

# Soil Basics

## (Or the world under our feet)



Score Four: Students, Schools, Streams, and the Bay

---

Rebecca Wolf and Nguyen Le  
Interstate Commission on the Potomac River Basin



# Soil: The Foundation For a Plant's Success

- **Soil provides plants with:**

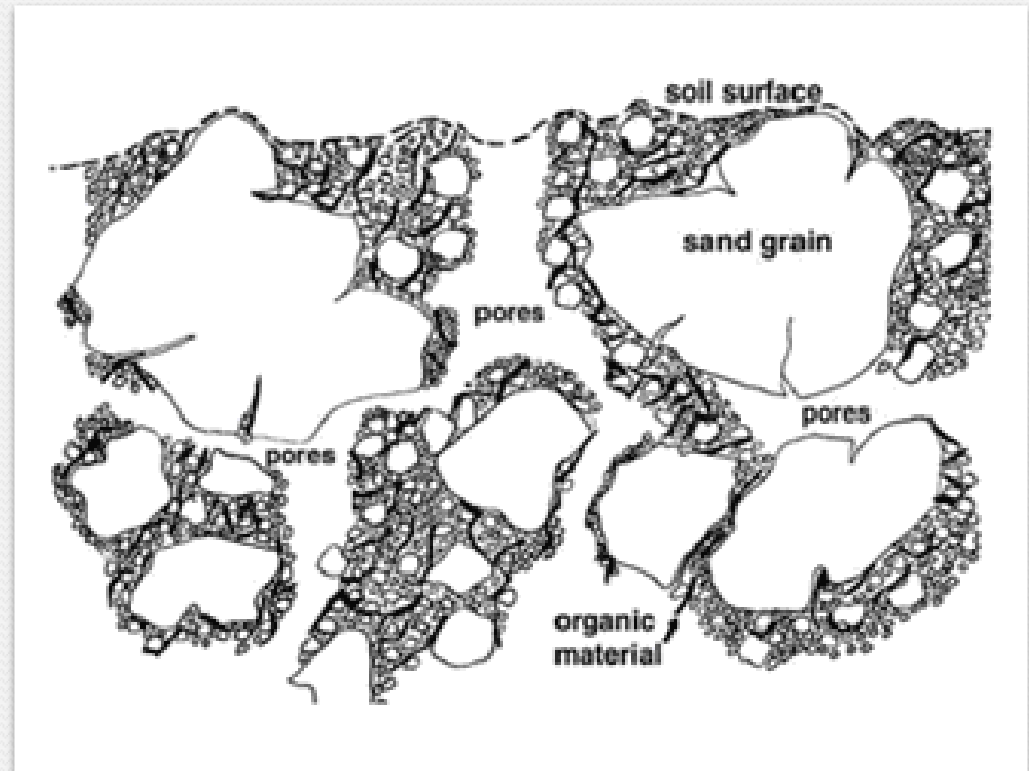
- Nutrients
- Minerals
- Water
- Oxygen



# It's Not Just Dirt

## Soil consists of:

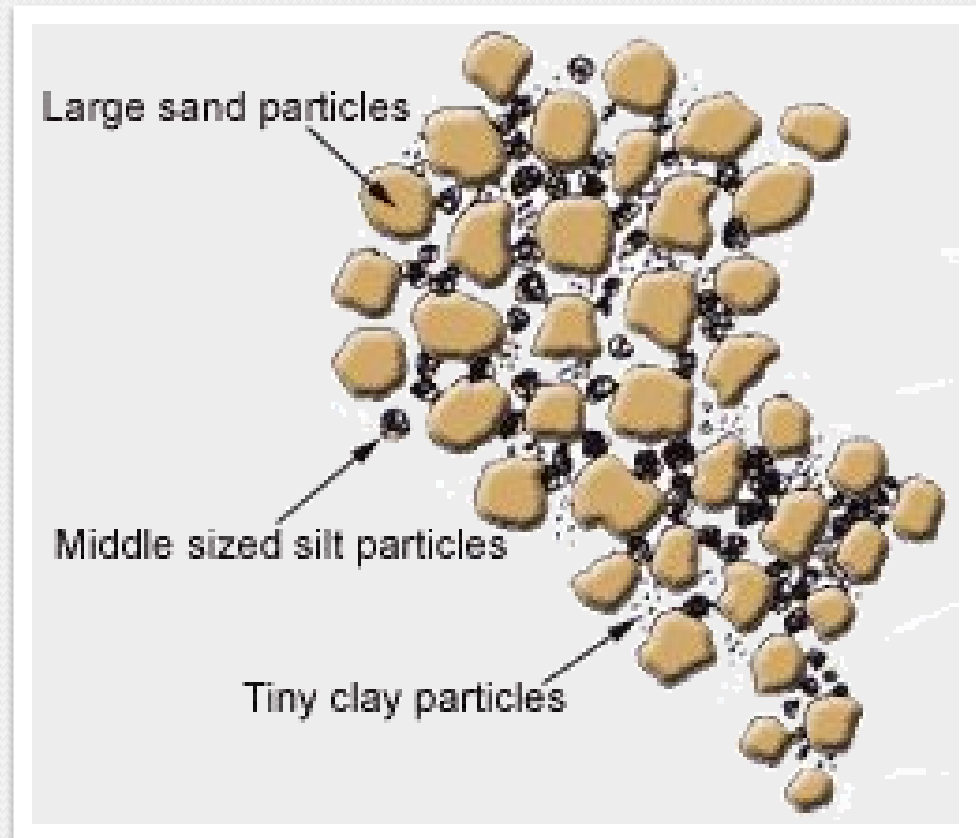
- *Mineral particles* – sand, silt, or clay.
- *Pore Spaces* between mineral particles.
- *Organic matter* – decomposing plants, animal matter and droppings.
- *Small organisms* – worms and insects and microorganisms, such as bacteria and fungi.



# Soil: It's a Mix

The three minerals that comprise soil are:

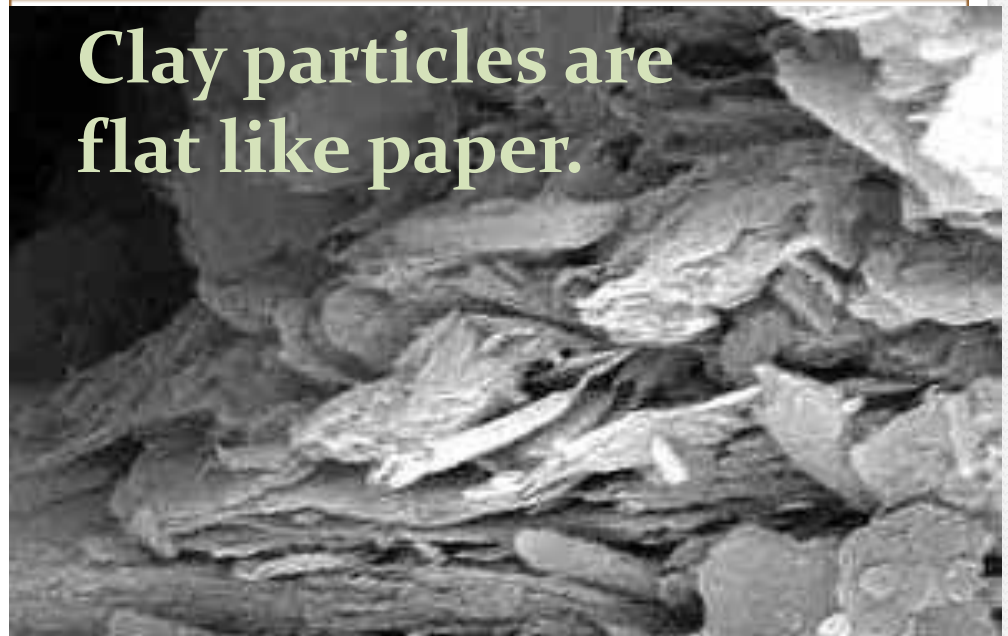
- Sand
- Silt
- Clay.



# More On Minerals

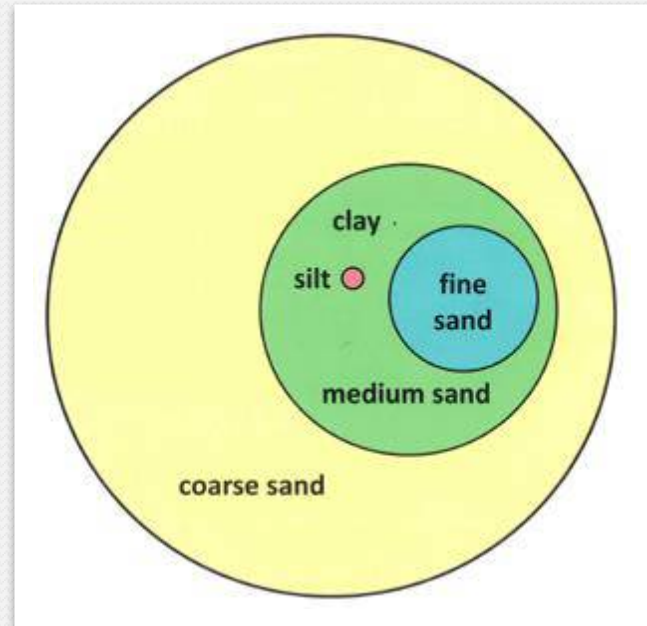
- These minerals are classified by size.
- You can see...
  - Sand with your eye or magnifying glass.
  - Silt with microscopes.
  - Clay with electron microscopes.

**Clay particles are flat like paper.**



# How soil feels tells us what it is!

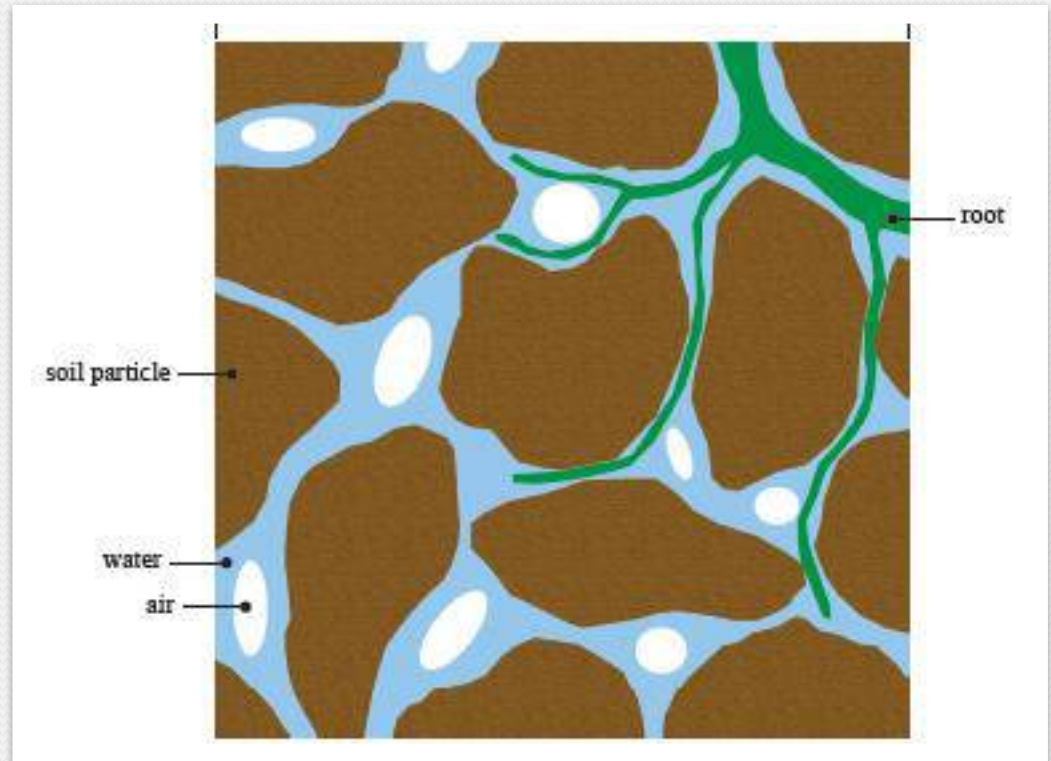
- The *mix of minerals* in a soil define how it feels. This is called its *soil texture*.
  - The particles feel differently, because of their different sizes and structures.
  - We can tell the general composition of soil from its texture.
  - How would you expect sand to feel in comparison to clay?





# Pore Space – where lots of action takes place.

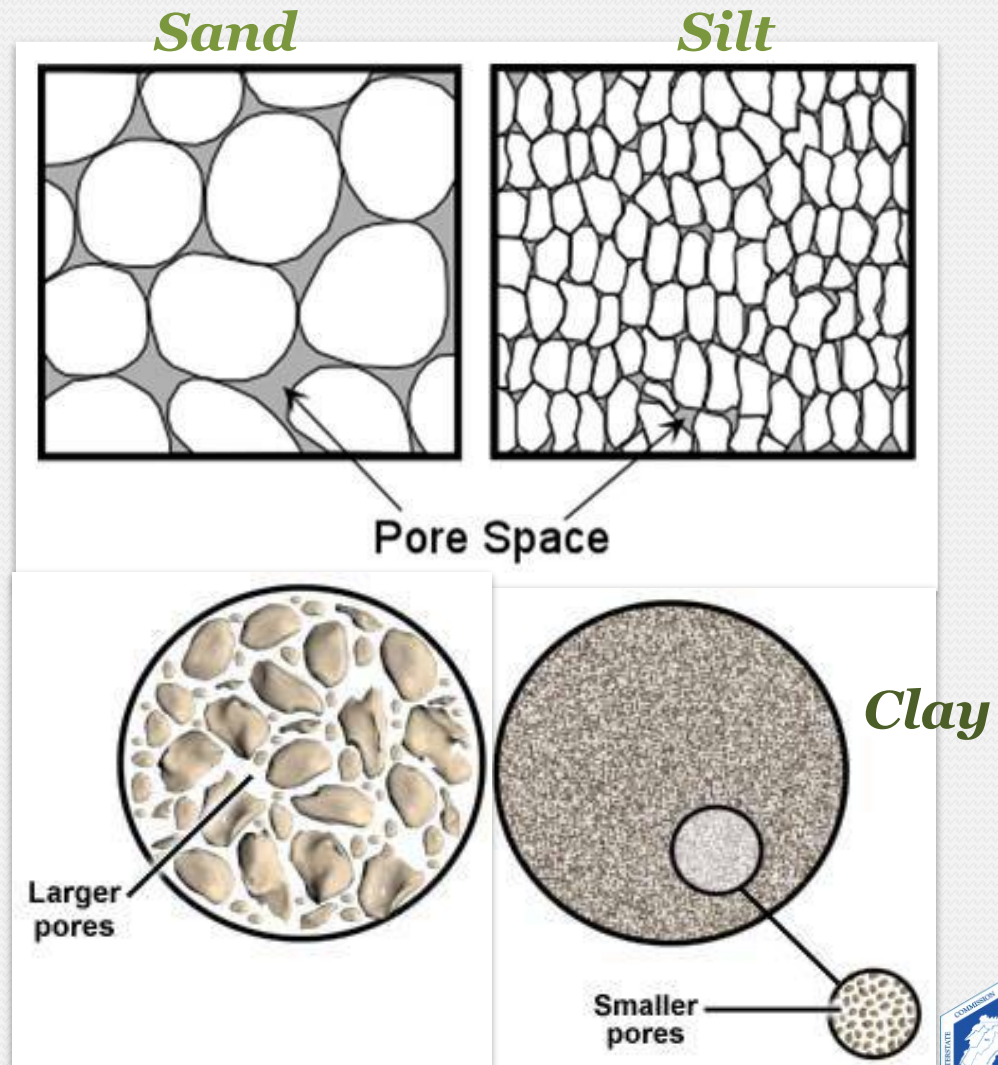
- The spaces between individual soil particles are called pore spaces.
- Pore spaces house water, oxygen, and microorganisms.
- Plant roots grow into and make pore spaces.



# Pore Space

Different types of minerals have different sized pore spaces.

- Which type of mineral has the largest pore spaces?
- How about the smallest?

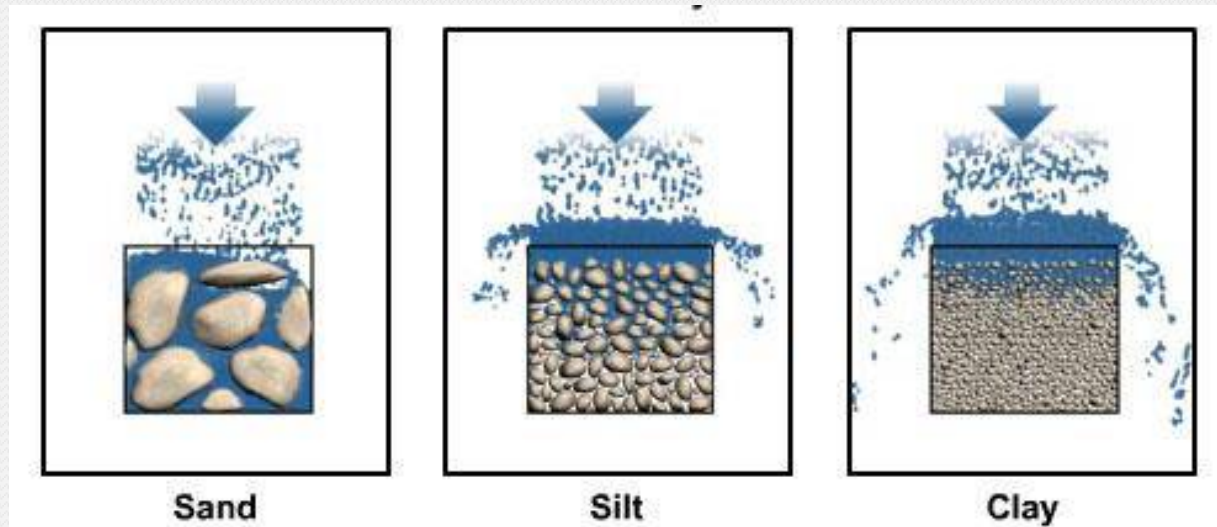




# Porosity and Permeability – related, but different

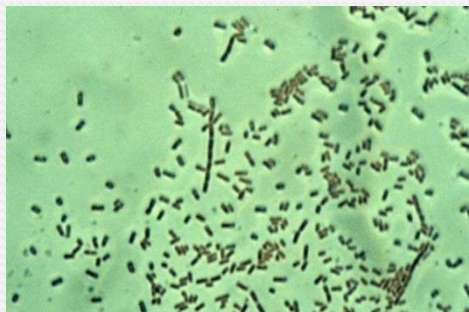
Porosity – Soil scientists define porosity as the *volume* of pores for a given amount of soil.

- Which mineral is most porous (has the greatest volume of pores for the same amount)?
- But which is most permeable? (Which will rain pass through the fastest?)



# Healthy Soil Supports Many Diverse Lifeforms

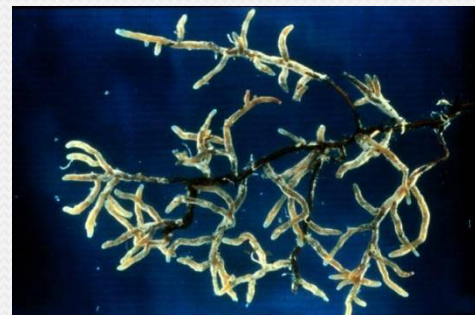
## Micro-organisms:



Bacteria

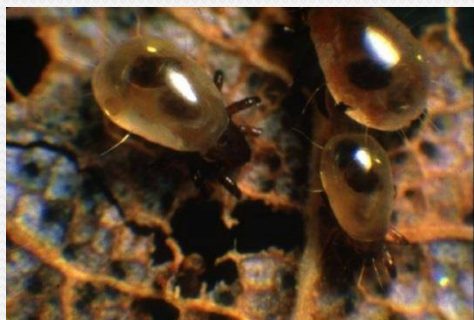


Nematodes



Fungus roots

## Organisms visible to the eye:



Tiny to large insects & spiders



Earth worms

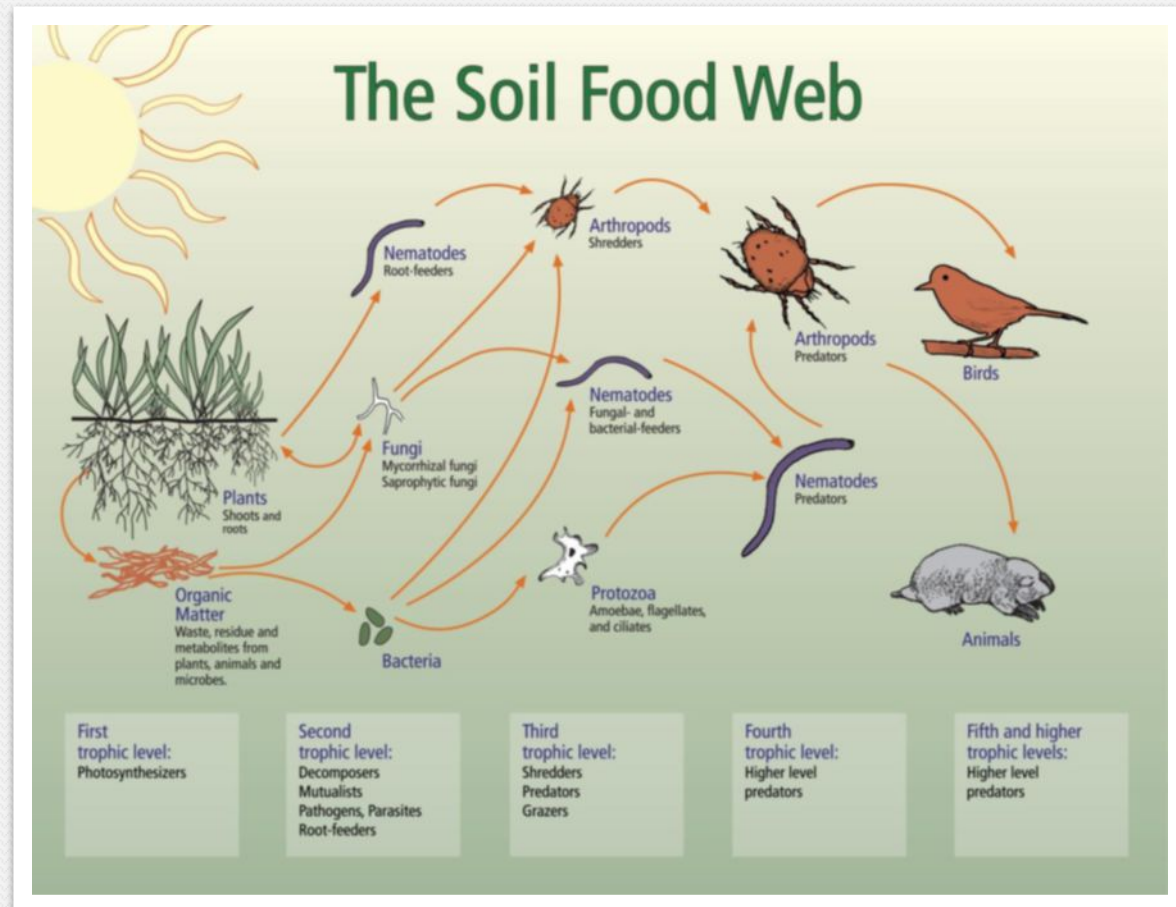


Tiny springtails

# These Organisms Make a Food Web

Where small organisms are eaten by larger ones.

- It starts with plants, which convert the sun's energy to a food source.
- Plant roots produce food (carbohydrates and proteins) for bacteria and fungi.
- Larger organisms eat the smaller ones.

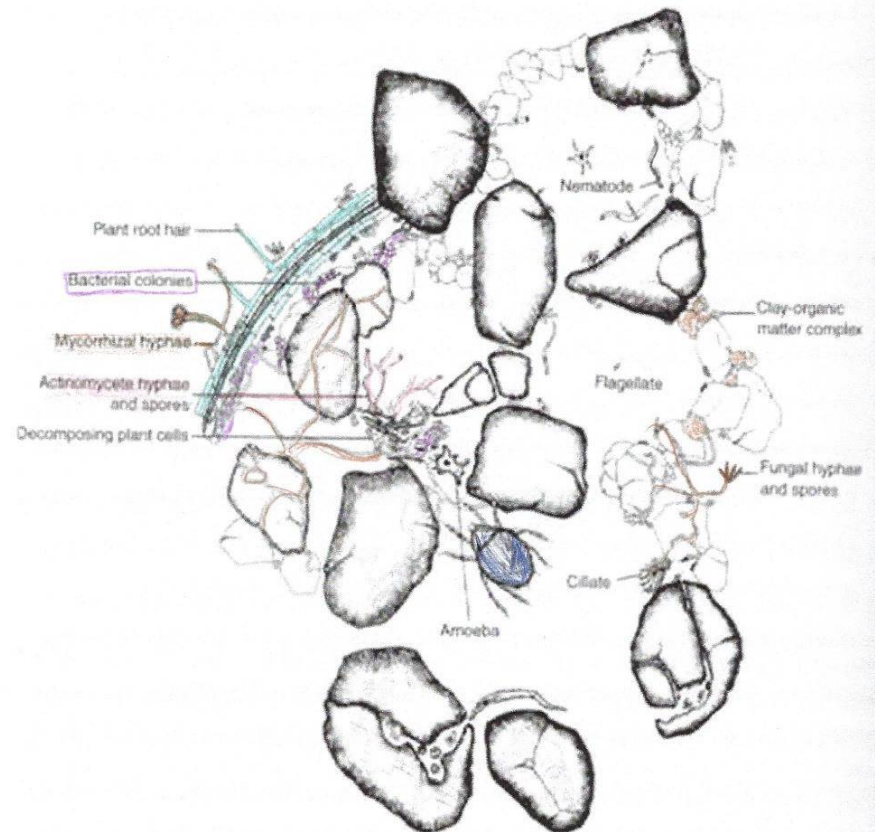




# Where do Soil Organisms Live?

**They live where there is space, food, and water.**

- In the top 4 inches of soil.
- Small and large organisms live where there is organic matter to digest.
- Micro-organisms live around plants roots.
  - Roots release proteins and sugars that bacteria eat.
  - Larger nematodes prey on the bacteria.
- Larger organisms, such as worms, make spaces between clumps of soil.



### 3 Ways Healthy Soil Helps Cleanse our Water

- Soil microorganisms decompose (break down and use) potential pollutants, such as manure and pesticides.
- Worms, beetles, and fungus create pore in soil -- enabling more rainwater to filter into the ground and reducing runoff.
- Bacteria secrete sticky substances that help soil to clump. Clumps of soil do not erode as much as loose soil, so less soil ends up in our streams.





# Review

- What different factors cause pore spaces in soil?
- Which would retain water the best – a sandy soil or a clayey soil?
- What types of organisms do you think you might find in your school soil?



# Application Question To Think About

Rain gardens are meant to catch large amounts of storm water and then let it slowly seep into the soil over one to two days.

- **Which mix of soils would work best in a rain garden? And why?**



# Investigations and Activities

Collect soil samples from school ground:

- Soil Components Texture Investigation
- Soils Percolation Investigation.
- Send to lab to have analyzed and/or use soil chemistry kits to learn pH and other chemical. characteristics.

# Resources for Teachers

- [Flow diagram for Texture by Feel](#). Commonly used in the field. Provided by the USDA Natural Conservation Resources Service. (Click [here](#) for a high-resolution version of the graphic.)
- [Soil Science Society of America](#) provides an excellent bank of soils lessons for multiple grades covering texture, biology, chemistry, forensics, and more. <http://www.soils4teachers.org/lessons-and-activities#General9>
- Basic Hydrologic Science Course Runoff Processes Section Four: Soil Properties. In depth explanations with public domain graphics. [http://wegc203116.uni-graz.at/metted/hydro/basic/Runoff/print\\_version/04-soilproperties.htm?vm=r#12](http://wegc203116.uni-graz.at/metted/hydro/basic/Runoff/print_version/04-soilproperties.htm?vm=r#12)
- [Soil Biology Primer](#), Natural Resources Conservation Service, USDA. <https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/>



# Definitions for teachers

Source (unless otherwise noted): Soil Health and Glossary, National Resources Conservation Service

[https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/?cid=nrcs142p2\\_053848](https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/?cid=nrcs142p2_053848)

- **Actinomycetes:** A large group of bacteria that grow in long filaments that are too small to see without magnification. Actinomycetes generate the smell of “healthy soil,” and are important in decomposing cellulose, chitin, and other hard-to-decompose compounds, especially at higher pH levels. Many produce antibiotics.
- **Arthropods:** Invertebrate animals with jointed legs. They include insects, crustaceans, sowbugs, springtails, arachnids (spiders), and others.
- **Bacteria:** Microscopic, single-celled organisms. They include the photosynthetic cyanobacteria (formerly called blue-green algae), and actinomycetes (filamentous bacteria that give healthy soil its characteristic smell).
- **Fungi:** Multi-celled, non-photosynthetic organisms that are neither plants nor animals. Fungal cells form long chains called hyphae and may form fruiting bodies such as mold or mushrooms to disperse spores. Some fungi such as yeast are single-celled.
- **Mineral:** A mineral is an element or chemical compound that is normally crystalline and that has been formed as a result of geological processes" (Source: Nickel, E. H., **1995**). "Minerals are naturally-occurring inorganic substances with a definite and predictable chemical composition and physical properties." (Source: O' Donoghue, **1990**).
- **Mycorrhizal associations:** A symbiotic association of certain fungi with roots. The fungi receive energy and nutrients from the plant. The plant receives improved access to water and some nutrients. Except for brassicas (mustard, broccoli, canola) and chenopods (beets, lamb's-quarters, chard, spinach), most plants form mycorrhizal associations.
- **Organic matter:** any material that is part of or originated from living organisms. Includes soil organic matter, plant residue, mulch, compost, and other materials
- **Permeability:** the qualitative estimate of the ease with which fluids, gases, or plant roots pass through soil.
- **Porosity:** the volume of pores in a soil sample divided by the bulk volume of the sample.
- **Silt:** a granular material of a size between sand and clay, whose **mineral** origin is quartz and feldspar. Silt may occur as a soil (often mixed with sand or clay) or as sediment mixed in suspension with water (also known as a suspended load) in a body of water such as a river. (source: Wikipedia)

