable
- D.** Adjusting the displayed color Doppler scale automatically

39. Field-return failure analysis, performed by a manufacturer on a transducer returned after a clinical malfunction, is intended to:

- A.** Immediately re-certify the probe as safe without further testing
- B.** Determine the patient's exam billing code retroactively
- C.** Replace the probe's disinfection log for compliance purposes
- D.** Determine the specific cause of the probe's failure to improve future design or QA

40. A 'chip-on-tip' transducer design integrates which component directly at the probe's distal end?

- A.** Beamforming electronics, reducing cable signal loss
- B.** An additional battery for wireless operation
- C.** A secondary backup piezoelectric crystal
- D.** A built-in disinfectant reservoir

41. Factory burn-in testing of a newly manufactured transducer is performed primarily to:

- A.** Sterilize the probe before initial packaging
- B.** Calibrate the operator's preferred preset settings

- C. Verify the probe's compatibility with a specific patient
- D. Identify early-failure components before the probe reaches clinical use

42. Adequate cable shielding in a transducer cable primarily protects signal quality from which source of interference?

- A. Physical wear from repeated bending
- B. Electromagnetic interference from nearby equipment
- C. Excessive coupling gel exposure
- D. Direct mechanical impact damage

43. The guard ring — a peripheral ring of inactive elements sometimes found at the edge of an array — serves which purpose?

- A. Actively transmitting a wider beam
- B. Increasing maximum operating frequency
- C. Serving as the primary Doppler element
- D. Reducing edge artifact and mechanical stress

44. An IPX water-ingress protection rating assigned to a transducer indicates:

- A. The maximum imaging depth achievable in a water bath
- B. The probe's compatibility with a specific gel brand
- C. The degree of protection against water/liquid entering the housing
- D. The frequency range approved for underwater use

45. A sparse array transducer design intentionally reduces the number of active elements primarily to achieve which tradeoff?

- A. Lower system channel-count and cost, at some expense to image quality or sensitivity
- B. Higher image quality than a fully populated array at equal cost

- C. Elimination of the need for any beamforming
- D. Guaranteed higher frame rate than any fully populated design

46. Beam-width (section-thickness) artifact occurs due to which underlying cause?

- A. Off-axis structures within beam thickness
- B. Excessive TGC at a single depth
- C. A dead element in the array
- D. Aliasing of the Doppler scale

47. Multipath artifact results from which mechanism?

- A. Sound traveling a straight, single-bounce path
- B. A dead element failing to receive
- C. Sound bouncing off multiple structures, adding travel time
- D. Excessive gain saturating the display

48. Pseudo-sludge artifact, sometimes seen within the gallbladder, is best explained by which mechanism?

- A. Beam-width/side-lobe artifact simulating layering debris that is not truly present
- B. Actual biliary sludge always being present when this appearance occurs
- C. A calibration error affecting only the gallbladder fossa
- D. A software bug unrelated to any acoustic phenomenon

49. The distinction between 'clean' shadowing and 'dirty' (dense) shadowing deep to a structure is primarily useful for differentiating which types of attenuators?

- A. Clean shadowing from fluid versus dirty shadowing from soft tissue
- B. Clean shadowing from smooth reflectors (e.g., stone) versus dirty shadowing from gas

- C. Clean shadowing from bone versus dirty shadowing from fat only
- D. There is no meaningful distinction between the two appearances

50. Distinguishing true posterior acoustic enhancement from a genuinely hyperechoic deep structure requires evaluating which factor?

- A. Present on every acquired frame
- B. Confined deep to the structure
- C. Scanned with patient supine
- D. Frequency above 5 MHz

51. Near-field clutter artifact, distinct from a comet-tail artifact, is best described as:

- A. A discrete, narrow, deep bright trail
- B. A fixed vertical dropout line
- C. A color-only artifact, no grayscale version
- D. Near-field haze from probe-face ring-down

52. Elevational compounding, as an image-processing technique, combines information from which acquisition approach?

- A. Multiple transmit frequencies averaged together
- B. Multiple steering angles within a single scan plane
- C. Multiple separate patients' images overlaid
- D. Multiple elevational (slice) planes averaged together to reduce noise

53. Panoramic (extended field of view) misregistration artifact most commonly results from which technical error?

- A. Inconsistent or excessively fast probe motion during the sweep
- B. Using too low a transducer frequency

- C. Applying too much overall gain during acquisition
- D. Selecting an inappropriately large color Doppler box

54. A tissue-specific propagation-speed preset on an ultrasound system is designed to address which limitation?

- A. The need to manually recalibrate TGC for every patient
- B. The need to manually adjust transducer frequency each exam
- C. The system's default 1540 m/s assumption not matching every tissue type exactly
- D. A requirement to reset the system's internal clock

55. Automated (one-touch) image-optimization algorithms adjust the displayed B-mode image primarily by:

- A. Automatically selecting the correct patient for the exam
- B. Automatically tuning gain, TGC, and dynamic range based on the current echo data
- C. Automatically diagnosing any pathology present
- D. Automatically switching the exam to a different modality

56. Voice-command control on a modern ultrasound system is primarily intended to improve which aspect of workflow?

- A. Automatically generating the final diagnostic report text
- B. Replacing the need for any physical system controls entirely
- C. Allowing hands-free control during sterile or difficult-access scanning situations
- D. Improving the transducer's acoustic output power

57. Wireless or cloud-based PACS distribution, compared to a traditional wired on-premises system, primarily offers which advantage?

- A. Elimination of the need for any patient identifiers

- B.** Guaranteed higher image resolution than wired storage
- C.** Remote access to images from outside the immediate scanning location
- D.** Automatic disinfection of transducers between exams

58. Tele-ultrasound, as an emerging workflow model, primarily enables which capability?

- A.** Fully autonomous scanning with no sonographer present at all
- B.** Elimination of the need for transducer calibration
- C.** Automatic translation of the exam into multiple languages
- D.** Remote guidance or interpretation support from an off-site expert during a live exam

59. A dual live/split-screen display comparing a current image side-by-side with a stored prior image serves which primary purpose?

- A.** Doubling the effective frame rate of the live image
- B.** Automatically calculating percentage change between exams
- C.** Facilitating direct visual comparison for interval change assessment
- D.** Replacing the need for a written comparison in the report

60. A system's built-in self-test diagnostic routine is designed to:

- A.** Automatically disinfect the transducer surface
- B.** Automatically verify internal hardware and software function before or during use
- C.** Verify the sonographer's individual login credentials
- D.** Replace the need for periodic external QA phantom testing

61. A software license activation requirement on certain advanced imaging features (e.g., elastography, 3D) exists primarily to:

- A.** Control access to optional, separately purchased software modules

- B.** Verify the operator's clinical certification status
- C.** Confirm the transducer has passed its most recent QA test
- D.** Automatically calibrate the system's TGC curve

62. Exporting a raw DICOM image file, rather than capturing a simple on-screen screenshot, offers which specific advantage?

- A.** Produces a smaller file size always
- B.** Automatically anonymizes patient information
- C.** Preserves full pixel data and metadata
- D.** Guarantees the image cannot be altered

63. Structured reporting software/templates used in sonography primarily aim to:

- A.** Automatically render a final diagnosis without physician input
- B.** Standardize documentation of required measurements and findings across exams
- C.** Replace the need for image archiving entirely
- D.** Eliminate variation in transducer selection between sonographers

64. The on-screen annotation/arrow tool available on most systems is used primarily to:

- A.** Automatically measure the distance between two points
- B.** Automatically adjust focal zone placement
- C.** Label or highlight a specific finding directly on the saved image
- D.** Control the system's overall output power

65. Dual-frequency compounding, as distinct from single-frequency frequency compounding, refers to:

- A.** Compounding images from two entirely different transducers
- B.** Alternating between B-mode and M-mode automatically

- C. Combining a fundamental and its third harmonic exclusively
- D. Combining images acquired at exactly two selected frequencies into one displayed image

66. A multi-monitor display configuration in an ultrasound suite primarily allows which workflow benefit?

- A. Doubling the maximum imaging depth
- B. Duplicating the exam onto two storage devices
- C. Viewing live imaging alongside priors/worksheets
- D. Increasing the maximum frame rate

67. Needle-enhancement beam steering, used during ultrasound-guided procedures, works by:

- A. Physically bending the needle to match angle
- B. Increasing gain uniformly across the image
- C. Switching to a different transducer
- D. Steering the beam nearer perpendicular to the needle

68. Respiratory gating, as distinct from ECG gating, synchronizes image acquisition to which physiological cycle?

- A. The patient's cardiac cycle
- B. The patient's gastrointestinal peristaltic cycle
- C. The patient's breathing cycle
- D. The transducer's own duty-factor cycle

69. Contrast destruction-replenishment imaging, used in certain contrast-enhanced ultrasound protocols, involves:

- A. Permanently destroying all agent at exam start
- B. Destroying microbubbles, then tracking reperfusion

- C. Replenishing the patient's blood volume
- D. Temporarily destroying harmonic capability

70. Key-image flagging, as distinct from saving the full cine loop archive, allows the operator to:

- A. Permanently delete all unflagged frames
- B. Automatically generate the written report
- C. Mark key frames for quick physician review
- D. Convert the exam to one static image

71. A configurable cine-buffer length setting on an ultrasound system controls:

- A. The maximum number of patients that can be stored simultaneously
- B. How many recent seconds/frames of imaging are retained for retrospective review
- C. The system's maximum achievable frame rate
- D. The transducer's maximum operating frequency

72. A dual-transducer simultaneous connection feature on certain systems is primarily useful for:

- A. Doubling the maximum imaging depth
- B. Averaging images from both probes together
- C. Increasing the Doppler Nyquist limit
- D. Switching probes without disconnecting either

73. An on-screen exam-duration timer displayed during scanning primarily supports which practice?

- A. Automatically billing the patient based on elapsed time
- B. Awareness of cumulative patient exposure time, supporting the ALARA principle
- C. Automatically terminating the exam at a fixed time limit
- D. Calibrating the transducer's frequency output

74. Automated body-habitus preset adjustment is designed to compensate for which patient factor?
- A. The patient's stated pain level
 - B. Tissue thickness/attenuation affecting gain and frequency
 - C. The patient's preferred appointment time
 - D. The patient's insurance coverage category
75. The zoom-region preview box, shown before actually applying a zoom function, allows the operator to:
- A. Selecting the correct transducer automatically
 - B. Permanently locking gain and TGC settings
 - C. Bypassing the need for caliper measurement
 - D. Confirming the region before committing to zoom
76. Manual planimetry (freehand tracing) as a measurement technique differs from an automated ellipsoid-formula calculation in that manual planimetry:
- A. Usable only for perfectly circular structures
 - B. Always more accurate than any automated method
 - C. Traces the true irregular border directly
 - D. Requires no operator input once started
77. A 'tardus parvus' arterial waveform pattern, showing a delayed systolic upstroke and blunted peak, is most suggestive of which condition?
- A. A completely normal high-resistance waveform
 - B. Acute complete distal occlusion with no flow
 - C. Normal venous flow at the sampled site
 - D. A significant stenosis proximal to the sampled site

- 78.** The angle-correction cursor in spectral Doppler is used by the operator to accomplish which task?
- A.** Physically steer the transducer's crystal elements
 - B.** Align the system's angle estimate with the true direction of blood flow
 - C.** Set the PRF to match the estimated maximum velocity
 - D.** Select which color represents flow toward the transducer
- 79.** Setting spectral Doppler gain too high produces which artifact on the waveform trace?
- A.** Aliasing of the peak systolic velocity
 - B.** Background noise filling in the spectral window
 - C.** A falsely narrowed spectral waveform
 - D.** Complete loss of the audible signal
- 80.** Setting the wall filter too high carries which specific clinical risk?
- A.** Introduces aliasing artifact
 - B.** Amplifies wall clutter excessively
 - C.** Loses genuine low-velocity flow
 - D.** Reduces angle-correction accuracy
- 81.** The Doppler reject control functions to accomplish which task?
- A.** Eliminate low-amplitude background noise from the spectral display
 - B.** Increase the maximum detectable velocity before aliasing
 - C.** Reverse the direction convention of the color map
 - D.** Automatically correct the angle of insonation
- 82.** Increasing color Doppler packet size (pulses per scan line for the color image) has which effect?
- A.** Improves velocity accuracy and sensitivity, at reduced frame rate

- B.** Improves frame rate, at reduced color sensitivity
- C.** No effect on frame rate or color sensitivity
- D.** Eliminates the need for wall filtering entirely

83. The color variance map, when enabled, adds which additional information to the standard color Doppler display?

- A.** The absolute peak systolic velocity at each pixel
- B.** The exact angle of insonation at each pixel
- C.** The total volume flow rate through the vessel
- D.** The degree of turbulence, shown as a distinct color overlay

84. Flash (or blooming) artifact in color Doppler is typically caused by which factor?

- A.** A true, sustained increase in flow velocity
- B.** Patient or transducer motion misinterpreted as flow
- C.** Excessive wall filter removing legitimate signal
- D.** Insufficient Doppler gain causing dropout

85. Twinkling artifact, seen on color Doppler overlying certain small strongly reflective structures, is best explained as:

- A.** True, genuine blood flow in the structure
- B.** A finding caused by system miscalibration
- C.** Noise artifact near a rough reflective structure
- D.** A B-mode-only phenomenon, no color component

86. The distinction between mean velocity and peak velocity in Doppler waveform analysis is significant because:

- A.** The two terms are always numerically equal

- B.** Mean velocity requires continuous-wave Doppler only
- C.** Peak velocity is used only for venous flow
- D.** Mean is time-averaged; peak is the single highest value

87. May-Thurner syndrome refers to which anatomic/hemodynamic condition?

- A.** Compression of the celiac artery by the median arcuate ligament
- B.** Compression of the renal vein between the aorta and SMA
- C.** Compression of the subclavian vein at the thoracic outlet
- D.** Compression of the left common iliac vein by the overlying right common iliac artery

88. Budd-Chiari syndrome refers to obstruction at which anatomic level?

- A.** Portal vein inflow to the liver
- B.** Hepatic venous outflow (veins or adjacent IVC)
- C.** Splenic artery inflow to the spleen
- D.** Renal vein outflow from the kidney

89. Nutcracker syndrome describes compression of which vessel, and by what structure?

- A.** Right renal vein, compressed by the liver
- B.** Left renal artery, compressed by the psoas
- C.** Left renal vein, between aorta and SMA
- D.** IVC, compressed by the pancreas

90. A splenic artery aneurysm is clinically notable in pregnancy primarily because:

- A.** It carries an elevated risk of rupture during pregnancy, a life-threatening emergency
- B.** It is exclusively a benign, incidental finding in pregnancy with no monitoring needed
- C.** It only occurs in patients who have never been pregnant

D. It resolves spontaneously in nearly all pregnant patients without intervention

91. A popliteal artery aneurysm is clinically significant primarily due to its association with which complication?

- A.** An exclusively cosmetic concern with no functional risk
- B.** Distal embolization or in-situ thrombosis leading to acute limb ischemia
- C.** Spontaneous conversion into a benign lipoma over time
- D.** An exclusively pediatric condition, never seen in adults

92. On Doppler/duplex evaluation of an arterial dissection, identifying the true lumen versus the false lumen is often aided by which finding?

- A.** Both lumens show identical flow always
- B.** The false lumen always has larger diameter
- C.** Color Doppler cannot distinguish the two lumens
- D.** True lumen shows brisk flow; false lumen sluggish

93. Vertebral artery dissection is an important consideration in a patient presenting with which combination of findings?

- A.** Chronic, bilateral lower-extremity swelling
- B.** Painless, longstanding varicose veins
- C.** Neck pain with posterior-circulation stroke symptoms
- D.** An asymptomatic incidental screening finding

94. Thoracic outlet syndrome, when it affects the subclavian vessels, is best evaluated with which Doppler technique?

- A.** A single static resting waveform only, without any positional change
- B.** Provocative positional maneuvers (e.g., arm abduction) while monitoring for flow changes

- C. Doppler evaluation exclusively of the contralateral, asymptomatic arm
- D. M-mode imaging of the clavicle bone itself

95. Giant cell (temporal) arteritis, when evaluated with ultrasound, classically demonstrates which Doppler/grayscale sign?

- A. A hypoechoic halo around the arterial lumen
- B. Markedly increased velocity, no wall finding
- C. Complete absence of arterial signal
- D. A well-defined, thick-walled true aneurysm

96. A Baker's cyst, when evaluated with ultrasound, is important to distinguish from which other posterior knee/calf finding?

- A. A normal, asymptomatic meniscus
- B. An entirely unrelated, incidental skin lesion
- C. Deep vein thrombosis of the popliteal or calf veins
- D. A benign lipoma located in the anterior thigh

97. Native (non-transplant) renal vein thrombosis is most classically associated with which underlying clinical condition?

- A. Acute viral upper respiratory infection
- B. Nephrotic syndrome and its hypercoagulable state
- C. Chronic, well-controlled hypertension alone
- D. A recent minor superficial skin laceration

98. Portal vein thrombosis, when evaluated with Doppler, characteristically shows which finding within the affected segment?

- A. Absent or markedly diminished flow signal within the portal vein lumen

- B.** Markedly increased, supraphysiologic flow velocity
- C.** A normal, unremarkable hepatopetal waveform
- D.** Flow present only during the cardiac diastolic phase

99. Mesenteric venous thrombosis, in contrast to acute mesenteric arterial occlusion, typically presents with which more gradual symptom pattern?

- A.** Identical, instantaneous-onset severe pain in every case
- B.** No abdominal symptoms whatsoever in any patient
- C.** A subacute, gradually worsening course over days, rather than sudden severe pain
- D.** Symptoms exclusively affecting the lower extremities

100. In a renal transplant, distinguishing acute tubular necrosis (ATN) from acute rejection using Doppler primarily relies on which observation?

- A.** ATN always normal RI; rejection always elevated
- B.** Elevated RI is nonspecific to both; needs correlation
- C.** Only rejection ever produces a Doppler abnormality
- D.** Color Doppler alone definitively diagnoses rejection

101. An ovarian dermoid (mature cystic teratoma), on Doppler evaluation, is classically characterized by which vascularity pattern?

- A.** Marked, diffuse internal hypervascularity throughout the mass
- B.** Absent or minimal internal vascularity, given its largely avascular tissue components
- C.** A single dominant feeding vessel with high-velocity flow
- D.** A vascular pattern identical to a corpus luteum cyst

102. Ovarian hyperstimulation syndrome (OHSS), evaluated with Doppler, is most associated with which clinical setting?

- A. Fertility treatment involving ovarian stimulation medications
- B. Natural, unstimulated spontaneous ovulation only
- C. Postmenopausal women not undergoing any hormonal treatment
- D. Early first-trimester pregnancy without any fertility intervention

103. A cesarean scar ectopic pregnancy implants at which specific anatomic location?

- A. Within the fallopian tube, identical to a typical tubal ectopic
- B. Within the myometrium at the site of a prior cesarean section scar
- C. Within the ovary itself
- D. Within the cervix, distinct from any prior surgical scar

104. Twin-to-twin transfusion syndrome (TTTS) occurs in which specific type of twin pregnancy?

- A. Dichorionic twins with separate placentas
- B. A singleton pregnancy, no twin involved
- C. Monochorionic twins with abnormal vascular connections
- D. Any twin pregnancy regardless of chorionicity

105. An abnormal ductus venosus waveform showing absent or reversed flow during the atrial contraction (a-wave) phase is a concerning sign in which clinical context?

- A. Fetal surveillance for significant cardiac compromise or severe growth restriction
- B. Routine, expected finding in every normal third-trimester fetus
- C. A maternal (not fetal) cardiac finding, unrelated to the fetus
- D. An artifact with no established clinical significance

106. Middle cerebral artery (MCA) peak systolic velocity measurement in a fetus is primarily used to screen for which condition?

- A.** Fetal cardiac structural defects
- B.** Fetal anemia risk
- C.** Maternal preeclampsia exclusively
- D.** Fetal renal agenesis

107. Varicocele grading via Doppler ultrasound is primarily based on which measurement or finding?

- A.** Testicular arterial peak velocity alone
- B.** Epididymal cyst size exclusively
- C.** Scrotal skin thickness measurement
- D.** Pampiniform vein diameter and reflux with Valsalva

108. Paget-Schroetter syndrome refers to thrombosis of which vessel, typically in which clinical setting?

- A.** Femoral vein, in immobile elderly patients
- B.** Axillary/subclavian vein after exertion, in athletes
- C.** Portal vein, in cirrhotic patients
- D.** Internal jugular vein, from catheter placement

109. A popliteal VEIN aneurysm, distinct from a popliteal ARTERY aneurysm, is clinically significant primarily due to its association with which complication?

- A.** Distal arterial limb ischemia from embolization
- B.** Spontaneous, complete resolution without any risk
- C.** Pulmonary embolism from thrombus formation within the venous aneurysm sac
- D.** An exclusively cosmetic finding with no health risk

110. Pelvic congestion syndrome is characterized on Doppler ultrasound by which finding?

- A.** Markedly narrowed pelvic veins with high-velocity flow

- B.** Dilated, tortuous pelvic/ovarian veins with slow or retrograde flow
- C.** Complete absence of any detectable pelvic venous structures
- D.** An exclusively arterial finding with no venous component

Answers

- 1. C.** TDI uses filter and gain settings tuned to the low-velocity, high-amplitude signals from myocardial or tissue motion, unlike conventional Doppler, which is tuned for high-velocity, low-amplitude blood flow. Static structures produce no Doppler shift, and cavitation is a bioeffect, not a signal type TDI is designed to detect.
- 2. B.** Elastography maps relative stiffness — stiffer tissue deforms less under compression or transmits shear waves faster. Perfusion is assessed with Doppler/contrast techniques instead, and attenuation/propagation-speed variance are separate physical parameters elastography does not directly display.
- 3. B.** Gas-filled microbubbles oscillate nonlinearly under insonation, generating strong harmonic signals detected by contrast-specific modes. They do not work by absorbing energy (an attenuation mechanism), by altering propagation speed, or by emitting a signal independent of the transmitted beam — they respond to and reshape the transmitted beam.
- 4. D.** Fusion imaging co-registers live ultrasound with a prior cross-sectional dataset using position tracking, aiding lesion targeting and biopsy guidance. Combining B-mode/color Doppler is simply duplex scanning. Frequency compounding and merging two separate systems' images describe unrelated techniques.
- 5. C.** Sensitivity is the proportion of true positives correctly identified among all patients who actually have the condition. Specificity instead measures correct identification among those without it. Predictive value depends on disease prevalence, and accuracy blends both true-positive and true-negative performance.
- 6. D.** Element-integrity testing checks whether each array element transmits/receives properly, catching dead or degraded elements that produce fixed dropout artifacts. TGC calibration is a separate QA check; ambient temperature and preset selection are workflow factors unrelated to the physical integrity of the elements.
- 7. A.** The outline groups image-degradation knowledge with transducer QA because recognizing what damage looks like on-screen is how a sonographer evaluates whether a probe is failing. It is not tied to protocol selection, patient BMI, or room lighting — those are separate workflow or environmental factors.

- 8. B.** Analyzing clinical history and prior imaging helps the sonographer target the exam, recognize expected versus unexpected findings, and improve overall diagnostic accuracy — a core patient-care skill in the outline. It is not primarily a billing formality, does not necessarily shorten the exam, and never substitutes for physician interpretation.
- 9. A.** Reviewing prior cross-sectional imaging helps the sonographer anticipate what to look for and interpret ambiguous findings more accurately. It is not merely a legal-documentation step, does not eliminate the need for a sonographic report, and frequency selection is a technical decision unrelated to legal requirements.
- 10. C.** Two-identifier verification is a foundational patient-safety practice specifically aimed at preventing wrong-patient/wrong-exam errors, a leading category of preventable medical mistakes. It does not address exam duration, transducer frequency selection, or informed consent — each a separate, distinct safety practice with its own dedicated process.
- 11. C.** A defined escalation pathway ensures a genuinely urgent finding reaches the physicians who can act on it without unnecessary delay — a critical-results communication requirement in most facilities. It does not hide findings from the patient's chart, does not leave notification solely to individual sonographer discretion outside the defined pathway, and specifically exists to avoid delaying communication until a routine future visit, which would defeat the purpose for a time-sensitive finding.
- 12. D.** Lateral resolution describes distinguishing two reflectors positioned side-by-side, perpendicular to the beam axis, at the same depth — governed by beam width. Distinguishing structures at different depths along the beam is axial resolution instead, distinguishing motion over time is temporal resolution, and echogenicity differences relate to contrast resolution, not lateral resolution.
- 13. C.** Elevational resolution describes beam width perpendicular to the imaging plane — the 'slice thickness' — controlled by the acoustic lens or elevational focusing. Depth-axis resolution is axial, side-to-side in-plane resolution is lateral, and a time-axis description does not correspond to any spatial resolution type.
- 14. D.** Contrast resolution is the ability to differentiate tissues of slightly different echogenicity displayed as different gray shades — influenced by dynamic range and gray-scale processing. Distinguishing closely spaced reflectors is spatial (lateral/axial) resolution, detecting motion is temporal resolution, and penetration depth is a separate performance parameter.
- 15. A.** The inverse-square law describes how intensity falls off with the square of distance from a source as the same total energy spreads over an increasingly larger area — intensity decreases, not increases, with distance. Frequency does not change with distance in a given medium, and propagation speed is a fixed medium property, not something that decreases with distance under this relationship.
- 16. C.** Bone's high stiffness gives it a much faster propagation speed (roughly 4080 m/s) than fat's slower speed (roughly 1450 m/s), both differing from the assumed soft-tissue average of 1540 m/s. Air

transmits sound much SLOWER than soft tissue (about 331 m/s), the opposite of the incorrect claim, and tissues clearly do not share one identical propagation speed — that variability is the basis for propagation-speed-error artifacts.

17. B. When waves overlap in phase (constructive) or out of phase (destructive), the resulting amplitude locally increases or decreases — the basis of phenomena like speckle. It does not permanently change frequency, does not cancel the beam everywhere (only at specific interference points), and has no effect on propagation speed, a medium property.

18. A. Half-value layer is the depth of tissue required to reduce beam intensity to 50% of its original value, a way of expressing attenuation properties per tissue type. It does not describe intensity doubling, is unrelated to field-of-view midpoint depth, and has no relationship to where axial and lateral resolution happen to be numerically equal.

19. C. ERA is the actual active piezoelectric surface area producing ultrasound, which may be smaller than the transducer's full physical footprint (including housing/casing). It is not the imaged tissue area at depth (a beam-geometry outcome downstream of ERA) and is not limited to just the lens region, which sits atop the active elements rather than defining their area.

20. A. Total attenuation accounts for ALL energy loss along the beam path (absorption, and scattering in every direction), while backscatter is only the specific fraction of scattered energy redirected back toward the transducer and available to form an image — necessarily a small piece of total attenuation, not the reverse. Attenuation occurs in essentially all tissue, not fluid alone, and the two terms describe genuinely different quantities, not synonyms.

21. B. A tissue's nonlinearity parameter (B/A) describes how strongly it distorts a propagating wave, generating harmonic frequencies as amplitude increases with distance — the physical basis of tissue harmonic imaging. It does not determine baseline propagation speed itself (a separate stiffness/density-driven property), does not set transducer resonant frequency (a crystal-thickness property), and has no direct role in the frame-rate formula.

22. C. The fundamental relationship is $p = Z \times u$ (pressure equals impedance times particle velocity), a foundational acoustic relationship distinct from the propagation-speed formula (impedance = density $\times$ speed). Dividing pressure by velocity, defining impedance via frequency, or expressing velocity as impedance divided by density are each a misstatement of the correct relationship.

23. A. A hydrophone is a specialized measurement device that directly detects acoustic pressure in a water tank, used to characterize a transducer's actual output (intensity, pressure) for calibration and bioeffects research. It does not measure cable electrical impedance, does not calibrate depth markers (a separate system function), and has no role in disinfectant testing.

24. B. Attenuation reduces intensity exponentially with distance traveled (consistent with the logarithmic dB scale used to describe it), not in a straight linear decline. It is a continuous decay, not a

stepwise drop at discrete intervals, and intensity does not increase before decreasing in a simple attenuating medium — that pattern instead describes harmonic buildup, a separate phenomenon.

25. D. Backscatter coefficient quantifies how much scattered acoustic energy returns toward the transducer, distinct from the absorption coefficient (energy converted to heat) and distinct from the forward-transmitted fraction. It is a property of scattering from diffuse (Rayleigh) sources specifically, not of specular reflection at a single large interface, which is characterized separately by the reflection coefficient.

26. A. In a dispersive medium, propagation speed varies slightly with frequency, so a broadband pulse's overall envelope (group velocity) can differ subtly from the phase velocity of its individual frequency components — a real but generally minor effect in soft tissue. It is not about near-field-versus-far-field speed differences, not about directional speed asymmetry (sound does not travel differently toward versus away from a source), and not a description of the Doppler shift itself.

27. D. Since $\text{wavelength} = \text{speed} \div \text{frequency}$, and propagation speed in the crystal material differs substantially from soft tissue's 1540 m/s, the wavelength differs even though frequency stays the same across the boundary (frequency, not wavelength, remains constant when a wave crosses into a new medium). Wavelength is medium-dependent, not a fixed constant, and there is no absolute wavelength-based absorption threshold describing this relationship.

28. D. A 2D matrix array steers the beam electronically in both azimuthal and elevational directions simultaneously, enabling true real-time volumetric acquisition — a 1D array steers in only one plane. Matrix design does not inherently raise maximum frequency, does not eliminate lens elements, and fully supports B-mode alongside Doppler.

29. C. Manufacturing yield describes what fraction of produced elements pass functional testing and meet spec, a production-quality metric distinct from the finished design's total element count (a design parameter), its frequency range (a design outcome), or its expected clinical lifespan (a durability estimate) — all separate concepts from the yield rate itself.

30. C. Multiplexing allows a system with fewer physical receive/transmit channels than the array has elements to still address all elements, by rapidly switching connections — a cost/complexity tradeoff in array design. It does not describe doubling crystal count, combining two physical transducers, or automatic mode-switching between imaging types.

31. A. Synthetic aperture imaging transmits with a smaller sub-aperture multiple times and combines the received data computationally, synthesizing the image quality benefits of a larger aperture without the size or cost of one physically. It does not use one giant physical aperture per pulse, does not involve physically expanding the housing, and does not mechanically fuse two separate probes.

32. A. RCA design addresses rows and columns separately rather than requiring one independent connection per element in a full matrix, dramatically reducing the number of electronic channels needed

while still achieving volumetric imaging. It is not a mechanically rotated 1D array (a wobbler design instead), not achieved through a fixed lens (a passive component, not an addressing scheme), and not simply two stacked separate arrays.

33. D. PVDF is a flexible polymer that exhibits piezoelectric behavior, offering mechanical flexibility rigid ceramic materials like PZT cannot, useful in certain specialized transducer designs. It is not identical to PZT (a fundamentally different material class), is not a metal housing alloy, and can serve as an active element itself, not only as backing material.

34. B. 1-3 connectivity composite design embeds thin piezoelectric ceramic rods (the '1' — one-dimensionally continuous) within a polymer matrix (the '3' — three-dimensionally continuous), improving bandwidth and sensitivity compared to solid ceramic. It does not describe layering different crystal types, generating three separate frequencies from one rod, or a specific backing-to-matching-layer ratio.

35. D. Single-crystal materials like PMN-PT typically offer superior electromechanical coupling efficiency and bandwidth compared to conventional polycrystalline PZT, improving sensitivity and image quality. They are generally MORE costly to manufacture, not less, remain subject to Curie-point depoling limits like other piezoelectric materials, and still benefit from a backing layer to control pulse length.

36. C. A virtual apex is a mathematically defined point located BEHIND the array (not a real physical focus) that beamforming algorithms use as a reference to correctly steer and diverge the beam, particularly relevant to sector/phased-array geometry. It is not simply the housing's physical center, is not a real focus in front of the array (its defining feature is being virtual/behind), and has no relation to the power supply's physical location.

37. D. True time delay beamforming applies genuinely accurate time delays regardless of frequency, an advantage for broadband transducers where analog delay-line approaches (which can introduce frequency-dependent phase errors) are less precise. It is actually MORE suited to broadband, not restricted to narrowband use, still requires beamforming calculation (just more accurately), and can be applied on both transmit and receive, not receive only.

38. A. Electrical impedance matching (a circuit-design concern) ensures efficient electrical power transfer from the system's transmit/receive electronics to the piezoelectric crystal — a distinct concept from the ACOUSTIC matching layer, which instead matches acoustic impedance between crystal and skin. It is not about physical housing alignment, and has no role in automatically adjusting the color Doppler scale, an unrelated display control.

39. D. Field-return analysis investigates why a returned probe failed clinically (e.g., element failure, cable damage), feeding back into manufacturing QA and design improvement. It does not automatically re-certify the probe as safe without actual testing, has no role in billing codes, and does not substitute for or replace a facility's own disinfection documentation.

40. A. Chip-on-tip designs place beamforming/processing electronics directly at the transducer tip rather than solely in the system console, reducing signal loss and noise that would otherwise occur over a long cable run. It does not describe an integrated battery for wireless power, a backup crystal, or a disinfectant reservoir — unrelated features.

41. D. Burn-in testing runs a new device under operating conditions before release to catch components likely to fail early ('infant mortality' failures), improving reliability before clinical deployment. It is not a sterilization step, does not calibrate individual operator presets (a separate post-sale customization), and has no patient-specific compatibility purpose.

42. B. Cable shielding specifically protects the transmitted electrical signal from electromagnetic interference generated by nearby equipment (monitors, electrosurgical units, etc.), preserving signal integrity. It does not address physical bending wear, gel exposure, or impact damage — those are mechanical/material durability concerns addressed by strain relief and cable jacket design, not shielding's electromagnetic function.

43. D. A guard ring of inactive elements at the array's periphery helps reduce edge artifacts and provides some mechanical protection to the functional active elements. It does not itself actively transmit a wider beam (it is inactive by definition), has no effect on maximum frequency, and is not used as the primary element for Doppler sensing.

44. C. IPX ratings are a standardized measure of a device's protection against liquid ingress, relevant to how aggressively a transducer can be immersed or cleaned. It does not describe imaging depth capability, gel-brand compatibility, or an 'underwater use' frequency approval — none of which are what an ingress-protection rating communicates.

45. A. Sparse arrays deliberately activate fewer elements than a fully populated design would use, reducing the number of electronic channels (and therefore cost/complexity) needed — accepting some tradeoff in image quality or sensitivity compared to a fully populated array. It does not achieve HIGHER quality than a full array at equal cost (the opposite tradeoff), still requires beamforming, and does not guarantee a universally higher frame rate.

46. A. Because the beam has real thickness in the elevational (slice) dimension, structures slightly out of the intended imaging plane can still contribute echoes, appearing falsely within a thin or complex structure (e.g., artifactual debris in a gallbladder). It is not a TGC misadjustment, not a dead-element issue (a different fixed dropout artifact), and unrelated to Doppler color aliasing, a distinct phenomenon.

47. C. Multipath artifact occurs when the returning echo takes a longer, indirect path — bouncing off multiple reflectors before returning to the transducer — causing the system to misplace the structure at an incorrect (usually deeper) position based on that extra travel time. A single straight-line path describes normal, non-artifactual imaging; a dead element causes fixed dropout, and uniform gain saturation is a distinct brightness issue, not a path-related artifact.

48. A. Pseudo-sludge is an artifactual appearance of layering debris caused by beam-width or side-lobe artifact from strongly reflective structures nearby, not necessarily representing true sludge — a well-recognized pitfall requiring correlation with patient position changes. It does not mean true sludge is always present, is not a location-specific calibration error, and has a genuine acoustic physics explanation, not a software defect.

49. B. Clean, sharply defined shadowing is classically associated with smooth, strongly reflective/attenuating structures like calculi, while dirty, more heterogeneous shadowing is classically associated with gas due to complex reverberation within the gas collection — a genuinely useful clinical distinction. Fluid does not cause shadowing at all (it causes posterior enhancement), soft tissue does not typically produce either shadowing pattern, and the distinction is a real, clinically applied one, not a meaningless artifact appearance.

50. B. True enhancement is geometrically confined to the region directly posterior to a low-attenuation structure (like a cyst) and does not extend beyond that structure's lateral margins, distinguishing it from a genuinely hyperechoic tissue that would appear bright regardless of what lies superficial to it. Frame consistency alone does not distinguish the two (both would appear in every frame), patient positioning is not the distinguishing factor, and transducer frequency threshold is not how this distinction is made.

51. D. Near-field clutter is diffuse haze/noise confined to the shallow near field, generated by the transducer face's own ring-down and reverberation, degrading visualization of very superficial structures — distinct from the narrow, discrete, often deep-penetrating trail of a comet-tail artifact. It is not a fixed dropout line (a dead-element signature) and is a grayscale (B-mode) phenomenon, not exclusively a color-mode finding.

52. D. Elevational compounding averages data acquired across slightly different elevational planes (using elevational beam steering capability, e.g., with a 1.5D or matrix array), reducing speckle/noise similarly to spatial compounding but in the slice-thickness dimension. Averaging multiple transmit frequencies instead describes frequency compounding, averaging multiple in-plane steering angles describes conventional spatial compounding, and combining separate patients' images is not a real clinical imaging technique.

53. A. Extended FOV relies on the system's motion-tracking algorithm correctly registering sequential frames as the operator sweeps the probe; inconsistent speed, angulation, or excessive speed can cause misalignment/misregistration in the final stitched image, producing warping or duplication artifacts. Frequency choice, gain level, and color box size are unrelated to this specific motion-registration failure mode.

54. C. Because the system assumes a fixed 1540 m/s average soft-tissue speed for its depth calculations, a tissue-specific preset (e.g., for fatty tissue, which is genuinely slower) can reduce the resulting propagation-speed-error/measurement inaccuracy in tissues that deviate meaningfully from that average. It is not related to manual TGC recalibration, transducer frequency selection, or the system's internal clock — unrelated system functions.

55. B. One-touch optimization features analyze the current image's overall echo signal and automatically adjust settings like gain, TGC curve, and dynamic range to produce a well-balanced image, saving manual adjustment time. It does not select or verify patient identity, does not diagnose pathology (a physician task), and does not switch to a different imaging modality altogether.

56. C. Voice control allows the sonographer to adjust settings (freeze, measure, annotate) without removing a sterile-gloved hand from the probe or reaching across the console, particularly useful in procedural or awkward-access scenarios. It does not itself generate diagnostic report text (a separate function), does not eliminate all physical controls (voice is a supplement, not a full replacement), and has no effect on acoustic output power.

57. C. Cloud/wireless PACS enables authorized remote access to stored images (e.g., for a physician reviewing from another location), extending beyond the reach of a purely wired, on-premises system. It does not eliminate the requirement for patient identifiers (still fully required), does not itself change image resolution (a separate acquisition parameter, unaffected by storage/transmission method), and has no relationship to transducer disinfection.

58. D. Tele-ultrasound connects a remote expert (often via live video/data feed) to guide or support a sonographer or less experienced operator performing a real-time exam, valuable in underserved or remote settings. It does not describe fully autonomous, unsupervised scanning, has no effect on transducer calibration requirements, and does not provide automatic multilingual translation.

59. C. Side-by-side live/prior display lets the sonographer or interpreting physician visually compare current findings against a prior exam in real time, aiding recognition of interval change. It does not affect or double frame rate (a separate acquisition parameter), does not itself calculate a numeric percentage change (that remains a separate measurement/comparison step), and does not eliminate the need to document comparison findings in the written report.

60. B. Self-test diagnostics check internal system hardware/software integrity (e.g., verifying subsystems are functioning), catching certain failures before they affect a clinical exam. It does not perform physical disinfection, is not a credential/login verification tool, and does not substitute for the separate, more comprehensive external QA testing performed with phantoms.

61. A. Many advanced features are sold as optional software add-ons; license activation is the mechanism controlling whether a given system has purchased access to that specific module. It is unrelated to verifying an individual operator's clinical certification, does not confirm recent transducer QA status, and plays no role in TGC calibration.

62. C. A raw DICOM export retains the full original acquired pixel data and embedded metadata, allowing accurate remeasurement or detailed comparison later — a screenshot instead captures only a compressed, fixed visual representation, potentially losing precision. DICOM files are not necessarily smaller (they often contain more data, not less), export does not automatically anonymize identifiers,

and DICOM files can still be edited/alterd with appropriate software, so this is not a guaranteed protection.

63. B. Structured reporting templates prompt for standardized, complete documentation of required elements (measurements, findings, impressions), improving consistency and reducing missed elements across exams and sonographers. It does not generate an autonomous diagnosis without physician review, does not eliminate the separate need for image archiving, and has no effect on which transducer is selected for a given exam.

64. C. The annotation tool lets the operator add text labels or pointer arrows directly onto a saved image to identify a specific finding for the reviewing physician — a documentation aid, not a measurement tool (calipers serve that separate function). It does not adjust focal zone placement and has no relationship to output power control.

65. D. Dual-frequency compounding specifically averages/combines images from two chosen discrete frequencies (a simpler special case of broader frequency compounding across multiple frequencies), improving certain image characteristics. It does not involve combining data from two different physical transducers, is unrelated to B-mode/M-mode switching, and is not specifically restricted to combining a fundamental with its third harmonic (typically it involves frequencies within the same transducer's bandwidth generally, not that specific harmonic relationship).

66. C. Additional monitors let the operator or interpreting physician view live imaging on one screen while simultaneously referencing a worksheet, prior exam, or other material on another — a workflow/ergonomic benefit. It has no effect on maximum imaging depth, does not by itself duplicate storage (a separate archiving function), and does not increase frame rate, an acquisition-side parameter.

67. D. Because a needle acts as a specular reflector, its visibility depends heavily on beam angle; needle-enhancement steering electronically angles a portion of the transmitted beam to strike the needle shaft closer to perpendicular, maximizing the strong specular reflection back to the transducer. It does not physically bend the needle, is not simply a uniform gain increase (which would not specifically improve needle conspicuity relative to surrounding tissue), and does not require switching to an entirely different transducer.

68. C. Respiratory gating times acquisition to specific points in the breathing cycle (e.g., to reduce motion artifact from diaphragmatic movement), distinct from ECG gating, which instead synchronizes to the cardiac cycle. It is not tied to GI peristalsis, and 'duty-factor cycle' describes an unrelated transducer transmit/receive timing property, not a patient physiological rhythm.

69. B. This technique intentionally applies a brief high-mechanical-index pulse to destroy microbubbles within the imaged region, then tracks how quickly and thoroughly they reperfuse (replenish) that region — providing perfusion information. It is a targeted, repeatable technique, not a one-time permanent destruction of all agent, has nothing to do with the patient's actual blood volume, and does not affect the transducer's own physical harmonic capability.

70. C. Key-image flagging lets the sonographer designate specific important frames within a larger cine loop for quick reference, while the full loop remains available/archived separately for complete review if needed. It does not permanently delete unflagged frames (both are typically retained), does not generate report text, and does not collapse an entire loop into one image.

71. B. Cine buffer length determines how much recent imaging history is continuously retained in memory, allowing the operator to scroll back and capture a moment that has already passed (e.g., a fleeting fetal cardiac view). It is unrelated to how many patient records the system can store, does not set the maximum frame rate (an acquisition parameter, though buffer length may be expressed in frames), and has no relationship to transducer frequency.

72. D. Having two probes connected simultaneously lets the operator switch quickly between exam types (e.g., a general abdominal survey and a focused cardiac view) without pausing to physically swap connectors — a workflow convenience. It does not increase maximum imaging depth, does not automatically blend two probes' images together, and has no effect on the Doppler Nyquist limit, a PRF-dependent parameter.

73. B. A visible exam-duration timer helps the sonographer stay aware of how long the patient has been exposed to ultrasound energy, supporting the ALARA principle of using the minimum necessary time. It does not itself generate a bill, does not force an automatic exam termination at a fixed cutoff, and has no role in frequency calibration.

74. B. Body-habitus presets adjust default gain, TGC, and sometimes frequency recommendations based on estimated tissue thickness/attenuation for a given patient size, helping achieve a better starting image more quickly. It has nothing to do with the patient's pain level, scheduling preference, or insurance category — none of which are acoustic parameters the system can sense or needs to adjust for.

75. D. The preview box overlays a visible boundary on the current image so the operator can confirm the intended region before triggering the zoom (write or read), avoiding wasted time re-zooming an incorrect area. It does not select a transducer, does not permanently lock gain/TGC (those remain independently adjustable), and does not eliminate the separate need for caliper-based measurement afterward.

76. C. Manual planimetry allows the operator to trace an irregularly shaped structure's true outline directly, useful when a structure does not approximate a simple ellipsoid, whereas an automated ellipsoid formula assumes a specific geometric shape (applying length/width/height measurements to a standard formula) that may not fit every structure well. Planimetry is not limited to circular structures only (quite the opposite — it is valuable specifically for IRREGULAR shapes), is not universally more accurate than every automated method (accuracy depends on operator skill and structure type), and clearly requires ongoing operator input to trace the border, not none.

77. D. Tardus parvus describes a dampened waveform — delayed acceleration time and a blunted systolic peak — occurring distal to a significant proximal stenosis. It is not a normal high-resistance

pattern (which shows a sharp, not delayed, peak), does not describe complete occlusion (which shows absent flow entirely), and is specifically an arterial finding, not a description of venous flow.

78. B. The angle-correction cursor is aligned parallel to the vessel/flow direction so the correct cosine value is applied in the Doppler equation, since accurate velocity calculation depends entirely on correctly identifying that angle. It does not physically move transducer elements, is not the mechanism for setting PRF/scale (adjusted independently), and does not control the direction-color convention, a fixed system default.

79. B. Excessive spectral gain amplifies noise along with true signal, filling in the area around the waveform envelope, obscuring detail. Aliasing is governed by scale/PRF, not gain. Excessive gain would WIDEN/fill the trace with noise (the opposite of falsely narrowing it), and would not cause loss of the audible signal — output would if anything be noisier, not absent.

80. C. Because a wall filter removes signals below its threshold, setting it too high risks discarding real low-velocity flow along with intended clutter — a documented pitfall in venous studies or diastolic flow assessment. It does not cause aliasing (governed by PRF/Nyquist, unrelated). It REDUCES rather than amplifies clutter, and has no direct effect on angle-correction accuracy.

81. A. Doppler reject is an amplitude-based threshold control (separate from the frequency-based wall filter) that removes low-amplitude signals believed to be noise, cleaning up the spectral display. It does not affect the velocity range before aliasing, does not alter the color direction convention, and does not perform any automatic angle correction, a manual operator task.

82. A. A larger packet size allows more accurate mean-velocity/variance estimation per color pixel, improving sensitivity to slow flow — but requires more time per frame, directly reducing frame rate. The reverse claim inverts the true relationship, packet size clearly affects both parameters, and it has no bearing on the wall filter's separate clutter-removal function.

83. D. Variance mapping adds a measure of the spread of velocities/directions present — turbulent flow shows high variance, typically overlaid in a distinct color layered onto the standard directional map. It does not display an absolute peak velocity number per pixel, does not show insonation angle per pixel, and does not calculate volume flow rate, a separate manual calculation.

84. B. Flash artifact arises from tissue or transducer motion generating a large, transient Doppler shift the system misinterprets as flow, briefly filling the color box with unrelated color. It is an artifact, not a genuine sustained velocity increase. Excessive wall filtering would instead REDUCE displayed signal, not cause a false burst, and insufficient gain causes dropout — essentially the opposite visual effect.

85. C. Twinkling artifact appears as a rapidly changing mosaic of color posterior to certain strongly reflective, rough-surfaced structures (classically renal or ureteral calculi), thought to arise from intrinsic Doppler-processing noise responding to the chaotic reflections — useful clinically as a stone-detection sign, but NOT genuine blood flow. It is not caused by system miscalibration specifically, and it is

inherently a color-mode finding (not a B-mode-only phenomenon), since it is a color-artifact-based sign by definition.

86. D. Mean (time-averaged) velocity integrates across the entire waveform, appropriately used for volume flow calculations, while peak systolic velocity captures only the single highest point of the cycle, used for stenosis grading and resistance-index calculations — genuinely different values with different clinical uses, not interchangeable. Mean velocity can be measured with pulsed-wave Doppler using appropriate tracing, not exclusively CW, and peak velocity is used extensively in ARTERIAL waveform analysis (e.g., stenosis grading), not exclusively venous.

87. D. May-Thurner syndrome specifically describes chronic compression of the LEFT common iliac vein against the vertebral body by the overlying RIGHT common iliac artery, predisposing to left-sided iliofemoral DVT. Celiac artery compression by the median arcuate ligament, renal vein compression between the aorta and SMA (nutcracker), and subclavian vein compression at the thoracic outlet are each distinct, separately named vascular compression syndromes.

88. B. Budd-Chiari syndrome results from obstruction of hepatic venous OUTFLOW — the hepatic veins themselves or the adjacent inferior vena cava — producing a distinctive dampened or reversed hepatic venous Doppler pattern. Portal vein inflow obstruction instead describes portal vein thrombosis, a distinct entity; splenic artery inflow and renal vein outflow describe entirely different vascular territories unrelated to Budd-Chiari.

89. C. Nutcracker syndrome specifically describes the left renal vein being compressed as it passes between the aorta (posteriorly) and the superior mesenteric artery (anteriorly) — the 'nutcracker' effect. It does not describe the right renal vein (which does not pass through this anatomic space the same way), does not involve renal artery compression by the psoas, and does not describe IVC compression by the pancreas — a different, unrelated compression scenario.

90. A. Splenic artery aneurysms carry a recognized increased risk of rupture specifically during pregnancy (particularly the third trimester), a genuine obstetric emergency given associated maternal mortality risk — making detection and surveillance clinically important, not merely incidental. They are not restricted to non-pregnant patients, and spontaneous resolution without any intervention or monitoring is not the expected natural history of a true aneurysm.

91. B. Popliteal artery aneurysms carry meaningful risk of thrombus formation within the aneurysm sac, which can embolize distally or thrombose in place, precipitating acute limb-threatening ischemia — the primary reason for surveillance and, often, intervention. It is not merely cosmetic, does not convert into an unrelated benign fatty tumor, and is a condition of adults (particularly older patients with atherosclerotic risk factors), not a pediatric entity.

92. D. The true lumen generally maintains more normal, brisk antegrade flow, while the false lumen (created by the intimal flap and often ending blindly or reentering distally) frequently shows delayed, sluggish, swirling, or absent flow — a genuinely useful distinguishing Doppler feature. The two lumens

do not show identical flow characteristics (that similarity would defeat the point of Doppler evaluation here), the false lumen is not invariably the larger of the two, and color Doppler is in fact a primary, useful tool for this distinction, not an incapable one.

93. C. Vertebral artery dissection classically presents with neck pain and posterior-circulation (brainstem/cerebellar) stroke symptoms, often with a history of trauma, chiropractic neck manipulation, or other mechanical neck stress — a clinically urgent diagnosis. It does not classically present with bilateral leg swelling (a venous, not vertebral-arterial, presentation), is not characterized by painless varicose veins (an unrelated venous finding), and is a genuine symptomatic vascular emergency in many cases, not solely an incidental screening finding.

94. B. Because thoracic outlet syndrome's vascular compression is often positional (worsened by specific arm/shoulder positions like abduction or hyperextension), provocative maneuvers performed WHILE monitoring subclavian artery or vein Doppler flow are key to reproducing and documenting the compression. A single static resting waveform without positional change may miss a purely positional compression, evaluating only the asymptomatic contralateral side would miss the diagnosis on the affected side, and M-mode of the bone itself does not assess vascular flow.

95. A. The 'halo sign' — a hypoechoic ring around the temporal artery lumen from inflammatory wall edema — is the classic, well-recognized ultrasound finding in giant cell arteritis, useful as a rapid, noninvasive diagnostic aid alongside clinical criteria. A markedly increased velocity without any wall finding does not capture the diagnostic B-mode sign, complete signal absence would suggest occlusion rather than the inflammatory wall change described, and a discrete true aneurysm is a different, unrelated vascular finding.

96. C. A ruptured or complicated Baker's cyst can clinically mimic DVT (calf pain and swelling), making sonographic distinction between the two — including direct evaluation of the deep venous system — clinically important. A normal meniscus is an unrelated intra-articular structure, an incidental skin lesion is not the relevant differential concern here, and an anterior-thigh lipoma is both anatomically distant and unrelated to the posterior-knee differential being tested.

97. B. Nephrotic syndrome causes a hypercoagulable state (partly from urinary loss of anticoagulant proteins), classically associated with renal vein thrombosis risk — a well-recognized clinical pairing tested on Doppler-focused exams. A viral URI, well-controlled hypertension alone, and a minor superficial skin laceration are not classic, specific associations with renal vein thrombosis.

98. A. Portal vein thrombosis produces absent or severely diminished flow in the thrombosed segment on Doppler interrogation, sometimes with visible echogenic material filling the lumen on grayscale. It does not produce markedly increased velocity (occlusion reduces, not increases, flow), a normal unremarkable waveform would argue against thrombosis rather than support it, and there is no diastolic-only flow pattern specifically describing this condition.

99. C. Mesenteric venous thrombosis often presents more insidiously, over several days, compared to the classically sudden, severe 'pain out of proportion' presentation of acute arterial mesenteric occlusion — a clinically useful distinguishing feature. It is not identical in onset pattern to arterial occlusion, it does produce abdominal symptoms in affected patients (not none), and it is an abdominal/mesenteric process, not a lower-extremity one.

100. B. A key, frequently tested point is that elevated resistive index is a NONSPECIFIC finding seen in both ATN and rejection (as well as other causes of transplant dysfunction), meaning Doppler alone cannot reliably distinguish between them — biopsy and clinical correlation remain necessary. Claiming ATN always shows a normal RI while rejection is always elevated overstates Doppler's actual specificity, claiming only rejection produces any Doppler abnormality ignores ATN's genuine (if nonspecific) Doppler findings, and claiming color Doppler alone is definitively diagnostic overstates its real clinical role.

101. B. Dermoids are composed largely of avascular tissue (fat, hair, calcification), so Doppler typically shows absent or minimal internal vascularity — helping distinguish a dermoid from a more concerning, typically hypervascular solid mass. Marked hypervascularity or a single dominant high-velocity feeding vessel would instead raise concern for a different process, and a dermoid's appearance is distinct from a corpus luteum cyst's classic peripheral 'ring of fire' hypervascularity, not identical to it.

102. A. OHSS is a recognized complication specifically of ovarian stimulation during fertility treatment (e.g., IVF protocols), producing enlarged, multicystic ovaries with increased stromal vascularity on Doppler. It is not a feature of natural unstimulated ovulation, does not occur in postmenopausal women (whose ovaries are not being stimulated), and is not a general first-trimester pregnancy finding absent fertility intervention.

103. B. Cesarean scar ectopic pregnancy specifically implants within the thin myometrial defect at a prior cesarean incision site, a distinct and increasingly recognized entity carrying significant risk of uterine rupture or severe hemorrhage. It is anatomically and clinically distinct from a typical tubal ectopic (implanted in the fallopian tube), from an ovarian ectopic (implanted in the ovary), and from a cervical ectopic (implanted in the cervix without relation to a surgical scar) — each a separately named, distinct entity.

104. C. TTTS specifically requires a monochorionic placenta with abnormal vascular connections allowing unbalanced blood flow between twins, creating a donor (growth-restricted, oligohydramnios) and recipient (fluid-overloaded, polyhydramnios) pair. It does not occur in dichorionic twins with fully separate placental circulations, is by definition a twin-specific phenomenon (not applicable to a singleton pregnancy), and is specifically dependent on monochorionicity, not simply 'any' twin pregnancy regardless of placental type.

105. A. Absent or reversed a-wave flow in the fetal ductus venosus reflects significantly increased right atrial pressure/cardiac compromise (or severe placental insufficiency in growth restriction), a recognized marker used in fetal surveillance protocols, not a normal or expected finding. It is a FETAL circulation

measurement, not a maternal cardiac finding, and it carries established, well-recognized clinical significance, not merely artifactual appearance.

106. B. Elevated MCA peak systolic velocity reflects a hyperdynamic fetal circulation in response to anemia (e.g., from alloimmunization or certain infections), making it the established noninvasive screening tool for fetal anemia. It is not the primary screening tool for structural cardiac defects (assessed by dedicated fetal echocardiography), is not exclusively a maternal preeclampsia marker (uterine artery Doppler serves that role instead), and has no established role in screening for renal agenesis, which is assessed by amniotic fluid volume and direct renal visualization.

107. D. Varicocele severity is graded largely by the diameter of the dilated pampiniform plexus veins and the degree of venous reflux demonstrated with Valsalva maneuver on Doppler — the defining features of this venous condition. Testicular arterial peak systolic velocity is not the basis for varicocele grading (a venous, not arterial, finding), epididymal cyst size is an unrelated separate finding, and scrotal skin thickness is not part of standard varicocele grading criteria.

108. B. Paget-Schroetter syndrome (effort thrombosis) specifically describes axillary/subclavian vein thrombosis, classically in young, otherwise healthy, athletic individuals following repetitive or strenuous upper-extremity activity, often related to thoracic outlet compression. It is a distinct entity from femoral DVT in immobile elderly patients, from portal vein thrombosis in cirrhotic patients, and from catheter-related internal jugular vein thrombosis — each a separately recognized clinical scenario.

109. C. A popliteal vein aneurysm carries a meaningful risk of thrombus forming within the dilated venous segment and subsequently embolizing to the lungs, producing pulmonary embolism — the primary clinical concern distinguishing it from the arterial counterpart's limb-ischemia risk. It does not cause distal ARTERIAL limb ischemia (that is the arterial aneurysm's characteristic complication instead), does not reliably resolve spontaneously without risk, and is not merely a cosmetic finding given its embolic potential.

110. B. Pelvic congestion syndrome results from dilated, tortuous, incompetent pelvic/ovarian veins showing slow, sluggish, or retrograde (reversed) flow, particularly with Valsalva — a chronic pelvic pain etiology in some patients. It is not characterized by narrowed, high-velocity veins (essentially the opposite finding), does not involve absent venous structures (dilation, not absence, is the finding), and is fundamentally a VENOUS condition, not an arterial one.