STUDY GUIDE - *Ch. 35.2 - Different Meristems Generate New Cells for Primary & Secondary Plant Growth*
- Ch. 35.3 - Primary Growth Lengthens Roots & Shoots

NAME: _____

- **PHYSICALLY PRINT OUT this PDF and HANDWRITE (with a black or blue pen) your answers directly on this PDF.** *Typed or digitally-written work is **not** accepted. Do **not** answer questions on separate paper.*
- **Importantly, study guides are NOT GROUP PROJECTS!!!** *You, and you alone, are to answer the questions as you **read** your assigned textbook. You are **not** to share answers with other students. You are **not** to copy any answers from any other source, including the internet.*
- **Get in the habit of writing LEGIBLY, neatly, and in a medium-sized font.** *AP essay readers and I will skip grading anything that cannot be easily read so start perfecting your handwriting, and don't write so large you can't add all the relevant details and key elaborations in the space provided.*
- **SCAN physical documents in color and with good resolution. Then, upload your final work as PDFs to Archie.** *Avoid uploading dark, shaded, washed-out, sideways, or upside-down scans of homework. Keep completed physical study guides organized in your biology binder to use as future study and review tools.*
- **READ FOR UNDERSTANDING and not merely to complete an assignment.** ***First**, read a section quickly to get an overview of the topic covered. Then, read it a **second** time slowly, paraphrasing each paragraph **out loud** and analyzing every figure. Finally, read it a **third** time as you answer the study guide questions if assigned and start building your memory. Try to write answers out in your own words, when possible, and try to purposefully and accurately use all new terminology introduced.*

Before starting Ch.35.2, **read over Ch.35.1 quickly to review the function/structure of root hairs, apical (terminal) & axillary (lateral) buds, dermal, vascular & ground tissue, plant cuticles, guard cells, trichomes, xylem, & phloem!!!**

1. a. What is the difference between **indeterminate and determinate growth**?

   b. Plants display indeterminate growth *(at least in the lengthening of their branches or growing of new branches)* because they **contain meristems inside the apical and axillary buds of branches**. What exactly are these **meristems**?

   c. What kind of growth do you as a human experience?

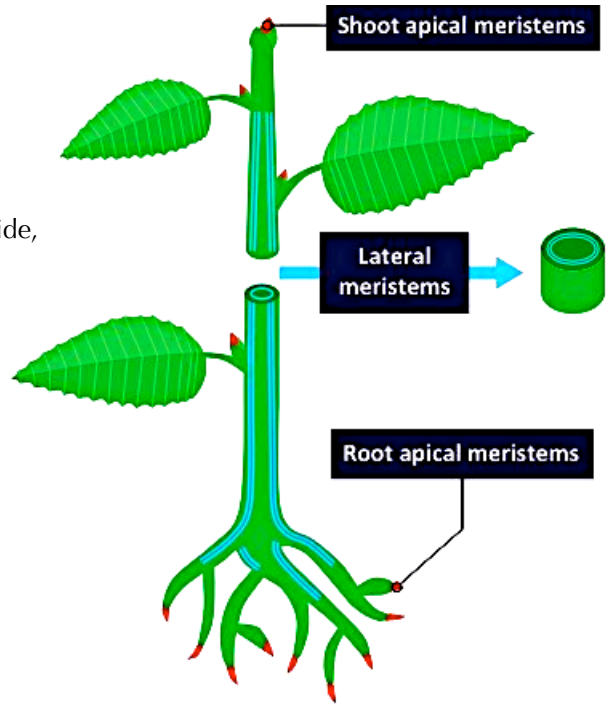
   d. Although **plants generally show indeterminate growth**, what are **three examples of plant parts that show determinate growth**?

      1. _____ 2. _____ 3. _____

2. a. Meristem tissue is found in plants in two different locations. Where are **Apical Meristems found**?

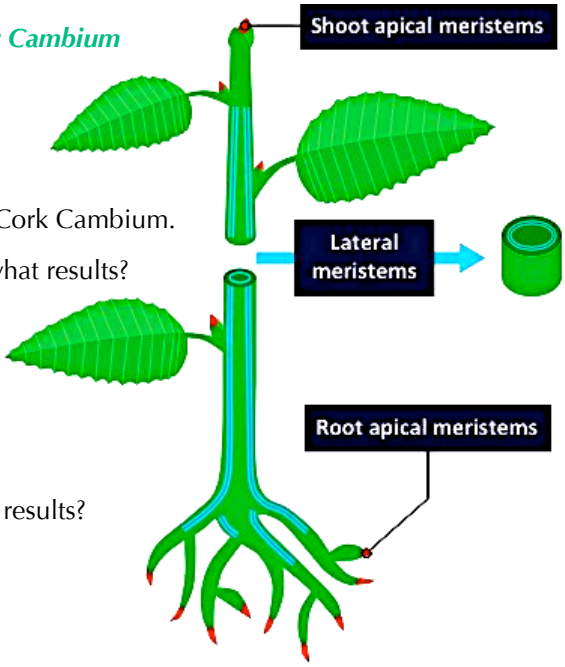
   b. As the cells in the **Apical Meristems** ***(inside apical buds)*** divide, what is the **name of the kind of plant growth** that occurs?

   c. What does **this type of plant growth cause**?



d. **Study Figure 35.11: PRIMARY GROWTH (Growth in Length) well!!!** *You are responsible for learning this independently.*

3. a. As the cells in the **Lateral Meristems** *(which include the Vascular Cambium & the Cork Cambium)* divide, what is the **name of the kind of plant growth** that occurs?

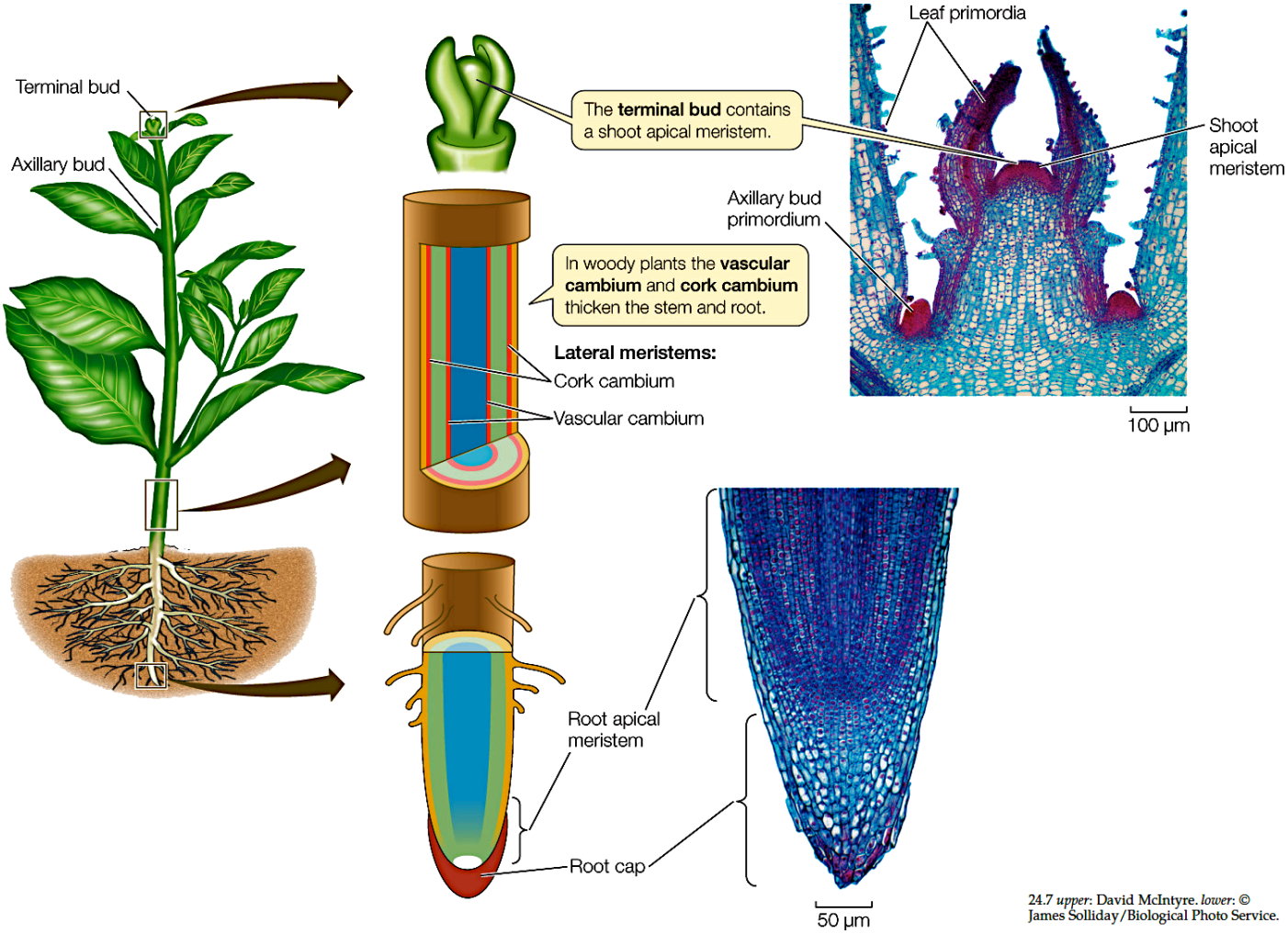


b. The **Lateral Meristems** are made up of the Vascular Cambium & Cork Cambium.

As the cells in the **Vascular Cambium meristem tissue divide**, what results?

As the cells in the **Cork Cambium meristem tissue divide**, what results?

c. **Study Figure 35.11: SECONDARY GROWTH (Growth in Branch Thickness) well!!!**
You are responsible for learning the information in this figure independently.



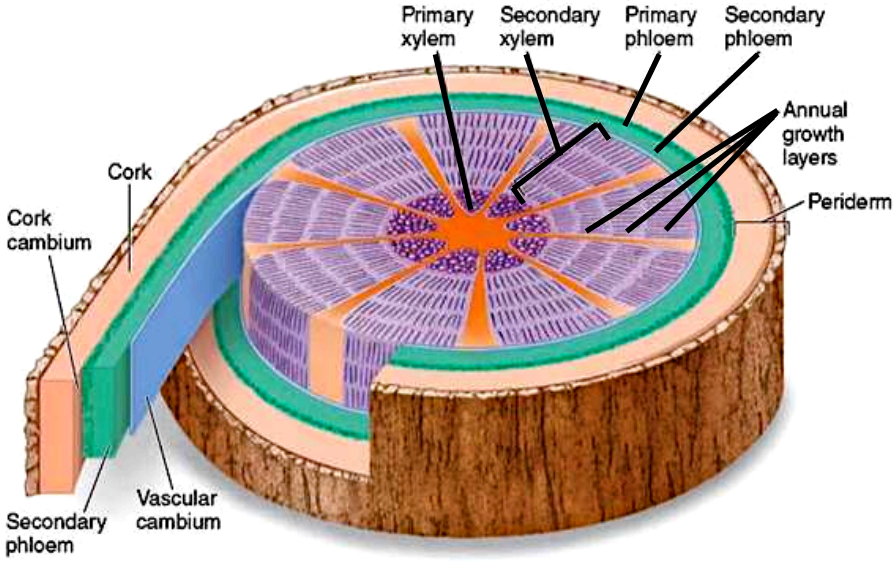
24.7 *upper*: David McIntyre. *lower*: © James Solliday/Biological Photo Service.

d. Based on what you learned in Figure 35.11, when the Vascular Cambium's lateral meristem cells divide, **which type of vascular tissue cells are added - in a ring - just to the INside the ring of Vascular Cambium cells**? *FYI, this vascular tissue is what we call **wood** in stores.*

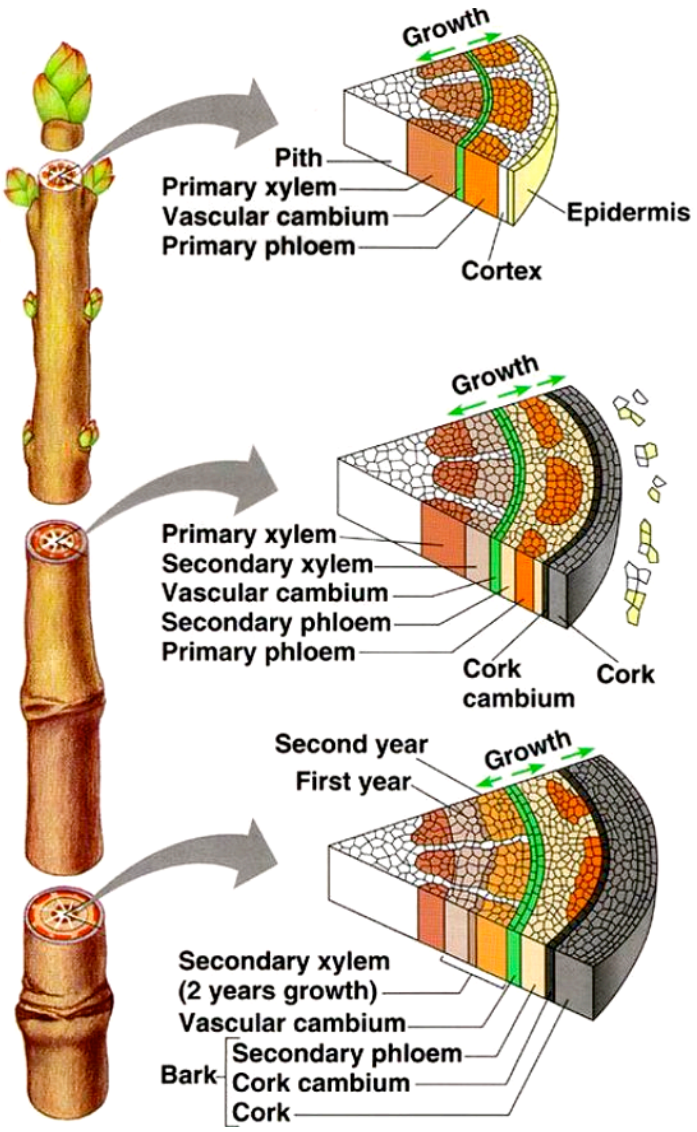
Since trees go **dormant** during winter when there is less sunlight for photosynthesis and less water since it may be frozen in the ground, the vascular cambium doesn't divide, but every spring, when daylight lengthens and temperatures thaw the ice and warm up the air again, and throughout the summer and early fall, cells of the vascular cambium divide anew. **The newest layer of cells deposited just to the interior of the ring of vascular cambium cells, form the next "growth ring" for that new year.** The growth rings that form every year can be seen when looking at a cross section of a tree trunk. *(See images below)*. As the tree grows taller and bigger, it should make sense that wider branches and trunks are needed **(with more xylem formed with lignin-containing, hardened cell walls)** in order to support the weight of the plant **and** carry more water from the soil up to all cells of the plant.

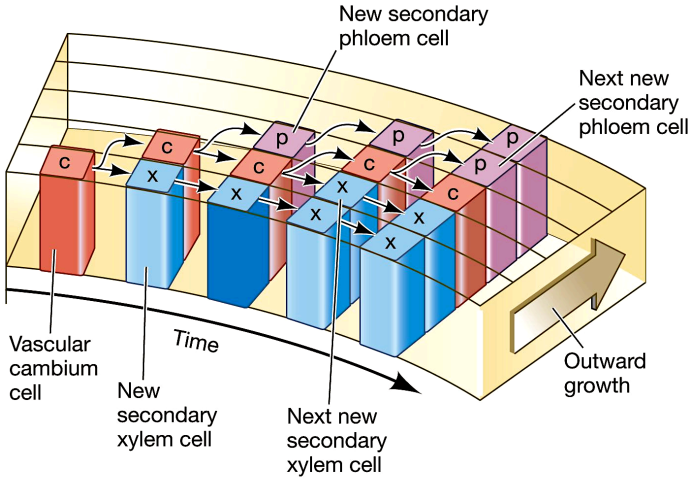
e. Based on what you learned in Figure 35.11, when the Vascular Cambium's lateral meristem cells divide, **which type of vascular tissue cells are added - in a ring - just to the OUTside the ring of Vascular Cambium cells**?

As the tree grows taller and bigger, it should make sense that more sugar-conducting tissue **(green in the image below)** is needed as well in order to transports more sugars from areas were they are formed (like leaves) or stored for the winter (like certain roots or modified shoots - think carrots or potatoes) to the areas where there are an increasing numbers of cells that **still need the carbon and energy stored in these sugars, but cannot perform photosynthesis themselves** (like cells inside shoots and roots or growing flowers and fruits).



f. The initial ring of xylem a young plant has is called the **primary xylem**. Each additional layer of xylem added by dividing vascular cambium every year is called the **secondary xylem**. The initial ring of xylem a plant has is called the **primary phloem**. Each additional layer of xylem added by dividing vascular cambium every year is called the **secondary phloem**. Pay attention, in the two figures shown here and in the explanation and figures in Figure 35.11 in your text, to where the primary and secondary xylem and phloem are located in relation to the vascular cambium. How does the location of the vascular cambium change as the years pass? *Explain.*



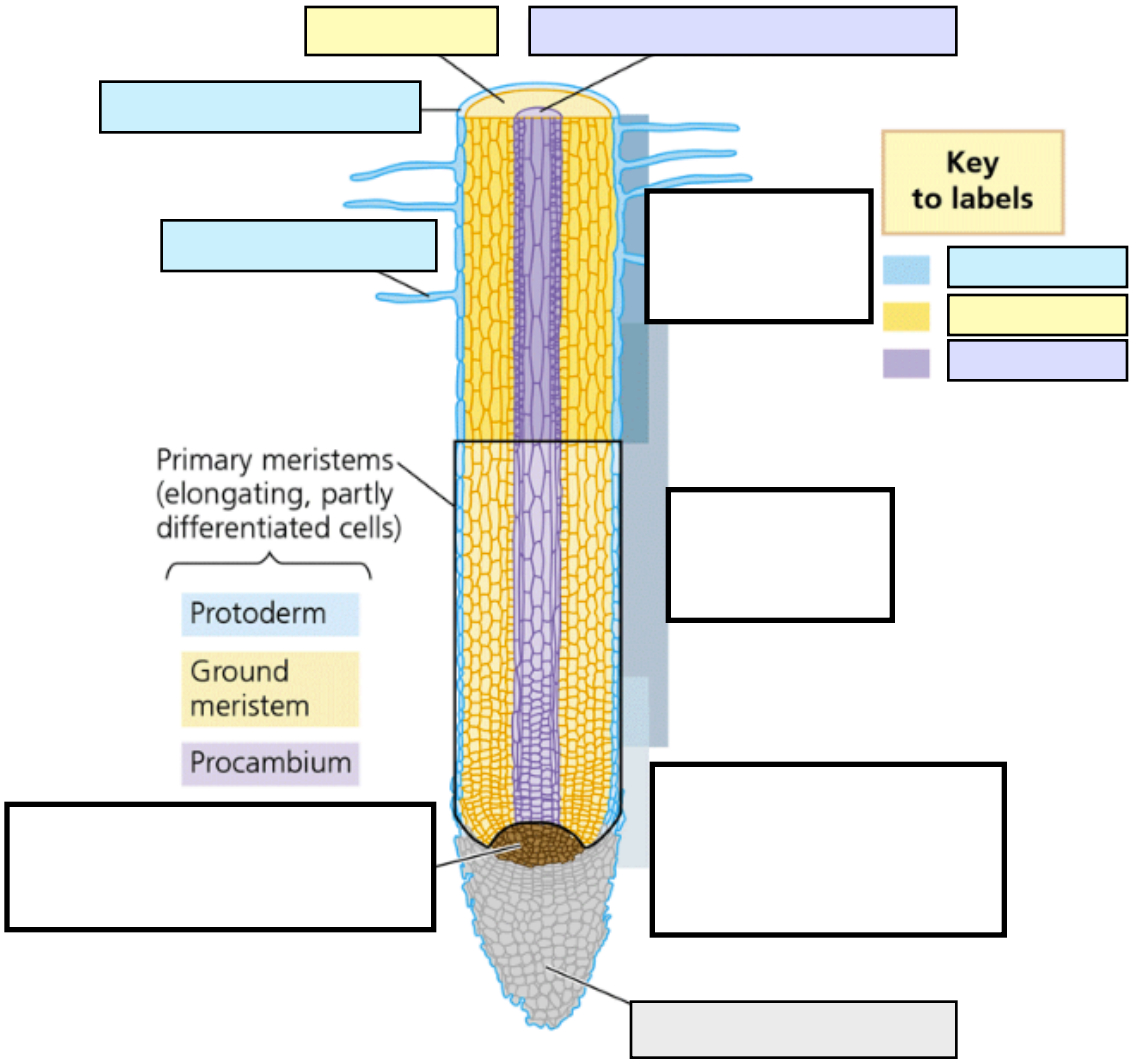


4. Meristem, like those found in the apical meristems at the tips of shoots and roots, are types of Stem Cells. What is a **stem cell**? *(The human zygote is an example of a stem cell too).*

5. a. As roots experience primary growth, lengthen, their tips push through abrasive soil particles that could damage the important apical meristem cells. What do you think would no longer be able to happen if the apical meristem in a root were damaged or removed?

b. Natural Selection has favored the evolution of root caps on the tips of roots. What is a **root cap** and what is its function?

c. See the cross section of a root tip below. Label the structures shown in this figure including the cortex, vascular cylinder (where phloem and xylem form), epidermis, apical meristem, root cap, root hair, zone of differentiation, zone of elongation, and zone of cell division.



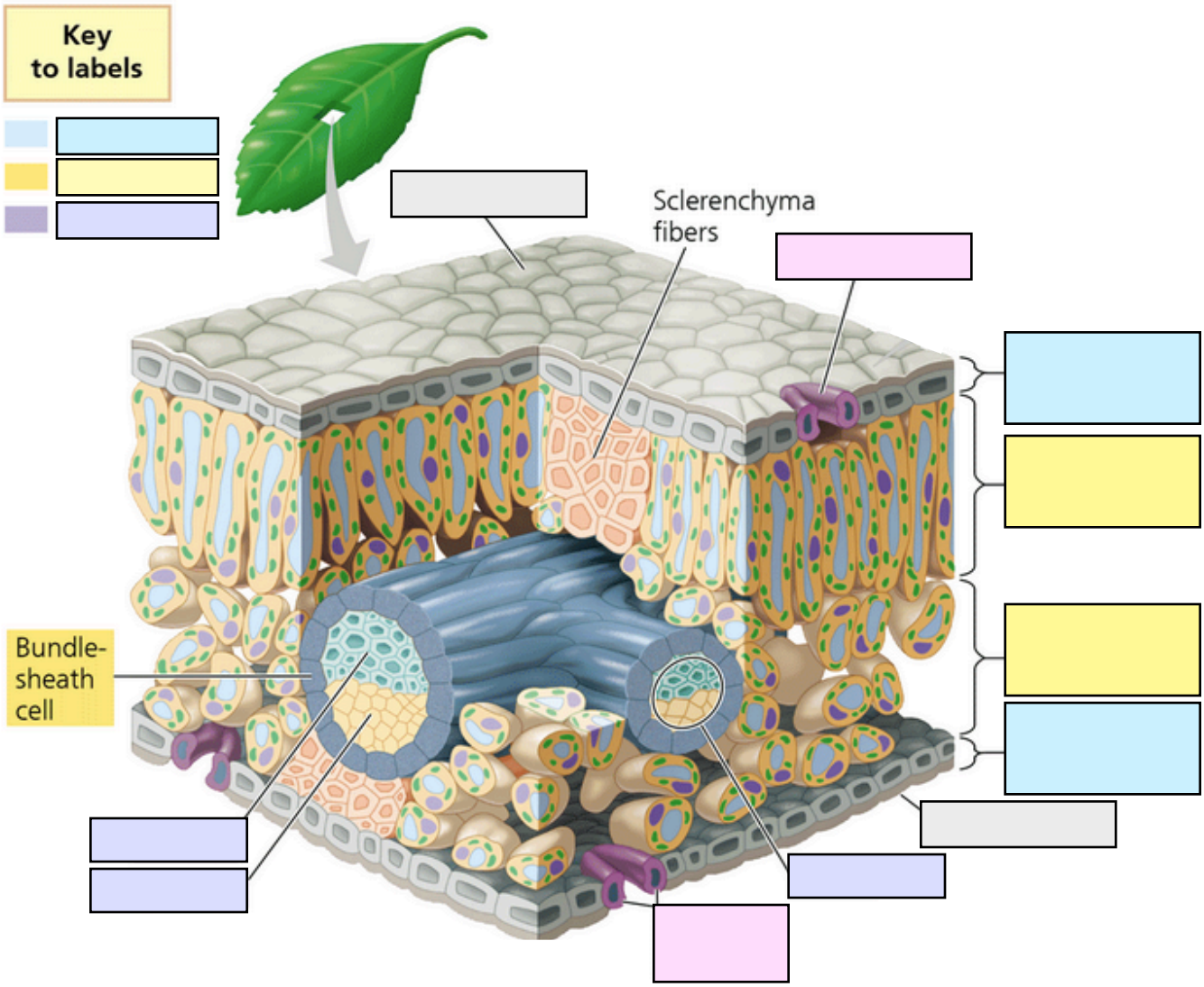
d. Explain what happens in the following root zones.

<u>Zone of Cell Division</u> =

<u>Zone of Elongation</u> =

<u>Zone of Differentiation</u> =

6. To understand the process of photosynthesis, students are expected to know basic **leaf structure** in greater detail. Using Figure 35.18, label each structure in the leaf below.



7. The leaf epidermis is covered in the cuticle. What is the purpose of the waxy **cuticle** again?

8. a. Stomata are structures made up of two guard cells that form a pore in the epidermis of the leaf. What are the two functions of stomata *(singular = stoma)*?

   1.

   2.

   b. So to review: What gas critical to photosynthesis enters the leaf through stoma?

   c. So to review: What is lost through the stoma that leads to transpiration?

9. Contrast the **spongy versus the palisade mesophyll** in leaves.

Spongy Mesophyll =

Palisade Mesophyll =

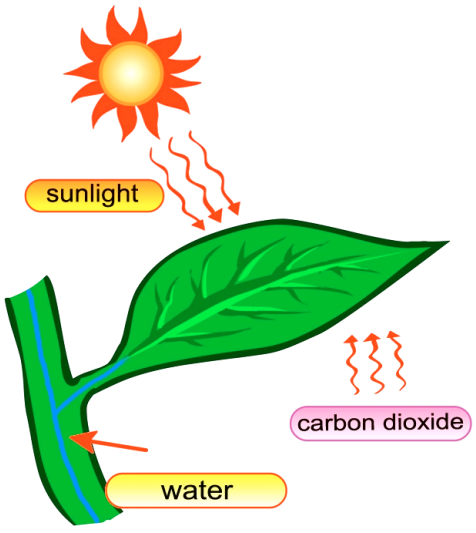
A QUICK REVIEW OF EVOLUTION BY NATURAL SELECTION

Since water is lost when stomatal pores are open, but open stomates are needed for effectively photosynthesis, the concentration of stomates and the location of stomates is under genetic control, these two aspects of stomates in plants are **influenced by natural selection** over time (many generations).

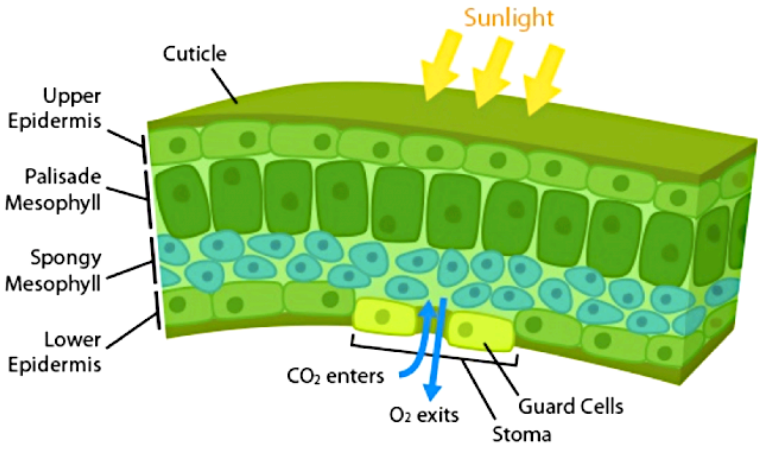
★ Remember, for natural selection to take place, the **organisms within a population in a given region must already exhibit some variation in a certain characteristic** (leaf size, stomata location, stomata concentration). This characteristic, and its versions (traits), must also be controlled by the genes in the DNA - **the characteristics must be inheritable**. If this is the case, and one variation is more beneficial to have than another, **the more beneficial variation increases the reproductive success of the organism that possesses it** (increases that organism's ability to survive in order to reproduce). Since there is differential reproductive success within the population, **the alleles for the genes that cause beneficial variations are passed down proportionally more success from generation to generation than the alleles for genes that cause the alternate, less beneficial variations of that character.** Over time, you will thus see the more and more of the descendants in that population exhibiting the favored trait/ version of a character. We say that **natural selection has SELECTED FOR a certain trait of a character**. A change in the frequency of the different alleles of a gene over time is evolution. After many generations, the trait that becomes the dominant within a population, that all descendants come to posses due to natural selection, is know as an **adaptation, since this feature of the organisms increases the organism's chances of survival and reproduction.**

HOW NATURAL SELECTION INFLUENCES THE EVOLUTION OF LEAF STRUCTURE IN DIFFERENT ENVIRONMENTS

All aspects of plants are influenced by natural selection. Even the existence of palisade versus spongy mesophyll has been shaped by evolutionary processes. **Leaves get hit by sun from above, so having a tightly packed layer of palisade mesophyll cells filled with chloroplasts increases the amount of photosynthesis that can be done, increasing the amount of solar energy that can be captured.**



Plants that have leaves that are surrounded by the air, like leaves on a typical tree, also would exhibit high rates of water loss if there were stomata on the top of their leaf surfaces since that's where the the most solar energy hits the leaf and, thus, where the water would evaporate out of the stomates most quickly as water inside the leaf heats up. **These types of plants have evolved to have stomates on the undersides, the shaded sides, of their leaves**. This way, **pores can be opened when the sun shines to allow for the necessary gas exchange to support photosynthesis, yet the plant can minimize water loss at the same time.**

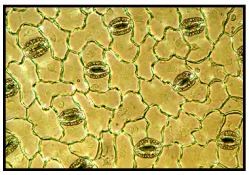


Even the **spongy mesophyll creating air pockets inside the leaf allows for the CO_2 gas, that diffuses into the leaf spaces via the stomatal pores, to quickly diffuse towards the palisade mesophyll cells with minimum obstacles, thus increasing the efficiency of photosynthesis in the spongy and especially palisade mesophyll cells.** O_2 which disrupts photosynthesis and is a waste product of the process can also more quickly diffuse away of the mesophyll cells and out of the leave.

Natural selection has favored the evolution of smaller leaves in plants that live in very dry environments (hot or cold like equatorial deserts or the arctic regions). Smaller leaves have fewer numbers stomata overall.

Natural selection may also favor the evolution of leaves with a lower concentration of stomata (lower number of stomata per amount of surface area) on leaves that live in very dry environments (hot or cold). **Lower concentration of stomata help the plant in conserving water and not loosing as much through transpiration (water evaporating out of the stomates).**

At the same time, in areas with lots of water availability, plants can afford to have more stomates and can afford to keep stomates open for a longer periods of time during daylight. **The more stomates, the more gas exchange can occur and the more photosynthesis can be supported (assuming there is enough sunlight to support the process).** In the moist, wet tropical rain forests, natural selection has often selected for leaves that are very large in plants near the ground, so that they can capture any sunlight that trickles through the canopy of tree leaves above. **More water is readily available in the soil to replace water lost by transpiration so leaves can also contain a large number to stomates or a high concentration of stomates, or both, on the lower sides of the leaf surfaces.**



Water lilies have leaves that float on the surface of liquid water. Here stomates on the underside of the leaf would not experience rapid gas exchange since gases that have diffused from the air into the liquid water move slower once in liquid water. The Water lily also does not have to worry about loosing water, as more water is readily available from roots that are found in the liquid water below. Therefore, **these leaves have stomata on the top surface of the leaf, where sunlight may cause lots of water loss, which is easily replaced however, and where gas exchange can happen efficiently directly with the air above water.**