**Maryland Licensed Tree Expert Exam Study Guide**

**For Exam Domain:**

**Biology and Physiology**

**Version 5.1**

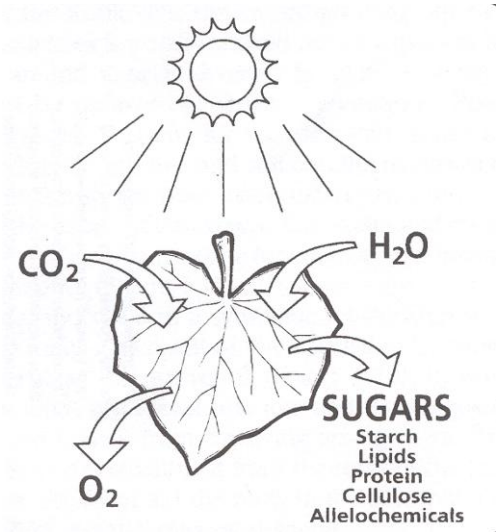
Cells are the basic building blocks of life. In plants, new cells come from the division of existing cells. Tree cell division occurs in structures called meristems. Following division, cells undergo differentiation, which changes structure and allows cells to assume specific functions.

Primary meristems are located at the ends of shoots and roots and are called apical meristems. Lateral buds may be inhibited by the active growth of terminal buds. This is called apical dominance.

Trees are divided into three major parts: crown, stem, and root system. The leaves and the branches that hold them make up the crown. The trunk is the main structural support and transports the water and nutrients up from the roots and the sugar and starches made in the leaves down to the rest of the tree.

Trees that lose their leaves every year are called deciduous. Trees that hold their leaves for more than one year are called evergreen. Needles and scales of conifers perform the same function as leaves of broadleaf trees.

Leaves are the food producers of the tree. Leaf functions include photosynthesis, transpiration, and respiration. Photosynthesis is the process of turning carbon dioxide and water into simple carbohydrates and oxygen using the energy of the sun. It is the process by which green plants use light to build sugar molecules. Literally photosynthesis means "putting together with light." Six molecules of water plus six molecules of carbon dioxide produce one molecule of sugar plus six molecules of oxygen, 6H2O + 6CO2 ----------> C6H12O6+ 6O2.





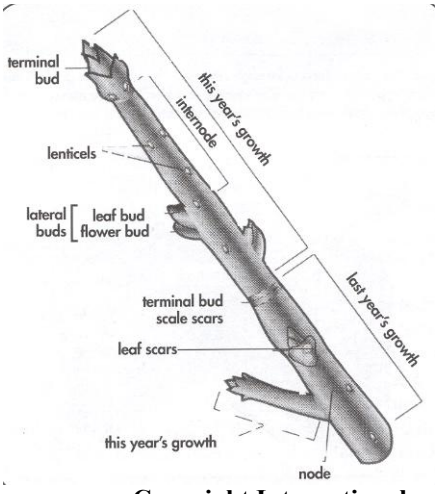

Much of the photosynthate is stored in the form of sugar or starch in the twigs, trunk and roots for later energy requirements. The energy created and stored by photosynthesis must be greater than the energy used in respiration. Otherwise, the tree must use its energy reserves. If this occurs over time, the tree may run out of energy reserves and die.

Fall color results from the breakdown of green chlorophyll in the leaves and the expression of other pigments which are always present. Anthocyanins produce the reds and purples; carotenoids the yellows, oranges and reds.

Respiration is the process by which chemical energy is used by the tree for all of its biological functions. In this process, the bonds of sugars and starches are broken, yielding energy, carbon dioxide and water. Respiration occurs at all times. Oxygen is required for normal respiration to occur. The oxidation of organic compounds in living cells releases stored energy, as fuel for the many life processes of the tree.

Transpiration is the loss of water in the form of water vapor from leaf surfaces. The evaporation of water cools the leaves & creates a "transpirational pull" that moves water up through the xylem. About 95% of the water absorbed by a plant is transpired. The rate of transpiration is affected by temperature, humidity and available water. Transpiration is also affected by cuticle thickness, presence of hairs on the leaf surface, and number and location of stomata. For example, plants with thick cuticle, small leaves, and sunken stomata are adapted to hot & dry conditions.

Twigs are small stems that provide the support structure for leaves, flowers and fruit. Branches support the twigs. Buds can occur along the twig, at the base of each leaf, just under the bark, or at the tip of each twig. A bud is an unexpanded shoot or flower. Terminal bud scale scars are useful in measuring annual twig elongation. You can measure a tree annual growth by measuring the distance between terminal bud scale scars, or nodes. The area between two nodes is known as an internode.






The flower is the reproductive unit of some trees. Parts of the flower include petals, sepals, one or more carpels (the female reproductive organs), and stamens (the male reproductive organs). A complete flower is one that contains all four floral organs: petal, sepal, stamen, carpels.

Tree fruit takes many shapes and forms. Angiosperms are flowering plants whose seed is enclosed in an ovary. Gymnosperms or "naked seeds" plants whose seeds are borne with no outer covering.

The stem of the tree functions in the conduction of water and minerals, to support of the tree, and in the storage of reserves. The outer covering of a tree branches and stem is the bark. It functions to moderate temperature, to defend against insects and injury, and reduce water loss. Small openings in the bark, lenticels, allow for gas exchange.

The cambium is a thin, continuous sheath of radially dividing cells that produces the xylem (to the inside) and the phloem (to the outside). Phloem carries sugars and food down

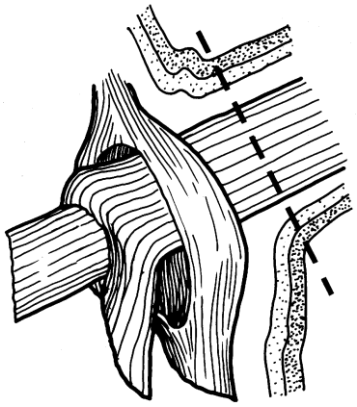
from the leaves to the rest of the tree. Xylem carries water and nutrients up from the roots to the rest of the tree.

The xylem, (the area of active, living wood) functions to transport water and nutrients, store food and water, and provide support for the tree. It can be thought of as a continuous column of water, where the evaporation of molecules from the leaves pulls the water up through the tree. Xylem is called sapwood. Farther inside the tree is dark wood called the heartwood. It is composed of dead cells and provides support for the tree.

Growth rings are the annual production of xylem by the cambium. They are visible because of the contrast between earlywood growth (light color) and latewood growth (dark color).

Radial transport is the horizontal movement or water or nutrients between cells through ray cells. Rays are channels of cells where water, nutrients & carbohydrates move laterally. Xylem rays in the sapwood are the pathways for food movement to and from the phloem.

The annual production of layers of tissue at the junction of the branch to the stem forms a shoulder or bulge called the branch collar.





Reaction wood is wood altered to counteract a lean in a tree. Reaction wood is specialized secondary xylem that develops in response to lean or similar mechanical stress to restore the stem to vertical. Conifers form compression wood as a type of reaction wood. In hardwoods, cell walls thicken on the upside of the lean; hardwoods have tension wood as a type of reaction wood.

Excurrent trees have strong apical control, strong central leader, and a cone-shaped crown. Decurrent trees have weak apical control, no strong central leader, and a diffuse crown.

The root system of tree may comprise 1/3 to 1/2 the entire volume of a tree. The roots serve four primary functions:

1. Anchorage
2. Storage

3. Absorption
4. Conduction

Water and essential elements are absorbed from the soil by the roots. Some water is used for growth and metabolism, but most lost through evaporation. This water loss creates "transpirational pull" that moves water through the xylem. Too little or too much soil moisture can result in leaf-water deficits. Water deficits can cause slowed photosynthesis, stomatal closure, and wilting leaves.

If the water potential is lower in the soil, water will actually move out of the roots into the soil. For example, when salt concentrations are high in the soil from deicing or excessive fertilization application, water can be drawn out of the roots causing "fertilizer burn."

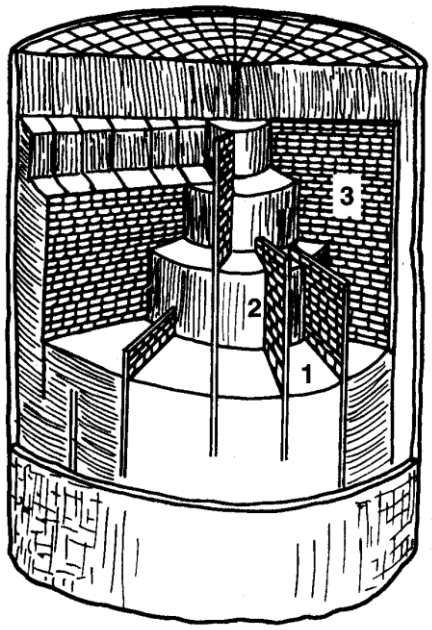
Many roots live in a symbiotic relationship with certain fungi. The result is termed mycorrhizae (fungus roots). The fungi aid the roots in absorption of water and essential mineral elements while the fungi derive nourishment from the roots. Mycorrhizae increase the roots' ability to absorb water and essential elements. Mycorrhizal fungi are essential to the health of all plants. They form a symbiotic (mutually beneficial) association with the roots of the tree and act as an extension of the tree's root system by increasing their absorption of water and nutrients. Mycorrhizal fungi produce structures called hyphae that allow the them to forage for some nutrients more effectively than roots alone. The fungi transfer some of these nutrients to the root and receive carbohydrates from the root.

Because the relationship between trees and mycorrhizae is symbiotic, both the tree and the fungi extract some benefit. Mycorrhizae are more effective than tree roots at accumulating water and nutrients, and can store excess nutrients, releasing them to the tree as needed. Nutrient uptake, particularly that of phosphorus, is enhanced in infertile soils because mycelial strands and their protruding hyphae explore the soil more extensively than nonmycorrhizal roots. The fungi also inhibit invasion by damaging fungi, and extend the life to root tips. Mycorrhizae release acids that break down substances that the tree cannot use without this help, and fix nitrogen from both the soils and atmosphere so that it is more available to the tree. Mycorrhizal fungi produce hormones that encourage the production of new root tips, which aids both the tree and the fungi.

The symbiotic relationship between mycorrhizae and trees benefits the fungi as well. Fungi cannot manufacture their own food due to lack of chlorophyll, a process that converts sunlight to energy used for producing sugars. Therefore, fungi must get this food from chlorophyll-producing plants. They do so by either penetrating the plant roots or forming a sheath around the root tips. This energy allows the fungi to reproduce and form large networks within the soils.

Compartmentalization is the process by which trees react to injury by forming physical and chemical barriers to contain the injury and its effects. After a tree is wounded, reactions are triggered to form boundaries around the wounded area. A model of this process is called CODIT = **C**ompartmentalization **O**f **D**ecay **I**n **T**rees. Trees form four walls around a decayed area:

Wall 1 – stops decay spreading vertically;
Wall 2 – limits decay spread inward;
Wall 3 – Limits lateral spread of decay;
Wall 4 – stops decay spread outward to new wood growth






It is fairly common for wall 1, 2 and 3 to fail. Wall 4 rarely fails, except where canker-causing fungi restrict its development or kill the cambium. Wall 4 is considered to be the strongest wall.


Wall 4 forms to stop the spread of decay to the new wood growth as the tree grows radially.


Wall 4 has completely closed to prevent decay from spreading to new wood as the tree grows out around it.