

## Soil Biology

The soil is teeming with life. Soil microbes range from microscopic bacteria to macroscopic earthworms and microarthropods. Some soil scientists say that there are more species of organisms in a shovel full of garden soil than can be found above ground in the entire Amazon rain forest (NRCS).

### Good Nitrogen-fixing plants for the garden:

- Red Clover
- Beans & Peas
- Lupines
- Siberian Pea Shrub
- Groundnut
- Blue Wild Indigo
- Vetch
- Alfalfa

**Bacteria** are the most abundant cells in the soil. They can occur singly or join together in groups. The bacteria (as well as other organisms) in the soil are responsible for the decomposition of residues. They secrete enzymes that break down molecules such as sugars and starches into basic chemical components like carbon and nitrogen, which the bacteria can use for energy. If the nutrients are not needed by the bacteria (or other degrading organisms) then they are released into the soil and become available for plant uptake.

Other types of bacteria such as rhizobia form specific associations with plants (e.g. legumes). The symbiotic relationship results in the formation of nodules by the plant. These bacteria fix nitrogen from the air and convert it to ammonium nitrogen, a form that can be used by the plant.

**Actinomycetes**, are another type of bacteria from which numerous antibiotics have been derived. They function to degrade the larger lignin molecules in organic residues. They are also responsible for the “earthy” smell of the soil from the production of geosmin.

**Fungi** are also important in the decomposition of crop residues, especially the recalcitrant compounds such as hemicellulose and lignins. They are also less sensitive than bacteria to acidic conditions. Ninety percent of plants with the exception of those in the Brassica family and a few others form a symbiotic relationship with certain fungi called mycorrhizal fungi. Mycorrhiza means fungus root. The fungus penetrates the root cells and forms specialized structures called arbuscules that are the site of nutrient exchange between the plant and fungus. The fungus also produces hyphae that grow out into the soil and absorb water and nutrients, especially phosphorus, and translocate them to the plant. In return, the fungus receives sugars from the plant that are used as a source of energy. Some soil-borne fungi are also pathogenic and cause diseases.

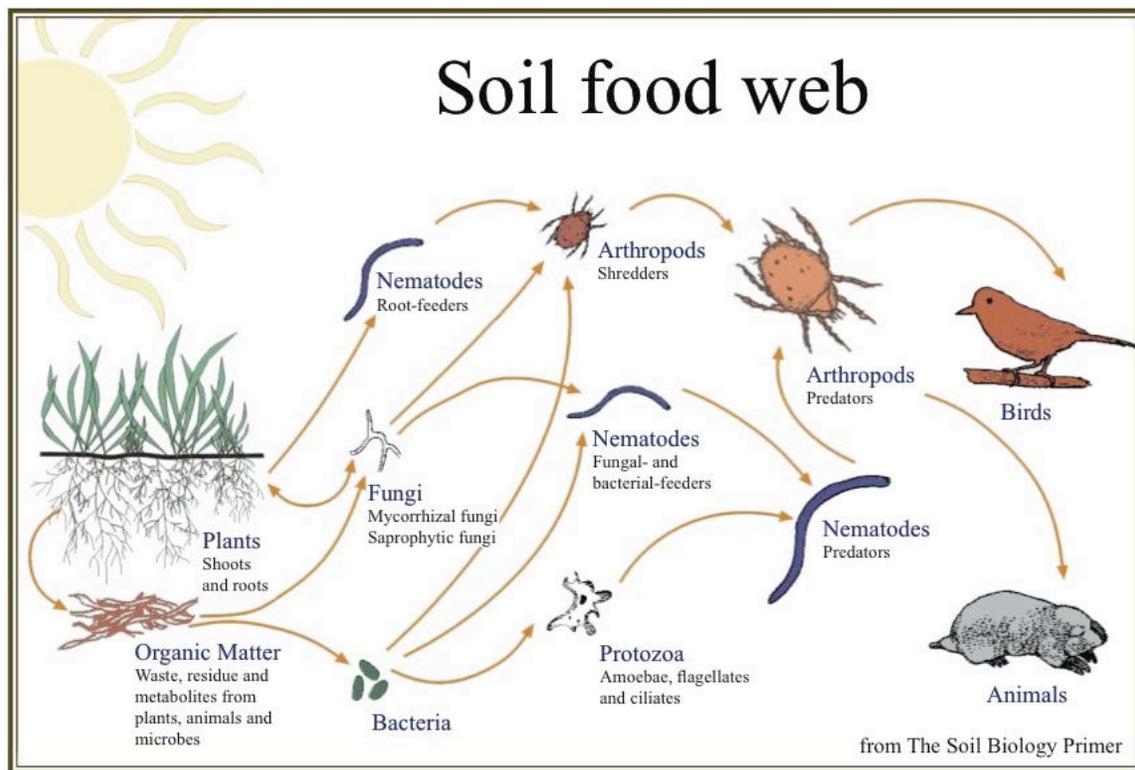
**Nematodes** are generally the most abundant multicellular organisms in soils. They are involved in organic matter decomposition and nutrient cycling, biological control of insects and other organisms, as well as serve as food for other soil organisms. A number are also parasites of plants and animals.



**Algae** are abundant in habitats with accessible light and adequate moisture. They can exist as single cells or can form long chains. Similar to plants, algae contains chlorophyll and therefore are able to convert sunlight into energy or form more complex compounds.

**Protozoa** are single celled animals that are classified based on their means of locomotion (cilia, flagella, etc.). They can feed directly upon microbial cells such as bacteria and fungi or they can adsorb solubilized organic and inorganic compounds.

Large macroscopic organisms such as **earthworms, insects and millipedes** are important for improving aggregation, soil drainage, and aeration due to their burrowing/-channeling nature.



All the life in the soil interacts together in what is termed the **soil food web**. With organic matter as the initial primary food source the bacteria, fungi, actinomycetes and nematodes feed and release nutrients for plant uptake. Then they themselves are fed upon by larger soil organisms such as arthropods, earthworms and so on (see above diagram).

Adapted from **Cornell Soil Health Assessment Training Manual, 2nd Edition (2009)**  
Free Download at: <http://soilhealth.cals.cornell.edu/extension/manual.htm>

**Authors:** S. Gabriel, sfg53@cornell.edu, 4.17.12, review by J Russell-Anelli (4.12.12)

*Building Strong and Vibrant New York Communities*

Cornell Cooperative Extension provides equal program and employment opportunities.