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BIOL 305L Spring 2020

Laboratory Three

General plant anatomy - a great place to start!

Introduction

Botany is the science of plant life. Traditionally, the science included the study of fungi, algae, and viruses. A person engaged in the study of botany is called a botanist. Botany covers a wide range of scientific disciplines including structure, growth, reproduction, metabolism, development, diseases, chemical properties, and evolutionary relationships among taxonomic groups. Botany began with early human efforts to identify edible, medicinal and poisonous plants, making it one of the oldest branches of science. Nowadays, botanists study about 400,000 species of living organisms.

The beginnings of modern-style classification systems can be traced to the 1500s-1600s when several attempts were made to scientifically classify plants. In the 19th and 20th centuries, major new techniques were developed for studying plants, including microscopy, chromosome counting, and analysis of plant chemistry. Within the last three decades, DNA was used to more accurately classify plants.

Today the scope and importance of modern botany has grown to cover many molecular, genetic and biochemical level aspects through organelles, cells, tissues, organs, individuals, plant populations, and communities. At each of these levels a botanist might be concerned with the following aspects of plant life:

- Geographic distribution patterns.
- Genetic relationships.
- Physiology.
- Biochemistry.
- Plant interactions with each other, animals and different environments.

The study of plants is vital because they are a fundamental part of life on Earth, which generates the oxygen and food that allow humans and other life forms to

exist. Through photosynthesis, plants absorb carbon dioxide, a greenhouse gas that in large amounts can affect global climate.

Just as importantly for us, plants release oxygen into the atmosphere during photosynthesis. Additionally, they prevent soil erosion and are influential in the water cycle. Plants are crucial to the future of human society as they provide food, oxygen, medicine, and products for people; as well as creating and preserving soil. It is believed that early in the Earth's history, the evolution of photosynthetic plants altered the global atmosphere of the earth, changing the ancient atmosphere by oxidation, removing carbon dioxide and introducing oxygen to allow cellular respiration to occur.

Throughout the upcoming semester we will be studying all of these aspects in detail. Where is the best place to start with this? Well. General form and function of a plant would seem logical.

Introduction to the plant Body

The body of a flowering plant consists of a root system and a shoot system. The root system, in most plants, is the below-ground portion. The shoot system, above the ground, consists of stems and leaves. Flowers, which are the reproductive organs, are modified shoot systems.

Shoot systems branch through the formation of buds, which originate at nodes where leaves are attached to the stems. In many plants, buds develop protective scales and become dormant for a period of time. In others, buds develop directly into adult shoots, some of which produce flowers for reproduction. Roots, stems and leaves collectively comprise the vegetative parts of plants.

A. Root System

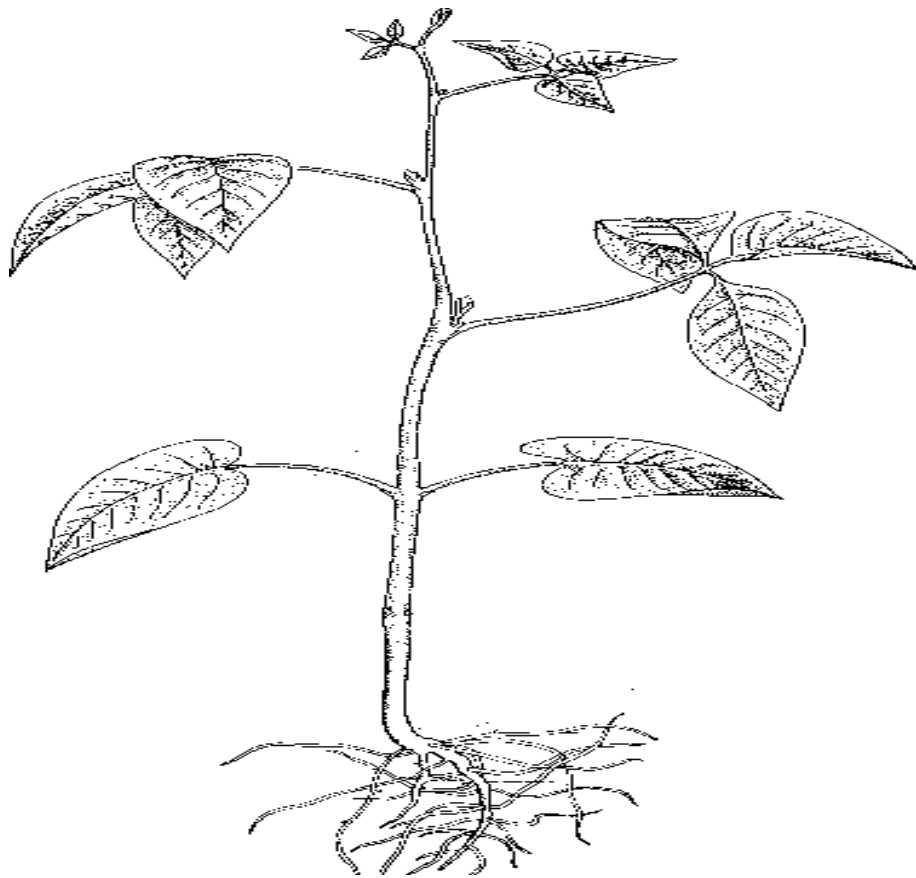
Note that the root system of the plant consists of one main root, called a primary root, or tap root, and many lateral roots, or branching roots. The primary root originates in the plant embryo. Lateral roots arise from within the tissues of the primary root. We will discuss and observe the internal root structure later.

B. Shoot System

The shoot system consists of the stem and its attached leaves, as well as any branching stems which may arise later at leaf nodes. The first leaves that you see above the surface of the soil are the cotyledons, or seed leaves. They are formed in the embryo, and are important in germination and seedling establishment. They may have already shriveled up and fallen off if your bean plant is well established. The cotyledons are "fleshy" in beans and other legumes and store nutrients for the young seedling. The cotyledons of many plants look very similar to

each other and it is often difficult to tell different plants apart when they have just germinated.

The foliage leaves are attached to the stem above the cotyledons. Foliage leaves have a leaf stalk, or petiole, and the expanded portion called the blade. Some leaves have projections of the petiole, called stipules. After the first leaves, the leaf blades of bean plants are divided; each part is called a leaflet. Such divided leaves are called compound leaves. There are many variations in leaf shape, dimension and vein patterns. The place where one or more leaves attach to a stem is called a node. One, two or sometimes more leaves attach to the stem at one node. The regions of the stem between leaves are called internodes. A shoot system branches at its nodes through the formation of buds. Buds arise in the axil of the leaf and its stem. Some of these shoots produce flower buds rather than vegetative buds. Roots, stems and leaves are commonly called the vegetative parts of the plant. Flowers, which are modified shoots, are the reproductive parts of plants. Flowers give rise to fruits and seeds. There may be some older plants to observe which have flowers and fruits.



Label the primary root, lateral root, stem, cotyledon, leaf, node and internode on the diagram of a typical plant.

What functions do you expect each of the following have for the plant?

- **Root**

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- **Stem**

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- **Cotyledon**

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- **Leaf**

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- **Flower**

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- Why are the leaves and stems of the plant green? How does the green pigment relate to an important plant function?

- Why are the roots not green?

C. Leaf system

Leaves are the main appendages of the stem, and in most vascular plants, the principal structure for photosynthesis. Although leaves vary tremendously in form and internal structure, most consist of a petiole and a blade.

Some of the variation in leaf structure is related to habitat. Aquatic leaves and leaves of dry habitats have special modifications to permit survival in those different habitats. Leaf shapes, margins, tips, and venation patterns are characteristics used to identify different species of flowering plants.

- ***Dicot Leaf Structure***

Examine a prepared slide of a lilac, *Syringa*, or similar leaf. Note the large midvein. As you scan your section locate the many branching veins, some of which will be in longitudinal section while others are in cross section.

Observe a portion of the blade to one side of the mid vein. Identify the:

Upper epidermis, which has a relatively thin but discernible cuticle

Palisade mesophyll

The veins, with their bundle sheaths of sclerenchyma

The spongy mesophyll

Lower epidermis, which also has a cuticle.

The palisade and spongy mesophyll are composed of parenchyma cells, which contain many chloroplasts for photosynthesis. Note the presence of intercellular air spaces among the spongy mesophyll cells and the relative distribution of stomata and guard cells in the lower epidermis. Most stomata open into an air space within the spongy mesophyll. The mushroom-shaped structures of the epidermis are trichomes, or epidermal hairs.

- ***A Monocot Leaf***

Observe a corn (*Zea mays*) leaf section. Note the distribution of veins. Monocot leaves generally have parallel veins rather than the branching network of veins common to dicot leaves. . Note too that the corn leaf has a uniform mesophyll region rather than distinctive palisade and mesophyll areas.

In the corn leaf the veins are surrounded by a sheath composed of large parenchyma cells. These cells are involved with C-4 photosynthesis. The larger vascular bundles contain extensions of sclerenchyma which connect to the epidermis for support. Identify the xylem and the phloem regions of the veins

D. Primary Structure of the Stem

The stem has two principal functions: support, and conduction of nutrients and water. Substances manufactured in the leaves are transported through the phloem tissue of stems to regions of the plant which are growing, or to developing flowers, seeds, and fruits; or to storage regions of the plant. Much of the nutrient material is stored in parenchyma cells of roots, seeds, and fruits, but stems are also important storage organs. Water and dissolved minerals are transported from the roots to the leaves in the xylem of the stem.

Leaves, the principal photosynthetic organs of the plant, are supported by the stems, which place them in positions favorable for absorption of light. Most dicots and all conifers have secondary growth, an expansion in girth as well as in length. Monocots lack true secondary growth, although some obtain large dimensions. While increase in length is accomplished by the meristems at growing

tips of plants (which is primary growth), secondary growth is accomplished by a special meristem, called cambium.

- ***Dicot Stem Structure***

Observe the stem cross section of alfalfa or sunflower. On this slide you will be able to examine the primary plant body, although a little secondary growth may have occurred in some of the stem sections. Both alfalfa and sunflower are excellent examples of herbaceous dicotyledons with little secondary growth. Identify the following tissues in your stem section:

Epidermis

Cortex region composed of collenchyma and parenchyma

Primary vascular bundles with conspicuous primary phloem fibers and phloem to the outside of a cambium layer of cells, and xylem to the inside of the cambium.

Pith. Note the pith rays between the vascular bundles. Look for cambium cells moving into the pith rays in the alfalfa stem sections. This is the start of secondary growth which results in the familiar growth rings of wood.

- ***Monocot Stem Structure***

The corn (*Zea mays*) stem is an example of a stem whose vascular bundles are distributed throughout the ground tissue. The vascular bundles in corn are closed, that is, no cambium is produced for secondary growth. (Bundles in which cambium is formed are said to be open.)

Obtain a prepared slide containing a cross section of a corn stem. Examine the section under the microscope's scanning objective. Compare the distribution of the vascular bundles in the corn stem with that in the alfalfa stem. Switch to the high power objective and study an individual vascular bundle, which resembles a face with eyes and nose. Each vascular bundle, which is surrounded by a bundle sheath composed of thick-walled sclerenchyma cells, consists of phloem toward the outside and xylem toward the inside.

The phloem consists of sieve-tubes and small, dense companion cells. The xylem consists of vessels with thick walls and much smaller parenchyma cells. Most of the vessels are intact, but some vessels have been stretched or destroyed during maturation of the stem. This destruction of vessels often results in the formation of a large air space (the "nose" of the "face"). The ground tissue of the corn stem cannot be distinguished as cortex and pith, since the vascular bundles are scattered throughout

E. Primary structure of a root

The primary root, the plant's first root, develops from the root meristem of the embryo. In gymnosperms and many dicotyledons, the primary root develops as a taproot, which gives rise to lateral, or branch, roots. The taproot and its smaller branched lateral roots form a taproot system. In monocotyledons and some dicotyledons, the primary root is commonly short-lived, so the root system of the

adult plant is composed of many branching adventitious roots (roots which originate from stem tissue). In these plants, the roots form a fibrous root system.

- ***Dicot Root Structure***

Obtain a prepared slide of a cross section of dicot root. Note the wide cortex and narrow vascular cylinder - or stele. Using your high power objective identify each of the following, beginning at the outermost cell layer and working toward the center of the root.

The single layer of epidermis

The wide cortex region of starch-storing parenchyma cells (note the many intercellular spaces)

The thick-walled endodermis, the internal border of the cortex.

The layer of thin-walled pericycle cells, which forms the outer layer of the vascular cylinder (stele).

Xylem, consisting of three or four radiating ridges of thick-walled cells

Strands of phloem alternating with the ridges of the xylem

- **Monocot Root Structure**

Obtain a prepared slide containing cross sections of mature *Zea* (corn) or of *Smilax* root. Examine the slide with low power and note the relative size of the cortex and the vascular cylinder. Unlike dicot roots, roots of monocots contain a central pith region interior to the vascular cylinder. Using the high power objective, identify the following tissues from the outside to the center of the root:

- **Epidermis**
- **Cortex** with a conspicuous, thick-walled endodermis
- **Xylem**, which alternates irregularly with small phloem patches.
- **Internal pith**

Homework!!!

Due in lab next week

You are to pick a plant species that you have an interest in. You are to write a two to three page report on it to include the following:

- The general structure of the root, stem and leaf system..
- Environmental adaptations of these structures.
- An explanation of **WHY** such adaptations exist in the environment of this plant species

Include references to back up your investigation on your plant species. Do NOT just go to Wikipedia and copy and paste what you find. Fully look into your plant species of interest.

BOTH the homework AND this lab handout are due in lab next week