Draw a Tree to get Your Degree

Summary of Activity: Review the functional anatomy of trees; review basic biosynthetic operations in plants; identify, observe and draw different kinds of useful features in plants; connect observed plant features to essential plant operations.

Skills to be Developed

1. Knowledgebase. Affirm and enhance student's knowledge of plant operations, functional anatomy and basic biosynthetic processes.
2. Empirical science. Develop students' powers of observation; empiricism over imagination.
3. Empirical science. Develop students' abilities to represent empirical observations in the preparation of simple sketches that accurately portray the observed subject.
4. Comprehension. Students are encouraged to develop a systems awareness of plant operations.
5. Synthesis. Students are encouraged to apply a systems approach toward comprehending complexity in all life experiences.

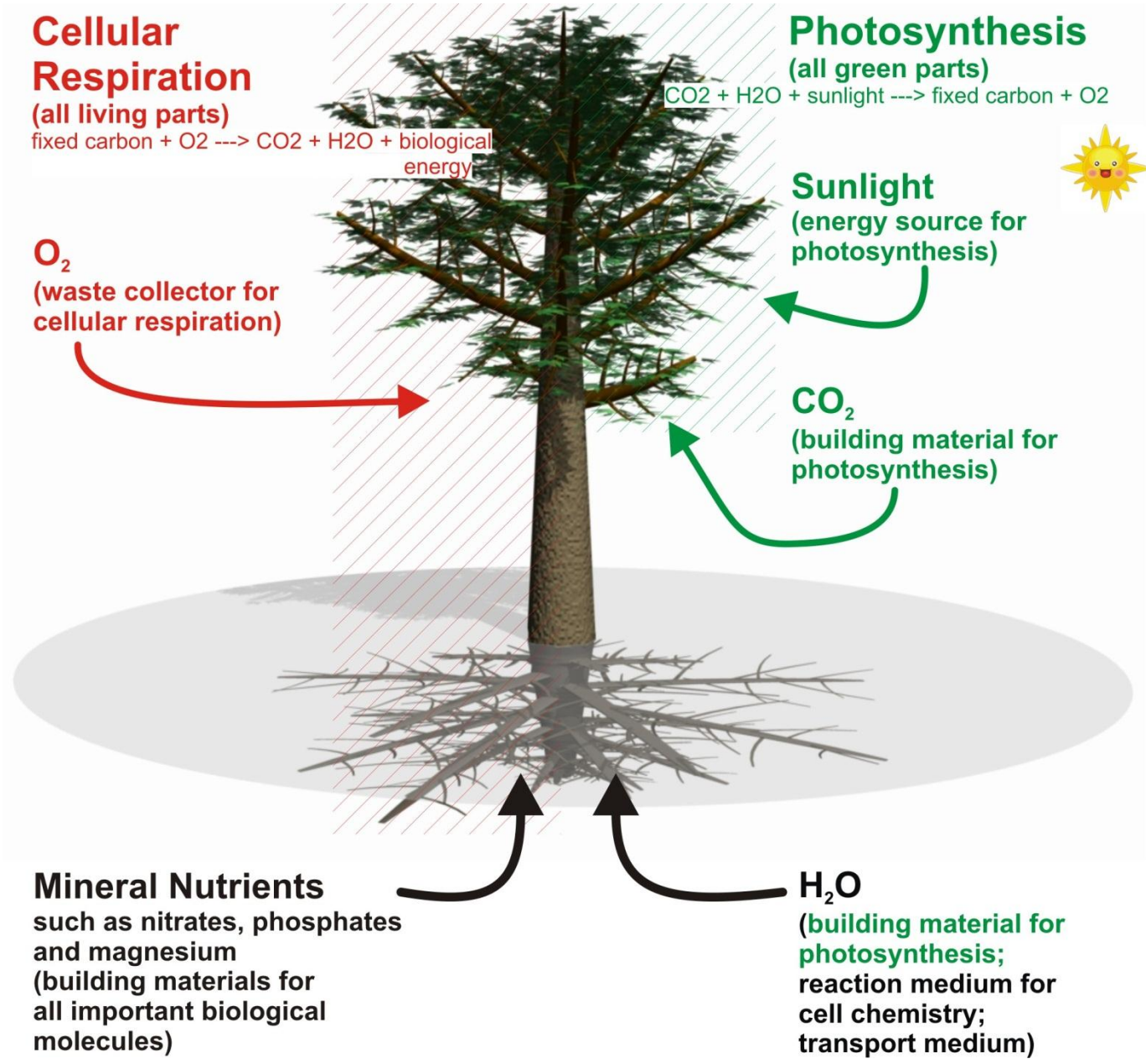
What Students Will Turn In for Credit: 1) this packet with sketches of trees and written answers to Quiz Prep questions; and 2) Quiz.

Basic Tree Anatomy – from an Engineer's point of view
Structurally, trees simply are constructed of two branching exchange systems mounted at opposite ends of a connecting trunk. One exchange system lies below ground – the roots. The other is above ground, lifted up by the trunk – the branches. Since the below-ground environment is much different from the above-ground environment, these two branching systems exchange different sets of things with their surroundings.

Above-ground Branching System
This system exploits the fluid motion of the atmosphere to consume necessary gases and to dispose of **waste** gases. For example, all living tissues in the tree need oxygen gas (O_2). Oxygen gas diffuses directly into the leaves, or through the bark to reach the underlying living layer of cells.

The tree makes its own sugar and other useful biological molecules. In order to accomplish this manufacturing process (photosynthesis), the tree needs certain **resources** from its surroundings. The above-ground branching system displays an array of leaves. The leaves support photosynthesis by collecting carbon dioxide gas from the atmosphere and light energy from the sun.

Below-ground Branching System
Unlike the above-ground environment, which is fluid, transparent and frequently bright, the below-ground environment is solid, opaque and always dark. The below-ground branching system anchors the tree and radiates tendrils that seek underground moisture. Although the underground environment is composed of solid particles, there are tiny spaces between them. Air and water can slowly move between these spaces. The roots spread out to intercept moving water. The tree takes in and distributes this water to the living cells that make up the rest of the tree – even to the leaves at the tippy top.

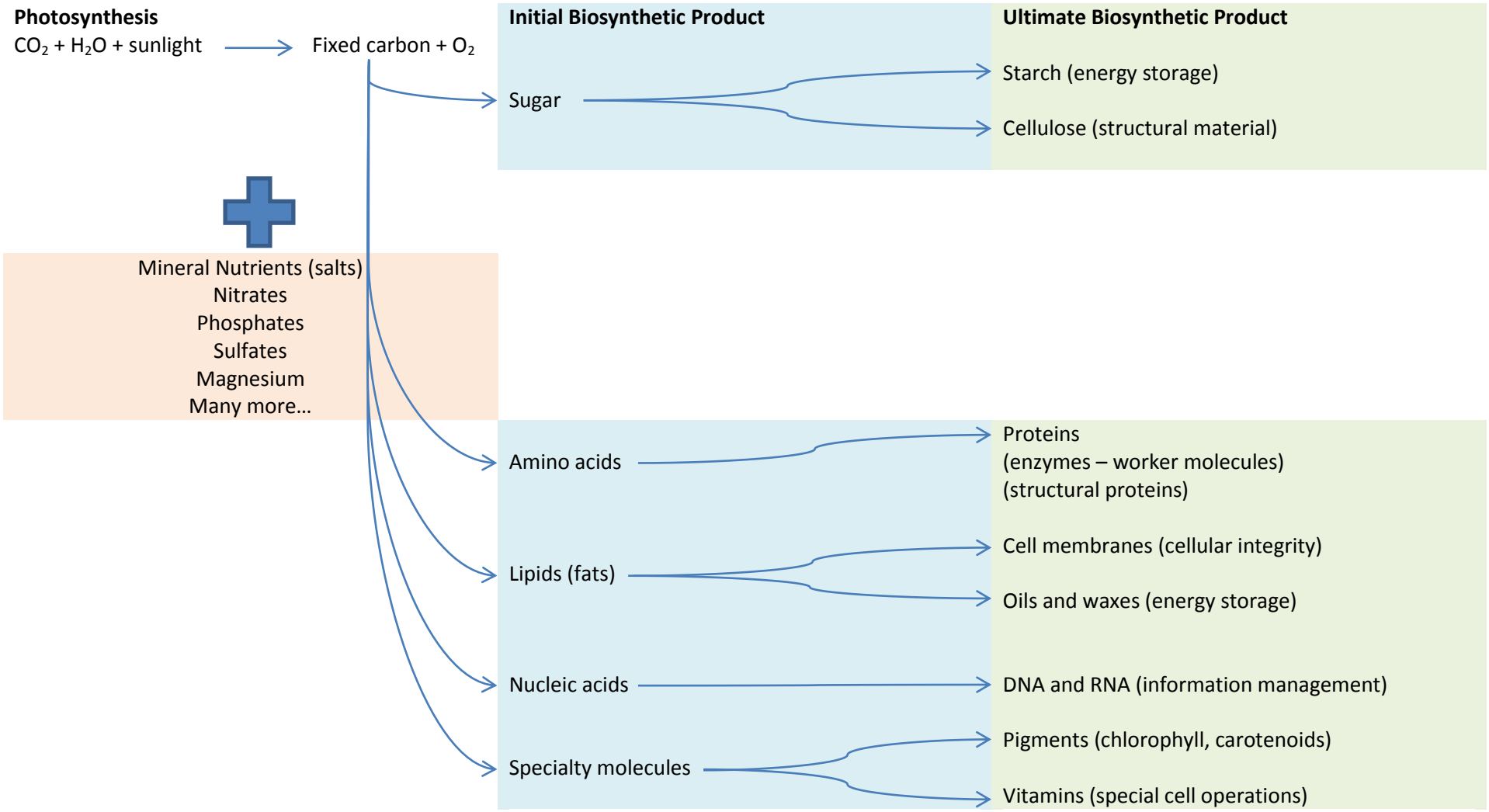


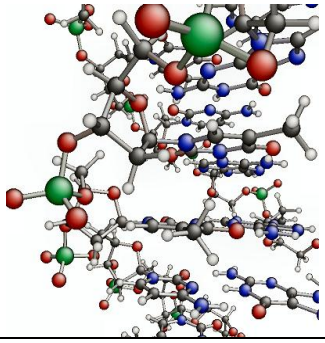
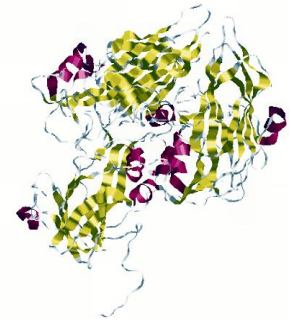
Arrows going toward the tree indicate that the tree is consuming the **resource**, putting it to rewarding use inside the tree.

As the water moves through the underground particles, mineral salts will dissolve into the water and be carried along by it. Some of these mineral salts contain chemicals that the uses to construct itself after being absorbed by the roots. Biologists call these useful salts, ***nutrients***. For example, nitrate is a nutrient that the tree uses for the construction of important biological molecules like, DNA and proteins. Phosphate is a nutrient that the tree uses for making DNA and cell membranes. All of this chemical construction activity happens inside each living cell – in a tiny, water-filled reaction vessel.

Living cells need water in order to remain chemically active (alive). Active cells maintain an internal water-filled reaction vessel where life's chemistry occurs. If the water dries up, life's chemistry stops.

The Role of Photosynthesis and Mineral Nutrients in a Plant's Biosynthetic Enterprise

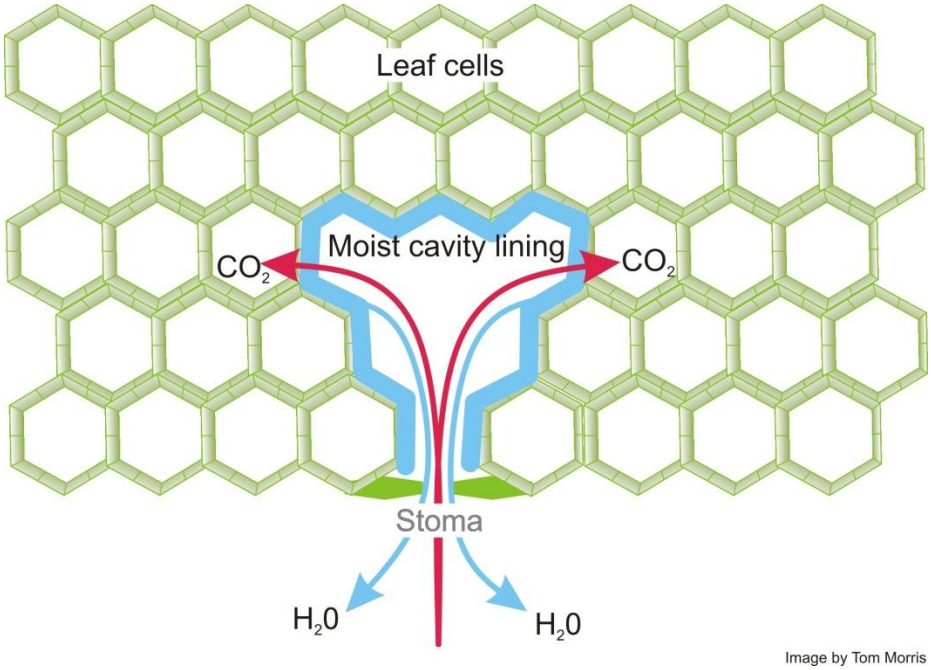


		
Living cell with water-filled interior. Life's chemistry happens in a water bath. Flimsy, biomolecules achieve their complex 3-dimensional shapes while suspended in water.	DNA molecule. Made from chains of fixed carbon and different combinations of mineral nutrients.	A large enzyme molecule (protein). Made from chains of fixed carbon and different combinations of mineral nutrients.

Leaves are the main site of water loss – through tiny pores called, stomata

Since leaves are the tree's main manufacturing centers, they are in intimate contact with the surrounding environment – especially when it comes to gas exchange. Leaves exchange gasses with the atmosphere (mainly carbon dioxide and oxygen gas) through tiny pores on their undersurface called, **stomata** (see below image).

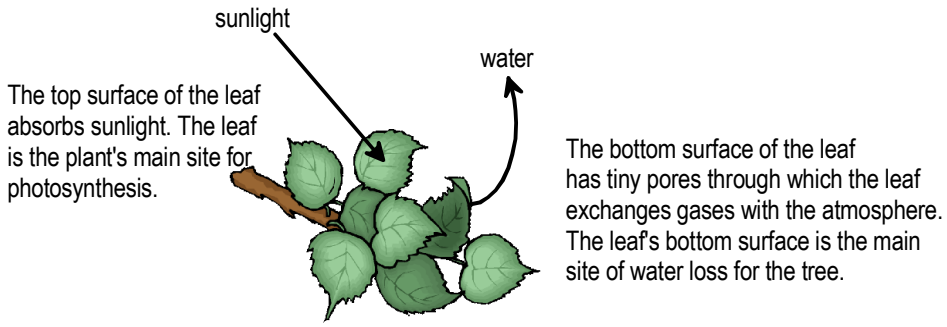
The internal exchange surfaces are kept moist with water in order to speed up the transfer of gas molecules from the leaf and the atmosphere. But in maintaining these moist exchange surfaces, some of the leaf's water always escapes from the surface and is carried out of the pores and into the atmosphere. The point is that leaves are the tree's main site of water loss.



A single stoma. Leaves have many stomata (plural for stoma).

There are several factors that can increase the amount of water lost by a leaf. They are listed below:

1. **Leaf size** – the larger the leaf, the more water it loses.
2. **Leaf temperature** – the warmer the leaf, the more water it loses.
3. **Direct exposure of leaf undersurface to moving air** – the more that a leaf's undersurface is directly exposed to moving air, the more water it loses.

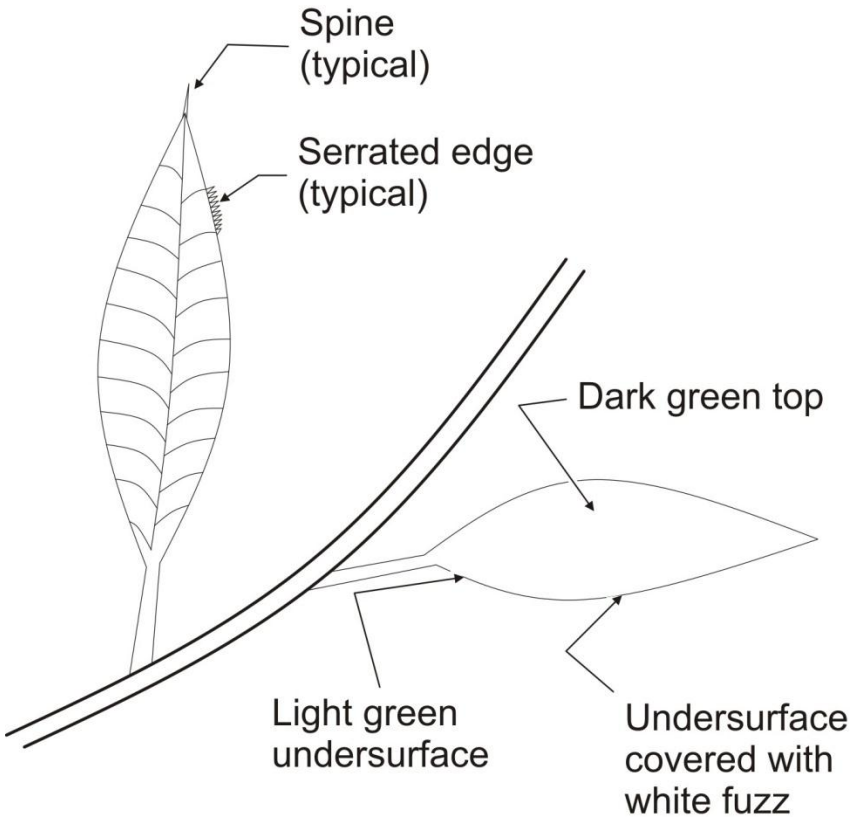
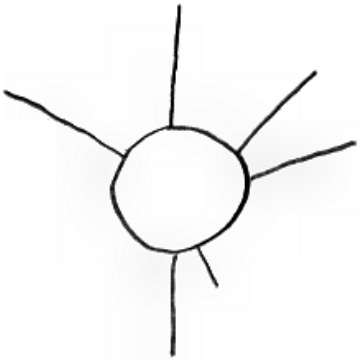


Your Assignment

Your instructor will guide you to several trees of his / her choice on campus or elsewhere. Please prepare careful sketches that show leaf detail, growth habit, and the distribution of surface roots (if visible). Consult the below example as a guide.

Also, please write complete answers to the Quiz prep questions.

Name of Plant: Example

Leaf Detail (example)	Growth Habit / Profile (example)
	 Surface Root Pattern (example)  Farthest radiation dist. = _____ ft.

Name of Plant:

Leaf Detail	Growth Habit
	Surface Root Pattern
	Farthest radiation dist. = _____ ft.

Quiz prep question 1. What three important materials do roots collect from the surrounding environment?

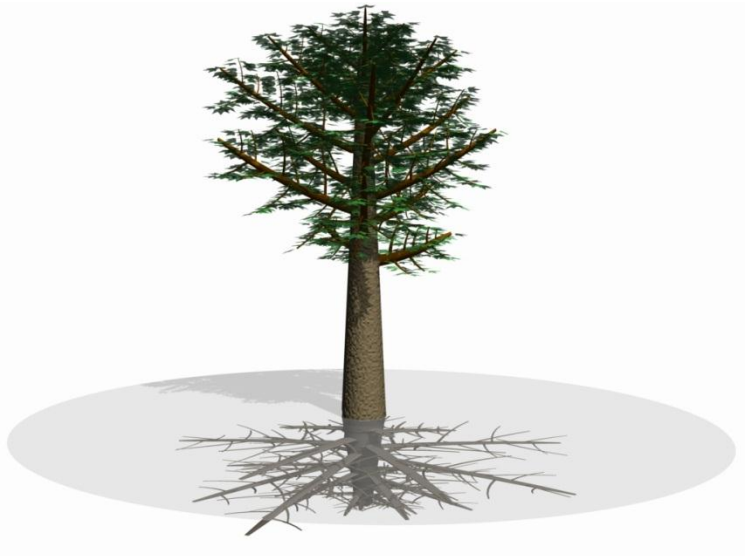
_____

_____

_____

Name of Plant:

Leaf Detail	Growth Habit
	Surface Root Pattern
	Farthest radiation dist. = _____ ft.



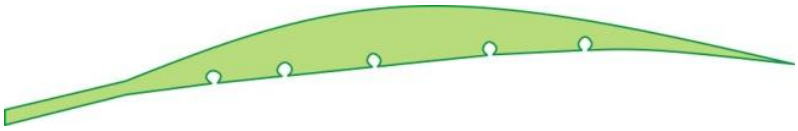
Quiz prep question 2. Consider the tree represented in the drawing at left. What important resource can the above-ground exchange system obtain from its surroundings that the below-ground exchange system cannot?

Quiz prep question 3. Draw a single arrow to indicate the main path of water flow into the tree, through the tree and out of the tree the tree at left.

Name of Plant:

Leaf Detail	Growth Habit
	Surface Root Pattern
	Farthest radiation dist. = _____ ft.

Quiz prep question 4. Draw an arrow to represent the escape of water from the leaf below. Be sure to distinguish between the leaf upper surface and the leaf under surface.



Quiz prep question 5. Why does the leaf tend to lose more water from one surface than the other?

Name of Plant:

Leaf Detail	Growth Habit
	Surface Root Pattern
	Farthest radiation dist. = _____ ft.

Quiz prep question 6. The tree's exchange systems collect several kinds of materials from the surrounding environment. For the items listed below, write why each is useful to the tree.

Oxygen gas _____

Carbon dioxide gas _____

Mineral nutrients _____

Water _____