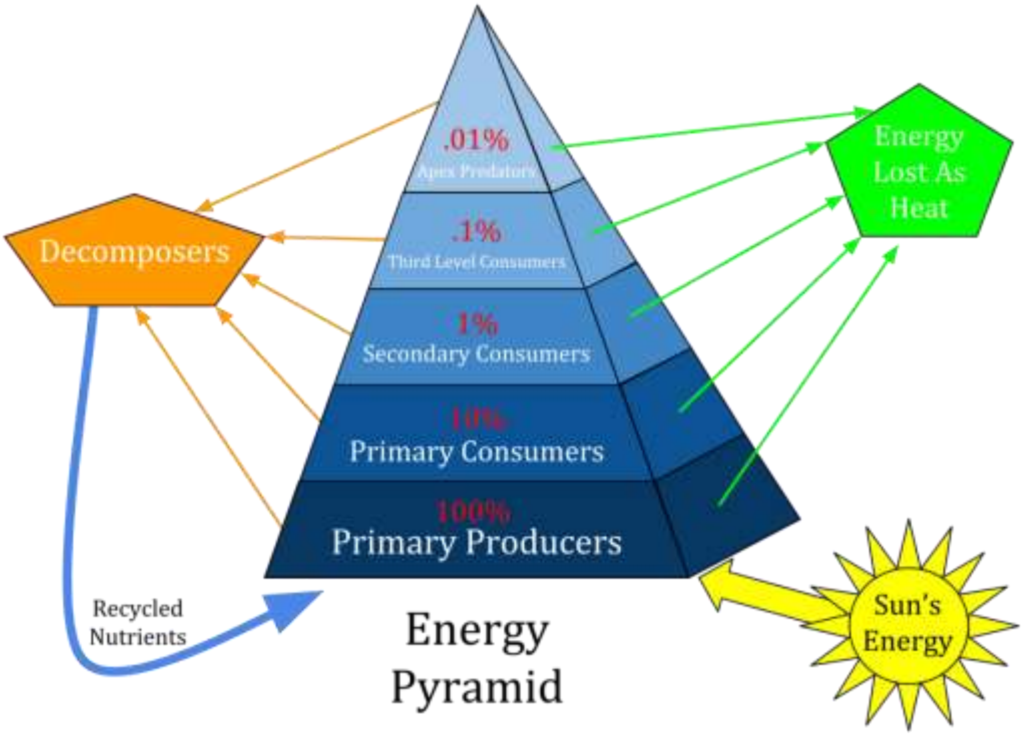
Soil organisms

The trophic pyramid shows how life on land is interconnected and interdependent.



In the ecological hierarchy of the planet,

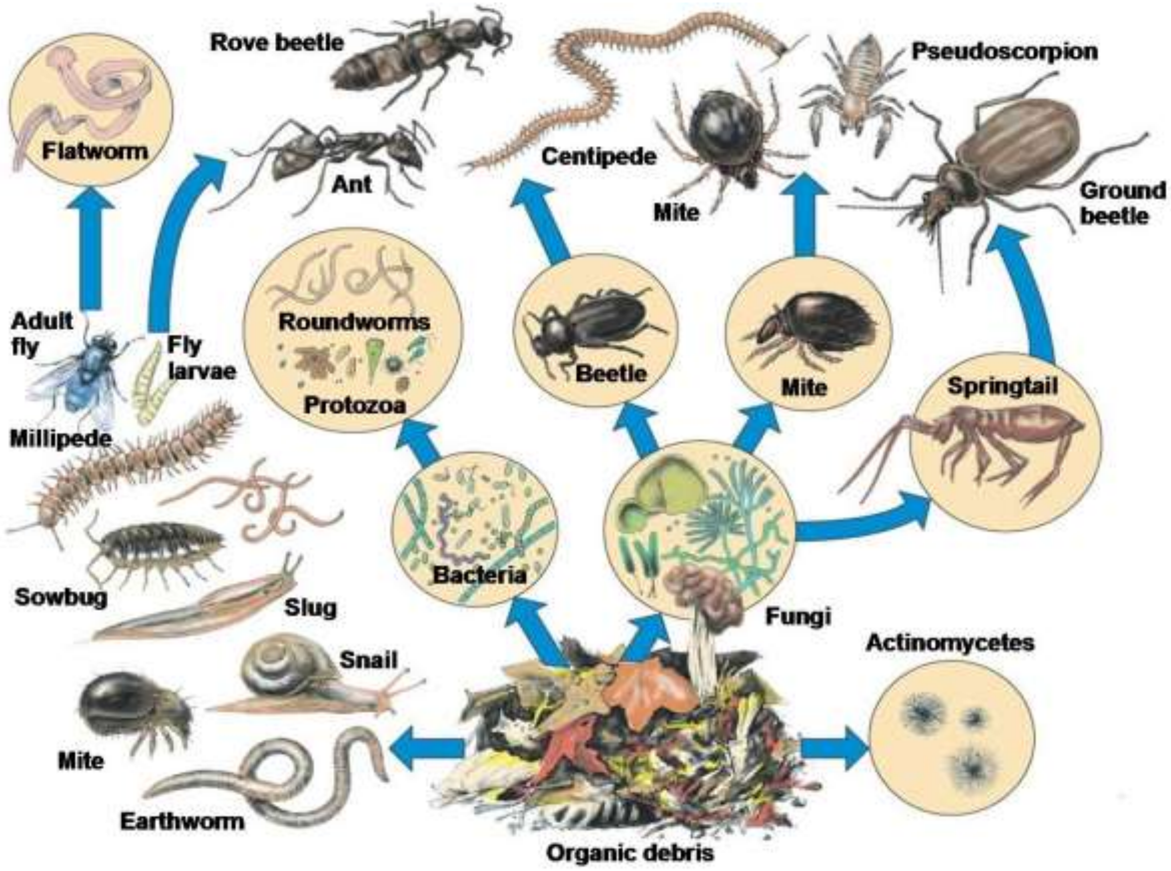
plants are **primary producers.** They utilise the sun’s energy, synthesising their own food by photosynthesis. Only plants and some algae can manufacture food in this way. All other forms of life depend on them.

Primary consumers are organisms which feed directly on this plant material - the herbivores.

Secondary consumers feed on primary consumers (animal material) – the carnivores.
(Some organisms feed on both plant and animal material - omnivores.)

Decomposers are a very important group, fulfilling the specialised function of breaking down dead or decaying matter into simpler substances and making them available to the **primary producers** once more.

Healthy soil is teeming with life and there are complex processes happening within the soil. The diagram below gives an indication of the range of life present in a typical soil. These organisms are responsible for processing organic matter into a state where it can be utilised by plants.



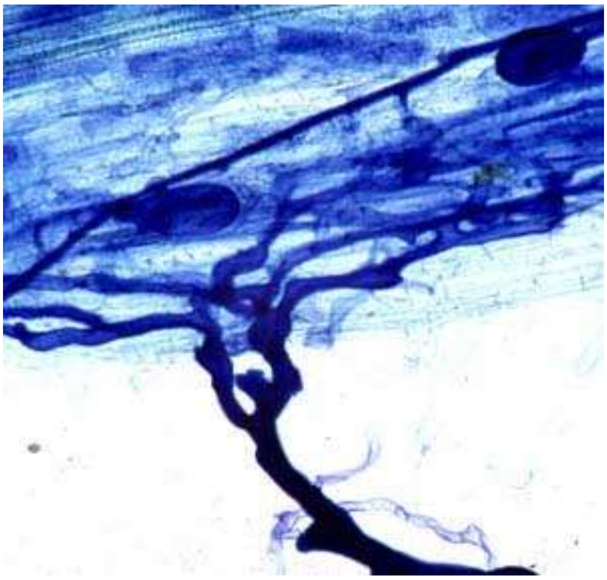
Importance of mycorrhiza

This is a current topic in which active research is being carried out on the relationships between fungi and plants, therefore more detailed information has been provided.

The word ***mycorrhiza*** comes from the Greek word for ***roots*** and it refers to several types of associations between the roots of plants and fungi*.* In this mutually beneficial (symbiotic) relationship the fungi obtain carbohydrates from the plant and in turn the plant gains greater access to nutrients in the soil. Mycorrhizal associations occur throughout the plant kingdom – only a few families, notably Brassicaceae, do not form them. The fungi consist of fine thread-like filaments called hyphae (hypha = singular).

The hyphae then extend out into the soil and form an extensive network to absorb nutrients. In sheathing (ectotrophic) mycorrhizas, the hyphae form a mass around the ***outside*** of feeder roots, causing them to thicken and branch. Each specific association has a specific pattern of branching. The fungal sheath sends out branches on its inner surface, forming a network which runs into the root tissue ***between*** the cells of the cortex and allows nutrient exchange between the plant and fungus. On the outside the sheath sends out a branching network of hyphae to absorb nutrients.

The magnified images below show branching hyphae networks.

Mycorrhiza and nutrients

Mycorrhizae are particularly responsible for gathering in **phosphates** from the soil. Phosphates are largely insoluble, and to take up enough for its needs the plant requires a huge absorbing area of roots – especially if the soil is nutrient-poor. The mycorrhizal network also gathers in other nutrients, including **nitrates**, in return for extracting sugars from the plant which allow it to grow.

Mycorrhizal associations develop in the following conditions:

- **a good supply of organic matter**
- **good soil aeration**
- **a restricted supply of nutrients**

These associations form naturally in well-drained sandy soils where there is plenty of leaf litter and nutrients tend to be leached away.

Benefits of mycorrhiza to the host plant:

- **improved nutrition**
- **faster growth -** because of improved nutrition plants are likely to grow faster
- **greater drought resistance –** phosphorus enables the plant to cope better with the physiological stresses of drought, and mycorrhiza help with phosphorus absorption. Mycorrhiza do not physically bring in or make more water available, but because of the benefits of improved soil structure, water infiltration is more efficient.
- **protection from harmful pathogens –** there is evidence to suggest that because of the presence of these beneficial organisms there is less room for harmful pathogens.
- **as an aid to plant survival** - mycorrhizal fungi are able to colonise the roots of a wide range of plant species and it has now been proved that mycorrhiza promote plant survival.

Mycorrhiza as an aid to soil structure

Mycorrhiza improve soil structure by bonding soil aggregates together, to each other and to plant roots. Soil bacteria cement soil particles and contribute importantly to soil structure. The pore spaces created allow the ready movement of water, air, roots and beneficial micro and macro-organisms.

Organic matter

In terms of the soil, organic matter describes all living things such as plant roots, worms and bacteria, as well as any matter that was once alive but is now dead and decaying, such as plant debris and animal remains. Without organic matter, soil would just be a collection of lifeless minerals. Live soil organisms act on the dead organic matter to produce humus and make nutrients available to plants. The return of organic matter is essential and a healthy soil and should comprise around 5%. All types of soil are improved by the addition of organic matter, from gritty sand to heavy clay. The general benefits of incorporating organic matter include:

- **on sandy soils, the improvement of a 'light' and 'hungry' soil structure by improving water and nutrient retention**
- **on clay soils, the improvement of a 'heavy' soil by opening up a dense structure to be more free-draining and adding nutrient-retaining matter**
- **it also helps make a good environment for all the soil microbes and organisms that work with and enhance plant health and growth**

Many of our actions as gardeners such as harvesting crops and chopping down dead stems mean that organic matter is not returned to the soil.

What are suitable organic materials?

Garden compost - this consists of plant material, kitchen vegetable waste and any other organic matter that once broken down, can be incorporated by digging or mulching the soil. At this stage the compost should be dark, crumbly and sweet smelling. Good garden compost may be in short supply, especially in a productive vegetable garden where it is needed to feed hungry crops.

Farmyard manure (FYM) - needs to be well rotted: it has to have broken down far enough to lose some nutrients and stabilise, otherwise it will scorch plants and excessive nutrients may lead to lush, sappy growth that is susceptible to pest and disease attack.

Composted green waste - can have a high pH which may not be suitable for adding to chalk soil and the nutrient content can be variable. However it is local, cheap and a good use of a waste product. It is composted in large heaps at very high temperatures which eliminate pathogens.

Spent mushroom compost – this used to be high in pH because of lime used in the mushroom cultivation process, but in many cases the method of cultivation has changed and the spent compost is lower in pH. Not easily obtainable in large quantities.

Leafmould – consists of rotted deciduous leaves. The pH is slightly acid (depending on the tree species used). The nutrient content is low, but it contains beneficial organisms.

Plant nutrients

How are nutrients made available in the soil?

- **Weathering of parent rock into soil produces minerals: the nature of underlying bedrock
dictates the mineral content.**
- **Nitrogen-fixing can take place in some groups of plants.**
- **Composts, manures and fertilisers add nutrients to the soil.**
- **Decomposition and humification release nutrients into the soil.**

Chemicals exist mostly in combined states – organic compounds for organic chemicals and mineral substances for inorganic chemicals.
Nearly all soil nutrients (except nitrogen) are present in minerals that make up the solid matter in soil. Soil N is usually in organic compounds (soil organic matter) in the soil.
For elements to become available to the plant, they must be converted from combined forms to the ionic state. For example, N in soil organic matter must be converted to the ions NH_4^+ or NO_3^- to be available for uptake. Nutrients present in soil minerals must also be converted to ionic forms (e.g. $H_2PO_4^-$ or K^+).

- **Water is essential for the uptake of nutrients: unless the nutrients are dissolved in the soil solution they are not available to the plant.**
- **Nutrients dissolved in the soil solution can travel into the plant root, either by diffusion or through the process of cation exchange.**