

FULL-LENGTH PRACTICE TESTS

PRACTICE TEST 9 - 100 QUESTIONS

1. The layer of cells between the xylem and phloem that produces new vascular tissue is called what?
 - A. Cork cambium
 - B. Cortex
 - C. Vascular cambium
 - D. Pericycle

2. According to ANSI Z133, what is the first action required when beginning tree work at any job site?
 - A. Conduct a hazard assessment
 - B. Start equipment
 - C. Begin climbing
 - D. Contact utility companies

3. Which soil particle type has the smallest size and highest surface area per unit volume?
 - A. Sand
 - B. Silt
 - C. Gravel
 - D. Clay

4. A tree with branching that produces a rounded, spreading crown without a single dominant leader has what growth form?

- A. Excurrent
- B. Decurrent
- C. Columnar
- D. Fastigate

5. What should an arborist do if the planned work would require closer approach to electrical conductors than minimum distances allow?

- A. Use rubber gloves and proceed
- B. Work during dry weather only
- C. Stop work and arrange for utility company to de-energize or protect lines
- D. Use wooden tools exclusively

6. Crown cleaning involves the removal of what types of branches?

- A. Dead, dying, diseased, broken, and weakly attached branches
- B. All lower branches
- C. Only dead branches
- D. Branches to reduce overall size

7. What soil characteristic describes the arrangement of soil particles into aggregates?

- A. Texture
- B. Structure
- C. Porosity
- D. Density

8. In CODIT, what does Wall 2 represent?

- A. Vessel plugging
- B. Ray cells
- C. Barrier zone
- D. Annual ring boundary limiting inward decay spread

9. Vascular discoloration in the sapwood of a wilting tree is often diagnostic of what type of disease?

- A. Foliar disease
- B. Root rot
- C. Vascular wilt disease
- D. Canker disease

10. A climbing rope must be retired from service when it shows what condition?

- A. Minor surface fuzz from normal use
- B. Core damage, significant sheath wear, or contamination
- C. Any visible wear
- D. Color fading from UV exposure

11. What is the primary driving force for water movement from roots to leaves?

- A. Transpiration pull (cohesion-tension)
- B. Root pressure alone
- C. Active pumping by xylem cells
- D. Osmosis in leaves

12. What is "volcano mulching" and why is it harmful?

- A. A beneficial mulching technique
- B. Mulch applied in a ring shape
- C. Mulch applied thinly over a wide area
- D. Mulch piled against the trunk, causing bark decay and girdling roots

13. Leaves arranged with three or more leaves originating from a single node are described as having what arrangement?

- A. Alternate
- B. Opposite
- C. Whorled
- D. Spiral

14. Conks or brackets growing from a tree trunk indicate what condition?

- A. Beneficial fungal activity
- B. Wood decay with established fungal infection
- C. Surface mold only
- D. Improved tree vigor

15. What is the minimum diameter for a branch to serve as a primary climbing tie-in point?

- A. 4 inches of live, sound wood
- B. 2 inches
- C. 6 inches
- D. Any diameter that holds weight

16. A support system that uses ground anchors connected to the tree by cables or straps is called what?

- A. Cabling
- B. Bracing
- C. Propping
- D. Guying

17. What root tissue initiates the development of lateral roots?

- A. Root cap
- B. Pericycle
- C. Epidermis
- D. Cortex

18. Which plant hormone is produced in response to stress and promotes stomatal closure?

- A. Gibberellin
- B. Auxin
- C. Abscisic acid
- D. Cytokinin

19. DBH is measured at what height above the ground?

- A. 4.5 feet (54 inches)
- B. 3 feet
- C. 5 feet
- D. 6 feet

20. Insects with piercing-sucking mouthparts that feed on plant fluids include which of the following?

- A. Caterpillars
- B. Sawfly larvae
- C. Leaf beetles
- D. Aphids, scales, and adelgids

21. Research on wound dressings has shown what?

- A. They accelerate healing significantly
- B. They do not prevent decay and may impede wound closure
- C. They are essential for all pruning cuts
- D. Only petroleum-based dressings are effective

22. Oak wilt disease is caused by what type of pathogen?

- A. Bacterium
- B. Virus
- C. Fungus
- D. Nematode

23. In tree risk assessment, likelihood of failure considers what factors?

- A. Defect severity, loading potential, and species characteristics
- B. Target value only
- C. Tree age exclusively
- D. Landscape design considerations

24. The periderm consists of what three tissues?

- A. Xylem, phloem, and cambium
- B. Pith, cortex, and epidermis
- C. Heartwood, sapwood, and bark
- D. Cork cambium, cork, and phelloderm

25. One-sided crown dieback often correlates with what below-ground condition?

- A. Uniform soil compaction
- B. Even fertilizer distribution
- C. Root damage or loss on the same side
- D. Normal growth variation

26. Guard cells control gas exchange by regulating the opening and closing of what structures?

- A. Lenticels
- B. Stomata
- C. Root hairs
- D. Vascular bundles

27. A tree protection plan should be prepared at what stage of a construction project?

- A. Before construction begins, during project planning
- B. After grading is complete
- C. When problems are observed
- D. After construction ends

28. Interveinal chlorosis on older leaves is characteristic of deficiency in which nutrient?

- A. Iron
- B. Calcium
- C. Boron
- D. Magnesium

29. Trees with strong compartmentalization ability are referred to as what?

- A. Poor compartmentalizers
- B. Good compartmentalizers
- C. Non-compartmentalizers
- D. Reactive compartmentalizers

30. When planting a tree, the root flare should be positioned where relative to soil grade?

- A. 4 inches below grade
- B. 2 inches below grade
- C. At or slightly above finished grade
- D. 6 inches below grade

31. Organic matter improves soil by doing what?

- A. Enhancing structure, water retention, and microbial activity
- B. Decreasing nutrient availability
- C. Increasing compaction
- D. Reducing drainage only

32. A proper pruning cut preserves what anatomical structure?

- A. The branch stub
- B. The central pith
- C. A 2-inch stub for sprouting
- D. The branch collar

33. What type of mycorrhizae forms a mantle around root tips and a Hartig net between root cells?

- A. Arbuscular mycorrhizae
- B. Endomycorrhizae
- C. Ectomycorrhizae
- D. Vesicular mycorrhizae

34. Excessive pruning of a mature tree can result in what negative outcome?

- A. Improved structure
- B. Epicormic sprouting and depleted energy reserves
- C. Faster wound closure
- D. Enhanced disease resistance

35. The 10-20-30 rule limits species representation in urban forests to what maximum percentage?

- A. 10 percent
- B. 20 percent
- C. 30 percent
- D. 40 percent

36. What type of tree inventory documents every tree in the management area?

- A. Sample inventory
- B. Statistical inventory
- C. Random plot survey
- D. Complete inventory

37. Yellowing of newest leaves while older leaves remain green indicates deficiency in what type of nutrient?

- A. Mobile nutrients
- B. All nutrients equally
- C. Immobile nutrients
- D. Macronutrients only

38. What is the proper response if electrical lines are discovered during tree work that were not previously identified?

- A. Continue if they appear to be phone lines
- B. Stop work immediately and contact the utility company
- C. Use fiberglass tools and proceed
- D. Work around them carefully

39. Root defects from container production that persist after planting most commonly include what?

- A. Excessive taproot development
- B. Improved lateral root distribution
- C. Enhanced root architecture
- D. Circling and potentially girdling roots

40. A tree risk assessment considers which three components?

- A. Likelihood of failure, likelihood of impact, and consequences
- B. Species, age, and location only
- C. Height, diameter, and crown spread
- D. Soil type, drainage, and pH

41. What type of growth is produced by apical meristems?

- A. Secondary growth
- B. Lateral growth
- C. Primary growth (elongation)
- D. Diameter increase

42. During tree establishment, where should irrigation water be applied?

- A. Only to surrounding soil
- B. Directly to the original root ball
- C. To leaves as foliar mist
- D. In a ring at the dripline only

43. Root damage severity is greatest when roots are severed where?

- A. Beyond the dripline
- B. At the outer edge of the root zone
- C. Uniformly throughout the root zone
- D. Close to the trunk

44. What bacterial disease affects trees in the rose family and spreads rapidly during warm, wet weather?

- A. Fire blight
- B. Bacterial leaf scorch
- C. Wetwood
- D. Crown gall

45. In tree appraisal, what does the condition rating evaluate?

- A. Species characteristics
- B. Site location factors
- C. Tree health and structural integrity
- D. Nursery replacement cost

46. An advanced tree risk assessment using specialized equipment is appropriate when?

- A. Assessing newly planted trees
- B. Internal decay is suspected but not visible
- C. Trees appear healthy with no defects
- D. Minor deadwood is present

47. Before climbing, a tie-in point should be tested by doing what?

- A. Applying body weight and observing for movement, sounds, or cracking
- B. Visual inspection only
- C. Assuming it is safe if diameter is adequate
- D. No testing is required

48. Job briefings before tree work must communicate what information?

- A. Equipment costs
- B. Marketing plans
- C. Future scheduling
- D. Hazards, responsibilities, and emergency procedures

49. Callus tissue that closes wounds is produced by what?

- A. Heartwood
- B. Pith
- C. Cambium at wound margins
- D. Root tips

50. What is the most effective method for treating severe soil compaction in the root zone?

- A. Heavy fertilization
- B. Prevention and remediation using vertical mulching and organic matter
- C. Foliar applications
- D. Increased irrigation only

51. Urban forest diversity protects against what primary threat?

- A. Catastrophic losses from species-specific pests or diseases
- B. Aesthetic monotony only
- C. High maintenance costs
- D. Property value reduction

52. Guy wires on newly planted trees should be removed when?

- A. After 5 years
- B. After 10 years
- C. Never
- D. After root establishment (typically 1-2 growing seasons)

53. Crown thinning accomplishes what objective?

- A. Reduces tree height
- B. Reduces crown density while maintaining natural form
- C. Provides clearance beneath the crown
- D. Removes dead branches only

54. When stomata close during water stress, what process is directly reduced?

- A. Root respiration
- B. Bark formation
- C. Photosynthesis (CO₂ uptake)
- D. Heartwood formation

55. Biological control uses what to manage pest populations?

- A. Natural enemies including predators, parasites, and pathogens
- B. Synthetic pesticides only
- C. Cultural practices exclusively
- D. Mechanical methods only

56. The branch bark ridge indicates what about proper pruning?

- A. Where flush cuts should be made
- B. The location for wound dressing application
- C. Areas of internal decay
- D. The upper boundary of the branch attachment for guiding cut placement

57. At what voltage threshold does the minimum approach distance from electrical conductors begin to increase beyond 10 feet?

- A. 25 kV
- B. 50 kV
- C. 75 kV
- D. 100 kV

58. What distinguishes reduction cuts from heading cuts?

- A. There is no difference
- B. Heading cuts are always preferable
- C. Reduction cuts are made to laterals at least 1/3 the diameter of the removed portion
- D. Reduction cuts leave stubs

59. Soil testing can determine nutrient levels but cannot indicate what?

- A. Soil pH
- B. Organic matter percentage
- C. Soil texture
- D. Nutrients actually absorbed by the tree

60. If climbing equipment becomes entangled during work, what is the proper response?

- A. Stop, secure position, and carefully untangle before proceeding
- B. Continue climbing to a better position
- C. Cut the equipment free
- D. Call for help and wait without action

61. Plant health care emphasizes what approach to plant problems?

- A. Calendar-based chemical applications
- B. Prevention and maintaining plant health
- C. Reactive pesticide treatment
- D. Removing affected plants immediately

62. Why are basal wounds more structurally concerning than wounds higher on the trunk?

- A. They are more visible
- B. They affect aesthetic value more
- C. They compromise the structural foundation where all loads transfer
- D. They are harder to treat

63. Annual rings visible in tree cross-sections are produced by what tissue?

- A. Phloem
- B. Cork cambium
- C. Pith
- D. Vascular cambium (xylem production)

64. When is structural pruning most effective for developing good tree form?

- A. Early in development when corrections require small cuts
- B. After the tree reaches mature size
- C. Only after defects cause problems
- D. During decline

65. Powdery mildew diseases on trees are caused by what type of organism?

- A. Bacteria
- B. Viruses
- C. Fungi
- D. Nematodes

66. Root hairs function primarily to do what?

- A. Provide structural support
- B. Increase surface area for water and nutrient absorption
- C. Store carbohydrates
- D. Produce hormones

67. A high-use pedestrian area beneath a tree with structural defects represents what in risk assessment?

- A. A defect
- B. A sign of disease
- C. An assessment method
- D. A high-occupancy target

68. What is the recommended depth for mulch application around trees?

- A. 2 to 4 inches
- B. 6 to 8 inches
- C. 8 to 12 inches
- D. 1 inch or less

69. Trees planted too deeply typically develop what problems?

- A. Excessive vigor
- B. Improved stability
- C. Trunk decay and stem-girdling roots
- D. Enhanced drought tolerance

70. What diagnostic tool creates cross-sectional images of internal wood condition using sound waves?

- A. Increment borer
- B. Sonic tomograph
- C. Resistograph
- D. Mallet sounding

71. According to ANSI A300, reduction cuts must be made to lateral branches of what minimum size?

- A. One-third the diameter of the cut stem
- B. One-quarter the diameter
- C. One-half the diameter
- D. Equal diameter

72. Interior crown thinning with excessive removal of inner branches (lion-tailing) causes what problems?

- A. Improved branch structure
- B. Enhanced wind resistance
- C. Better weight distribution
- D. Excessive end-weight loading and increased failure risk

73. What is the primary benefit of preserving mature trees during construction?

- A. Lower insurance costs
- B. Reduced initial costs
- C. Immediate environmental and aesthetic benefits that cannot be replaced for decades
- D. Simplified site design

74. What condition requires alternative assessment methods rather than climbing?

- A. Minor outer crown deadwood
- B. Evidence of severe structural defects or advanced basal decay
- C. Previous proper pruning
- D. Moderate lichen growth

75. The feed control bar on a wood chipper must be capable of doing what?

- A. Stopping or reversing the feed mechanism
- B. Increasing feed speed
- C. Adjusting chip size
- D. Directing discharge

76. Deficiency symptoms appearing on the newest leaves first indicate the lacking nutrient has what property?

- A. High toxicity
- B. High mobility in the plant
- C. Relationship to soil pH
- D. Immobility (cannot be translocated from older tissue)

77. In tree appraisal, what does species rating reflect?

- A. Location on property
- B. Tree age
- C. Relative value and desirability of the species for landscape use
- D. Condition percentage

78. What is the term for repeatedly removing growth back to permanent scaffold branches or knobs?

- A. Crown thinning
- B. Pollarding
- C. Crown reduction
- D. Crown cleaning

79. What factor most strongly influences wound closure rate?

- A. Type of wound dressing
- B. Time of year
- C. Wound shape
- D. Tree vigor and growth rate

80. Sapwood differs from heartwood because sapwood does what?

- A. Contains living cells and conducts water
- B. Resists decay better
- C. Is always darker colored
- D. Provides structural support only

81. A basic tree risk assessment should evaluate what areas of the tree and site?

- A. Crown only
- B. Trunk only
- C. Crown, trunk, root zone, and target area
- D. Root zone only

82. A vertical crack extending downward from a codominant stem union indicates what?

- A. Normal growth
- B. A serious structural defect indicating potential union failure
- C. Improved strength
- D. Minor cosmetic issue

83. Air excavation tools remove soil using what medium?

- A. Water
- B. Mechanical action
- C. Chemical agents
- D. Compressed air that displaces soil without cutting roots

84. The formation of specialized wood in leaning trees to help maintain position is called what?

- A. Reaction wood
- B. Normal wood
- C. Sapwood conversion
- D. Heartwood formation

85. When should fertilization be applied to established landscape trees?

- A. Every spring regardless of need
- B. During drought stress
- C. When testing confirms nutrient deficiency
- D. Immediately after transplanting

86. A fungal conk on a tree trunk is classified as what type of evidence?

- A. Symptom
- B. Sign (direct evidence of the causal organism)
- C. Environmental factor
- D. Normal feature

87. What rigging component controls the descent rate of pieces being lowered?

- A. Friction device
- B. Sling
- C. Block
- D. Choker

88. Integrated pest management prioritizes what approach?

- A. Immediate pesticide application
- B. Calendar-based treatment
- C. Single-tactic programs
- D. Monitoring, identification, thresholds, and appropriate tactic selection

89. Oak wilt spreads between unconnected trees primarily through what mechanism?

- A. Wind-blown spores
- B. Contaminated soil
- C. Insect vectors (nitidulid beetles) carrying spores to fresh wounds
- D. Rain splash

90. Container-grown trees held too long develop what condition?

- A. Improved root architecture
- B. Root-bound with circling roots
- C. Enhanced transplant success
- D. Natural root distribution

91. Root flare excavation is performed to accomplish what?

- A. Expose and assess the root-trunk transition zone
- B. Improve drainage
- C. Add fertilizer
- D. Increase soil depth

92. Higher specific gravity of wood indicates what properties?

- A. Lower strength
- B. Lighter weight
- C. Reduced density
- D. Greater density and strength

93. What assessment must occur before climbing any tree?

- A. Financial appraisal
- B. Inventory documentation
- C. Pre-climb safety inspection for hazards
- D. Marketing evaluation

94. Tree protection fencing should be installed at what time?

- A. When problems appear
- B. Before construction begins
- C. After grading
- D. At project completion

95. Action thresholds in IPM define what?

- A. Maximum pesticide rates
- B. Calendar treatment dates
- C. Cost limits
- D. Pest levels at which intervention is justified

96. A lightning protection system requires inspection at what frequency?

- A. Annually and after lightning events
- B. Every 10 years
- C. Never after installation
- D. Monthly

97. Cable and brace support systems require inspection at what minimum frequency?

- A. Every 10 years
- B. Monthly
- C. At least annually and after major storms
- D. Only when problems are visible

98. Crown raising is performed to accomplish what?

- A. Reduce crown density
- B. Provide vertical clearance beneath the crown
- C. Remove dead branches
- D. Decrease overall height

99. Nitrogen-fixing bacteria in legume root nodules convert what to plant-usable forms?

- A. Soil minerals
- B. Organic matter
- C. Carbon dioxide
- D. Atmospheric nitrogen

100. In risk assessment, "consequences" refers to what?

- A. Severity of harm if failure occurs and strikes the target
- B. Probability of failure
- C. Tree species characteristics
- D. Assessment method used

PRACTICE TEST 9: ANSWER KEY

WITH EXPLANATIONS

1. **C. Vascular cambium** - The vascular cambium is a thin, cylindrical layer of meristematic cells positioned between the xylem (wood) and phloem (inner bark). This lateral meristem is responsible for secondary growth, continuously producing new xylem cells toward the interior of the tree and new phloem cells toward the exterior. This process allows trees to increase in diameter throughout their lives, adding a new layer of wood each growing season visible as annual rings.
2. **A. Conduct a hazard assessment** - ANSI Z133 requires that before any tree work begins, a thorough hazard assessment must be conducted. This assessment identifies potential dangers including electrical conductors, dead branches, decay, traffic hazards, bystanders, and site-specific conditions. The assessment informs work planning, equipment selection, and safety precautions. Beginning work without proper hazard identification puts workers at unnecessary risk and violates industry safety standards.
3. **D. Clay** - Clay particles are the smallest soil particles, measuring less than 0.002 mm in diameter. Their extremely small size gives them an enormous surface area relative to their volume—thousands of times greater than the same weight of sand particles. This large surface area carries electrical charges that attract and hold water molecules and nutrient ions, giving clay soils high water retention and cation exchange capacity but also making them prone to poor drainage and compaction.
4. **B. Decurrent** - Decurrent (also called deliquescent) growth form describes trees that develop a rounded, spreading crown with multiple major branches and no single dominant central leader. This form is common in many hardwood species including oaks, elms, and maples. It contrasts with excurrent form, where a single dominant leader extends to the tree's apex, typical of many conifers. Understanding growth forms helps predict pruning needs and structural development patterns.
5. **C. Stop work and arrange for utility company to de-energize or protect lines** - When planned work would violate minimum approach distances from electrical conductors, work must stop until the utility company de-energizes the lines, installs protective covering, or provides appropriate supervision. There are no shortcuts—rubber gloves, wooden tools, or dry weather do not provide adequate protection from electrical hazards. Only qualified line-clearance arborists with specific training may work closer to energized conductors.
6. **A. Dead, dying, diseased, broken, and weakly attached branches** - Crown cleaning as defined by ANSI A300 involves selective removal of problematic branches including dead, dying,

diseased, broken, and weakly attached branches. This pruning type improves tree health by removing potential infection sources and reduces hazard by removing branches most likely to fail. Crown cleaning differs from crown thinning (reduces density) and crown reduction (reduces overall size).

7. **B. Structure** - Soil structure describes how individual soil particles (sand, silt, clay) are arranged into larger aggregates or clumps. Good structure creates pore spaces of varying sizes that allow water infiltration, drainage, air movement, and root penetration. Structure can be granular, blocky, platy, or massive (structureless). Compaction destroys soil structure by breaking down aggregates and reducing pore space, directly harming root function.
8. **D. Annual ring boundary limiting inward decay spread** - In the CODIT (Compartmentalization of Decay in Trees) model, Wall 2 is formed by the boundary between annual growth rings. This wall limits the inward spread of decay toward the center of the tree. The ring boundary represents a change in wood characteristics between late wood of one year and early wood of the next. Wall 2 is generally stronger than Wall 1 but weaker than Walls 3 and 4.
9. **C. Vascular wilt disease** - Vascular discoloration (brown or olive streaking in the sapwood) is a classic diagnostic indicator of vascular wilt diseases including Dutch elm disease, oak wilt, and Verticillium wilt. These diseases colonize xylem vessels, blocking water transport and often producing toxins. The discoloration results from the tree's response to infection, including tylosis formation and accumulation of phenolic compounds. Cutting affected branches and observing vascular streaking aids diagnosis.
10. **B. Core damage, significant sheath wear, or contamination** - Climbing ropes must be immediately retired when they show evidence of core damage (lumps, soft spots, inconsistent stiffness), significant sheath wear exposing the core, contamination with chemicals or substances that could weaken fibers, heat damage, or shock loading from a fall. Minor surface fuzz from normal use is expected and acceptable. Rope inspection before each use is mandatory; compromised ropes can fail catastrophically without warning.
11. **A. Transpiration pull (cohesion-tension)** - The cohesion-tension theory explains that water movement from roots to leaves is primarily driven by transpiration from leaf surfaces. As water evaporates from leaves, it creates negative pressure (tension) that pulls water upward through continuous columns in xylem vessels. Water molecules' cohesive properties (attraction to each other) and adhesion to vessel walls maintain these columns. This passive mechanism can lift water over 300 feet in tall trees.
12. **D. Mulch piled against the trunk, causing bark decay and girdling roots** - Volcano mulching is the harmful practice of piling mulch against tree trunks, creating a volcano-shaped mound. This causes multiple problems: constant moisture against bark promotes decay; the warm, moist environment attracts rodents that gnaw bark; and roots growing into the mulch may circle and

eventually girdle the trunk. Proper mulching maintains a 3-6 inch gap between mulch and trunk with 2-4 inch depth in a donut shape.

13. **C. Whorled** - Whorled leaf arrangement has three or more leaves originating from a single node, arranged in a circle around the stem. This arrangement is less common than alternate or opposite and is found in species like catalpa and some Prunus varieties. Identifying leaf arrangement is an important characteristic for tree identification that can be observed year-round by examining twig structure.
14. **B. Wood decay with established fungal infection** - Conks, brackets, and mushrooms growing from tree trunks are fruiting bodies of wood decay fungi. Their presence indicates the fungus has been established in the wood long enough to produce reproductive structures—typically years. By the time fruiting bodies appear, significant internal decay has usually developed. The type of fungus (identified by fruiting body characteristics) indicates decay type (white rot vs. brown rot) and typical decay patterns.
15. **A. 4 inches of live, sound wood** - Safe climbing tie-in points require live, healthy branches at least 4 inches in diameter at the attachment point with sound connection to the parent stem. The branch must be free of decay, cracks, and structural defects. Dead branches, regardless of diameter, should never serve as primary tie-in points because they may fail without warning. Load testing by pulling firmly before committing full weight helps verify the anchor's integrity.
16. **D. Guying** - Guying systems use cables, straps, or rope connecting the tree trunk to ground anchors (stakes, deadmen, or earth anchors) to provide external support. Common applications include newly transplanted large trees that need support during root establishment and trees with compromised root systems. Guy attachments should use broad straps to prevent bark damage, and systems should be removed after roots establish (typically 1-2 years).
17. **B. Pericycle** - The pericycle is a layer of cells located inside the endodermis, surrounding the vascular tissue of roots. It retains meristematic (cell-dividing) capability and initiates the formation of lateral (branch) roots. When lateral root development begins, pericycle cells start dividing, forming a new root primordium that grows outward through the cortex and epidermis. This internal origin explains why lateral roots emerge from within the parent root.
18. **C. Abscisic acid** - Abscisic acid (ABA) is often called the "stress hormone" because it accumulates in response to environmental stresses, particularly drought. ABA promotes stomatal closure, reducing water loss through transpiration. It also inhibits growth and promotes dormancy in buds and seeds during unfavorable conditions. Understanding ABA's role helps explain tree responses to drought stress and the tradeoff between water conservation and photosynthetic capacity.
19. **A. 4.5 feet (54 inches)** - DBH (Diameter at Breast Height) is the standard measurement taken at 4.5 feet (54 inches or 1.37 meters) above ground level on the uphill side of the tree. This standardized measurement point enables consistent comparisons between trees and over time. When abnormalities exist at 4.5 feet (swelling, branches, wounds), measurement is taken at the

nearest representative point. DBH is fundamental to inventory, appraisal, and management calculations.

20. **D. Aphids, scales, and adelgids** - Insects with piercing-sucking mouthparts insert needle-like stylets into plant tissue to withdraw fluids, typically from phloem or cell contents. Common examples include aphids, scales, mealybugs, adelgids, psyllids, and leafhoppers. Many excrete honeydew (excess sugars), which supports sooty mold growth. These insects can transmit plant pathogens, cause leaf distortion, and weaken plants through continuous sap removal.
21. **B. They do not prevent decay and may impede wound closure** - Extensive research has demonstrated that wound dressings (pruning paints, sealers, wound paint) do not prevent decay entry into wounds, do not speed wound closure, and may actually slow the tree's natural wound response by trapping moisture or creating favorable conditions for decay organisms. Trees compartmentalize wounds most effectively when left untreated. This finding contradicts traditional practices still sometimes seen.
22. **C. Fungus** - Oak wilt is caused by the fungus *Bretziella fagacearum* (formerly *Ceratocystis fagacearum*). This vascular pathogen colonizes xylem vessels, blocking water transport and producing toxins. The disease spreads locally through root grafts between adjacent oaks and over longer distances via nitidulid beetles that carry spores from fungal mats on infected trees to fresh wounds on healthy trees. Oak wilt is particularly devastating to red oak group species.
23. **A. Defect severity, loading potential, and species characteristics** - Likelihood of failure in tree risk assessment considers the presence, type, and severity of structural defects; the tree's exposure to loading forces (wind, ice, snow, saturated soils); species-specific failure characteristics; tree size; and defect history. A tree with severe defects in a high-wind location has greater failure likelihood than a sound tree in a sheltered location. This component focuses solely on failure probability, not consequences.
24. **D. Cork cambium, cork, and phelloderm** - The periderm is the protective outer tissue that replaces the epidermis in woody stems and roots. It consists of three tissues: cork cambium (phellogen), which produces cork cells (phellem) toward the outside and phelloderm toward the inside. Cork cells are dead at maturity with walls impregnated with suberin, making them waterproof and protective. The periderm forms the outer bark that protects underlying living tissues.
25. **C. Root damage or loss on the same side** - Crown symptoms often mirror root zone conditions because specific root sectors supply corresponding crown portions. When roots on one side of the tree are damaged or lost (from construction, disease, or other causes), the crown section they supplied loses its water and nutrient source, showing dieback while other portions remain healthy. This asymmetric pattern helps diagnose root problems that may not be visible above ground.
26. **B. Stomata** - Guard cells are specialized kidney-shaped cells that flank each stoma (plural: stomata), the microscopic pores on leaf surfaces through which gas exchange occurs. Guard cells

regulate stomatal opening by changing shape in response to turgor pressure, light, CO₂ concentration, and hormones like abscisic acid. When guard cells become turgid, they bow outward, opening the stomatal pore; when flaccid, the pore closes, reducing water loss.

27. **A. Before construction begins, during project planning** - Effective tree protection requires planning before any construction activity begins. Tree protection plans should be developed during project design, specifying which trees to preserve, protection zone boundaries, fencing specifications, prohibited activities, monitoring requirements, and responsible parties. Plans developed after construction begins cannot prevent damage that has already occurred. Protection specifications should be included in construction contracts.
28. **D. Magnesium** - Magnesium is a mobile nutrient, meaning it can be translocated from older tissue to support new growth. When magnesium is deficient, the plant moves existing supplies from older leaves, causing interveinal chlorosis (yellowing between veins while veins remain green) on older leaves first. Magnesium is a central component of the chlorophyll molecule, explaining why its deficiency affects green coloration. This differs from iron deficiency, which appears on youngest leaves.
29. **B. Good compartmentalizers** - Trees vary in their ability to form effective barriers against decay spread after wounding. Species with strong compartmentalization ability ("good compartmentalizers") produce robust chemical and physical barriers that effectively wall off infected tissue. Examples include oaks and many tropical hardwoods. Poor compartmentalizers (willows, poplars) form weak barriers, allowing decay to spread extensively. This characteristic influences pruning decisions and wound management.
30. **C. At or slightly above finished grade** - The root flare (trunk flare, root collar) should be visible at or slightly above the final soil grade after planting and settling. Planting too deeply buries the flare, promoting bark decay, encouraging girdling root development, and interfering with proper gas exchange at the trunk base. Many tree problems trace to improper planting depth—either from nursery practices or improper planting technique.
31. **A. Enhancing structure, water retention, and microbial activity** - Organic matter improves virtually every aspect of soil function. It promotes aggregation (improving structure), increases water-holding capacity, enhances nutrient retention through cation exchange, provides slow-release nutrients as it decomposes, and supports beneficial soil organisms including mycorrhizal fungi and decomposers. Adding organic matter is one of the most effective ways to improve soil conditions for tree growth.
32. **D. The branch collar** - Proper pruning cuts preserve the branch collar, the swollen area at the base of a branch where it attaches to the parent stem. The collar contains specialized tissue that enables effective compartmentalization and wound closure. Cutting outside the collar allows these tissues to function; flush cuts that remove the collar damage trunk tissue and impair wound response; stub cuts prevent proper closure and invite decay entry.

33. **C. Ectomycorrhizae** - Ectomycorrhizal fungi form a visible mantle (sheath) around root tips and grow between root cortex cells, forming a network called the Hartig net. They do not penetrate root cell walls. This type is common in temperate forest trees including oaks, pines, birches, and beeches. The fungal sheath often gives colonized roots a distinctive appearance. Ectomycorrhizae dramatically enhance water and mineral absorption, especially phosphorus.
34. **B. Epicormic sprouting and depleted energy reserves** - Removing excessive live crown (more than 25% from mature trees) causes severe stress. The tree loses stored energy in removed branches, has reduced photosynthetic capacity, and often responds with vigorous epicormic sprouting (water sprouts from dormant buds). These sprouts are weakly attached, require ongoing maintenance, and indicate the tree is stressed. Over-pruning predisposes trees to decline, pest attack, and sunscald.
35. **A. 10 percent** - The 10-20-30 diversity guideline recommends that no single species comprise more than 10% of an urban forest population. This limit protects against species-specific threats like Dutch elm disease or emerald ash borer. Combined with limits on genus (20%) and family (30%), this multi-level approach ensures protection against threats at various taxonomic levels, preventing any single pest or disease from causing catastrophic canopy loss.
36. **D. Complete inventory** - A complete inventory documents every tree in the management area, recording location, species, size, condition, and maintenance needs for each individual. This comprehensive approach enables specific work orders, detailed tracking, and precise management. It requires more resources than sample inventories but provides essential data for urban forest management. Modern complete inventories often use GPS and mobile technology for efficient data collection.
37. **C. Immobile nutrients** - Immobile nutrients (iron, manganese, boron, calcium, copper, zinc) cannot be translocated from older tissue to support new growth. When deficient, the tree cannot supply developing leaves from existing reserves, so symptoms appear on newest leaves first. Iron and manganese deficiency typically causes interveinal chlorosis (yellowing between veins) on young leaves. Deficiency often results from high soil pH making nutrients chemically unavailable.
38. **B. Stop work immediately and contact the utility company** - Unexpected electrical conductors require immediate work stoppage. Never assume wires are safe based on appearance—communication cables may be attached to power poles with energized components nearby, and some power lines appear similar to phone lines. Only the utility company can confirm line types and voltages. Proceeding with work near unidentified lines creates life-threatening hazards and violates safety standards.
39. **D. Circling and potentially girdling roots** - When trees remain in containers too long, roots reaching container walls begin growing in circles. After planting, these circling roots often continue their circular pattern rather than growing outward into surrounding soil. They may eventually girdle (strangle) the trunk or major roots, causing decline or death years or decades

later. Root inspection and correction at planting is essential but cannot completely correct severe defects.

40. **A. Likelihood of failure, likelihood of impact, and consequences** - Tree risk assessment evaluates three components: (1) likelihood of failure—probability the tree or part will fail based on defect severity, loading potential, and species characteristics; (2) likelihood of impact—probability that if failure occurs, it will strike the target; and (3) consequences—severity of harm if impact occurs. All three must be considered to determine overall risk rating and appropriate response.
41. **C. Primary growth (elongation)** - Apical meristems at shoot and root tips produce primary growth through cell division and elongation, increasing plant length. This contrasts with secondary growth (diameter increase), produced by lateral meristems (vascular cambium and cork cambium). Both types of growth occur simultaneously in woody plants—primary growth extends the extremities while secondary growth increases girth of previously formed stems and roots.
42. **B. Directly to the original root ball** - Newly planted trees have all their absorbing roots in the original root ball. This limited root volume can dry out even when surrounding soil is moist because water moves poorly between dissimilar soil types. Irrigation must target the root ball directly, keeping it consistently moist (not saturated) until roots grow into surrounding soil. As establishment progresses over 1-3 years, irrigation can shift to a wider area.
43. **D. Close to the trunk** - Root damage severity increases with proximity to the trunk because larger, more critical roots are located closer to the trunk, and a greater percentage of the root system is affected by damage in this zone. Roots within 3× trunk diameter distance are critical; severing major roots in this zone often causes severe decline or death. Damage beyond the dripline affects smaller, more expendable roots with less impact on overall tree health.
44. **A. Fire blight** - Fire blight is caused by the bacterium *Erwinia amylovora* and affects trees in the rose family (Rosaceae) including apple, pear, crabapple, hawthorn, and mountain ash. It spreads rapidly during warm (75-85°F), wet weather, particularly during bloom. Symptoms include rapid wilting and blackening of shoots (appearing burned), often with characteristic "shepherd's crook" bending of affected shoots. Bacterial ooze may be visible on infected tissue.
45. **C. Tree health and structural integrity** - The condition rating in tree appraisal evaluates the tree's overall health (crown density, leaf color and size, growth rate, absence of decline symptoms) and structural integrity (absence of decay, cracks, weak attachments, codominant stems). Trees in excellent condition receive 100%; significant health problems or structural defects reduce the rating. This factor substantially affects final appraised value.
46. **B. Internal decay is suspected but not visible** - Advanced assessment using specialized equipment (resistance drills, sonic tomographs, aerial inspection) is appropriate when conditions affecting management decisions cannot be determined through visual examination. Suspected internal decay indicated by external clues (old wounds, fungal fruiting bodies, hollow sounds when

sounding) warrants quantitative assessment to determine decay location, extent, and residual wall thickness.

47. **A. Applying body weight and observing for movement, sounds, or cracking** - Before committing full weight to a climbing system, load test the tie-in point by applying body weight gradually while observing and listening for any movement, cracking sounds, or visual changes indicating weakness. This test helps identify compromised anchors that might fail under dynamic climbing loads. If any concern exists, select a different tie-in point. Visual inspection alone may miss internal defects.
48. **D. Hazards, responsibilities, and emergency procedures** - ANSI Z133 requires job briefings before tree work begins. These briefings must communicate specific hazards identified at the site, how hazards will be controlled, individual crew member responsibilities, communication protocols, emergency procedures, and the overall work plan. Briefings should be repeated when conditions change significantly. Effective communication prevents incidents resulting from misunderstanding or lack of awareness.
49. **C. Cambium at wound margins** - Callus tissue (woundwood) is produced by the vascular cambium at wound margins. Cambial cells around the wound edges begin dividing, producing new tissue that gradually rolls over the wound surface from the edges inward. Callus production rate depends on cambial activity—vigorous trees with active growth close wounds faster. Proper pruning that preserves the branch collar optimizes callus production by maintaining healthy cambium adjacent to the wound.
50. **B. Prevention and remediation using vertical mulching and organic matter** - Soil compaction is much easier to prevent than correct. Where compaction exists, remediation options include vertical mulching (drilling holes filled with organic matter), radial trenching, air injection, and surface organic matter application. These techniques gradually improve conditions but may not fully restore severely compacted soils. Protection during construction remains the most effective strategy.
51. **A. Catastrophic losses from species-specific pests or diseases** - Urban forest diversity requirements exist primarily to prevent devastating losses when species-specific threats arrive. The loss of American chestnut, American elm, and ash species demonstrates how communities with monocultures or low diversity can lose entire canopy populations. Diversity ensures no single pest or disease can eliminate more than a portion of the urban forest, maintaining overall canopy coverage and benefits.
52. **D. After root establishment (typically 1-2 growing seasons)** - Guy wires should remain only until roots establish sufficiently to anchor the tree independently—typically 1-2 growing seasons for most transplants. Leaving guys longer prevents proper trunk development (trunk strengthening requires wind movement), creates potential for trunk girdling as the tree expands against support materials, and may cause attachment hardware to become embedded.

53. **B. Reduces crown density while maintaining natural form** - Crown thinning selectively removes branches throughout the crown to reduce density (number of branches and foliage quantity) while preserving the tree's natural shape. Benefits include improved light penetration, reduced wind resistance, and decreased weight on branch unions. This differs from crown reduction (reduces overall size) and crown raising (removes lower branches). Proper thinning is distributed throughout the crown.
54. **C. Photosynthesis (CO₂ uptake)** - When stomata close to conserve water, carbon dioxide cannot enter the leaf for photosynthesis. This creates a fundamental tradeoff: the tree conserves water but cannot produce carbohydrates. Prolonged stomatal closure during extended drought depletes energy reserves, reduces growth, and weakens the tree's ability to defend against pests and pathogens. Trees that survive severe drought may remain compromised for subsequent years.
55. **A. Natural enemies including predators, parasites, and pathogens** - Biological control uses living organisms to suppress pest populations. Predators (lady beetles, lacewings, predatory mites) consume pests directly; parasitoids (parasitic wasps, flies) develop inside pest bodies, killing them; and pathogens (*Bacillus thuringiensis*, insect-killing fungi) cause disease. Approaches include conservation (protecting natural enemies), augmentation (releasing additional natural enemies), and classical (introducing natural enemies for invasive pest control).
56. **D. The upper boundary of the branch attachment for guiding cut placement** - The branch bark ridge is a raised line of bark at the top of a branch attachment where branch and trunk bark meet and turn inward. It marks where branch tissue ends and trunk tissue begins, indicating where the pruning cut should begin. The cut should angle down and away from this ridge, ending just outside the branch collar at the bottom of the attachment.
57. **B. 50 kV** - The minimum approach distance for unqualified workers is 10 feet for voltages below 50 kV. Above 50 kV, the distance increases by 4 inches for each additional 10 kV. For example, at 100 kV (50 kV above threshold), the minimum distance would be 10 feet plus 20 inches (4 inches × 5 increments of 10 kV), totaling approximately 11 feet 8 inches. These distances apply to all body parts, tools, and materials.
58. **C. Reduction cuts are made to laterals at least 1/3 the diameter of the removed portion** - Reduction cuts remove back to lateral branches large enough (minimum one-third the diameter of the removed branch) to assume the terminal role and continue growth in the same general direction. This maintains natural form while reducing size. Heading cuts remove to random points or to laterals too small to assume terminal function, stimulating multiple weakly attached sprouts—a fundamentally different outcome.
59. **D. Nutrients actually absorbed by the tree** - Soil testing reveals nutrient concentrations in soil but cannot indicate what the tree has actually taken up. Nutrients may be present but chemically unavailable (like iron in alkaline soils), or roots may be damaged and unable to absorb available

nutrients. Foliar (tissue) analysis reveals nutrient concentrations within the plant itself, showing what has actually been absorbed regardless of soil conditions.

60. **A. Stop, secure position, and carefully untangle before proceeding** - If climbing equipment becomes entangled, stop immediately and secure your position before attempting to resolve the problem. Continuing to climb with entangled equipment creates unpredictable tensions and movement limitations that could trap or injure the climber. Take time to carefully identify the entanglement and resolve it systematically before proceeding. Rushing increases risk.
61. **B. Prevention and maintaining plant health** - Plant health care (PHC) shifts focus from reactive pest treatment to proactive health maintenance. Healthy, vigorous plants better resist and tolerate pest pressure. PHC integrates proper cultural practices (appropriate watering, mulching, soil management), regular monitoring to detect problems early, accurate diagnosis, and intervention only when monitoring indicates thresholds are exceeded. This approach often reduces pesticide use while improving long-term plant health.
62. **C. They compromise the structural foundation where all loads transfer** - The tree base is where all above-ground weight and wind loads transfer to the root system. Decay or damage at this location compromises the structural foundation. A wound of a given size at the base affects a greater percentage of the tree's load-bearing capacity than the same-sized wound higher on the trunk. Basal wounds can lead to complete structural failure; higher wounds affect only portions above them.
63. **D. Vascular cambium (xylem production)** - Annual rings visible in tree cross-sections are formed by xylem (wood) produced by the vascular cambium. In temperate climates, the cambium produces large, thin-walled cells in spring (earlywood) and smaller, thick-walled cells in summer (latewood). This alternating pattern creates visible rings, with each ring typically representing one year's growth. Ring width reflects growing conditions during that year.
64. **A. Early in development when corrections require small cuts** - Structural pruning is most effective when started early because developing good form requires only small cuts that close quickly with minimal stress. Removing a 1-inch competing leader is far less harmful than removing a 6-inch codominant stem later. Early intervention shapes growth before defects become serious structural problems. Regular evaluation and pruning during the first 10-15 years establishes lifelong structure.
65. **C. Fungi** - Powdery mildew diseases are caused by various fungal species that produce characteristic white, powdery growth on leaf surfaces, consisting of fungal mycelium and spores. Unlike most fungi, powdery mildew thrives in dry conditions (though high humidity promotes infection). The fungi draw nutrients from epidermal cells without initially killing them. While unsightly, powdery mildew rarely causes serious harm to established trees.
66. **B. Increase surface area for water and nutrient absorption** - Root hairs are tubular extensions of epidermal cells on young roots that dramatically increase surface area for absorption. A single

root may have millions of root hairs, increasing absorptive surface by 5-20 times. Root hairs are short-lived (days to weeks), extremely fragile, and continuously replaced as roots grow. They are easily destroyed by transplanting or soil disturbance, explaining why newly transplanted trees need careful water management.

67. **D. A high-occupancy target** - A high-use pedestrian area represents a high-occupancy target—a location where people are frequently present and could be harmed by tree failure. Target occupancy significantly affects risk assessment because it determines how likely people would be present if failure occurred. High-occupancy targets (sidewalks, playgrounds, parking lots) require more careful risk management than low-occupancy areas.
68. **A. 2 to 4 inches** - Mulch should be applied 2-4 inches deep for optimal benefits. This depth conserves moisture, moderates temperature, suppresses weeds, and improves soil as it decomposes. Shallower applications provide inadequate benefits; deeper mulch can restrict oxygen, retain excessive moisture against the trunk, harbor rodents, and encourage stem-girdling roots. Proper depth is critical—more is not better.
69. **C. Trunk decay and stem-girdling roots** - Trees planted too deeply have trunk bark in contact with soil moisture, promoting bark decay that may progress into wood. Additionally, buried trunks often develop adventitious roots that grow tangentially, eventually girdling the trunk or major roots. These problems may take years or decades to manifest, making deep planting a hidden cause of later decline. The root flare should always be visible at or above grade.
70. **B. Sonic tomograph** - Sonic tomography uses sound wave transmission between multiple sensors placed around the trunk to create cross-sectional images of internal wood condition. Sound travels faster through solid wood and slower through decayed or hollow areas. By analyzing transmission times between sensor pairs, software generates images showing decay location and extent. This non-destructive technique complements other assessment methods.
71. **A. One-third the diameter of the cut stem** - ANSI A300 specifies that reduction cuts must be made to lateral branches at least one-third the diameter of the branch being removed. Laterals of this size can assume the terminal role and continue growth without stimulating excessive sprouting. Cuts to smaller laterals function more like heading cuts, stimulating multiple weakly attached water sprouts.
72. **D. Excessive end-weight loading and increased failure risk** - Lion-tailing (removing interior branches while leaving foliage only at branch ends) concentrates weight at branch tips, creating lever-arm forces that increase stress at branch unions. It also removes damping foliage that normally slows branch movement in wind. This improper pruning pattern increases branch failure risk and often leads to sunscald on newly exposed bark. Interior branches should be retained for proper weight distribution.
73. **C. Immediate environmental and aesthetic benefits that cannot be replaced for decades** - Mature trees provide substantial immediate benefits including shade, energy savings, stormwater

management, air quality improvement, wildlife habitat, and aesthetic value that newly planted trees cannot match for 20-50+ years. A single mature tree may provide hundreds of dollars in annual benefits. These values cannot be replaced on any practical timeline, making preservation planning critical during development.

74. **B. Evidence of severe structural defects or advanced basal decay** - Trees showing severe structural problems (horizontal cracks, significant lean with root plate movement, extensive basal decay) may not safely support a climber's dynamic loads. Climbing such trees risks triggering failure. Alternative access methods (aerial lifts) or ground-based assessment may be necessary. The pre-climb inspection specifically evaluates whether climbing can be conducted safely.
75. **A. Stopping or reversing the feed mechanism** - The chipper feed control bar is a critical safety device positioned across the feed opening that stops or reverses the feed mechanism when pushed. If entanglement begins, pushing this bar may stop the feed before the operator is pulled further into the machine. This device must be tested before operation, never disabled, and positioned within easy reach during operation.
76. **D. Immobility (cannot be translocated from older tissue)** - Immobile nutrients cannot be moved from older tissue to support new growth. When these nutrients are deficient, developing leaves cannot receive them from existing plant reserves, so symptoms appear on newest leaves first. Understanding nutrient mobility helps diagnose deficiencies: symptoms on new growth indicate immobile nutrients (iron, manganese, calcium, boron); symptoms on old growth indicate mobile nutrients (nitrogen, phosphorus, potassium, magnesium).
77. **C. Relative value and desirability of the species for landscape use** - Species rating in tree appraisal reflects characteristics affecting landscape value: longevity, maintenance requirements, pest and disease susceptibility, growth rate, ornamental features, structural strength, and overall desirability. High-value species like oaks receive higher ratings than short-lived or problem-prone species. Ratings are often developed regionally to reflect local growing conditions and preferences.
78. **B. Pollarding** - Pollarding is a traditional practice of repeatedly removing all growth back to permanent scaffold branches (pollard heads or knobs) on a regular cycle (typically annually to every few years). When properly initiated on young trees and maintained consistently, pollarding creates distinctive forms common in European landscapes. It differs from topping in being a planned system requiring regular maintenance. Topping without subsequent management creates hazards.
79. **D. Tree vigor and growth rate** - Wound closure rate correlates directly with annual radial growth rate because callus tissue is produced by cambial activity at wound margins. A vigorous tree producing half an inch of radial growth annually closes wounds twice as fast as one producing a quarter inch. This relationship explains why maintaining tree health is critical when wounding is unavoidable and why wounds on stressed trees may become permanent decay entry points.

80. **A. Contains living cells and conducts water** - Sapwood is the outer portion of wood containing living parenchyma cells (in rays and axial parenchyma) and functional xylem vessels and tracheids that actively conduct water. As the tree grows, older sapwood gradually converts to heartwood through cell death and accumulation of extractives. Heartwood no longer conducts water or contains living cells but provides structural support.
81. **C. Crown, trunk, root zone, and target area** - A thorough basic risk assessment systematically evaluates all tree parts that could fail: crown (dead branches, weak attachments), trunk (cracks, decay, structural defects), and root zone (stability indicators, root defects). It also assesses the target area to identify what could be harmed and evaluate consequences. Limiting assessment to any single zone potentially misses critical information.
82. **B. A serious structural defect indicating potential union failure** - Vertical cracks extending downward from codominant stem unions (sometimes called "rams horn" cracks) indicate stress concentration and potential failure of included bark unions. These cracks may extend during wind loading, eventually causing complete separation. This is a serious structural defect often warranting immediate mitigation—the crack represents active structural failure in progress.
83. **D. Compressed air that displaces soil without cutting roots** - Air excavation tools use high-pressure compressed air to displace soil particles without cutting roots. This technology enables root examination, root collar investigation, trenching in root zones, and girdling root treatment while minimizing root damage. The ability to work in root zones without significant root loss has expanded tree preservation options during construction.
84. **A. Reaction wood** - Reaction wood is specialized wood formed in response to non-vertical orientation, helping trees maintain or regain upright position. In hardwoods, reaction wood (tension wood) forms on the upper side of leaning stems and branches, pulling upward. In conifers, reaction wood (compression wood) forms on the lower side, pushing upward. Reaction wood has different properties than normal wood, affecting both living trees and wood products.
85. **C. When testing confirms nutrient deficiency** - Fertilization benefits trees when actual nutrient deficiencies limit health or growth. Soil or tissue testing identifies whether deficiencies exist and which nutrients are lacking. Fertilizing without confirmed need wastes resources, may harm trees (excess nitrogen promotes succulent growth susceptible to pests), and can pollute water resources. Most established landscape trees do not require regular fertilization.
86. **B. Sign (direct evidence of the causal organism)** - Fungal fruiting bodies (mushrooms, conks, brackets) are reproductive structures of fungi—direct evidence of the organism itself. This makes them "signs" of disease, as opposed to "symptoms," which are plant responses (wilting, chlorosis, dieback). Finding a conk on a trunk is a sign of wood decay fungus; determining the significance requires assessing decay extent and structural impact.
87. **A. Friction device** - Friction devices (Port-a-wrap, rigging wrench, or rope wrapped around a friction post) control descent rate by allowing ground personnel to apply friction to the lowering

line. Proper friction control enables smooth, controlled lowering; insufficient friction allows dangerous uncontrolled descent with potential for shock loading and system failure. The person operating the friction device has critical responsibility for safe rigging operations.

88. **D. Monitoring, identification, thresholds, and appropriate tactic selection** - Integrated pest management follows a systematic decision process: regular monitoring detects pest presence, accurate identification ensures appropriate response, action thresholds determine whether intervention is justified, and appropriate tactics are selected based on effectiveness, cost, and environmental impact. This approach prevents unnecessary treatment while ensuring effective response when needed.
89. **C. Insect vectors (nitidulid beetles) carrying spores to fresh wounds** - Oak wilt spreads between non-root-connected trees primarily via nitidulid (sap-feeding) beetles that carry fungal spores from infected trees to fresh wounds on healthy trees. These beetles are most active in spring and early summer, which is why oak pruning is discouraged April-July in oak wilt areas. The disease also spreads through root grafts between adjacent oaks.
90. **B. Root-bound with circling roots** - Trees grown too long in containers develop circling roots that conform to container walls. This root-bound condition persists after planting—circling roots often continue circling rather than growing outward. Without correction at planting (cutting, spreading, or removing circling roots), they may eventually girdle the trunk or major roots, causing decline or death years later.
91. **A. Expose and assess the root-trunk transition zone** - Root flare excavation removes soil, mulch, or debris burying the trunk base, allowing visual assessment of the root-trunk transition and identification of problems like girdling roots, trunk decay, or improper planting depth. Many tree problems trace to buried root flares. Excavation is both diagnostic and therapeutic (removing girdling roots, allowing trunk to dry).
92. **D. Greater density and strength** - Specific gravity (ratio of wood density to water density) directly correlates with wood strength. Higher specific gravity indicates denser wood with more cell wall material per unit volume, resulting in greater mechanical strength. Species with high specific gravity (oak, hickory) produce stronger wood than those with low specific gravity (cottonwood, willow).
93. **C. Pre-climb safety inspection for hazards** - Before climbing any tree, a thorough safety assessment must identify potential hazards including structural defects, decay, dead branches, electrical conductors, wildlife, and overall tree condition. This inspection determines whether the tree can safely support climbing operations and identifies conditions requiring precautions or alternative methods. Pre-climb inspection is mandatory under ANSI Z133.
94. **B. Before construction begins** - Effective tree protection requires physical barriers installed before any construction activity begins—before equipment arrives on site. The fence must be at the critical root zone boundary (minimum), remain throughout construction, and be clearly

identified. Protection implemented after construction begins cannot prevent damage already done. Prevention is the only effective protection strategy.

95. **D. Pest levels at which intervention is justified** - Action thresholds define pest population, damage level, or conditions at which treatment becomes justified because potential damage exceeds treatment costs and risks. Below threshold, pest presence is tolerated; above threshold, intervention is warranted. Thresholds vary with plant value, pest species, time of year, and management objectives.
96. **A. Annually and after lightning events** - Lightning protection systems require annual inspection to verify component condition and proper function. Additional inspection after lightning strikes detects damage not immediately visible. Tree growth may require conductor repositioning over time. Proper maintenance ensures continued protection throughout system service life.
97. **C. At least annually and after major storms** - Tree support systems require regular inspection to ensure proper function. Annual inspection at minimum, plus inspection after significant storms, verifies hardware condition, cable tension, tree growth around components, and continued appropriateness for current conditions. Neglected systems may fail to provide intended support or may damage trees as they grow.
98. **B. Provide vertical clearance beneath the crown** - Crown raising removes lower branches to increase clearance beneath the crown for pedestrians, vehicles, buildings, or sight lines. It is commonly needed along streets, over parking areas, and near buildings. Crown raising should be accomplished gradually on young trees rather than removing large lower limbs from mature trees, which creates significant wounds.
99. **D. Atmospheric nitrogen** - Nitrogen-fixing bacteria (*Rhizobium* and related species) in legume root nodules convert atmospheric nitrogen gas (N_2) to ammonia (NH_3), which plants can use for growth. This symbiosis allows legumes to thrive in nitrogen-poor soils and enriches soil nitrogen for subsequent plants. Legume trees include black locust, honeylocust, redbud, and Kentucky coffeetree.
100. **A. Severity of harm if failure occurs and strikes the target** - Consequences in tree risk assessment evaluate what harm would result if the tree fails and strikes the target. Consequences range from negligible (minor property damage) to severe (serious injury or death). Factors include target type (people vs. property), target vulnerability, and potential failure size. Higher consequences justify more aggressive risk mitigation.