

# Understanding Root Anatomy

**H**OW LONG would you survive if you could not eat or drink? A few days? A week? You probably wouldn't live very long. Remove the roots from a plant, and you would likely see that plant die, unless it was given care needed to grow new roots. Roots are extremely important to plant growth.



## Objective:



Examine plant roots and their functions.

## Key Terms:



aeration	root hairs
apical meristem	roots
available water	secondary roots
epidermis	taproot system
fibrous root system	unavailable water
napiform root	water-holding capacity
primary root	
root cap	

## Roots

**Roots** are the plant organs usually found underground. They are essential to a plant's health. When roots are weak, damaged, or diseased, the whole plant suffers.

The roots carry out important functions for the plant. They absorb water and dissolved minerals. They anchor the plant in the ground and provide support for the aboveground part of the plant. They also store food made through photosynthesis. This food can be used later when the plant needs it to grow or survive.

## ROOT STRUCTURES

When a plant seed germinates, the first structure to emerge from the seed is a root. This first root becomes the **primary root**. The primary root of some plants is the most important root in the whole root system. As the primary root develops, other roots branch out from it. These roots are called **secondary roots**.

At the tip of the root is an area of growth called the **apical meristem**. It is where cells divide. Behind the apical meristem, cells enlarge and differentiate. The apical meristem is easily damaged. A root has a layer of cells called a **root cap** that protects the apical meristem from damage as the root grows through the large and sometimes coarse soil particles. As the root pushes through the soil, cells from the root cap wear off. New cells for the root cap are made in the root apical meristem.

The surface of the root is covered with a skin of cells called the **epidermis**. This epidermis is where the water and minerals enter the root through osmosis and diffusion. Specialized epidermal cells called **root hairs** are located about  $\frac{1}{2}$  inch from the root cap. Each root hair is an individual cell. Root hairs greatly increase the surface area of the root. The larger surface area created by the root hairs improves absorption. In fact, the greatest water absorption occurs through the root hairs. Root hairs live only a few days and never develop into multi-cell roots. Because of their short life, roots need to grow continually.



FIGURE 1. When a plant seed germinates, the first structure to emerge from the seed is a root.

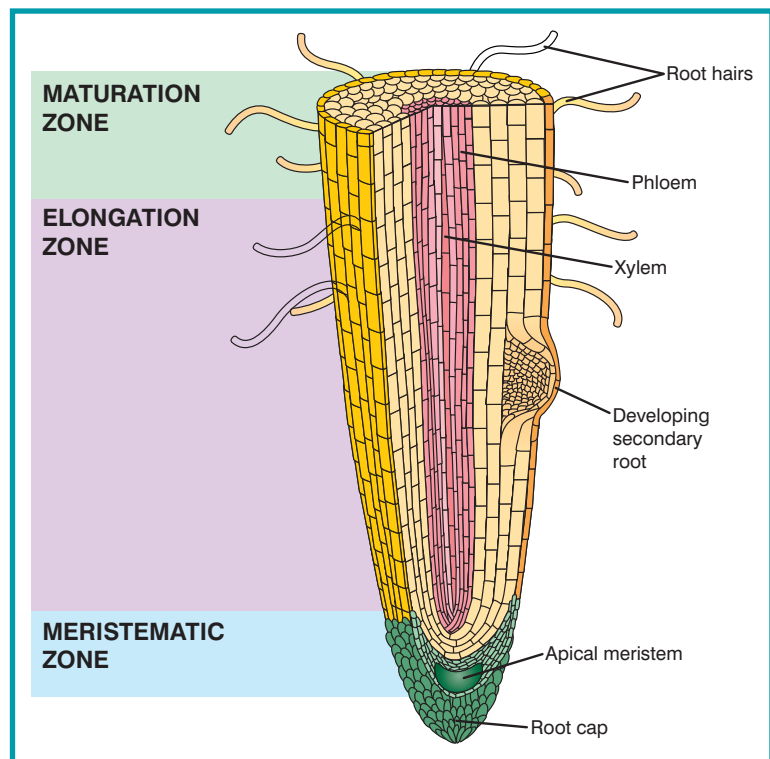


FIGURE 2. A microscopic view of a root tip showing root hairs and the root cap.

## ROOT SYSTEMS

Plant root systems are organized in two basic ways. The two ways have a lot to do with primary and secondary roots.

### Taproot System

A root system composed of one primary root and many secondary roots branching off the primary root is called a **taproot system**. Many dicot plants have taproot systems. A specialized type of taproot is a **napiform root**. Examples of napiform roots are radishes, beets, and carrots.

### Fibrous Root System

A **fibrous root system** is characterized by roots roughly the same size and length. Monocot plants typically have fibrous root systems.

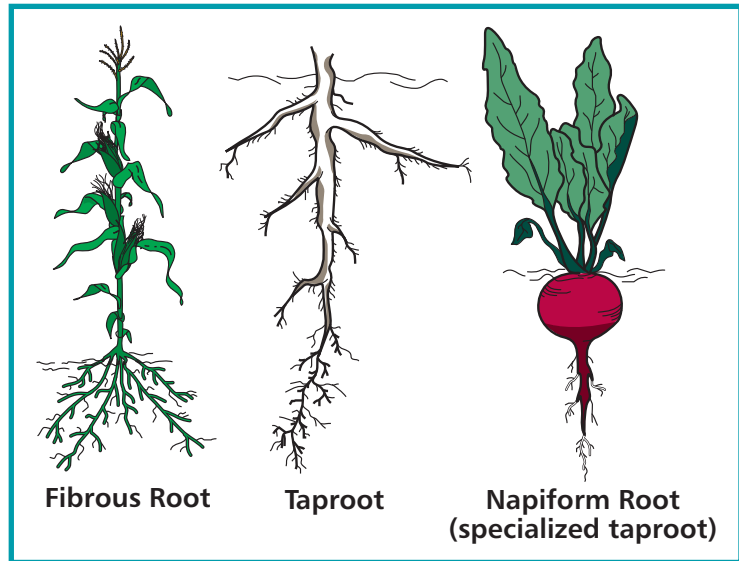


FIGURE 3. A monocot usually has a fibrous root system, and a dicot usually has a taproot or napiform root system.

## ROOT HEALTH

A healthy root system is white or nearly white and smells fresh. Roots in poor health appear black, brown, or dark orange and smell rotten or sour.

### Soil Aeration

A healthy root system is often dependent upon good soil aeration. In fact, the vast majority of a plant's roots can be found growing in the top 2 feet of soil. This is because roots need oxygen for cellular respiration. A good exchange of gases occurs near the surface of the soil.

A high percentage of pores in a soil provides good aeration. **Aeration** is the exchange of gases in the medium. Sandy soils have very good aeration, whereas clay soils have poor aeration. Pore spaces are vital for healthy root growth. Root cells require

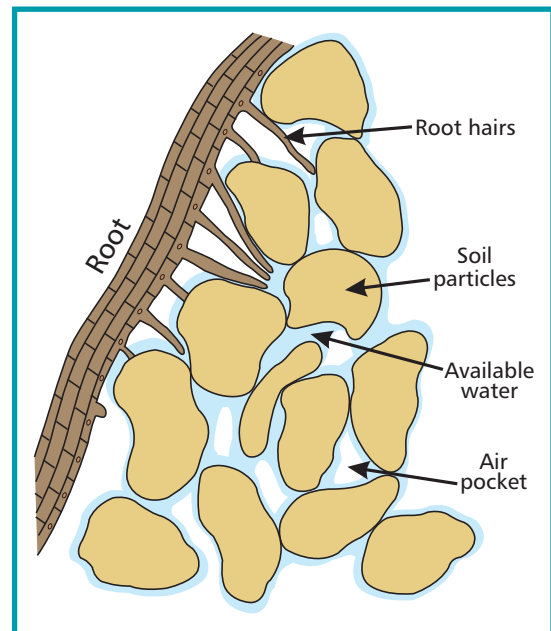


FIGURE 4. A high percentage of pores in a soil provides good aeration.

oxygen from the pore spaces to convert sugars to energy via respiration. A byproduct of this respiration is carbon dioxide. A medium must have sufficient pore spaces to allow an exchange of carbon dioxide and oxygen.

## Soil Moisture

Water is required for healthy plant growth. **Available water** is water that can be absorbed by the plant roots. Available water is found in the pore spaces of the medium. Some water in soil is considered unavailable for plant use. **Unavailable water** is a thin film of water that binds so tightly to the medium's particles that it cannot be used by plants.

The ability of soils to hold water is known as **water-holding capacity**. Sandy soils have low water-holding capacity. Clay soils have high water-holding capacity.

Soils saturated with water have a poor exchange of gases. Soils that stay wet for an extended period, such as during a flood, can cause the death of root tissues by depriving them of oxygen. Extensive root damage often leads to the death of entire plants.

Watering a plant properly is one of the most important ways to keep the root system healthy. In general, when a plant is being watered, the growing medium should be thoroughly soaked and allowed to approach dryness before the plant is watered again.

Usually, proper watering for a potted plant begins with growing the plant in a pot with proper drainage holes in the bottom. The medium should be soaked with water until water is dripping out of the drainage holes. This encourages roots to grow through the entire pot. The plant's soil is usually allowed to dry slightly before watering again. If plants have adequate drainage, overwatering is not a matter of *how much* water is applied but rather *how often* watering occurs.



**FIGURE 5.** Watering a plant properly is one of the most important ways to keep the root system healthy.

## Summary:



Roots are the plant organs usually found underground. They function to absorb water and dissolved minerals, anchor the plant in the ground, and store food made through photosynthesis.

The first structure to emerge from the seed is the primary root. As the primary root develops, secondary roots branch out from it. At the tip of the root is an area of growth called the apical meristem. A root has a layer of cells called a root cap that

protects the apical meristem from damage. Specialized epidermal cells called root hairs greatly increase the surface area of the root.

Plant root systems are organized in two basic ways. A root system composed of one primary root and many secondary roots branching off the primary root is called a taproot system. A fibrous root system is characterized by roots roughly the same size and length.

A healthy root system is white or nearly white and smells fresh. A healthy root system is often dependent upon good soil aeration. Root cells require oxygen from the pore spaces to convert sugars to energy via respiration. Water must be available for healthy roots. Watering a plant properly is one of the most important ways to keep the root system healthy.

### Checking Your Knowledge:

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1. What are the functions of roots?
2. What are the major structures of a root?
3. How do taproot and fibrous root systems differ?
4. What role does soil aeration play in root health?
5. How should plants be watered?

### Expanding Your Knowledge:

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Remove a plant from a pot. Examine the roots. Determine if the root system is healthy. Remove some of the roots and view them through a magnifying glass or microscope. Look for the root hairs.

### Web Links:

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#### Plant Roots

[http://facweb.furman.edu/~lthompson/bgy34/plant anatomy/plant\\_root.htm](http://facweb.furman.edu/~lthompson/bgy34/plant anatomy/plant_root.htm)

#### Roots

<http://extension.oregonstate.edu/mg/botany/roots.html>

#### Agricultural Career Profiles

<http://www.myaert.com/career-profiles>