ROOTS

Background Information

Roots are plant parts that grow downward and, in most cases, anchor land plants in the soil. Roots absorb water and dissolved nutrients and transport these to parts of the plant where they are needed. They do not, generally, produce leaves or buds.

Most plants have roots, but there are some exceptions. The exceptions are bryophytes and the groups of green algae that are classified as plants. Bryophytes have root-like structures called rhizoids for absorbing water, but because rhizoids lack vascular tissue they are not considered roots.

The first root of a plant, called the **primary root**, arises from a part of the seed called the **radicle**, and emerges when the seed **germinates** — when it emerges from its dormant state and begins to grow. As the roots develop, they form one of two types of root systems:

- A taproot system forms when the primary root grows directly down into the soil and becomes the main root, or **taproot**. Smaller roots, known as **secondary roots** or **lateral roots**, branch from the primary root. Most dicotyledons such as beans, carrots, and oak trees have taproots.

- A fibrous root system forms when the primary root is replaced by a number of roots, all of similar thickness. These roots look like a mass of fibers growing into the soil in all directions. Monocotyledons such as grasses and corn have fibrous roots.

Taproot

Fibrous root

Did you know?

If a gardener wishes to move a plant from one part of a garden to another, it is important that he or she first establishes which type of root system the plant has — a taproot or a fibrous root system. Plants with fibrous roots transplant fairly easily as they have many roots and, if some are damaged, they can rely on others to absorb water and nutrients. Plants with taproots are far more difficult to transplant because they rely solely on one root and that root often penetrates deep into the ground, making it very difficult to remove without severely damaging it. Moving even a young oak tree, for example, can be challenging, as a 6 ft (1.8 m) tree may have a taproot of almost the same length.

The main functions of most roots are:

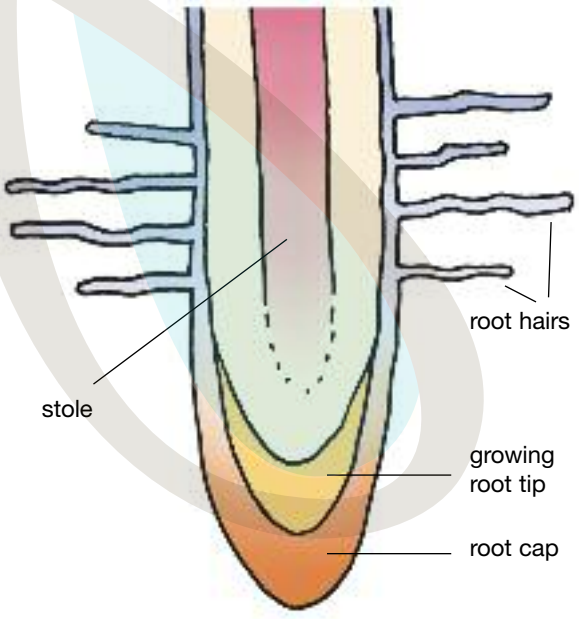
- to absorb water and dissolved nutrients from the soil
- to transport water and dissolved nutrients to other parts of the plant
- to anchor the plant so that it does not fall over

The structure of a root is, like all things in nature, related to its function. This means roots must have a structure suitable for absorbing moisture and they must grow continuously. Through growing, roots not only anchor the increasingly heavy plant in more soil, but also reach new supplies of nutrients or moisture when the area surrounding them becomes dry or depleted of nutrients.

The part of the root associated with growth is the root tip, and this is covered and protected by the **root cap**, which is made of tiny cells that are constantly rubbed off and replaced as the root penetrates new areas of soil. Scientists have shown that, apart from protecting the root tip, these cells play an important role in causing roots to grow downward.

The parts of the root associated with absorbing water and dissolved nutrients are the **root hairs**, tiny hair-like outgrowths that grow from the outer surface of the root behind the root cap. Root hairs dramatically increase the surface area of the root, creating a large area for absorbing water and nutrients from the soil. Inside the root is a core of vascular tissue called the **stele**, that helps transport water and dissolved nutrients from the roots to other parts of the plant.

Structure of a root tip



Roots anchor plants in soil by growing between the soil particles and pressing outward. As the upper parts of the plant grow, so the roots grow to compensate for the increasing height and weight of the above-ground plant. Roots do this effectively when the soil has structure and strength, but they are less effective when the soil is either waterlogged or very sandy, which explains why trees in these types of soil can sometimes blow over in heavy winds. Even the roots of floating aquatic plants function to keep the plants upright by hanging downward, stabilizing the plants in the water, so the leaves face up toward the light.

In addition to anchoring plants and absorbing water and nutrients, some plants have special roots modified to perform functions such as storing food and water, breathing, or adding extra support to the plant. Each of these functions is an **adaptation**, a development that helps organisms survive in the environment where they live.

Storage roots are modified for storing food or water, a modification that allows a plant such as a carrot or a beet to survive dormant periods. Storage roots may be one of three shapes:

- conical, or cone shaped e.g., carrots and parsnips
- **napiform**, meaning they are broader than they are long e.g., turnip
- **fusiform**, meaning they are swollen in the middle and tapered at both ends e.g., white radishes

Tuberous roots are also storage roots, but unlike carrots and beets where the whole root is modified for storage, tuberous roots involve the swelling of only part of the root. Sweet potatoes are an example of a plant with a fibrous root system that produces tuberous storage roots. (Note: potatoes are modified stems, not roots, because potatoes produce buds.)

Conical root

Napiform root

Self-testing review sheet: Modified roots

The following example shows part of a self-testing sheet teachers can create for students to review modified roots.

Student name: _____ Date: _____

1. Cover the right-hand column before you start.
2. Complete each of the sentences in the left-hand column by writing the missing words in the spaces provided.
3. Uncover the right-hand column to check your answers.

Modified roots are roots that have _____ to perform special functions.	adapted
Conical, napiform, and fusiform are names of modified _____ that function as _____ roots.	taproots, storage
Roots such as the white radish that are swollen in the middle and tapered at both ends are called _____ roots.	napiform
Sweet potatoes are an example of a _____ storage root, where only part of the root is modified for storage.	tuberous
Pneumatophores are roots modified for _____ . They are found on plants such as mangroves that grow in _____ soil.	breathing, waterlogged (or wet)
Aerial roots are roots that arise _____ the ground.	above
Adventitious roots are roots that do not arise from the _____ root, but from stem or leaf tissue.	primary
Epiphytic plants such as orchids grow on other plants, but do not _____ them. Orchids have unbranched _____ roots that hang down toward the ground and absorb moisture from the _____ .	harm, aerial, atmosphere (or air)

ACTIVITY 1

Examining Root Systems and Functions

Purpose

To examine fibrous and taproot systems and to understand the basic functions of roots.

Material

One tray of bean seedlings.

One tray of corn seedlings.

Magnifying glass.

Bucket filled two thirds with tepid water.

Unprinted newspaper or absorbent towel.

Plastic forks.

Photographs or diagrams of fibrous root and taproot systems.

Diagram, Structure of a root tip.

Books and pictures of roots.

Self-testing review sheet: Roots.

Botany journals and pencils.

Presentation

- Most Montessori teachers present this concept in Years 4 and 5.
- This activity is divided into parts and can be presented over several days.
- Announce to the students that in this activity they will have the opportunity to show that roots absorb moisture from the soil and to examine the roots of bean and corn plants. They will examine special types of roots in the next activity.

PART 1: DISCUSSING THE STRUCTURE AND FUNCTION OF ROOTS

- Review the main characteristics of roots and explain why the rhizoids of bryophytes are not classified as roots.
- Describe how roots develop. Begin with the germinating seed, and explain how taproot systems and fibrous root systems develop. Use photographs or diagrams to illustrate the difference between the two systems.

- Ask the students if they can name the three basic functions of roots: absorbing water and dissolved nutrients, transporting water and nutrients to other parts of the plant, and anchoring the plant (or stabilizing aquatic plants). Discuss these functions.

- With the students, examine the diagram, Structure of a root tip, and the diagrams or photographs of the root systems. Discuss how the structure of the whole root system and of individual roots helps roots perform their basic functions.

- Ask the students to use their journals to draw a diagram of the structure of a root tip and to list the basic functions of roots.

PART 2: EXAMINING A FIBROUS ROOT SYSTEM AND A TAPROOT SYSTEM

- Place the two trays of seedlings, beans and corn, on the table facing the students.

- Demonstrate using a plastic fork to carefully remove one plant from each tray without damaging the roots.

- Place the plants on a piece of paper, and take the paper and plants to the bucket of water.

- Carefully pick up one plant, and rinse the roots in the bucket to remove the soil. Do not rub the roots. Replace the plant on the paper to drain.

- Ask the students to work in pairs, and give each pair a piece of paper for supporting and draining the roots. Ask them to take turns to remove one plant from each tray, beans and corn, and to rinse the roots.

- When all the pairs have two seedlings, ask the students to examine and compare the root systems of the two plants. Suggest the students use the magnifying glass to examine the root tips. Can they see the root hairs?

- Ask the students to use their journals to create a table with two columns, one labeled Bean Roots and the other labeled Corn Roots. In each column, ask the students to write notes about their observations of the two root systems.

- Ask the students to draw labeled diagrams of the two seedlings showing the differences in the root systems.

- Demonstrate the resource material and the self-testing review sheet. Encourage the students to complete a review sheet.

- Ask the students to use their journals to write two or three paragraphs explaining how the structure of root systems and of roots helps roots perform their three main functions.