

## The 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**.

### Root Systems

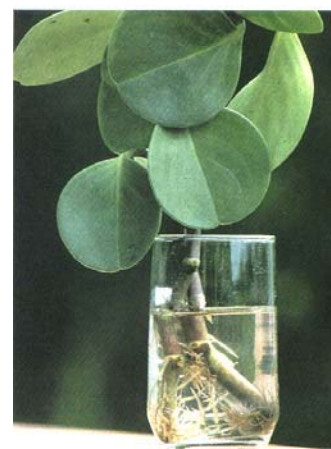
While examining the tap and fibrous roots provided, attempt to relate the root system structure to its functions of anchorage, absorption, storage, and conduction. Examine too, the stem cuttings available. Roots arising from stem cuttings are also adventitious. Cuttings are one way that plants have of vegetative propagation.



Taproot system



Fibrous root system

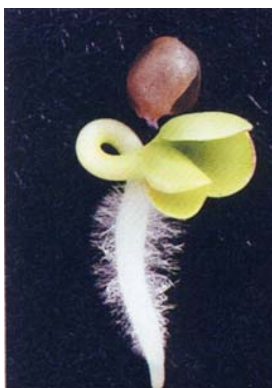


Adventitious roots

### Root Structure

#### 1. The Root Tip

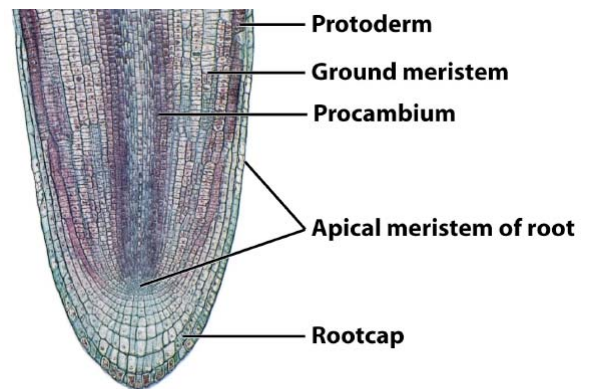
Examine a living radish seedling. Identify the root cap and the many root hairs. What is the function of root hairs? What function does the root cap have? The root tip is coated with a mucigel, or slimy layer, which lubricates the root as it grows through the soil.



Radish seedling



Root tip with root hairs



Root tip

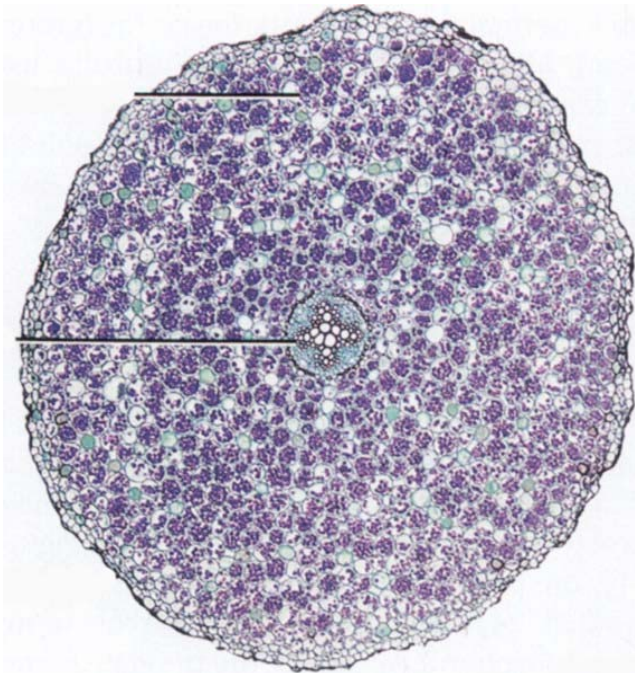
Examine a prepared slide of onion or lily root tip. Locate the meristem initials as well as the three derivative meristems: protoderm, ground meristem and procambium. What tissues are formed from each of these meristems? In addition to the region of cell division, find the region of elongation, and, if possible, the region of maturation.

## 2. Dicot Root Structure

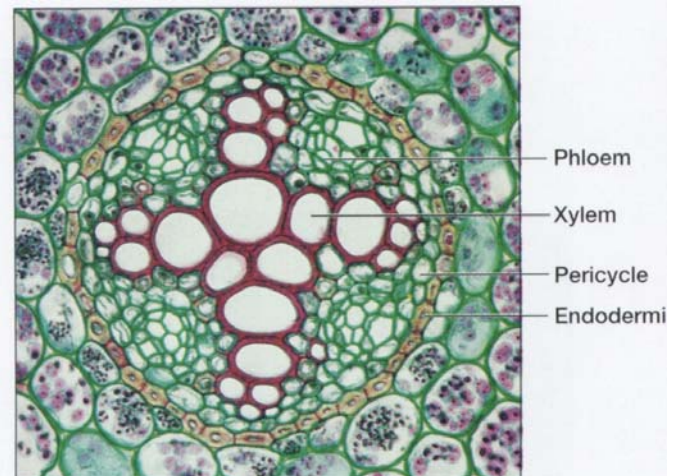
Obtain a prepared slide of a cross section of *Ranunculus* root. Ideally, you will observe both a young root slide and a mature root slide. Note the wide cortex and narrow vascular cylinder, or stele.

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. Do you see evidence of the casparian strip that surrounds the cell walls of the endodermis in mature roots? Compare the endodermis layer in the young root with that of the mature root.
- The layer of thin-walled **pericycle** cells, which forms the outer layer of the vascular cylinder (the **stele**)
- **Xylem**, consisting of three or four radiating (2 – 5) ridges of thick-walled cells
- Strands of **phloem** alternating with the ridges of the xylem



Ranunculus root, xs



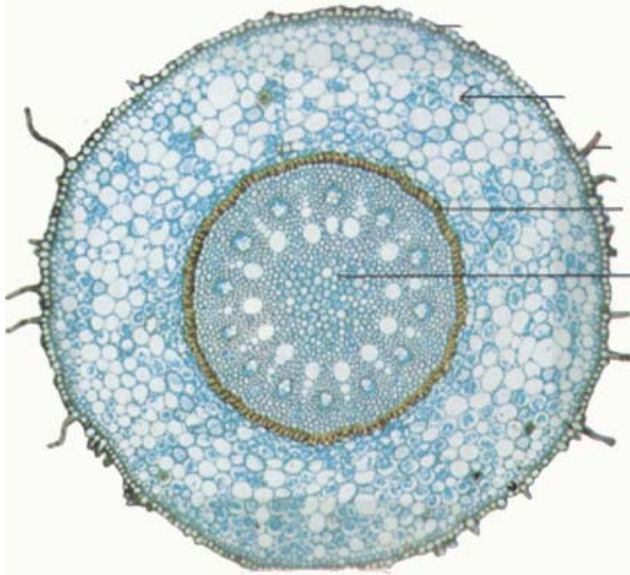
Ranunculus root stele

## 3. Monocot Root Structure

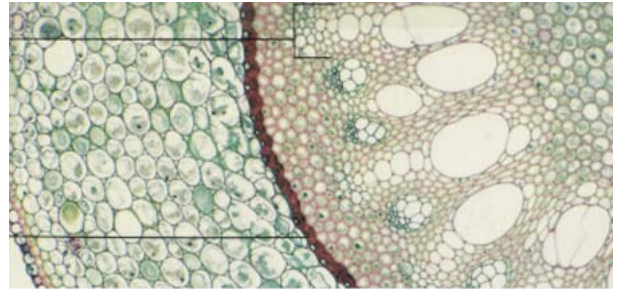
Obtain a prepared slide containing cross sections of mature *Zea* (corn) or of *Smilax* root. Examine the slide with low power and note the relative size of the cortex and the vascular cylinder. Unlike dicot roots, roots of monocots contain a central **pith** region interior to the vascular cylinder.

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**



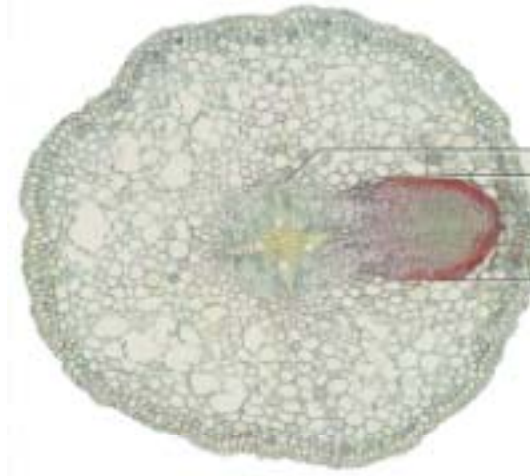
Monocot Root Cross Section



Monocot cortex and stele with pith

**4. Lateral Root Origin**

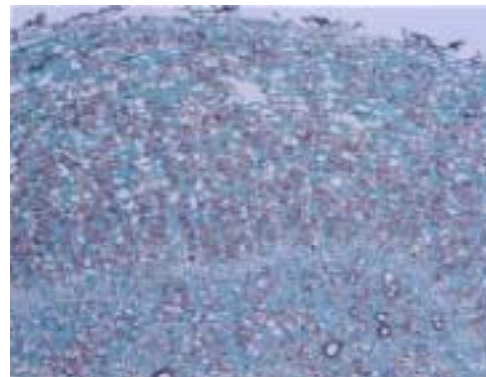
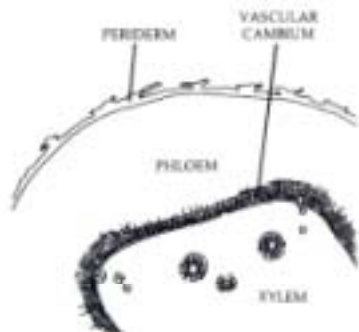
Observe the slide of lateral root origin. From which region in the root do lateral roots originate?



Lateral root origin in *Salix*

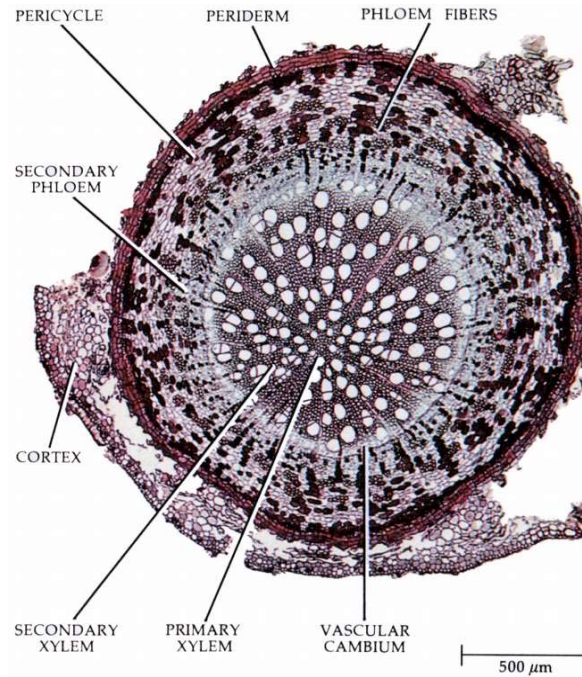
**5. Storage Roots**

Make a slide of a very thin section of a carrot root. Stain the slide with iodine and observe the slide with the high power objective of the microscope. Look for evidence of starch and evidence of xylem vessels. What tissue is modified for food storage in the carrot?



6. **Woody Roots**

Observe demonstration materials and/or prepared slides of woody roots that are available.



7. **Specialized Roots**

Observe the demonstration materials and/or prepared slides of root adaptations available.



Buttress Roots



Bald Cypress knees



Prop roots



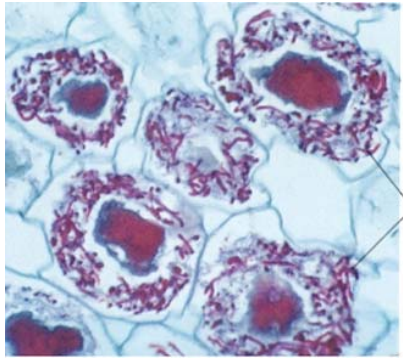
Water storage root



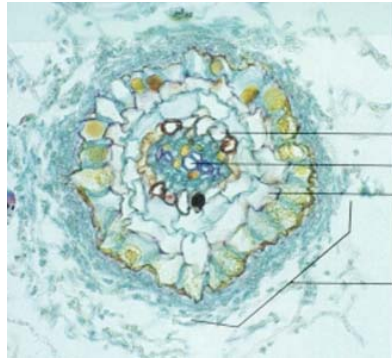
Clinging Roots

**8. Mycorrhizae**

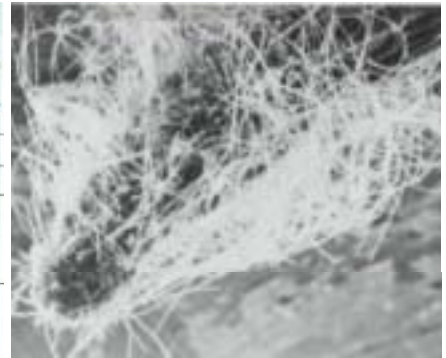
The majority of vascular plants form root associations with fungi to increase their absorption of mineral nutrients. Fungi, which live by absorbing nutrients from their surroundings, are ideal organisms to make these associations. There are both endomycorrhizae and ectomycorrhizae. Endomycorrhizae penetrate cells of the root cortex with their hyphae (the threadlike cells of a fungus); some just are found in the cortex spaces. Mycorrhizae function as sophisticated root hairs; plants that associate with ectomycorrhizae often do not produce root hairs. Observe materials available showing mycorrhizae.



Endomycorrhizae



Ectomycorrhizae



Mycorrhizae on pine root



Seedlings with and without mycorrhizae associates

**9. Root Nodules**

Some legumes and a few other plants produce root nodules, which contain bacteria or cyanobacteria that "fix" nitrogen (make nitrogen into a form which is useful as a plant nutrient). When the bacteria enter the root they induce the root to form "tumors", the nodules. The bacteria grow and produce the nitrogen products in the nodules. Later in the spring we can pull up clover and other herbaceous legumes in the area and examine the conspicuous nodules.

