

Tree Growth & Wood Structure – Lesson 1



Success in any field requires learning basic principles.

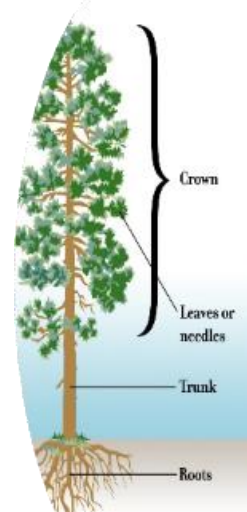
This is especially true for grading lumber, which relies on visual analysis.

Understanding and applying these principles improves grading efficiency and success.

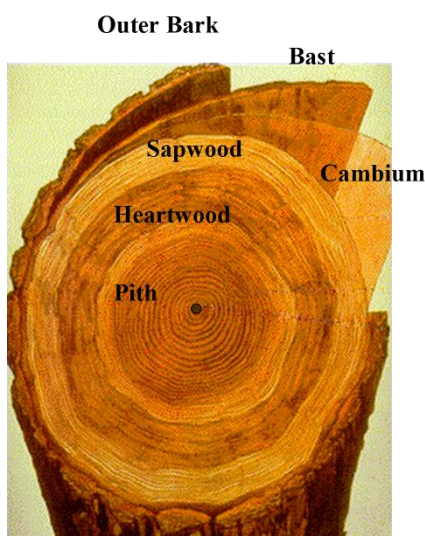
Since lumber is produced from trees, which are living plants, it is desirable, and sometimes necessary, to have a general knowledge of tree growth and structure.

I. Tree Structure:

- a) Crown: Branches and twigs that bear needles; transforms sap into food through photosynthesis.
- b) Trunk: Provides support, conducts liquids, and stores food.
- c) Roots: Anchor the tree, absorb moisture and minerals, and transport sap to the crown.



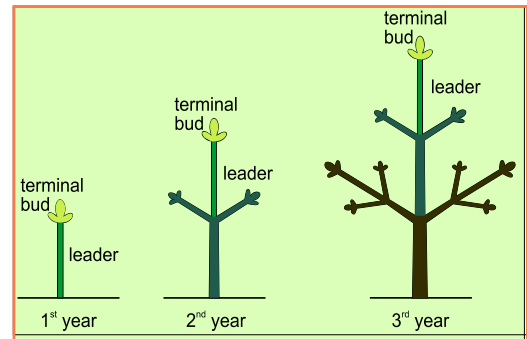
II. Parts of the Trunk:



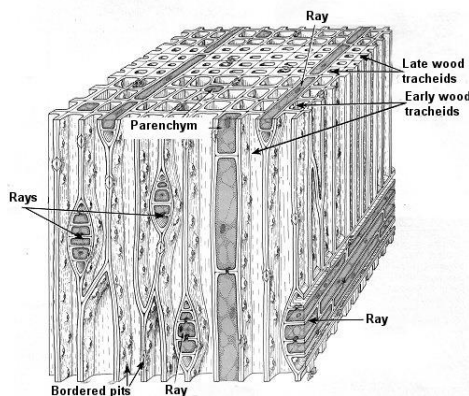
- a) Pith: Soft core at the center, representing initial growth.
- b) Heartwood: Provides mechanical support; no active function.
- c) Sapwood: Conducts sap; lighter in color and higher in moisture content.
- d) Cambium: Slimy layer where tree growth occurs; produces wood and bark cells.
- e) Bark: Outer protective layer; consists of outer bark (protection) and inner bark (transports food).

III. Tree Growth:

- a) Annual height growth occurs through a single shoot called a leader.
- b) Growth involves the formation of new rings of wood and branches each year.
- c) Trees grow taller from the leader and increase in girth with annual rings.



IV. Cell Structure:



- a) Wood cells are long, thin, hollow tubes running parallel to the trunk or branch.
- b) In softwood, cells have closed tapered ends with small openings called "pits" for moisture passage.

V. Wood Rays:

- a) Bands of cells running radially from the bark to the pith.
- b) Represent about 7-10% of the total volume of wood.
- c) Store and distribute food materials in the tree.
- d) Limit shrinkage and swelling due to moisture changes.



VI. Resin Ducts:

a) Fill or cover wounds with resin, acting as a healing agent.



b) Visible in Pine and Douglas-fir as minute dots on end-sections and fine lines on flat surfaces.

c) Help determine the direction or slope of the grain and species.

VII. Growth Patterns:

a) In temperate regions, cell growth by the cambium is rapid in spring and slower in summer and autumn.



b) Dormant period in winter when growth ceases.

c) Springwood: Lighter colored layer formed in spring.

d) Late Wood (Summerwood): Darker colored layer formed later in the season.

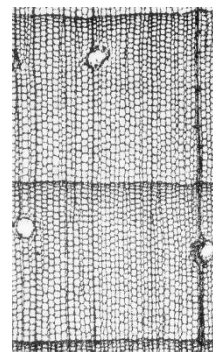
e) Annual rings represent one year's growth and vary in appearance among species.

VIII. Comparison of Tree Species:

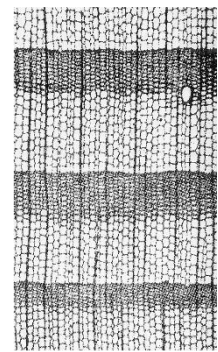
a) White Pine vs. Douglas Fir:

b) Douglas Fir has a wider summerwood band, making it stronger.

c) Density refers to the percentage of summerwood in the annual ring.

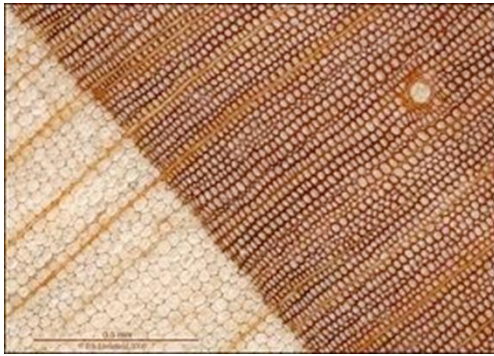


White Pine



Douglas Fir

IX. Moisture Absorption:



a) Rapid growth in spring due to high moisture absorption, forming wood cells with large cavities and thin walls.

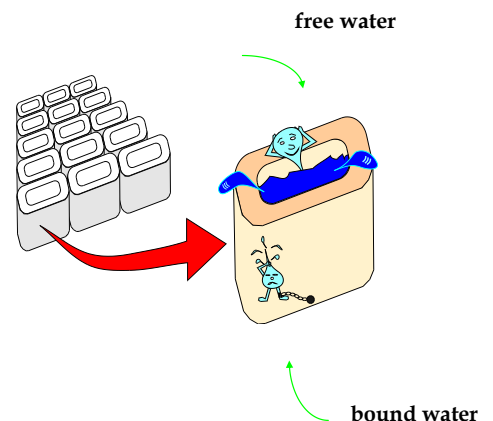
b) Slower growth later in the season with thicker cell walls and smaller cavities.

X. Advantages of Wood:

- a) Easily adaptable to various uses with few limitations.
- b) Widely used for decorative and structural purposes.
- c) Made up of hollow tube-shaped cells or fibers, an ideal structural configuration.
- d) Proper design, preparation, maintenance, or specialty treatment can overcome many limitations.

XI. Moisture in Wood:

- a) Held in cell cavities as "free water" and in cell walls as "bound water."
- b) Drying process: moisture leaves cell cavities first, then cell walls dry and shrink.
- c) Fiber Saturation Point: Critical moisture content (23-29%) where cell cavities are empty but cell walls are still saturated.



XII. Shrinkage:

- a) Occurs when moisture leaves cell walls, mainly in the girth of the cell.
- b) Lumber shrinks in width and thickness, not significantly in length.
- c) More shrinkage across tangential (flat grain) face than radial (vertical grain) face due to wood rays.

XIII. Drying and Strength:

- a) No change in strength properties from green condition to fiber saturation point.
- b) Below fiber saturation point, cell walls harden and stiffen, increasing strength.
- c) Size varies ~1% for each 4% change in moisture content (0.7% for Western Red Cedar).

XIV. Definition of Grain:

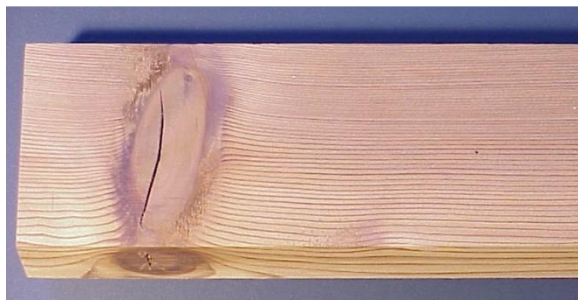
- a. Fibers in wood and their direction, size, arrangement, appearance, or quality.
- b. In grading, refers to:
 - i. Arrangement or direction of wood elements and annual rings (e.g., vertical grain, flat grain, mixed grain, cross grain).
 - ii. Relative width of growth rings (e.g., coarse grain, close grain).

XV. Types of Grain:

- a) Flat Grain: Lumber sawn tangentially or parallel to growth rings; evident contrast between springwood and summerwood.

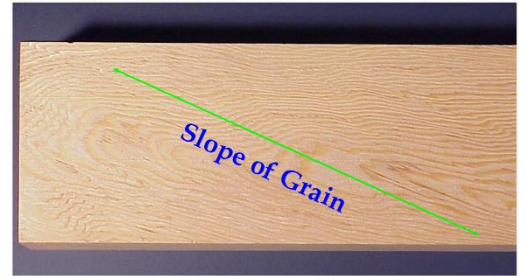


- b) Vertical Grain: Lumber sawn radially or at right angles to growth rings.



XVI. Strength Characteristics:

- a) Affected by knots, their location, and slope of grain.
- b) Slope of grain measured over a representative length and area in thicker and wider lumber.
- c) Local deviations around knots are disregarded in general slope measurement.



XVII. Spiral Grain:

- a) Right-hand Spiral: Spiral grain on the outer portion of the log.
- b) Left-hand Spiral: Spiral grain penetrates to the core of the log.
- c) Caused by abnormalities preventing parallel sawing to the bark.



XVIII. Rate of Growth:

- a) Describes the relative width of growth rings.
- b) Measured by counting annual rings along a 3" line and dividing by three.
- c) Close Grain: Six rings per inch.
- d) Medium Grain: Four rings per inch.



XIX. Tree Tolerance:

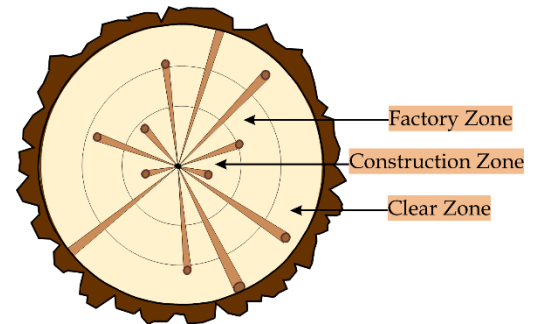
- a) Tolerant Trees: Retain more green lower branches (e.g., Hemlock).
- b) Intolerant Trees: Grow rapidly upward, lower branches die and drop off (e.g., Douglas-fir).



- c) Intolerant trees have long trunks with fewer knots, important for clear lumber recovery.

XX. Branch Distribution:

- a) Many branches occur near the pith, fewer towards the bark, and almost none at the outer edge.
- b) Lumber Categories: Logs produce three broad categories of lumber.



XXI. Tree Growth Factors:

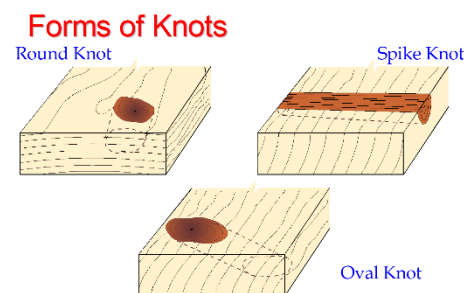
- a) Trees grow with varying combinations of soil, moisture, air, and sunlight, facing extremes of weather and storms.
- b) Wood Variability: Wood varies in structure and appearance due to growth conditions and parasite attacks.
- c) Manufacturing and Seasoning: Additional characteristics develop during manufacturing and seasoning.
- d) Grading Lumber: Understanding natural, manufacturing, and seasoning characteristics is essential for accurate lumber grading.

XXII. Natural Characteristics:

- a) Include knots, holes, pitch streaks, honeycomb, shake, stain, rot, and more.

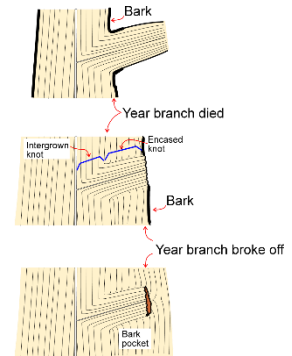
XXIII. Knots:

- a) Portions of branches cut through by a saw, classified by size, form, quality, and occurrence.
 - Types of Knots: Round, oval, and spike knots.
 - Qualities of Knots: Intergrown, sound, tight, loose, encased, fixed, unsound, star checked, firm, and hollow knots.



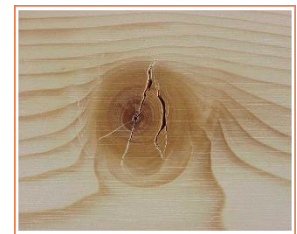
XXIV. Branch Growth:

- a. Branches originate in the pith and grow in diameter and length each year.
 - i. Living Branches: Trunk fibers intergrow with branch fibers.
 - ii. Dead Branches: Trunk fibers disassociate from branch fibers, leading to the branch being cast off and covered by new wood growth.



XXV. Intergrown Knots:

- a) Reduce strength as much as loose knots or holes due to grain deflection around the knot.



XXVI. Tight Knots:

- a) Fixed by growth, shape, or position; retain their place in the wood. Can be red or black. Often combined with "sound" in grading.

XXVII. Loose Knots:

- a) Surrounded by pitch or bark; separate from the wood during drying.



XXVIII. Fixed Knots:

- a) Retain place in dry lumber but can be moved under pressure.

XXIX. Encased Knots:

- a) Surrounded by pitch or bark; not intergrown with surrounding wood rings.



XXX. Unsound Knots:

- a) An Unsound Knot contains decay.



XXXI. Star Checked Knots:

- a) Have seasoning checks from pith to edge due to shrinkage during drying.

XXXII. Hollow Knots:

- a) Through opening limited to the size of other permitted holes.

XXXIII. Occurrence Classification:

- a) Refers to the position of knots in lumber.

XXXIV. Knot Clusters:

- a) Two or more knots grouped together with deflected wood fibers around the unit.



XXXV. Well Scattered Knots:

- a) Not in clusters; separated by at least the diameter of the smaller knot.

XXXVI. Knot Holes:

- a) Holes resulting from the loss of a knot.

XXVII. Slough Knot:

- a) A corner knot hole extending from one wide face into the adjoining narrow face.



XXVIII. Pin Holes:

- a) Small black holes (1/16 inch) caused by beetles, mostly in sapwood; affect appearance but not strength.



XXIX. Grub Holes:

- a) Oval or circular holes made by wood-boring grubs, found in felled or fire-killed timber; can penetrate deep into heartwood.

XXX. Teredo Holes:

- a) Clean, circular holes made by marine borers in saltwater-stored logs; often covered with a chalky substance.



XXXI. Pitch Streak:

- a) Accumulations of solid pitch or resin in streaks.

XXXII. Pitch Pocket:

- a) Openings between growth rings containing liquid or granulated pitch; can extend through the piece.



XXXIII. Bark Pocket:

- a) Openings between growth rings in non-resinous species like Hemlock; can extend through the piece.

XXXIV. Shake:

- a) Lengthwise separations in wood, often between growth rings; can be surface, through, or heart shakes.



XXXV. Bright Sapwood:

- a) Natural-colored sapwood, not limited to any grade unless specified.

XXXVI. Natural Red Heartwood:

- a) Uniformly red-colored heartwood, permitted in all grades.

XXXVII. Stained Wood:

- a) Variation from natural wood color; includes stained sapwood and heartwood.

XXXVIII. Decay/Unsound Wood:

- a) Disintegration due to fungi, affecting strength and appearance; also known as "dote" or "rot."



XXXIX. White Specks:

- a) Small pits caused by the fungus "Phellinus pini," filled with white cellulose; do not develop further after the tree is felled.



XL. Honeycomb:

- a) Advanced stage of white specks with larger, more numerous pockets.

XLI. Peck:

- a) Channeled or pitted areas in Cedar and Cypress; unaffected wood tissue between pockets.

XLII. Compression Wood:

- a) Abnormal wood in leaning coniferous trees; hard, brittle, and shrinks/swells parallel to fibers.

XLIII. Wane:

- a) Bark or lack of wood on the edge or corner of a piece.



XLIV. Manufacturing Characteristics:

- a) Include skip, improper trimming, dog holes, picaroon holes, tearing of face, torn grain, loosened grain, raised grain, wavy surface, machine burn, machine bite, saw cuts, machine offset, chip and saw channel, double arbor saw step, improper trimming, and not true to standard sizes.

XLV. Skips in Dressing:

- a) Areas that failed to dress, classified as slight, small, medium, and heavy.



XLVI. Hit and Miss Skips:

- a) Series of skip spots with surfaced areas between.

XLVII. Improper Trimming:

- a) Pieces trimmed under or over standard length or cut at an angle.

XLVIII. Picaroon Holes:

- a) Caused by a lumber handling device; excessive use can degrade lumber.



XLIX. Dog Holes:

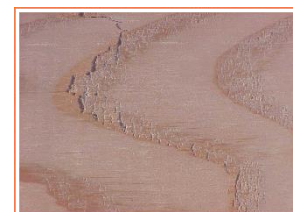
- a) Result from handling logs with equipment; appraised in relation to other characteristics.

L. Tearing of Face:

- a) Small pieces of wood fiber torn out during rough sawing.

LI. Torn Grain:

- a) Occurs around knots or in irregular growth pieces during dressing.



LII. Loosened Grain:

- a) Separation between springwood and summerwood without displacement.

LIII. Raised Grain:

- a) Unevenness between springwood and summerwood on dressed lumber.

LIV. Wavy Dressing:

- a) Uneven dressing caused by defective machines; classified from very slight to very heavy.

LV. Machine Burn:

- a) Darkening of wood due to overheating by machine knives or rolls.



LVI. Machine Bite:

- a) Depressed cut at the end of the piece, caused by misalignment of the planer bed or tail plate.

LVII. Saw Cuts (Kerfs):

- a) Cuts that can pass completely or partially through the thickness and width of the wood.



LVIII. Machine Offset:

- a) Abrupt dressing variation near the end of the piece, caused by improper planer setup.

LIX. Chip and Saw Channel (Rabbeted Edge):

- a) Channel or recess cut along the edge, caused by misaligned chipper heads.

LX. Double Arbor Saw-Step:

- a) Misalignment of two opposing saws, also known as "stepping."

LXI. Falling Breaks:

- a) Separations across wood fibers caused by impact during tree felling.



LXII. Seasoning Characteristics:

- a) Caused by drying; include checks, splits, warp (crook, cup, bow, twist), damp stock, fuzzy tongue and groove, collapse, case hardening, and honeycombing.

LXIII. Seasoning Check:

- a) Rapid surface drying when the surface of the lumber dries quickly due to exposure of high temperatures, while there is a significant difference in moisture content between the surface and the core of the lumber.



LXIV. Split:

- a) Lengthwise separation of wood on the end of a piece due to tearing apart of wood cells.



LXV. Warp:

- a) Deviation from a true surface, including bow, crook, cup, twist, or combinations.

LXVI. Cup:

- a) Deviation in the face of a piece from edge to edge, caused by uneven drying or grain contraction.



LXVII. Crook:

- a) Edgewise deviation from end to end, often caused by seasoning or irregular fiber formation.



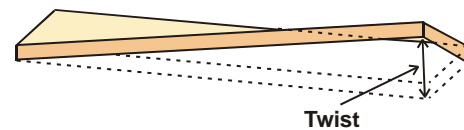
LXVIII. Bow:

- a) Flatwise deviation from end to end, limited by thickness.



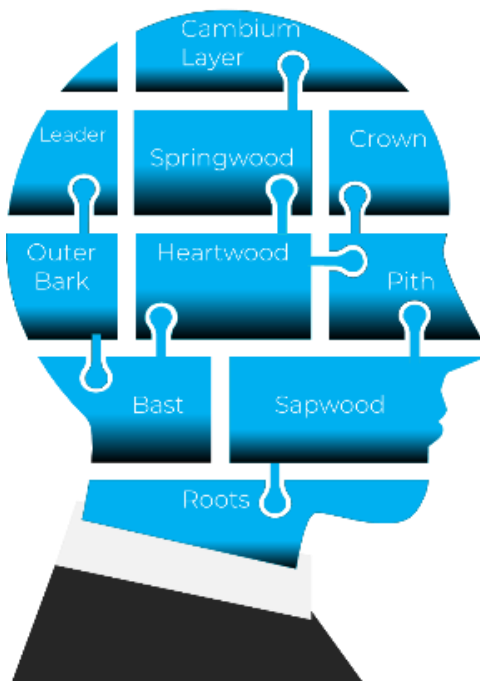
LXIX. Twist:

- a) Curl or spiral deviation, measured by the distance an edge is raised above a flat surface.



LXX. Collapse:

- a) Severe distortion of cells during early drying, causing a caved-in appearance.



Wood Structure Review

Some Thought-Provoking Questions

- 1 Seat of tree growth?
Cambium layer
- 2 Conducts moisture and minerals to the crown?
Sapwood
- 3 Has large cell cavities and thin cell walls?
Springwood
- 4 Distributes prepared tree food?
Bast
- 5 Protects tree from insects and weather?
Outer bark
- 6 Anchors the tree?
Roots
- 7 Provides mechanical support?
Heartwood
- 8 Where is the sap converted to tree food?
Crown
- 9 Soft pulpy core?
Pith
- 10 Height growth in coniferous trees?
Leader