

Lab: Life Cycles and Plant cells and Tissues

In this Lab we will review Life cycles, and you'll get a chance to become more familiar with the three main types of life cycles we will be dealing with: Gametic, Zygotic and Sporic. You'll *see* them, *draw* them, and be able to assign them to the life cycles of some organisms we will be studying more closely.

We will also become familiar with the main types of plant cells and tissues. You'll look at cells in the *ground* tissue, *dermal* tissue and *vascular* tissue.

This Lab has 3 parts: I Life cycles, II Plant cells, III Specialized plant cell components and organelles. The hands-on part of the Lab will focus on II and III, I will have to be reviewed by you!

Important concepts and terms to know:

1. Life Cycles

- Haploid
- Diploid
- Mitosis and meiosis
- Alternation of generations
- Gamete
- Zygote
- Egg cell, sperm cell
- Spore
- Sporophyte
- Major similarities and differences between the Gametic life cycle, zygotic life cycle and sporic life cycle
- What are some representative organisms that have the above three life cycles?

2. Plant tissue systems and cell types

- Dermal tissue – what is and what kinds of cells comprise it?
- Vascular tissue - what is and what kinds of cells comprise it?
- Ground tissue - what is and what kinds of cells comprise it?
- Structure, function, and location (including which tissue system) of the following cell types (be able to identify them visually!):
 - Parenchyma
 - Collenchyma
 - Sclerenchyma (Sclerids and Fibers)
 - Epidermal (including stomata and guard cells)
 - Phloem
 - Companion cells, sieve tube members, sieve plates
 - Xylem
 - Tracheids, vessel members

3. Specialized organelles: plastids and crystals

- What are plastids (generally): significance of endosymbiosis
- What are some specific plastids, and their functions, and where can they be found
 - Chromoplasts
 - Pigment bodies
 - Starch grains (amyloplasts)
- Crystals: excess inorganic substances. What are they? Where can they be found? What makes the following different from one another?
 - Raphides
 - Druses
- Know and be able to locate the general parts (organelles) and structures of/in the plant cell, and what their major function/composition are. Focus on the following (in addition to the structures/plastids above): *Use a diagram for this*
 - Cell wall
 - Plasma membrane
 - Chloroplasts
 - Vacuole/tonoplast (membrane)
 - Nucleus
 - Mitochondria
 - Plasmodesmata
 - Middle lamella
 - Cytoskeleton

PROCEDURE:

I. Life cycles

The general procedure here is to read the materials about life cycles, look at diagrams, and understand the differences and major stages in the three (mostly two – zygotic and sporic) life cycles. Pay particular attention to the variations on the sporic theme (alternation of generations), and the evolutionary trend from dependent sporophyte (mosses and initially ferns) to dependent gametophyte (gymnosperms and angiosperms). Be able to draw the generalized life cycles, and be able to look at a life cycle and assign it to one type of life cycle.

II. Cells and Tissues of the Plant (Angiosperm) Body

The vascular plant sporophyte is usually composed of three kinds of vegetative organs: stems, leaves, and roots. In this lab, you will learn about the various cells and tissues that make up these organs.

A **tissue** is a group of cells that are structurally and/or functionally distinct, and that perform a common function. Tissues composed of just one kind of cell are called **simple tissues**, while those composed of more than one cell type are called **complex tissues**. **Parenchyma** is an example of a simple tissue (composed only of parenchyma cells); **xylem** is an example of a complex tissue (composed of tracheids, vessel members, parenchyma cells, and sometimes fibers). Tissues are organized into three tissue systems: the **dermal**, **vascular**, and **ground** systems. All three tissue systems occur in leaves, stems, and roots.

The various kinds of cells that compose plant tissues and their characteristics, location, and function are summarized in the handout and in your book. Refer to that table as you examine cells and tissues today.

As you study the material provided, always start by viewing the material under the lowest magnification power to get an overview of the tissues. Once you have oriented yourself, then examine the tissues and cells in detail at progressively higher magnifications.

Cell type 1. Parenchyma:

Parenchyma cells are widely distributed throughout the plant body. They make up most of the cortex and pith, as well as the leaf mesophyll. Tissue composed only of parenchyma cells is sometimes called parenchyma tissue, but parenchyma cells are also found in complex tissues such as xylem and phloem. Parenchyma cells are living at maturity, are important in a variety of metabolic functions, have uniformly thin primary cell walls, and come in a variety of shapes. They may contain chloroplasts and be capable of photosynthesis. Often parenchyma cells function as storage cells for water and/or food reserves or as secretory cells.

- Examine the prepared slide of a *Medicago* (alfalfa) stem cross section. Identify the parenchyma cells that make up the **pith** (the tissue in the middle of the stem), the parenchyma cells in the **pith rays** (the zones between the vascular bundles), and the parenchyma cells of the **cortex** (the tissue outside the vascular bundles).

Cell type 2. Collenchyma:

Collenchyma cells, like parenchyma, are living at maturity and have only primary cell walls. However, their walls are unevenly thickened (they tend to be particularly thick at the corners), and the cells often are long. Collenchyma cells have a much more restricted distribution within the plant, and usually are aggregated into strands just beneath the epidermis or along the veins of some leaves. They provide support in young tissues.

- Use a razor blade to cut several thin cross sections from a celery leaf petiole, and examine them with your compound microscope (see text p. 514).
- The tissue that makes up the ribs of celery (the strings that get stuck between your teeth)

is collenchyma. Each rib is formed of many strands of collenchyma cells stacked end to end. The collenchyma cells look dark in the center, and the lighter colored walls appear to glisten. The larger cells near the collenchyma, i.e., those that compose most of the celery stalk, are parenchyma cells.

- Identify the collenchyma and parenchyma cells in the celery cross section.
- Now look beneath the epidermis on the *Medicago* stem you studied earlier. Can you identify collenchyma in this organ? Where is it located?

Cell type 3. Sclerenchyma:

The category "sclerenchyma" includes two cell types, sclereids and fibers, which provide mechanical support or serve to make plant tissues hard. Fibers and sclereids differ greatly in shape but have two features in common: they always have a thick secondary cell wall inside the primary wall, and they are always dead at functional maturity (i.e., they die before they start serving their function for the plant).

a. Sclereids: Sclereids (stone cells) are usually found in the hardest parts of a plant, such as seed coats, nut shells, and the endocarp surrounding a pit in a drupe (e.g., a cherry pit). Their primary function is to make plant tissue hard. They are also scattered through the flesh of a pear, which is what gives this fruit a gritty texture. Sclereids vary greatly in shape, but the ones in pears are roughly spherical.

Make a wet mount of pear (*Pyrus*) tissue. Place a little bit of macerated tissue (which has already been stained with safranin) on a slide. Place the cover slip on the slide and press down gently to separate the cells.

- Find the clumps of stained sclereids. Note the absence of a protoplast and the thick secondary (inner) walls with conspicuous **pits**, which appear as deep channels here because of the thickness of the wall.

b. Fibers: Another kind of sclerenchyma cell is the fiber. Fibers are long and narrow and have a supportive function in plants.

- Examine a prepared slide of a *Tilia* (basswood) one-year-old stem cross section. Try to locate the fibers. These fibers, which have very thick cell walls, are part of the phloem. Identify the phloem, phloem fibers, cortex, xylem, epidermis, and pith.
- Examine a slide of oak (*Quercus*) bark. The long, narrow cells are fibers. The short, wide cells are vessel elements (part of the xylem tissue of adjacent wood); see Part 5.

Cell type 4. Epidermis:

The epidermis (Dermal Tissue) is the essentially continuous outer layer(s) of cells around the plant body. The epidermis may have openings (pores) in it called **stomata** (singular: **stoma**). Each stoma is surrounded by two cells that control the opening and closing of the pore.

- Make an epidermal peel and locate stomata, and epidermal cells.
- Examine a prepared slide of a *Medicago* (alfalfa) young stem cross section. Identify the single layer of epidermal cells. Also note the strands of collenchyma beneath the epidermis at the corners of the stem and the larger parenchyma cells composing the pith.
- Look at a prepared slide of a leaf and locate the epidermal cells. Look for the waxy layer too (a secretion to help protect the leaves from desiccation)

Cell type 5. Vascular Tissues:

The vascular tissues, xylem and phloem, conduct water and dissolved materials throughout the plant. The xylem also functions in mechanical support (wood is made of xylem). Both xylem and phloem are complex tissues; i.e., they contain several cell types. In the stems of herbaceous plants and very young stems of woody plants, the vascular tissues are located in bundles.

- Examine the prepared slide of *Medicago* again. Identify the vascular bundles. You should also be able to identify the epidermis, cortex, pith, and pith rays. Keep this slide for use in the next section.

a. Phloem:

The function of the phloem is to transport carbohydrates and other dissolved organic substances from one part of the plant to another. The conducting cells are **sieve-tube members**. These cells are alive at maturity but lack a nucleus. Each sieve-tube member is accompanied by a smaller **companion cell**, which contains a nucleus. Other cell types found in the phloem include parenchyma cells, and frequently there are also fibers.

- Examine the prepared slide of *Medicago* again. Find one of the vascular bundles and examine it under high power. The phloem is located toward the outside of the bundle.

Now examine a prepared slide of a *Cucurbita* (squash) stem in cross section. Look at the whole cross section first. Notice that the vascular bundles are arranged in two rings around a hollow pith. Identify the epidermis, collenchyma cells (just inside the epidermis in certain areas), cortex, and vascular bundles. What type of cells make up the cortex?

- Now look closely at one vascular bundle. Identify the phloem. In *Cucurbita*, phloem is located on both the inside and outside of the vascular bundle.

The sieve-tube members (the conducting cells of the phloem) are fairly large and are either clear or filled with a dark substance called P-protein. At the end of a sieve-tube member is a **sieve plate**. Carbohydrates and other dissolved organic materials can move from one sieve-tube member to another through the openings in the sieve plate. The small, somewhat box-like cells next to the sieve-tube members are the companion cells.

The largest cells are the phloem parenchyma cells. Find sieve-tube members, companion cells, and phloem parenchyma cells.

Locate a sieve plate. You may have to examine several different bundles to find one.

b. Xylem:

The two functions of the xylem are conduction (of water and dissolved minerals) and mechanical support. The conducting cells are **tracheids** and **vessel members** (the latter are rare outside of the angiosperms). These cells are specialized types of sclerenchyma in having secondary walls and in being dead at functional maturity. Other cell types found in the xylem include parenchyma cells and fibers.

Examine the cross section of the *Cucurbita* stem again. The xylem is located in the middle of the vascular bundle. The largest cells are vessel members.

- Examine a longitudinal section of a *Cucurbita* stem. The secondary walls of tracheids and vessel members have distinctive thickenings in them. These thickenings may wrap around the cell like rings (**annular thickenings**) or like a spiral (**helical thickenings**), or the walls may be almost entirely thickened except for un-thickened pits (**pitted**). Find vessel members with annular thickenings.
- Examine a slide of *Pinus* wood. The cells you see are tracheids. Notice the pitted thickenings in the cell walls. These are called **bordered pits**.

Review:

- Examine a cross section of a *Helianthus* (sunflower) stem. Identify the vascular bundles, xylem, phloem, cortex, pith, and epidermis. To what tissue system (i.e., vascular, dermal, and ground tissues) does each of these tissues belong? Find examples of collenchyma, parenchyma, and sclerenchyma cells.

III. Specialized plant cell components: plastids and crystals

DRAW and LABEL including SIZE.

1. **Chromoplasts** and pigment bodies: Chromoplasts are plastids (like chloroplasts) that contain carotenoid pigments (chloroplasts contain chlorophyll too). These bring color to parts of plants. They are fragile, so preparation has to be done carefully! Petals of yellow flowers such as daffodils and marigolds are good specimens for the study of chromoplasts.

From Wikipedia:

Chromoplasts are **plastids** responsible for **pigment synthesis and storage**. They, like all other plastids (including **chloroplasts** and **leucoplasts**), are **organelles** found in specific photosynthetic eukaryotic species.

Chromoplasts, in the traditional sense, are found in coloured organs of plants such as fruit and floral petals, to which they give their distinctive colors. This is always

associated with a massive increase in the accumulation of **carotenoid** pigments. The conversion of chloroplasts to chromoplasts in ripening tomato fruit is a classic example.

Chromoplasts synthesize and store pigments such as orange **carotenes**, yellow **xanthophylls** and various other red pigments; as such, their color varies depending on what pigment they contain. The probable main evolutionary role of chromoplasts is to act as an attractant for pollinating animals (e.g. insects) or for seed dispersal via the eating of colored fruits. They allow the accumulation of large quantities of water-insoluble compounds in otherwise watery parts of plants.

- a. With a twisting action, tear a piece from a petal and make a wet-mount. Look at the torn edge – a good place to find single cell layers. In Marigolds, chromoplasts are easy to see in the papillate epidermal cells along the margin of the petal.
 - b. By through-focusing, find the location of the plastids (and the pigments) within a single cell. In marigolds, the pigment is stored in lipid globules. If plastids have ruptured, you may be able to see the many small colored globules exhibiting Brownian motion in the cytosol or vacuole.
 - c. Fruits: with a sharp razor blade, get some flesh from a fruit provided (do not get the epidermis), and make a wet-mount. In tomatoes and carrots, the pigment is found in crystal-like pigment bodies. For the carrot, cut some thin longitudinal sections of the most colored part of the root and prepare a wet-mount. Find the pigment bodies.
2. **Starch Grains (amyloplasts)** – a type of storage leucoplast can be found in starch-storing parenchyma cells such as in cotyledons (seed leaves) of bean or pea seeds, endosperm (food for seeds) of corn and of course in potatoes. Any starchy part of a plant really.
- a. Using a razor blade, make a *thin* scrape of starchy material that is provided (probably a potato), and make a wet-mount. Your goal is to get only one cell layer (or as few as possible anyway). Look for the large ‘sacs’ that are the amyloplasts.
 - b. Now do it with polaroids to get a better look.
 - c. Now use a piece of kim-wipe to ‘draw’ some Lugol’s reagent through your coverslip. This solution is used to identify starch (remember the bacteria experiment). What happens to the starch?
3. **Crystals.** Excess inorganic substances in plants, often consisting of calcium salts such as calcium oxalate, are often deposited in the vacuole of the cell in a crystalline form. There are two major types of crystals: **raphides** are needle-like crystals that occur in bundles, and can be found in banana peels, and the leaves,

stems and petals of *Zebrina* and *Impatiens*. Druses are compound crystals which can be found in the pith or cortical parenchyma cells in the stems of *Begonia*, *Ricinus*, geranium and other plants.

- a. Using a razor blade, cut a *thin*, longitudinal section of the material provided and identify the two types of crystals.
 - b. Examine them with polaroids to see if it makes a difference.
4. Eukaryotic cell organelles and their functions. Using diagrams, your book etc. Be able to locate and identify the major organelles (listed above and in the 'glossary'), and be able to describe at least one function. Draw, label and write them down!

