Tree Biology

• This session will cover tree anatomy (structure) and tree physiology (function) including how a tree is put together, how it grows in its environment and Compartmentalization of Decay in Trees (CODIT)

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Tree Biology

- Tree Biology - the study of structure and function, and the relationship between them
  - Anatomy - the study of the component parts of the tree
  - Physiology - the study of the biological and chemical processes within these components
Tree Anatomy-Cells and Tissues

- **Apical Meristems**-primary meristems that produce cells that result in elongation of roots and shoots
- **Lateral Meristems**-secondary meristems that produce cells that result in an increase in diameter
  - **cambium**-thin, continuous sheath of dividing cells that produces cells that will become the vascular system of the tree
  - **xylem**-produced to the inside (H₂O)
  - **phloem**-produced to the outside (CHOs)
- **cork cambium**-produces bark
Apical (Primary) Meristem-Shoots

April 2
Apical (Primary) Meristem-Shoots

From ISA Introduction to Arboriculture Tree Biology CD
Apical (Primary) Meristem-Roots
Lateral (Secondary) Meristems
Tree Anatomy-Cells and Tissues

- **Xylem**: wood of the tree, made up of live and dead cells
  - conducts water and mineral elements
  - supports weight of tree
  - storage of resources
  - defends against spread of disease/decay

- **Phloem**: responsible for movement of sugars, produced in the leaves, to roots and throughout the plant for storage and consumption
Tree Anatomy - Cells and Tissues

- Sapwood
- Heartwood
- Bark
  - Living phloem
  - Periderm
    - Cork cambium
    - Cork
- Vascular cambium
Tree Anatomy-Cells and Tissues

- **Sapwood**: xylem which functions to conduct water
- **Heartwood**: xylem which is non-water conducting tissue - can sometimes be darker in color
- **Earlywood**: xylem (wood) produced in Spring
- **Latewood**: xylem (wood) produced in Summer - growth ring
- **Ray cells**: cells that function to transport sugars and other compounds through the trunk radially
Tree Anatomy-Bark

- **Bark** - outer covering of a tree’s branches and stems composed of non-functional phloem and corky cells
  - moderates temperature
  - defense against injury
  - reduces water loss

- **Lenticels** - small openings in bark that allow for gas exchange
Tree Anatomy-Branches

- **Branch collar** - shoulder area where a branch joins another branch or trunk created by the overlapping xylem tissues.
- **Branch bark ridge** - area of a tree’s crotch where the growth and development of the two adjoining limbs pushes the bark into a ridge.

From ISA Arborists’ Certification Study Guide, Figure 8.2, 1st edition
Tree Anatomy-Leaves

- **Leaves** - food producers of the tree
  - **chloroplasts** - specialized organelles found in cells that are the site of photosynthesis
  - **chlorophyll** - green pigment of plants, found in the chloroplasts
  - **cuticle** - waxy layer outside the epidermis of a leaf
  - **stomates** - small pores between two guard cells through which gases are exchanged
Tree Anatomy-Roots

Functions of Tree Roots

• Anchorage
• Absorption
• Conduction
• Storage
Small absorbing roots

Sinker roots

Taproot (walnut, hickory, etc.)

Lateral roots - can extend 2-3 times the crown radius, usually in top 12” of soil
Fig. 1.10 How roots grow.

- The Root Collar is usually at or near the groundline and is identifiable as a marked swelling of the tree trunk.

- The Framework of major roots usually lies less than eight to twelve inches below the surface and often grows outward to a diameter one to two times the height of the tree.

- A complex network of smaller non-woody Feeder Roots grow outward and upward from the framework roots. These smaller roots branch four or more times to form fans or mats of thousands of fine, short, non-woody roots. These slender roots, with their tiny root hairs, provide the major portion of the absorption surface of a tree's root system. They compete directly with the roots of grass and other groundcovers.

- Because Roots Need Oxygen in order to grow, they don't normally grow in the compacted, oxygen-poor soils under paved streets.

Note: A few species have a Taproot that grows straight down three to seven feet or more until they encounter impenetrable soil or rock layers, or reach layers with insufficient supplies of oxygen.
Tree Physiology - Photosynthesis

- **Photosynthesis** - process by which green plants use light energy to build carbon molecules from water and carbon dioxide

- **Photosynthate (Food)** - sugar and other products of photosynthesis, much of which is stored for later energy requirements
Tree Physiology - Photosynthesis
Chlorophyll and Chloroplasts

\[
\begin{align*}
\text{CO}_2 & + \text{H}_2\text{O} & \rightarrow & \text{C}_6\text{H}_{12}\text{O}_6 & + \text{O}_2 \\
\text{Carbon dioxide} & & & \text{Sugars} & \text{Oxygen} \\
\text{Water} & & & \text{Chlorophyll} & \\
\text{Sun's energy} & & & \\
\end{align*}
\]

Light energy

\[
\begin{align*}
\text{Carbon dioxide} & \quad \text{Oxygen} \\
\text{Water} & \quad \text{Carbohydrate (food)} \\
\end{align*}
\]
Tree Physiology - Photosynthesis

Figure 1: Leaf Tissue Anatomy

- Upper Epidermis
- Lower Epidermis
- Vascular Tissue
- Phloem
- Xylem
- Vein
- Stoma
- Guard Cells
- Spongy Parenchyma
- Palisade Parenchyma
- Cuticle
- Cereal Tissue
- Ground Tissue

Diagram showing the flow of water, carbon dioxide, food, and oxygen through the leaf tissue.
Phloem (food)
From ISA Arborists Certification Study Guide, Figure 1.12, 1st edition

Fig. 1.12 Diagram showing photosynthesis, water and nutrient transport and transpiration.
Tree Physiology-Respiration
Tree Physiology - Respiration

- **Respiration** - process by which carbohydrates produced from photosynthesis are converted to energy by using oxygen.

Opposite reaction of photosynthesis

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C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O + \text{Energy}
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Tree Physiology
Hormones and Growth Regulation

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<th>Germination</th>
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<th>Flowering</th>
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Auxins produced in the canopy growing tips stimulate root growth.

Gibberellins produced in the root growing tips stimulate canopy growth.
Fig. 1.15  Excurrent tree.  Decurrent tree.
Tree Physiology
Hormones and Apical Dominance
Humans Heal and Trees Seal
CODIT-Compartmentalization of Decay in Trees

C.O.D.I.T.

Compartmentalization of Decay in Trees.
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-Wall 1-resists vertical spread of decay-xylem plugging-weakest wall

-Wall 2-resists inward spread of decay-compact latewood cells

-Wall 3-resists lateral spread-ray cells

-Wall 4-resists outward spread into new wood that is formed-strongest wall

Figures Courtesy of ISA Introduction to Arboriculture Tree Biology
CD/Photos Courtesy of Vince Urbina
QUESTIONS?