THE SOILS AROUND US

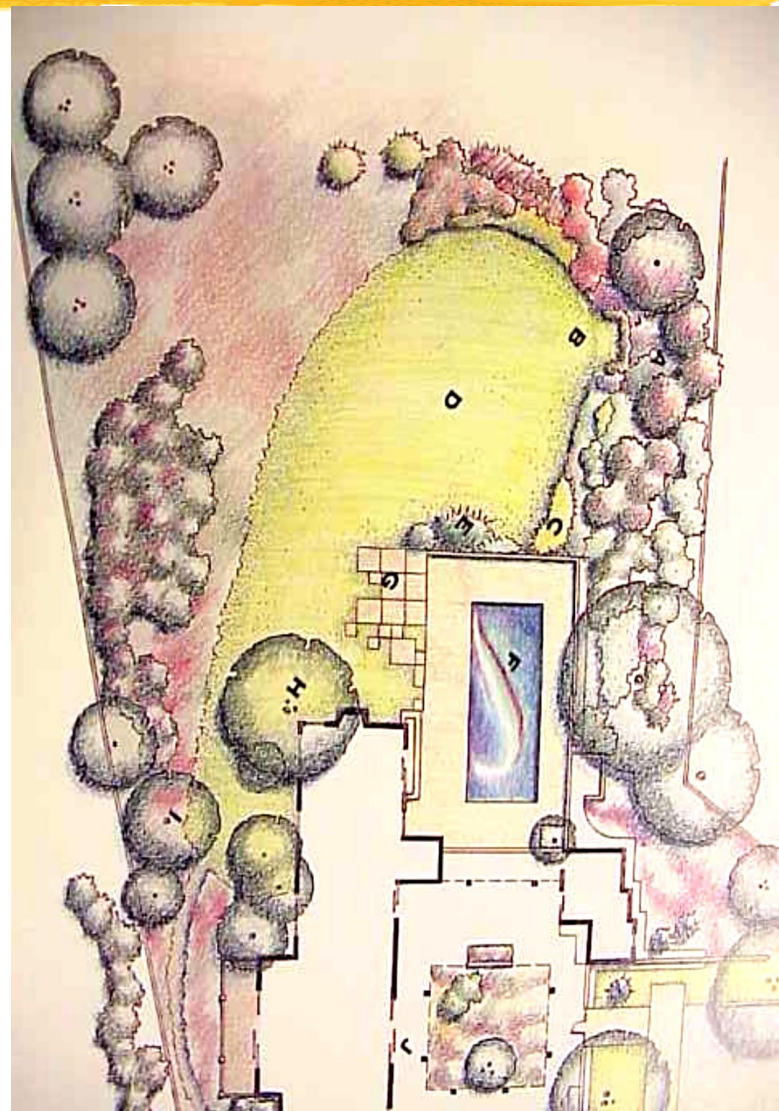
CHAPTER 1

Functions of Soils in Our Ecosystem (Fig. 1.2)

- Supports plant growth
- Controls water in hydrologic system
- Functions as a recycling system

Functions of Soils in Our Ecosystem

- Important role in engineering medium
- Provides habitat for numerous organisms

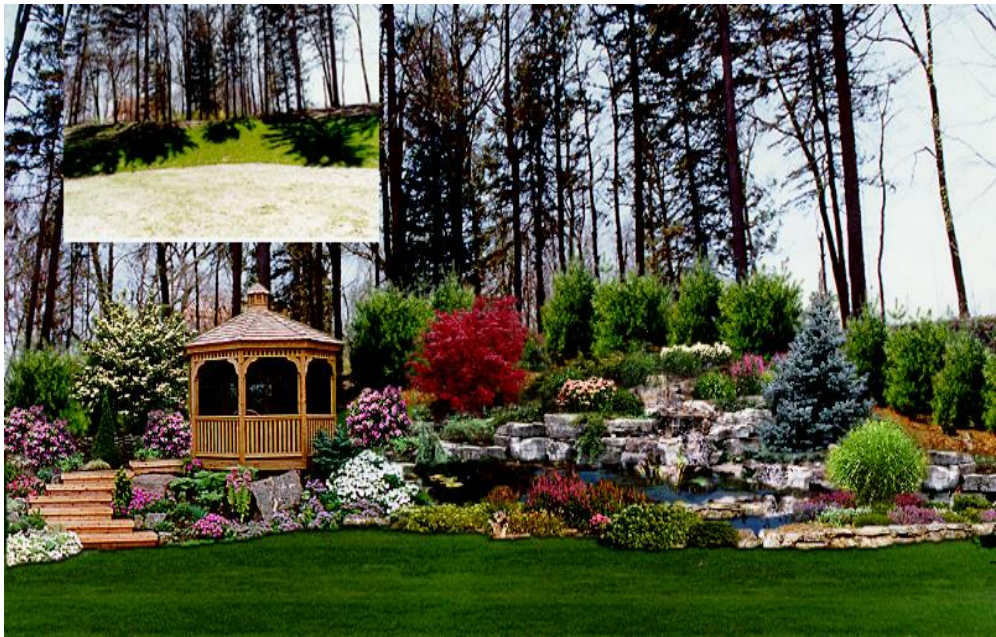


Medium for Plant Growth

- Physical support
- Water and water-holding capacity
- Air

Medium for Plant Growth

- Temperature modification
- Protection from toxins
- Nutrient elements

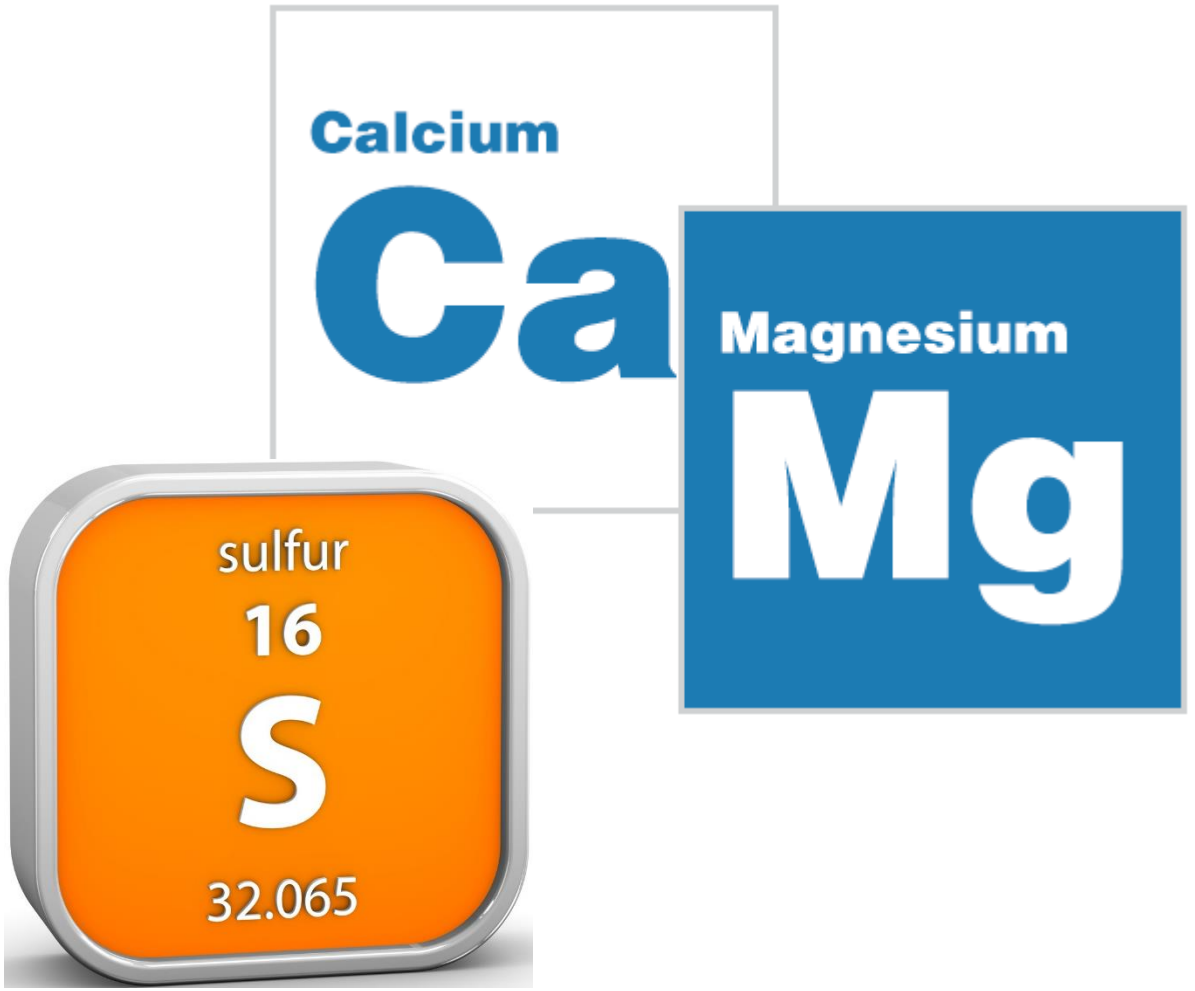


Essential Macroelements for Plant Growth

- Nitrogen
- Phosphorus
- Potassium

Essential Macroelements for Plant Growth

- Calcium
- Magnesium
- Sulfur



Essential Microelements for Plant Growth (Table 1.1)

- Iron
- Manganese
- Boron
- Zinc
- Copper
- Chlorine
- Cobalt
- Molybdenum
- Nickel
- **Hydroponics** - plants grown in nutrient solutions instead of soil

Regulator of Water Supplies

- All of water supplies have at some time or another passed through the soil

Recycler of Raw Materials

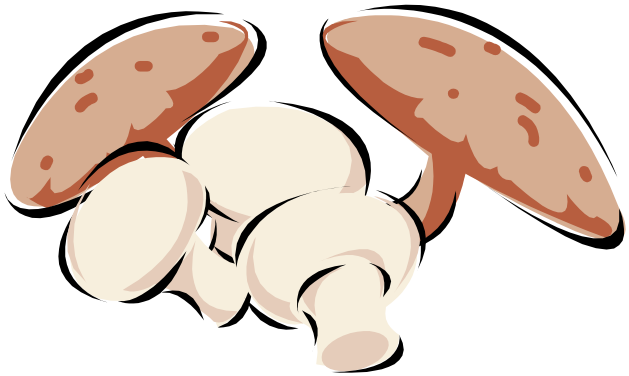
- Organic waste is turned into humus
- Converts mineral nutrients into forms utilized by plants

Habitat for Soil Organisms

- Predators
- Prey
- Producers
- Consumers

Habitat for Soil Organisms

- Parasites



- Soils harbor much of the earth's diversity

Engineering Medium

- "Terra firma", solid ground
- Some soils are more stable than others
- Bearing strength, compressibility, and stability are harder to predict with soils

Soil as an Environmental Interface

- **Lithosphere** - rock
- **Atmosphere** - air
- **Hydrosphere** - water

Soil as an Environmental Interface

- **Biosphere** - living things
- **Pedosphere** - soil

Soil as a Natural Body

- **"The Soil"** - a collection of individually different soil bodies

- **"A Soil"** - individual body of soil or three dimensional natural body

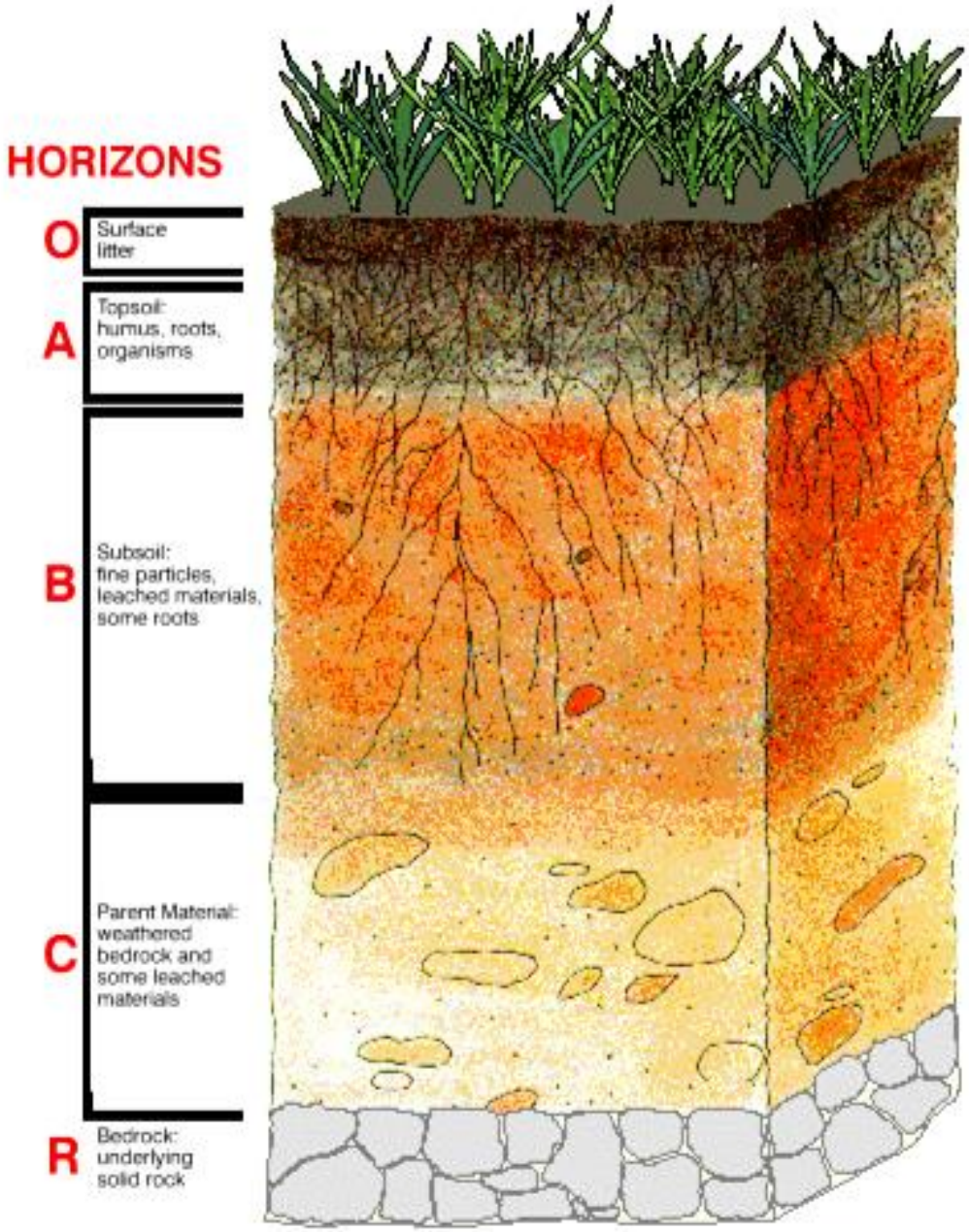
Soil as a Natural Body

- Soil is the product of both destructive and creative (synthetic) processes
- **Soil horizons** - contrasting soil layers
  - **Pedology** - study of soil as a natural body
  - **Edaphology** - study of soil as a living entity

Soil Profile and Its Layers

- **Soil profile** - vertical section of soil exposing a set of horizons (**Figure 1.9**)
  - Profiles can be helpful in identifying potential soil problems

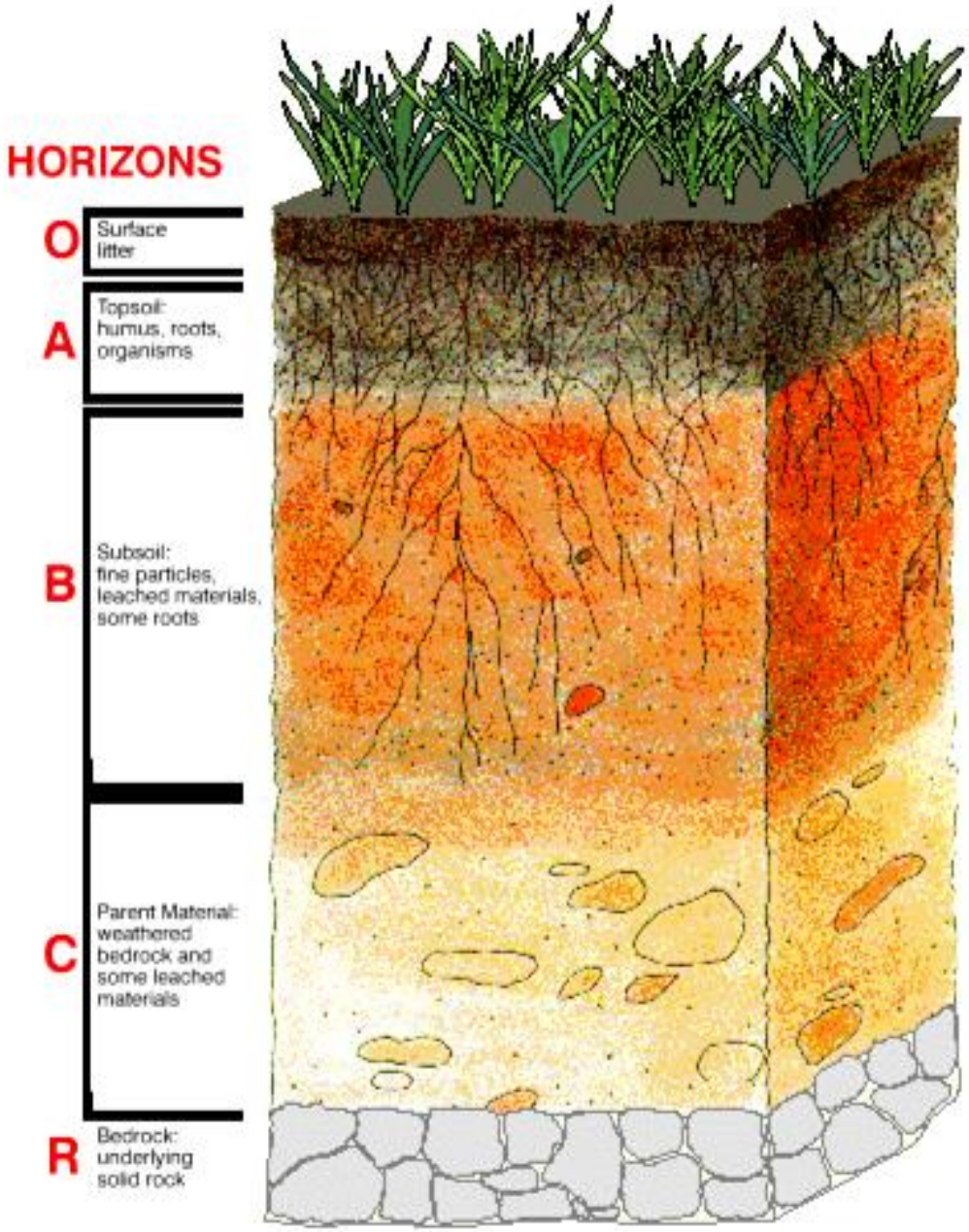
Primary Layers of a Soil Profile



Soil Profile and Its Layers

- **O-horizon** - organic layer (**Figure 1.10**)
- **A-horizon** - nearest the surface with mineral particles (**topsoil**)
- **Plow layer** - cultivation of the top 5-10 inches of soil profile

Primary Layers of a Soil Profile

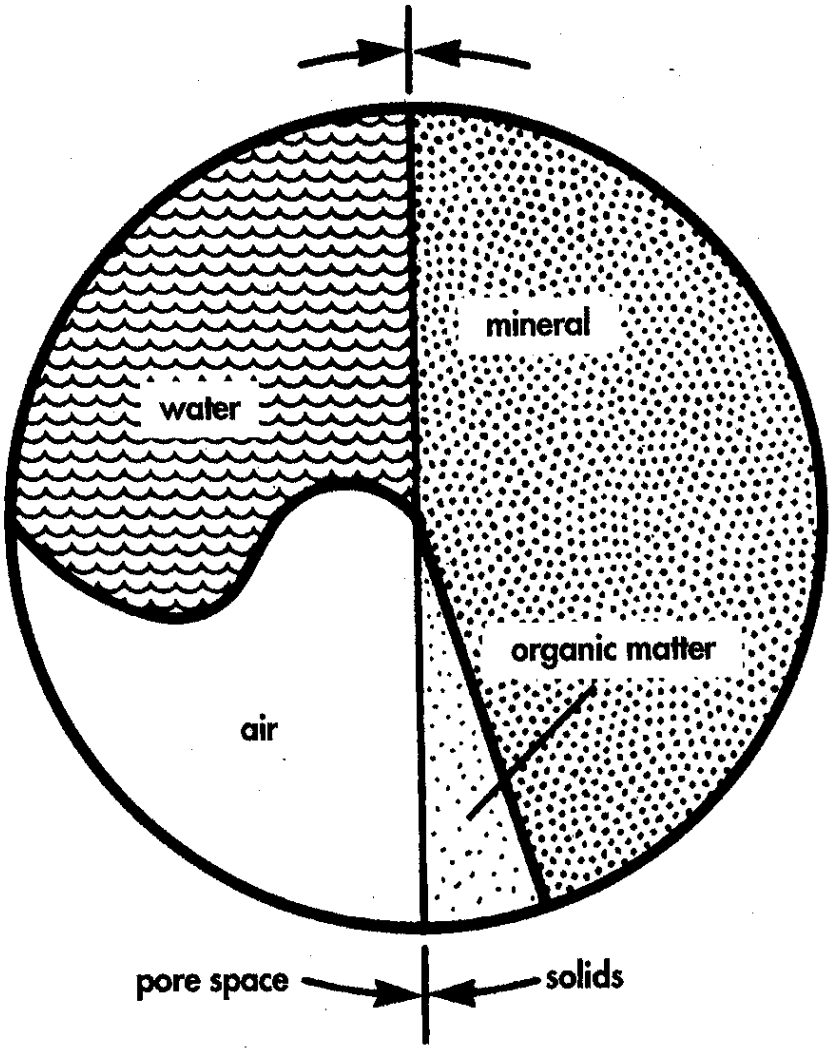


Soil Profile and Its Layers

- **Subsoil** - layer below A and O horizons
- **B-horizon** - accumulation of clays, gypsum, and calcium carbonates
- **C-horizon** - least weathered part of soil
- **R-horizon** - bedrock

Major Components of Soil

- **Air**
  - 25% of soil volume
- **Water**
  - 25% of soil volume



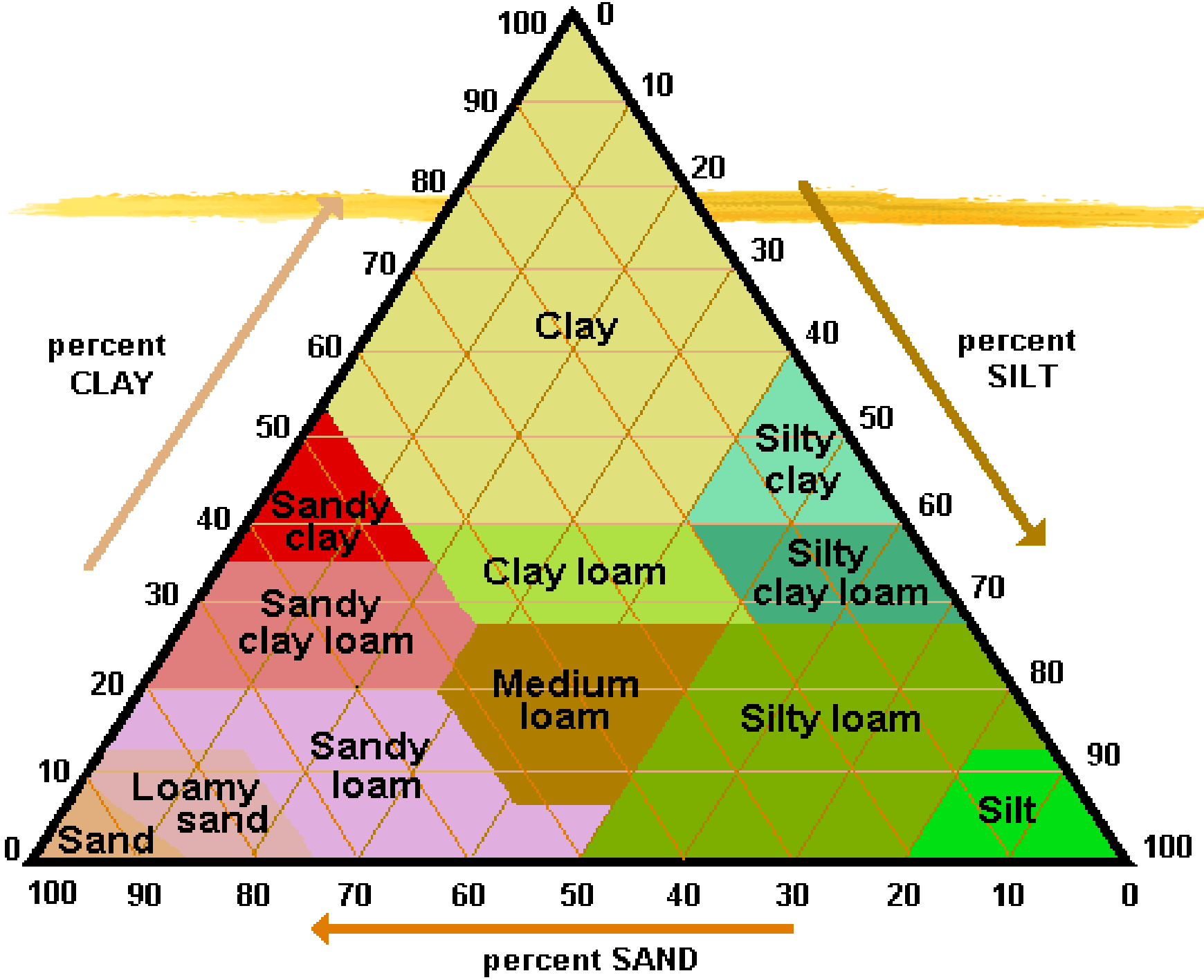
Major Components of Soil

- **Mineral matter**
- **Organic matter**
  - 5% by volume
  - 2% by weight

Mineral Constituents of Soils

- Most of the soil's framework consists of **mineral particles**

- Particles vary greatly in size and composition
  - **Sand** - 2.0 to 0.05 mm.
  - **Silt** - 0.05 to 0.002 mm.
  - **Clay** - < 0.002 mm.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percent CLAY
percent SILT
percent SAND
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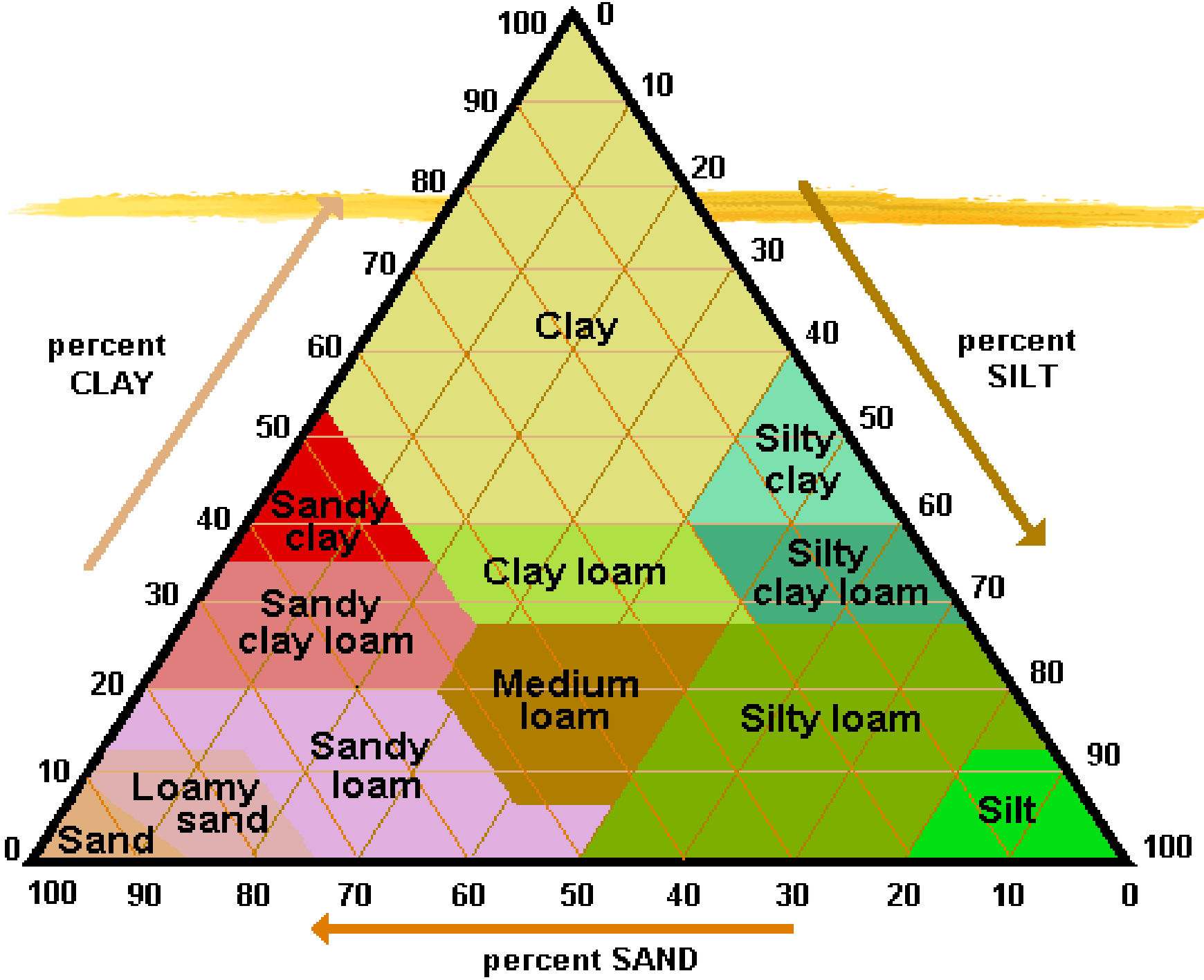
Silty clay
Sandy clay
Clay loam
Silty clay loam
Sandy clay loam
Medium loam
Silty loam
Sandy loam
Loamy sand
Sand
Silt

Mineral Constituents of Soils

- **Colloidal systems** - two-phase systems in which very small particles of one substance are dispersed in a medium of a different substance (**Table 1.2**)
  - Site of soil chemistry and physical activity
  - Important in supplying nutrients

Soil Texture

- **Proportion of particles in different size ranges**
  - Sandy loam
  - Silty clay
  - Clay loam
  - Important in holding inorganic chemicals and supplying nutrients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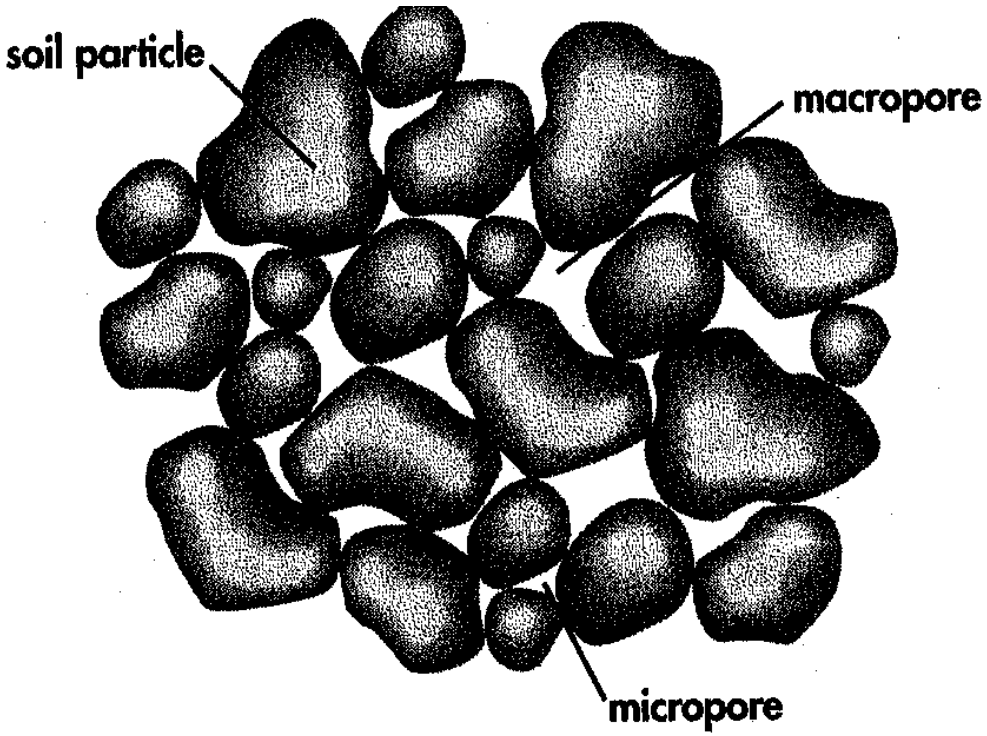
Silty clay
Sandy clay
Clay loam
Silty clay loam
Sandy clay loam
Medium loam
Silty loam
Sandy loam
Loamy sand
Sand
Silt

Soil Structure

- **Arrangement of soil particles**
- **Aggregates** - association of different size soil particles



Soil Organic Matter

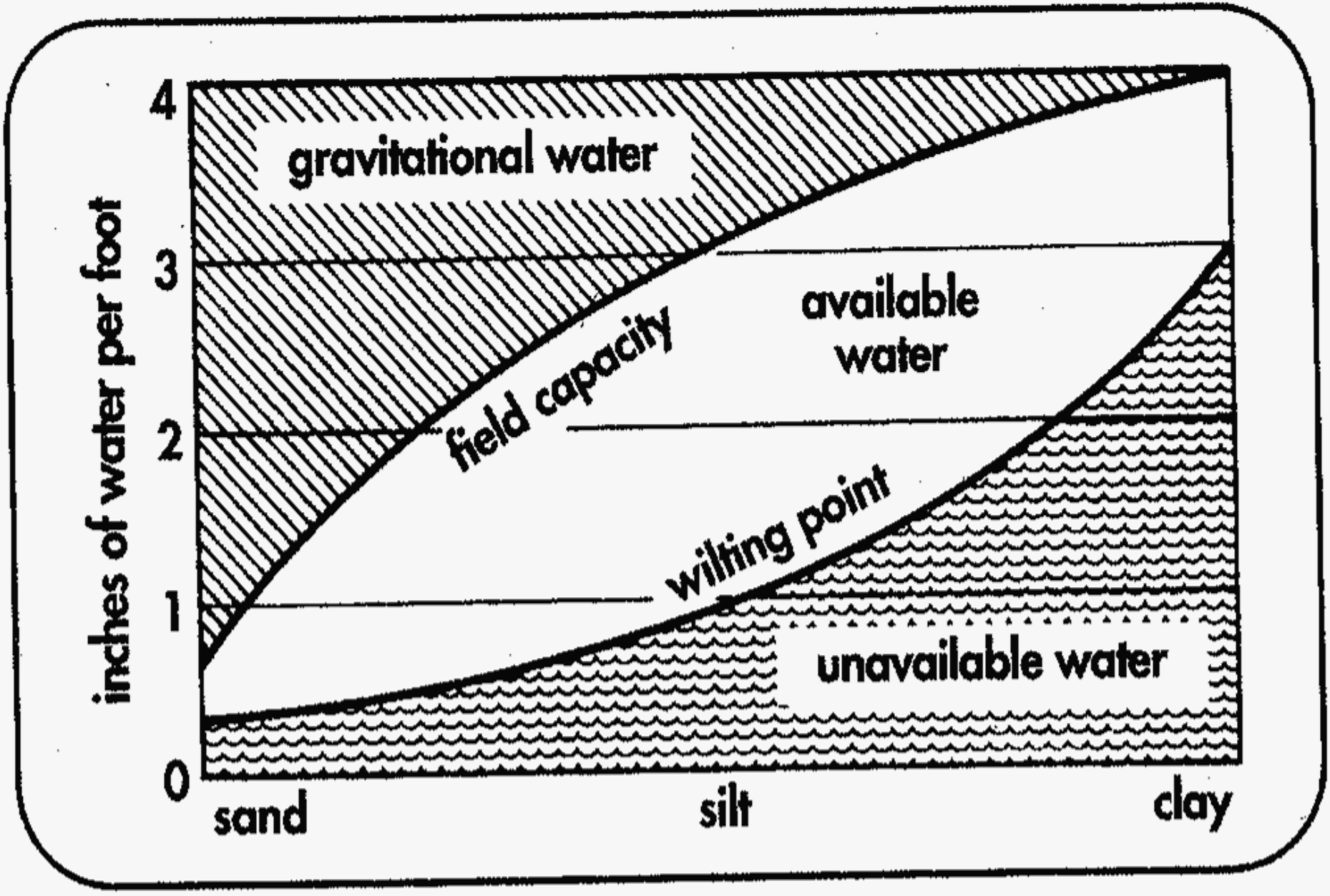
- Includes the soil **biomass**
- Surface soils contain 1-6% OM
- Binds mineral particles into a granular soil structure
- Increase water-holding capacity
- Major source of plant nutrients (N,P,S)

Soil Organic Matter

- **Humus** - collection of complex organic compounds
  - Black or brown in color
  - Important in formation of soil structure
  - Increases soil's capacity for plant growth

Soil Water

- Held within soil pores
- Considered a soil solution
  - Nutrient solution with Ca, K, N, P
- Not all soil water is available to plants
  - **Macro** and intermediate pores - yes
  - **Micro-pores** - no


inches of water per foot
4
3
2
1
0
gravitational water
field capacity
available water
wilting point
unavailable water
sand
silt
clay

Soil Water

- Soil solution (**Figures 1.17,18**)
  - **Neutral**: H^+ ions = OH^- ions
  -
  - **Acidic**: H^+ ions > OH^- ions
  - **Alkaline** or basic: OH^- ions > H^+

Soil Water

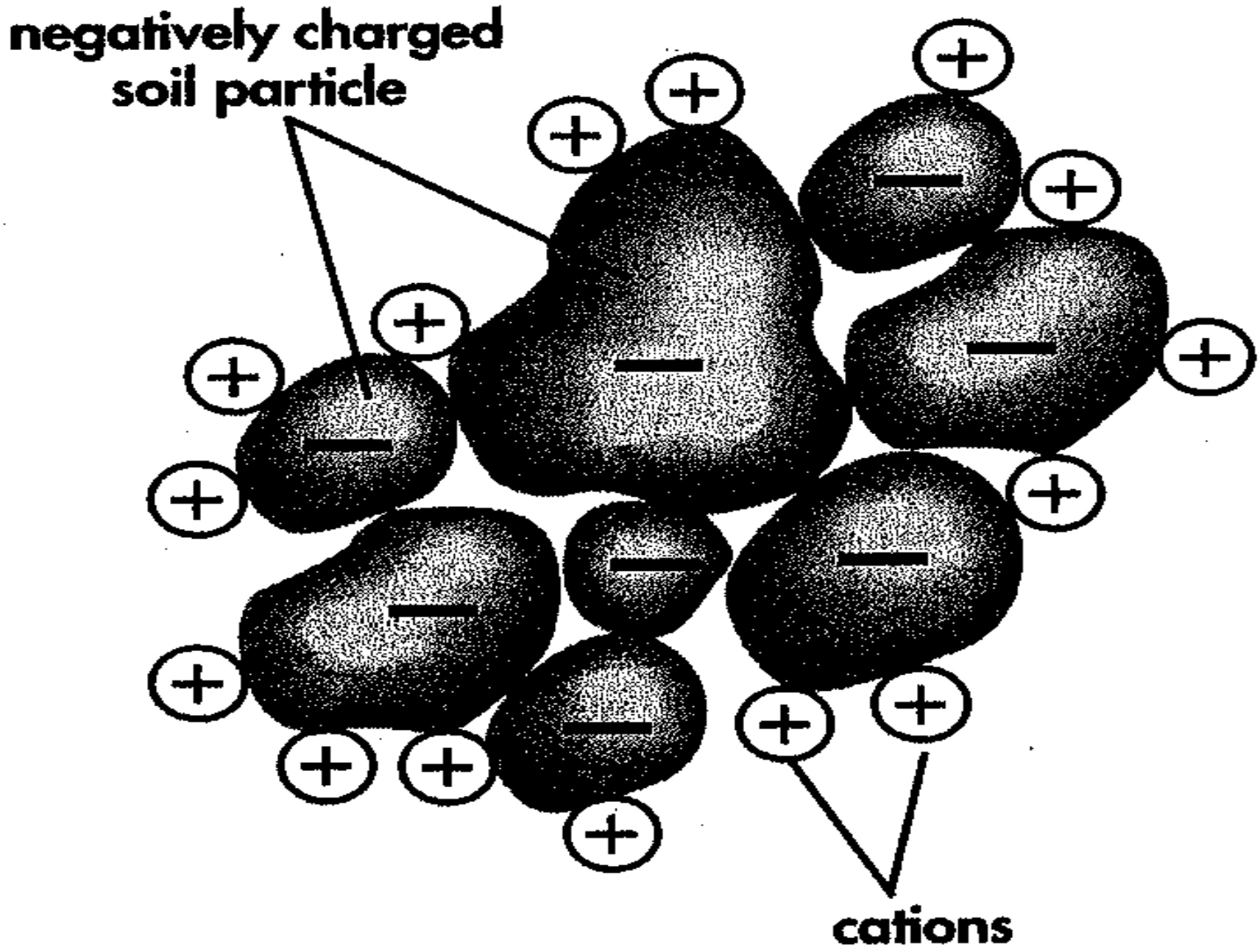
- **pH** = acidity or alkalinity of soil solution
  - Considered **master variable**
  - Controls chemical and biological reactions
  - Bio-availability of nutrients and pollutants

Soil Air

- Air content is inversely related to water content
- Varies greatly from place to place
- Higher moisture content than atmospheric air
- CO_2 is higher and O_2 lower compared to atmosphere

Supplying Plant Nutrients

- Provision of essential nutrient elements to plants
- **Adsorption** or attraction of charge ions
- Held as **exchangeable ions**
  - Most important chemical reaction nature
- **Roots can only absorb nutrients dissolved in soil solution**


negatively charged
soil particle
cations

Nutrient Uptake by Plant Roots

- **Nutrients must be in soluble form!**
- Located at root surface
- Basic mechanisms for nutrient concentration at root surface (**Fig. 1.20**)
  - **Root interception**
  - **Diffusion** - greater concentration to lower concentration
  - **Microorganism activity**

Soil Quality, Degradation, and Resilience

- **Reusable resource**
- Not considered a **renewable resource**
- **Soil quality** - measure of the soil's ability to carry out ecological functions
  - Chemical
  - Physical
  - Biological

Soil Quality, Degradation, and Resilience

- **Resilience** - ability recover from minor degradation
- **Restoration ecology** - restoring of plant and animal communities
- **Soil restoration** - restoring soils to their original condition

KENILWORTH MARSH RESTORATION, WASHINGTON, D.C.

SUMMARY

- Each soil is characterized by unique properties, horizons, and profiles
- Soils perform five ecological functions
  - Medium for plant growth
  - Regulate water supplies
  - Recycle raw materials and waste products
  - Engineering medium for construction

SUMMARY

- Soil is a major ecosystem
- Good surface soil for plant growth is:
  - 1/2 soil material (minerals/organic matter)
  - 1/2 pore spaces filled with water and air