Lesson C2–2

Examining Plant Structures and Functions

Unit C. Plant and Soil Science

Problem Area 2. Basic Principles of Plant Science

Lesson 2. Examining Plant Structures and Functions

New Mexico Content Standard:

Pathway Strand: Plant Systems

Standard: **II:** Address taxonomic or other classifications to explain basic plant anatomy and physiology.

Benchmark: **II-A.** Examine unique plant properties to identify/describe functional difference in plant structures including roots, stems, flowers, leave and fruit.

Performance Standard: **1.** Identify plant structures (e.g., seeds).

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Describe the cellular structure of plants.
2. Identify the major parts of plants and explain their functions.
3. Distinguish between plants based on seed cotyledons.
4. Explain the absorption and transport systems of plants.

List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Biondo, Ronald J. and Jasper S. Lee. *Introduction to Plant and Soil Science and Technology*. Danville, Illinois: Interstate Publishers, Inc., 1997. (Textbook and Activity Manual, Chapter 5)

Lee, Jasper S. and Diana L. Turner. *Introduction to World AgriScience and Technology*, 2nd Edition. Danville, Illinois: Interstate Publishers, Inc., 1997. (Textbook and Activity Manual Chapters 5 and 7)

Other Resources. The following resources will be useful to students and teachers:

Barnes, Robert F., Darrell A. Miller, and C. Jerry Nelson. *Forages*. Ames, Iowa: Iowa State University Press, 1995.

Cooper, Elmer L. *Agriscience Fundamentals and Applications*. Albany, New York: Delmar Publishers, Inc., 1997.

Morgan, Elizabeth M.; Ray E. Chelewski; Jasper S. Lee; and Elizabeth Wilson. *AgriScience Explorations*, 2nd Edition. Danville, Illinois: Interstate Publishers, Inc., 2000.

Parker, Rick. *Introduction to Plant Science*. Albany, New York: Delmar Publishers, 2000.

Schraer, William D. and Herbert J. Stoltze. *Biology: The Study of Life*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1995.

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Specimen plant materials
Overhead projector
Copies of student lab sheets with necessary materials

Terms. The following terms are presented in this lesson (shown in bold italics):

Alternate leaf arrangement
Bulb
Cell
Cell specialization
Cladophyll
Compound leaf
Corm

Cotyledon
Dicotyledon
Fibrous root system
Flower
Fruit
Leaf
Monocotyledon
Multi-cellular organism
Opposite leaf arrangement
Organ
Organ system
Osmosis
Phloem
Reproductive parts
Rhizome
Root
Seed
Simple leaf
Stem
Stolon
Taproot system
Tendril
Tissue
Transpiration
Tuber
Vegetative parts
Whorled leaf arrangement
Xylem

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Bring a small plant specimen (about 18 inches long) that has been pulled up so that leaves, stems, and roots are obvious. A specimen with flowers and/or fruit is preferred. Ask students to name the different parts of the specimen. As they do, have them describe the function of the part and how it is useful to humans. Move from the interest approach into the objectives and anticipated problems for the lesson.

Summary of Content and Teaching Strategies

Objective 1: Describe the cellular structure of plants

Anticipated Problem: What is the cellular structure of plants?

I. Cells are the structural basis of all living organisms.

A. A ***cell*** is a tiny structure that forms the basic building blocks of plants.

1. All organisms are made of one or more cells.
2. Protoplasm in cells carries out life processes.

B. Plants are ***multi-cellular organisms***, meaning that they have many cells.

1. Some cells have specific functions.
2. ***Cell specialization*** is the presence of cells that perform unique activities for a plant. (Flowers, leaves, roots, and stems are made of specialized cells.)

C. Cells are formed into groups that work together.

1. ***Tissue*** is formed by groups of cells that are alike in activity and structure.
2. An ***organ*** is formed by tissues that work together to perform specific functions.
3. An ***organ system*** is a group of organs that works together to perform a function.

D. Cell structure is the organization of the material that forms a cell.

1. Plant cells have three major parts: wall, nucleus, and cytoplasm.
2. The cell wall surrounds the cell and controls the movement of materials into and out of the cell.
3. The nucleus is near the center of a cell and contains protoplasm, chromosomes, and other structures that control cell activity.
4. The cytoplasm is a thick solution inside the cell wall surrounding the nucleus.
5. Plant cells have many additional parts, including: chloroplasts, nucleolus, vacuole, mitochondria, and golgi body.

Many techniques can be used here to help students master this objective. As an example, students could use Chapter 5 in Introduction to World AgriScience and Technology to help understand the structure of cells. Use TM: C2–2A to illustrate the major parts of a cell. Use prepared slides for students to see cells under a microscope.

Objective 2: Identify the major parts of plants and explain their functions

Anticipated Problems: What are the major parts of plants? What are the functions of these parts?

II. Plants are comprised of vegetative and reproductive parts.

A. The major ***vegetative parts*** of plants are stems, leaves, and roots.

1. A ***stem*** is the central axis that supports the leaves, connects them with the roots, and transports water and other materials between the leaves and roots. Stems vary widely in appearance based on the species of plant. Stems may be vertical or horizontal and modified for climbing and to store water and food. Several specialized kinds of stems are important:
    a. Rhizome—A ***rhizome*** is an underground stem that grows horizontally. It may grow adventitious roots and stems to develop as a separate plant. Examples include iris and wild ginger.
    b. Tuber—A ***tuber*** is an enlarged part of a stem that grows underground. A tuber can develop into a separate plant. Examples include potatoes and yams.
    c. Tendril—A ***tendril*** is a threadlike leafless growth on a stem that attaches itself around other stems and objects. Tendrils typically grow in a spiral shape. After attaching itself, it holds the stem in position. Vines and climbing plants often have tendrils. Examples include sweet peas and cucumbers.
    d. Stolon—A ***stolon*** is an above ground stem that grows horizontally and propagates new plants. Strawberries are well known as examples of plants that multiply using stolons.
    e. Bulb—A ***bulb*** is an underground food-storage organ consisting of flattened, fleshy stem-like leaves with roots on the lower side. Examples of bulbs are onions and daffodils.
    f. Corm—A ***corm*** is a food storage structure at the end of a stem that grows underground. It is an enlarged or swollen stem base. Examples include gladiolus and crocus.
    g. Cladophyll—A ***cladophyll*** is a leaflike branch that resembles a leaf. It is also called a cladode. A cladophyll functions much like a leaf.
2. A ***root*** is the part of a plant that grows in the soil or other media. Roots anchor plants, absorb water and minerals, and store food. The root system structure varies widely depending on the species of plant. Overall, roots can be classified as two major types:
    a. Fibrous—A ***fibrous root system*** is made of many small roots and spread throughout the soil.
    b. Taproot—A ***taproot system*** is made of one primary root with a number of small secondary roots.
3. A ***leaf*** is typically a large, flat, green organ attached to the stem. Leaves carry out photosynthesis, transpiration, and may store food. Shape, arrangement, and other features vary widely with the species of plant. There are two major kinds of leaves and three major types of arrangements:
    a. Simple—A ***simple leaf*** has only one blade.
    b. Compound—A ***compound leaf*** is divided into two or more leaflets
    c. Leaf attachment also varies. This refers to the spacing and arrangement of leaves on the stem of a plant. The major kinds of attachment are:

(1) Alternate—***Alternate leaf arrangement*** is one leaf at each node on a stem.
(2) Opposite—***Opposite leaf arrangement*** is two leaves are attached at nodes opposite each other.
(3) Whorled—***Whorled leaf arrangement*** is three or more leaves are at each node.

B. The major ***reproductive parts*** of plants are flowers, seed, and fruit.
   1. A ***flower*** is a part containing the reproductive organs. The types of flowers vary considerably. In general, flowers produce pollen and ovules. Fertilization occurs when a pollen cell unites with an ovule.
   2. ***Seed*** are formed by fertilized ovules and contain new plant life.
   3. ***Fruit*** are the ovaries which develop to protect and nourish the developing seed. The kinds and nature of fruit vary widely.

   (Note: Details on flowers are presented in the following lesson.)

Use a wide variety of techniques to help students master this objective. Providing text materials will enhance student learning, with Chapter 7 in Introduction to World AgriScience and Technology being a good example. Use TM: C2–2B to illustrate the parts and functions of plants. Use TM: C2–2C to illustrate the parts of a typical stem. Use TM: C2–2D to illustrate the cross section of a tree stem. Use TM: C2–2E to show the kinds of specialized stems. Use TM: C2–2F to illustrate the types of root systems. Use TM: C2–2G to illustrate the types of leaves.

Objective 3: Distinguish between plants based on seed cotyledons.

Anticipated Problem: What is a cotyledon? How do plants differ based on cotyledons?

III. A ***cotyledon*** is the fleshy structure within a seed that contains food for a developing embryo.
   A. Depending on the plant species, a seed may have one or two cotyledons.
   B. A plant species producing seed with one cotyledon is a ***monocotyledon***, or monocot.
      1. All grasses are monocots. Corn, wheat, oats, Bermuda grass, and sugarcane are examples of monocots.
      2. Monocot plants have long, narrow leaves with parallel veins. All leaves branch from the main stem.
      3. Stems are non-woody and tend to have a large area of pith in the center.
   C. A plant species producing seed with two cotyledons is a ***dicotyledon***, or dicot.
      1. All plants other than grasses are dicots. Soybeans, trees, lettuce, sunflowers, and petunias are examples of dicots.
      2. Dicot plants have broad leaves with a net-type of veins.
      3. Stems are often long and branching. They may be woody or non-woody, depending on the plant species.

Use local plants (crops, wild flowers, and ornamentals) as specimens to illustrate differences in plants based on cotyledons. If seed structure has not been taught, some time should be devoted to seed structure.

Use TM: C2–2H to illustrate differences in dicot and monocot seed. Use TM: C2–2I to illustrate how a monocot plant grows. Use TM: C2–2J to show how a dicot plant grows. Have sprouted corn and bean seed for students to see. (The seed will need to be prepared for germination several days ahead of time so that the sprouts will be visible and comparisons can be made. An approach used by some teachers is for small groups of students to prepare rag doll tests of corn and bean seed to study the germination structures.)

Objective 4: Explain absorption and transport systems of plants.

Anticipated Problem: How do plants absorb and transport materials?

IV. Water and nutrients are primarily absorbed by the roots and transported throughout the plant by various tissues in the roots, stems, and leaves.

A. Roots have tiny root hairs covered with thin membranes that allow water and nutrients to enter.

1. ***Osmosis*** is the movement of water from greater concentration in the soil or media to lower concentration in the root.
2. Water enters until the concentration in the root is equal to the concentration outside the root.
3. The water entering roots also carries inorganic substances known as nutrients.

B. After absorption by roots, water is passed from cell to cell until it reaches the xylem.

1. ***Xylem*** is tissue, formed as tubes, that conducts water up the stem and to the leaves.
2. The petiole of the leaf takes the water from the xylem in the stem to the leaf veins, which distribute it throughout the leaf.

C. Leaves lose water by ***transpiration***.

1. Transpiration occurs through tiny stomata on leaves.
2. Transpiration creates somewhat of an upward pull that assists the xylem in moving water and nutrients.

D. Manufactured food is conducted from the leaves through the stems to the roots in phloem tissue.

1. ***Phloem*** is the tissue that conducts sugars, proteins, hormones, dissolved materials, and salts from leaves to other parts of a plant.
2. The structure is observed as elongated sieve-type cells that form tube structures in stems.

Use a wide range of teaching strategies to illustrate absorption and material transport. A cross section of a corn stalk can be used to show xylem tissue and tubes for the movement of materials. Use the roots of a plant specimen to help students see root hairs (a hand lens or other magnification may be needed). Use TM: C2–2K to show the arrangement of tissues in stems. Use TM: C2–2L to illustrate root structure. Use TM: C2–2M to illustrate root structure as related to absorption. Use TM: C2–2N to illustrate stomata. Use LS: C2–2A on plant tissues for students to identify and compare the vascular tissues of monocots and dicots. Use LS: C2–2B for students to carry out an activity that measures the loss of water

from a plant by transpiration. Student-oriented learning materials are supported by Chapter 7 in the text, Introduction to World AgriScience and Technology.

Review/Summary. Focus the review and summary of the lesson on the student learning objectives. Have students explain the content associated with each objective. Use specimens of plant materials for students to use in demonstrating their knowledge of the objectives. Use student responses as the basis for reteaching. Questions at the end of the chapter in the textbooks and in the activity manuals may be used in the review/summary process.

Application. Application can involve one or more of the following student activities:

Monocot and Dicot Plant Tissues—LS: C2–2A
Measuring Water Loss from a Plant by Transpiration—LS: C2–2B

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is attached.

Answers to Sample Test:

Part One: Matching

1=j, 2=c, 3=a, 4=i, 5=h, 6=g, 7=d, 8=e, 9=b, 10=f

Part Two: Completion

1. Osmosis
2. Transpiration
3. dicot
4. xylem

Part Three: Illustration

1. Use TM: C2–2A as a guide for scoring this sketch.
2. Use TM: C2–2B as a guide for scoring this sketch.

Sample Test Name_____

Test

Lesson C2–2: Examining Plant Structures and Functions

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term next to the definition.

a. cells	f. stems
b. multi-cellular	g. leaves
c. tissue	h. roots
d. organ	i. flower
e. organ system	j. monocot

_____ 1. Plant with seed having one cotyledon.

_____ 2. Formed by a group of cells similar in activity and structure.

_____ 3. Tiny structures that are the basic building blocks of plants.

_____ 4. The part of a plant containing reproductive organs.

_____ 5. Anchor plants in the soil.

_____ 6. Large, flat plant structures attached to stems.

_____ 7. A collection of tissues.

_____ 8. A collection of organs.

_____ 9. Organisms containing more than one cell.

_____ 10. Connect leaves and roots.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. _____ is the movement of water from greater concentration in the soil to lower concentration in the roots of plants.
2. _____ is the loss of water by leaves.
3. A _____ is a plant from a seed with two cotyledons.
4. The tissue forming tubes in plants that conducts water and nutrients from the roots is _____.

Part Three: Short Answer

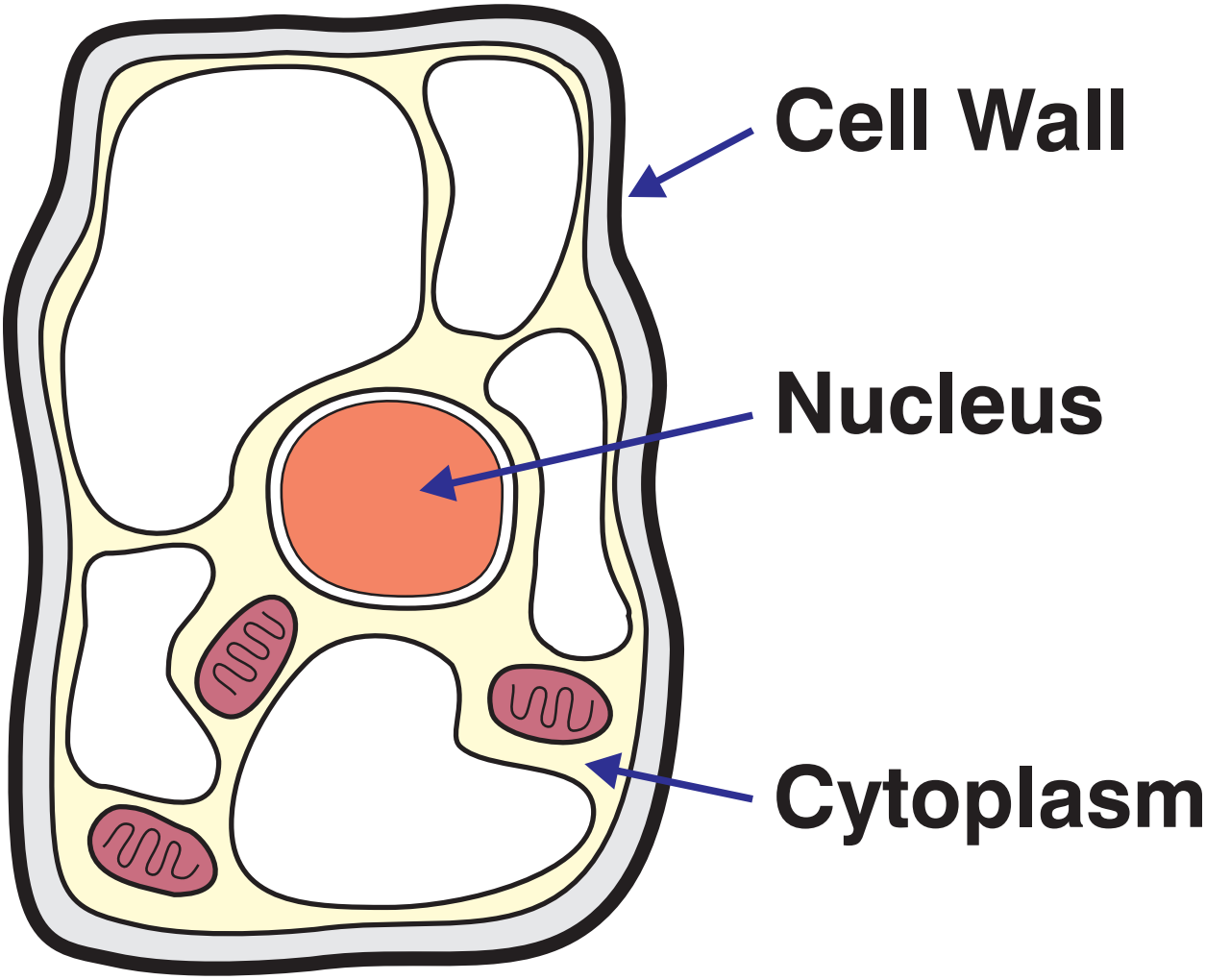
Instructions. Complete the following:

1. Draw and label the major parts of a plant cell.

2. Draw and label the major parts of a plant.

TM: C2–2A

MAJOR PARTS OF A PLANT CELL



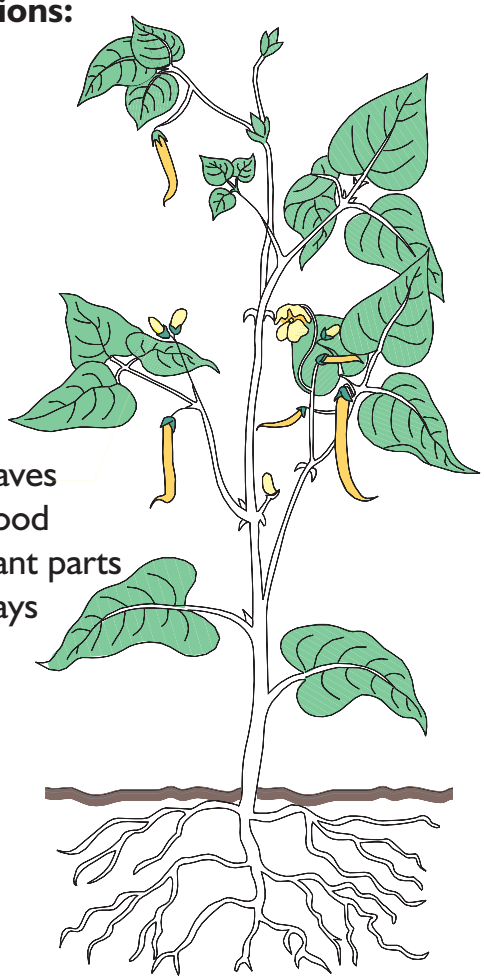
Plant Cell

TM: C2–2B

FUNCTIONS OF LEAVES, STEMS, ROOTS, AND FLOWERS

Female Flower Functions:
Reproduction
Anchor plant
Store food in
seeds and fruits

Male Flower Function:
Pollination



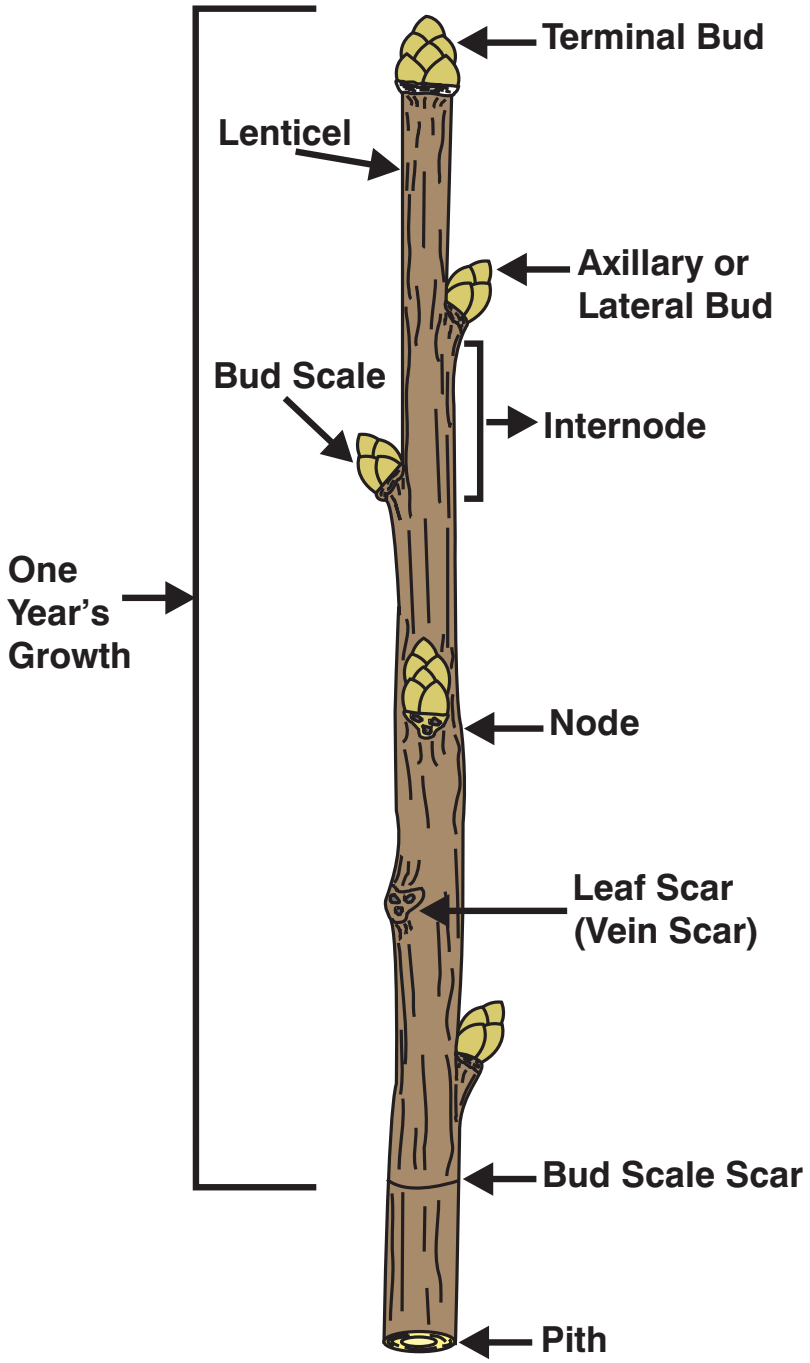
Leaf Functions:
Photosynthesis
Transpiration
Food storage
in some crops—
lettuce, cabbage, etc.

Stem Functions:
Conducts water and
minerals from soil to leaves
Conducts manufactured food
from leaves to other plant parts
Produces leaves and displays
them to light
Supports leaves,
flowers and fruit
Stores food reserves
in some plants—
potato, asparagus,
cabbage hearts, etc.

Root Functions:
Absorb water
and minerals
Anchor plant
Store food reserves
in some crops—
carrots, beets, etc.

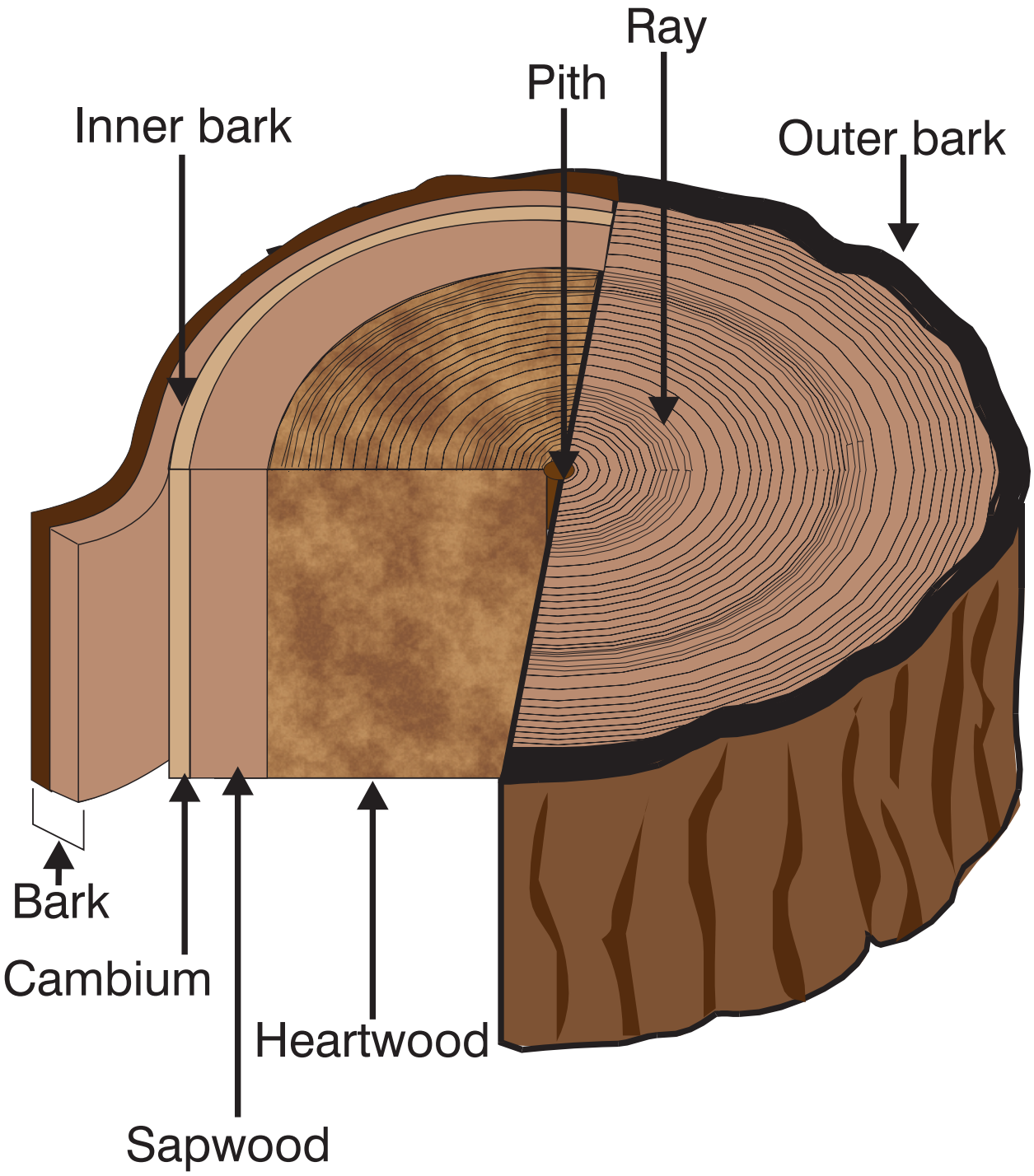
TM: C2–2C

PARTS OF A TYPICAL STEM



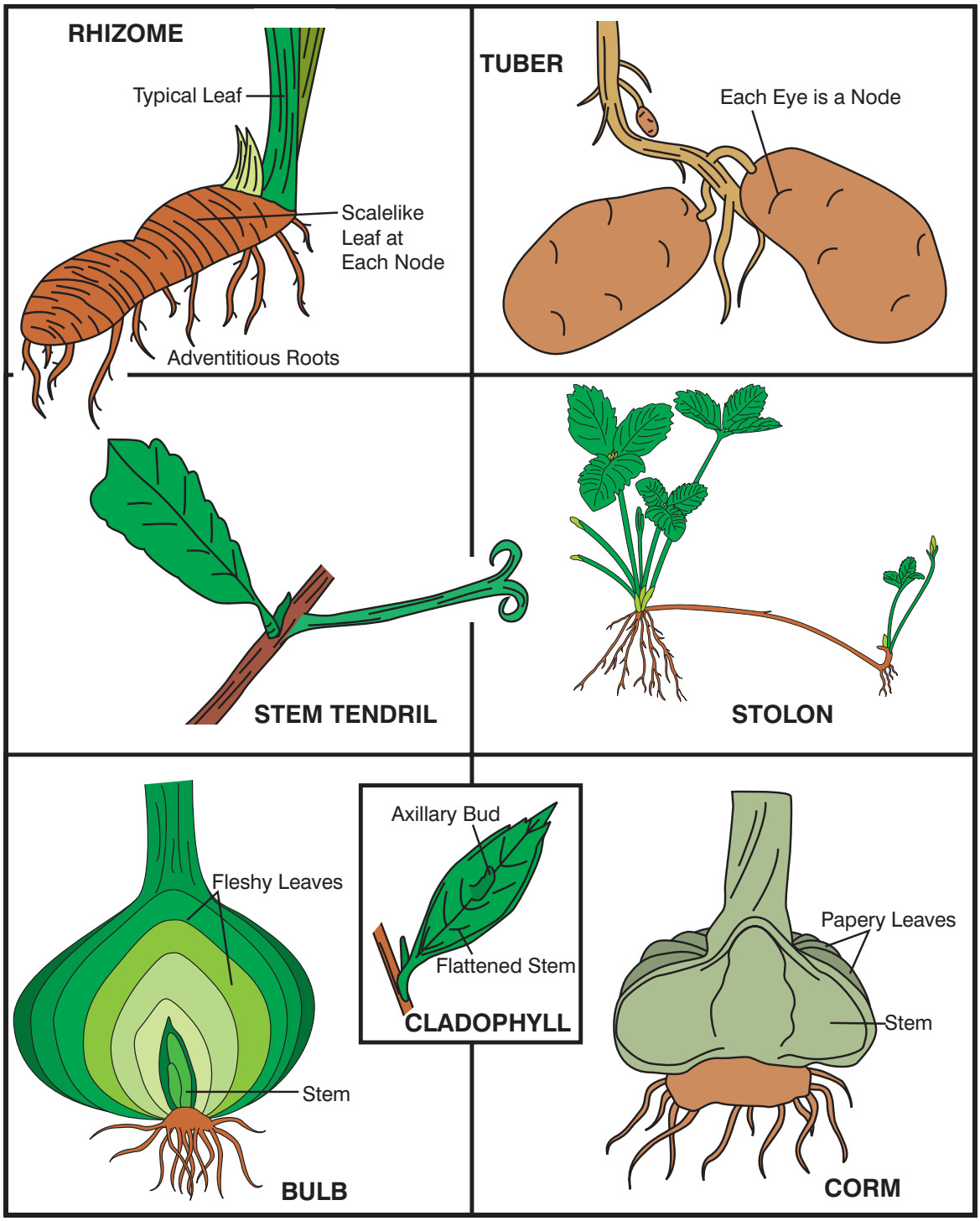
TM: C2–2D

CROSS SECTION OF A TREE



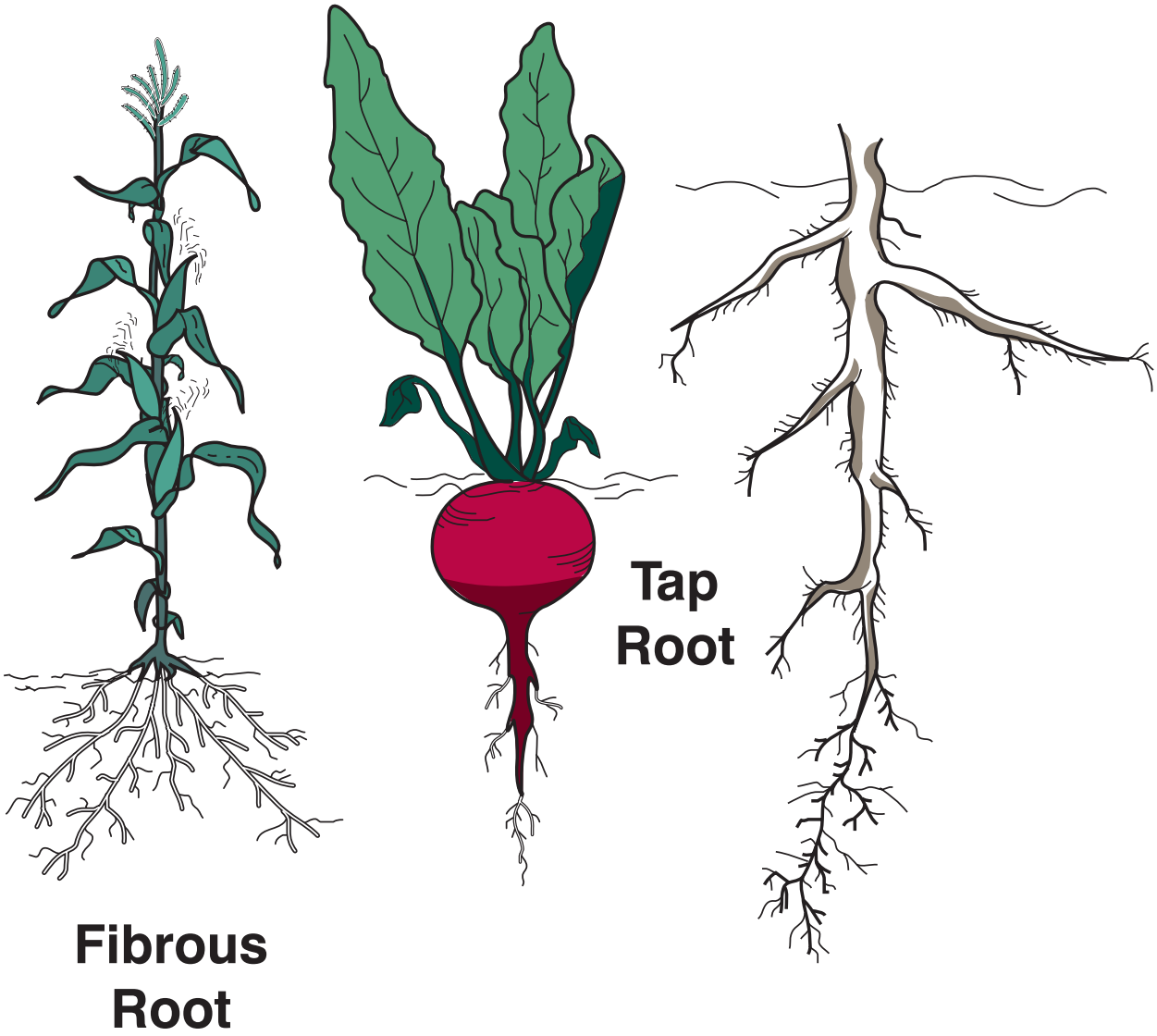
TM: C2–2E

SPECIALIZED STEMS

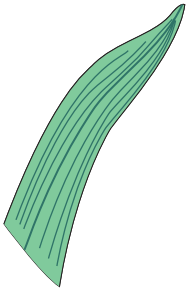


TM: C2–2F

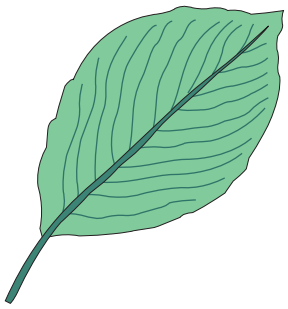
KINDS OF ROOTS



Leaf Venation Patterns



Parallel Venation

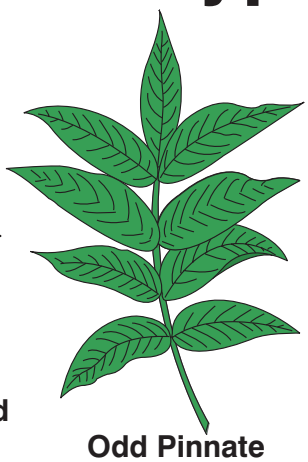


Pinnate Venation

Palmate Venation

Leaf Types

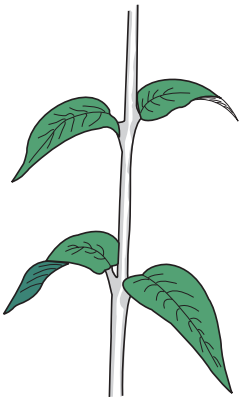
Palmately Compound



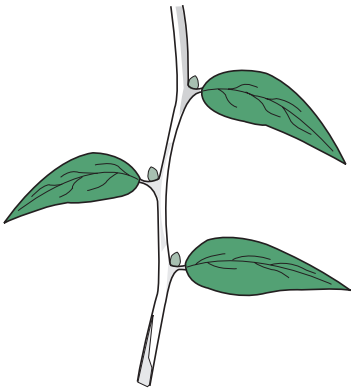
Odd Pinnate

Even Pinnate

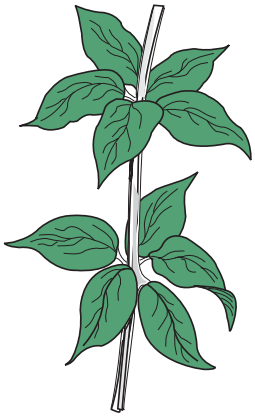
Leaf Arrangements



Opposite



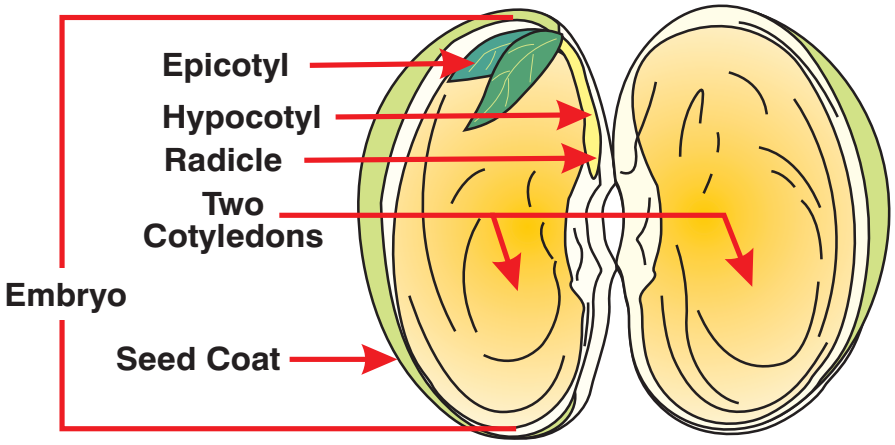
Alternate



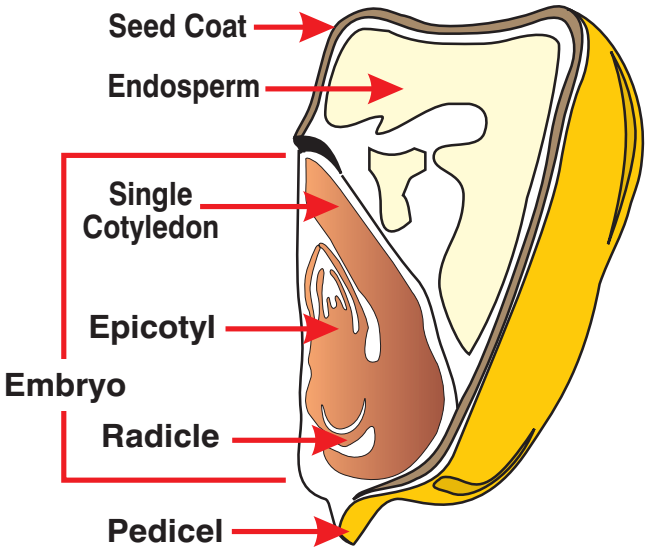
Whorled

TM: C2–2H

COMPARISON OF MONOCOT AND DICOT SEED

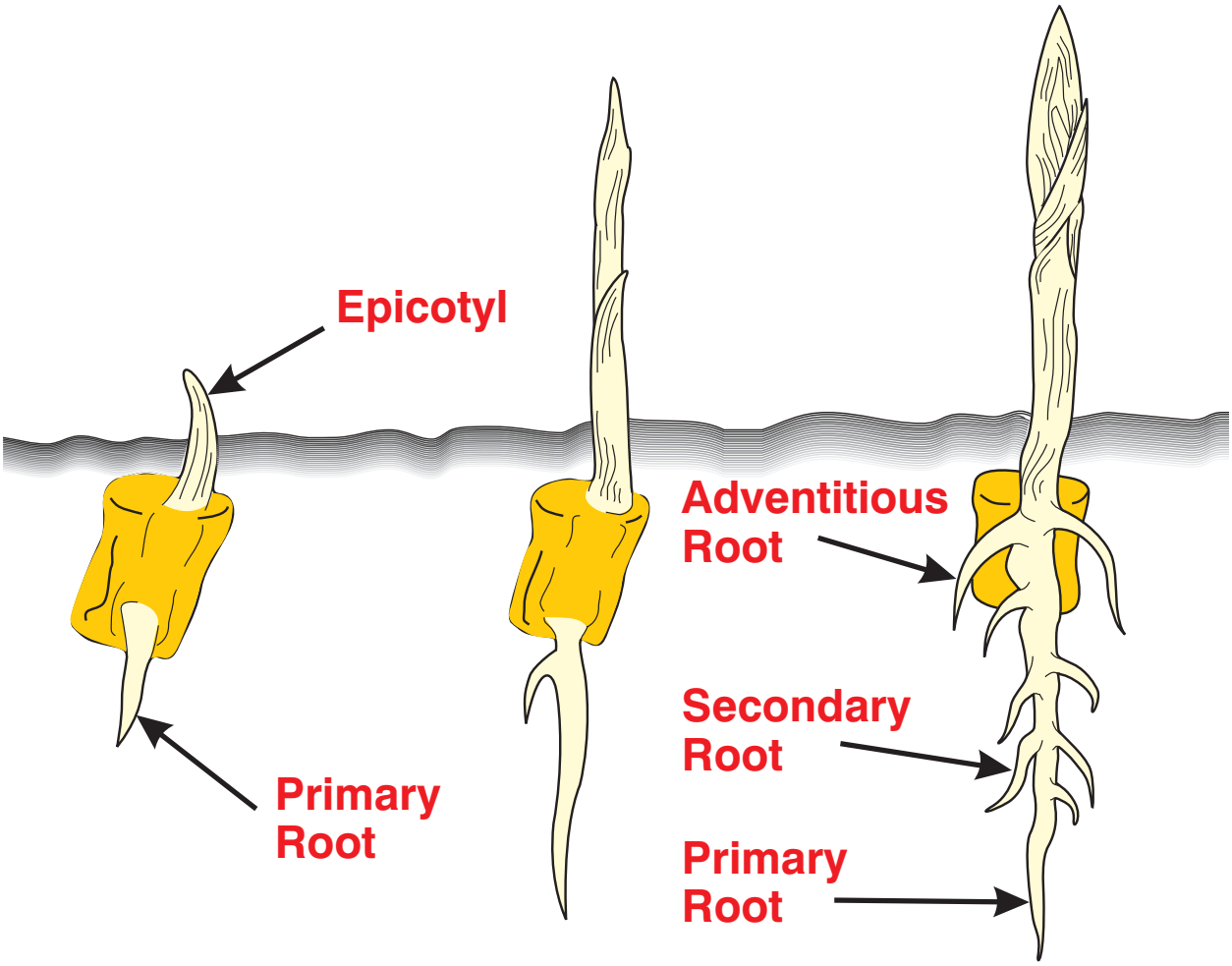


BEAN SEED



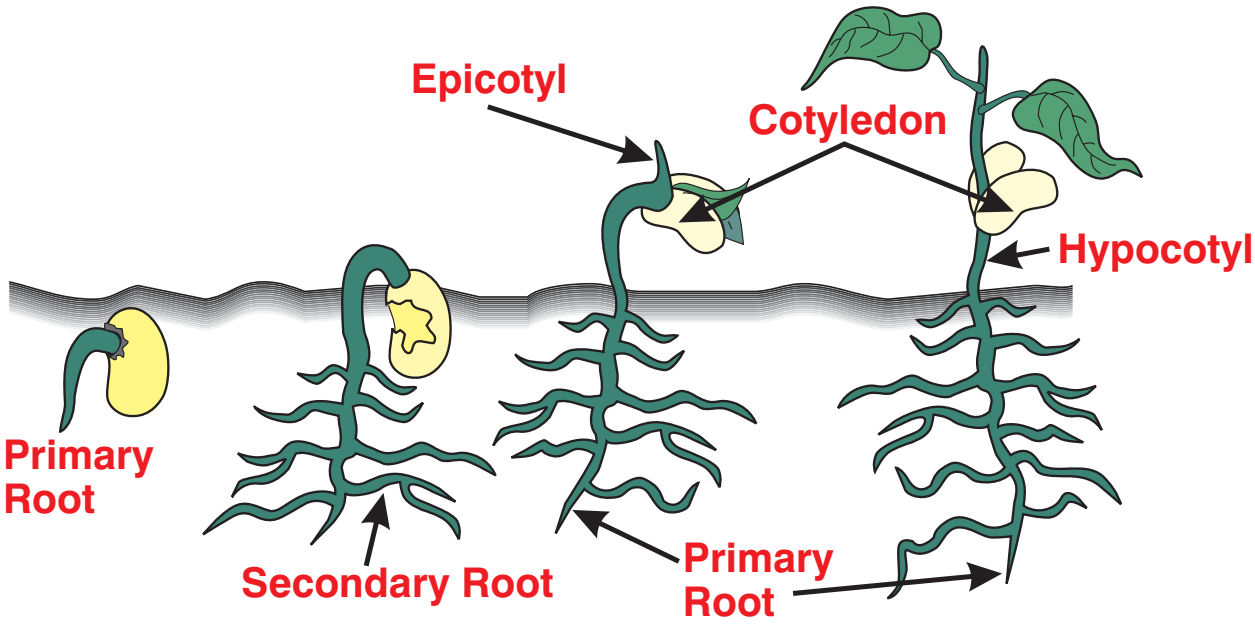
CORN SEED

CORN


Epicotyl
Primary Root
Adventitious Root
Secondary Root
Primary Root

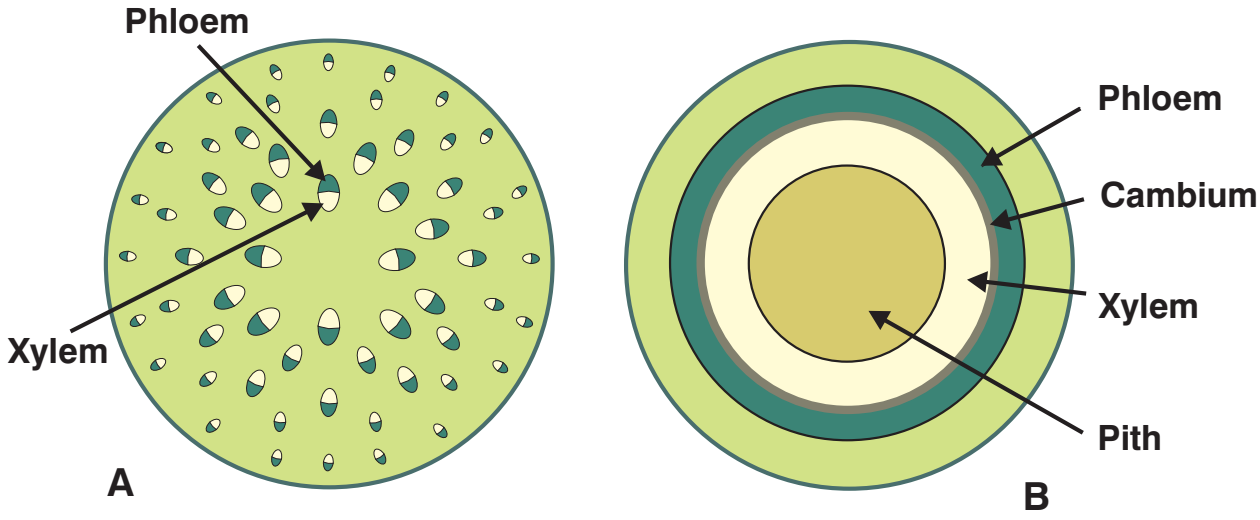
TM: C2–2J

BEAN

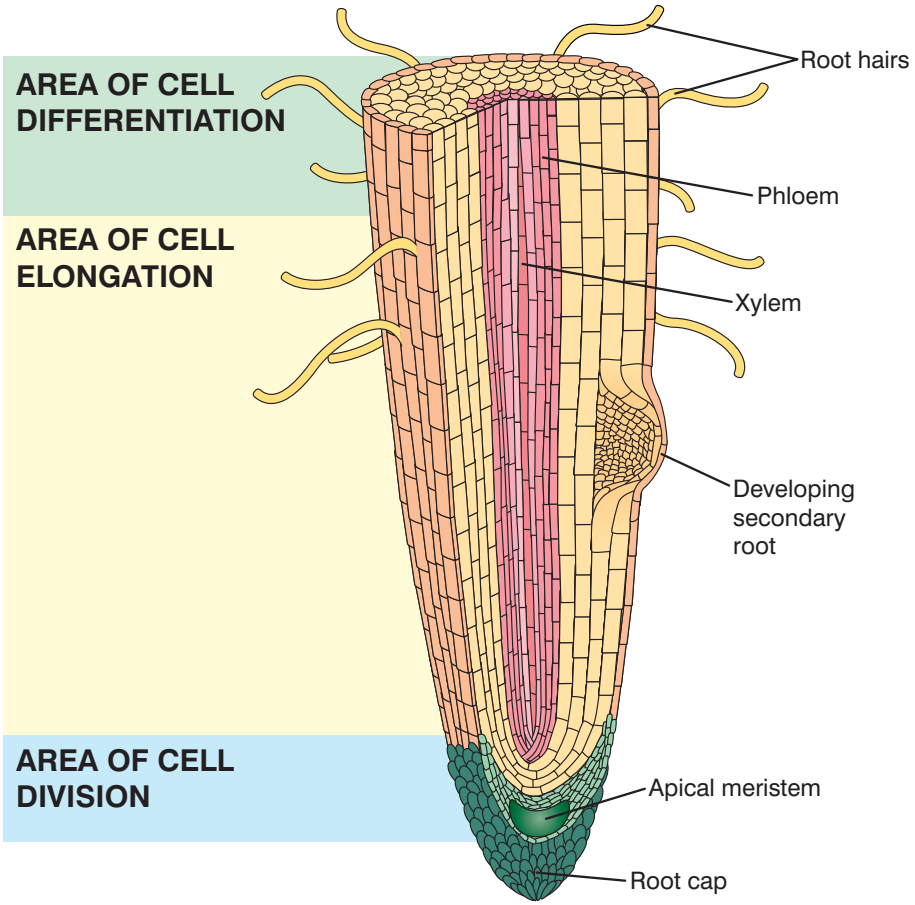

Epicotyl
Cotyledon
Hypocotyl
Primary Root
Secondary Root
Primary Root

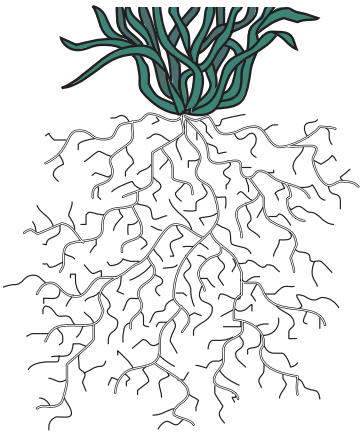
TM: C2–2K

ARRANGEMENT OF TISSUES IN STEMS

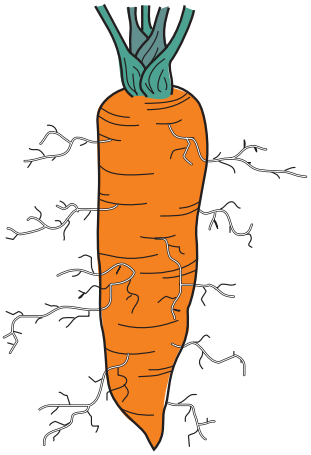


ROOTS





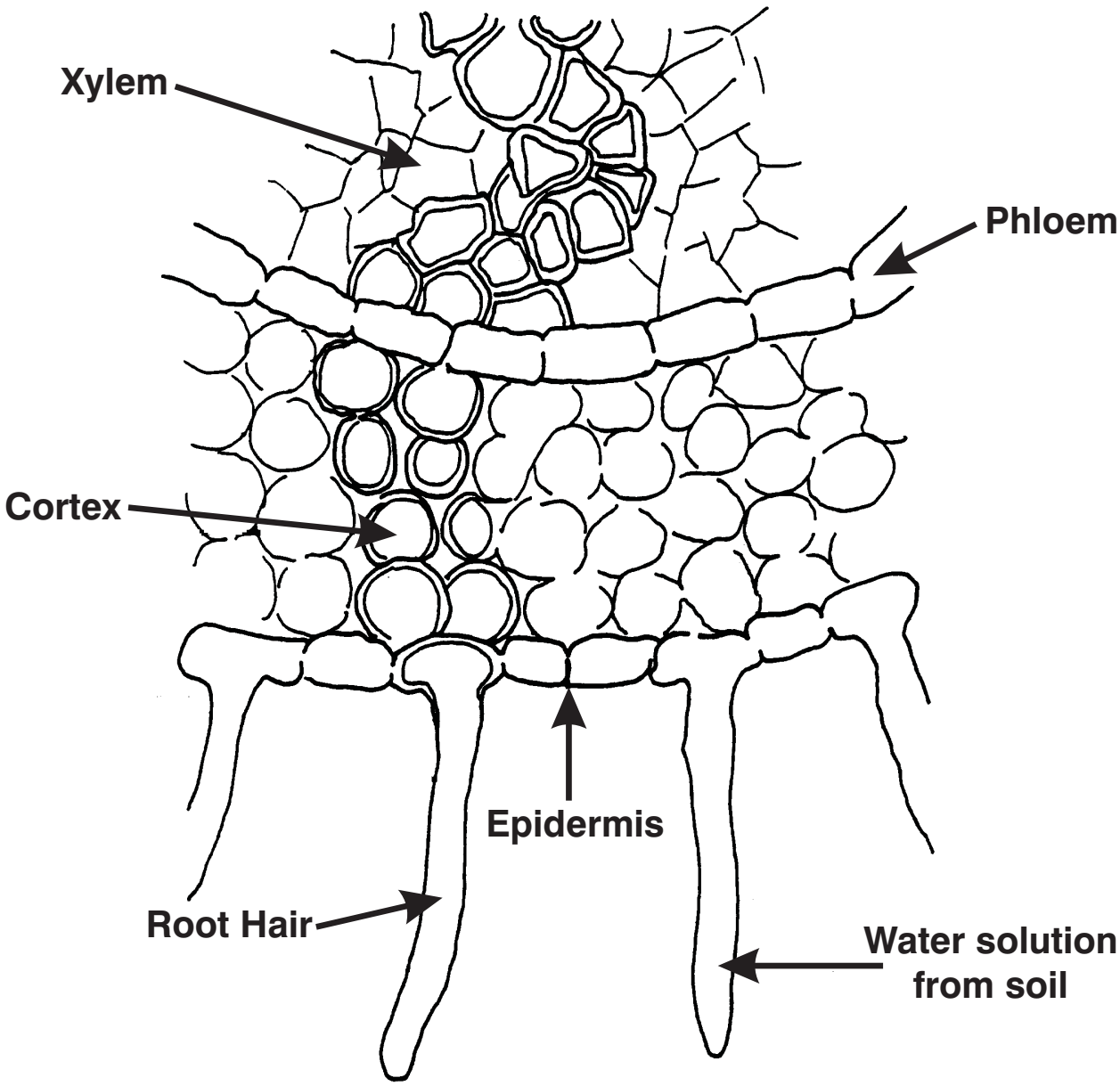
Fibrous Root (turfgrass)



Taproot (carrot)

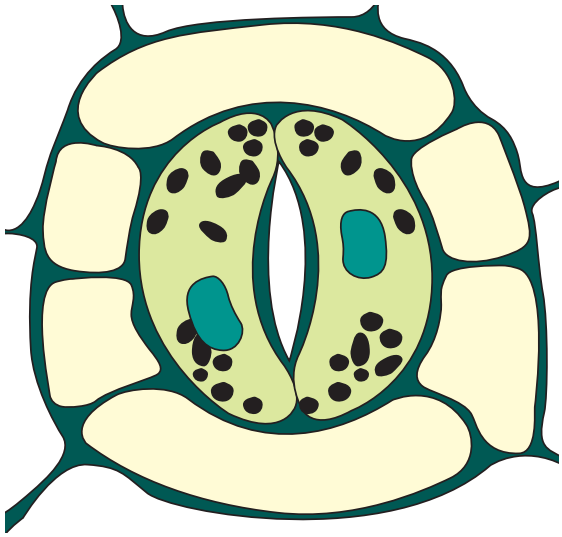
TM: C2–2M

ABSORPTION

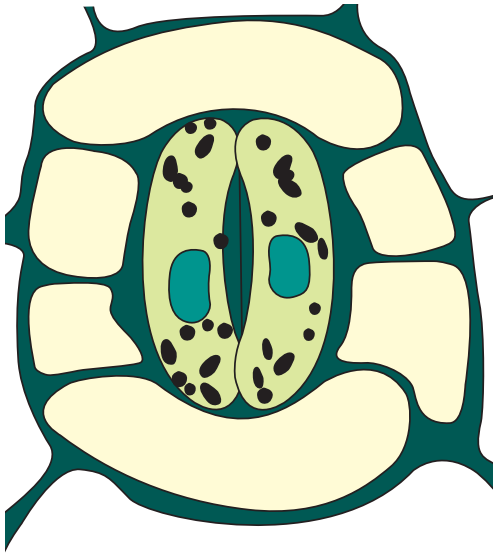


TM: C2–2N

STOMATA



Stoma Open



Stoma Closed

Name _____

Lab Sheet

Monocot and Dicot Plant Tissues

Purpose:

The purpose of this activity is to discover the specialized tissues in plant stems. (Note: This activity can be carried out by individuals or in pairs.)

Objectives:

1. To locate the two vascular and the other four specialized tissues, given monocot and dicot plant specimens.
2. To describe the functions of these specialized tissues.

Materials: (These are materials needed for individuals or pairs.)

1. One large carrot or small woody branch (one that can be cut with a knife)
2. One corn stalk or picture of the cross section of a corn stalk
3. One sharp knife

Procedure:

1. Carefully cut the carrot or branch straight across with the knife.
2. Carefully cut the corn stalk straight across with the knife.
3. Study the freshly cut cross section. Identify the vascular tissues.
4. Draw cross sections of the two stems in the space below. Label the major parts.

Questions:

1. Which plant has annual rings?

2. How many cotyledons does a dicot have?

3. What two kinds of vascular tissues did you see? How do the functions of the two differ?

Name_____

Lab Sheet

Measuring Water Loss from Transpiration

Purpose:

The purpose of this activity is to discover the amount of water a plant loses by transpiration. (This activity can be carried out by groups of two to four students working together.)

Objectives:

1. To use a technique to collect water that is transpired by plants.
2. To measure the amount of water that is transpired.

Materials: (These are the materials needed for each group of students.)

1. A rapidly growing plant in a pot, bucket, or other container, or a plant growing in a convenient location.
2. Plastic bag or sheet of clear plastic that will cover the plant or a branch of the plant containing 10 to 12 leaves.
3. String, rubber bands, or other suitable tie materials to hold the plastic in place over the plant.
4. Stake to support the weight of the plastic.
5. Plastic straw or other suitable tubing for a drain.
6. Graduated beaker or measuring cup.

Procedure:

1. Be sure the plant is well watered.
2. Cover the entire vegetative portion of the plant with plastic material.
3. Locate tubing at bottom of plastic covering to serve as a drain.
4. Place plant in sunny location for an entire day to promote transpiration.
5. Collect and measure the water that is transpired during daylight hours; record the measurement; and empty the beaker.
6. Collect and measure the water that is transpired during dark hours (night); record the measurement, and empty the beaker.
7. Compare differences in the amount of transpired water that is collected.

Questions:

1. Which period (day or night) produced the most water in the container? Why?

2. Does temperature have an effect on transpiration? Does light? Does air humidity?