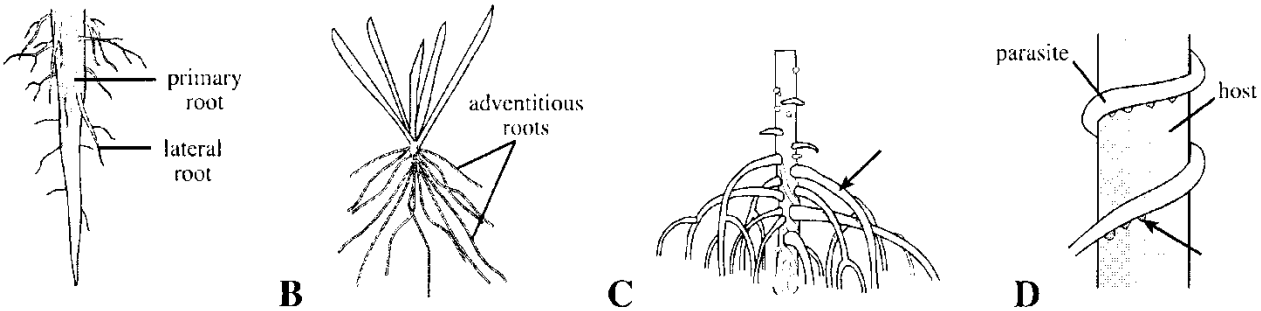
ROOT TYPES

Various modifications of roots have evolved. If the primary root becomes dominant, it is called a **tap root**, and the plant is described as having a **tap root system**. If the primary root soon withers and subsequent roots are **adventitious**, the plant has a **fibrous root system**. Several plant species, particularly those that are biennials, have **storage roots** in which the tap root has become greatly thickened, accumulating reservoirs of high-energy storage compounds (usually starch). Many plants that are epiphytic (grow on another plant), particularly tropical members of the monocot families Araceae and Orchidaceae, have **aerial roots**. These are adventitious roots that generally do not enter the soil and may absorb water and minerals from the air.

Many plant species with bulbs or corms have **contractile roots**, roots that actually contract vertically, functioning to pull the rootstock further into the soil. Parasitic plants have specialized roots called **haustoria** that penetrate the tissues of a host plant. Some adventitious roots called **prop roots** grow from the base of the stem and function to further support the plant.

Some plant species that grow in swamps or marshes have **pneumatophores**, roots that grow upwardly from soil to air that function to obtain additional oxygen. **Buttress roots** are enlarged, horizontally spreading and



often vertically thickened roots at the base of trees that aid in mechanical support; they are found in certain tropical or marsh/swamp tree species.

Storage roots; *Raphanus sativus*, radish

Buttress roots; *Ficus rubiginosa*

Pneumatophores; *Avicennia germinans*, black mangrove.

STEMS AND SHOOTS

Stems function both as supportive organs (supporting and usually elevating leaves and reproductive organs) and as conductive organs (conducting both water/minerals and sugars through the vascular tissue between leaves, roots, and reproductive organs). As mentioned earlier, a **shoot** is a stem plus it's

associated leaves. Sporophytic shoots that are branched and bear leaves are an apomorphy for all vascular plants; the leafy shoot like structures of mosses and some liverworts are gametophytic and not directly homologous with shoots of vascular plants.

The first shoot of a seed plant develops from the **epicotyl** of the embryo. The epicotyl elongates after embryo growth into an axis (the stem) that bears leaves from its tip, which contains the actively dividing cells of the shoot **apical meristem**. Further cell divisions and growth results in the formation of a mass of tissue that develops into the immature leaf, called a **leaf primordium**.

The point of attachment of a leaf to a stem is called the **node**. The region between two adjacent nodes is the **internode**. The tissue at the upper (adaxial) junction of leaf and stem (called the **axil**) begins to divide and differentiate into a **bud primordium**. As the shoot matures, the leaves fully differentiate into an amazing variety of forms. The bud primordium matures into a **bud**, defined as an immature shoot system, often surrounded by protective scale leaves. Buds have an architecture identical to the original shoot. They may develop into a lateral branch or may terminate by developing into a flower or inflorescence.

Vascular strands run between stem and leaf, providing a vascular connection, composed of xylem and phloem, for water, mineral, and sugar transport. The vascular strands of leaves are termed **veins**. The mostly parenchymatous tissue external to the vascular (conductive) tissue of a stem is termed the **cortex**. The **pith** is the central, mostly parenchymatous tissue. In monocots, in which there are numerous, scattered vascular bundles (an atactostele), the intervening parenchymatous tissue is termed **ground meristem**.

The stems of some vascular plants, notably the conifers and non-monocot flowering plants, contain **wood**, which technically is secondary xylem tissue, derived from a vascular cambium. In these woody plants **bark** refers to all the tissues external to the vascular cambium, consisting of secondary phloem (inner

bark), leftover cortex, and derivatives of the cork cambium (the last comprising the outer bark, or periderm.