

# University of California Cooperative Extension Alameda County: 100 Years & Counting!



**Problem-solvers, catalysts, collaborators, stewards and educators. Since 1914, University of California Cooperative Extension scientists and academics, along with campus and community partners, have been helping make California the nation's leading agricultural state.**

# 100 Years of Cooperative Extension

## Practical. Connected. Trusted.

- UC Agriculture & Natural Resources is celebrating the centennial of the passage of the Smith-Lever Act and the beginning of Cooperative Extension in California.
- Local programs:
  - Master Gardeners
  - 4-H
  - Viticulture
  - Weed Science
  - IPM
  - Livestock & Natural Resources
  - Watershed Management
  - Food Systems

## UCANR Strategic Initiatives



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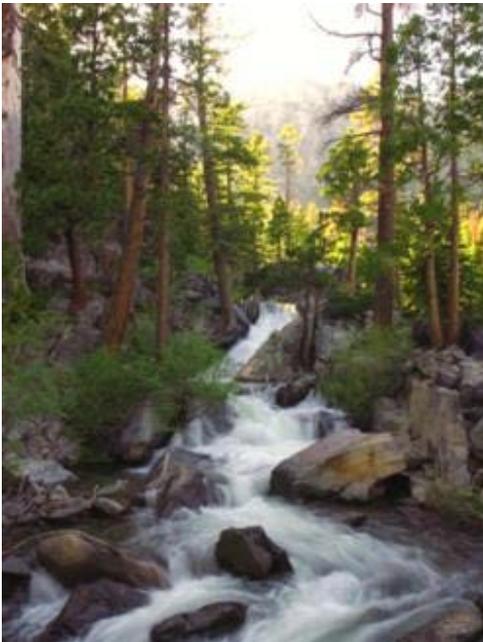
## Endemic and Invasive Pests and Diseases



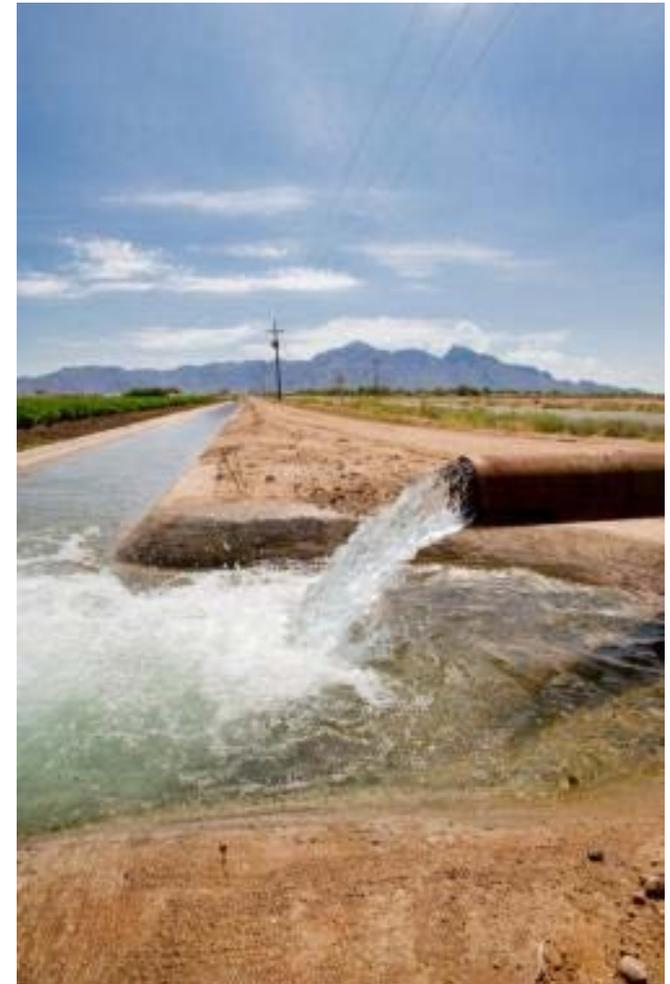
## Healthy Families and Communities



## **Sustainable Food Systems**



## **Sustainable Natural Ecosystems**



## **Water Quality, Quantity and Security**

**Today, the University of California Cooperative Extension  
is Still Here Working with  
Community & Government Partners  
to Develop a Healthy California!**



**100 Years and Counting!**

**Happy Birthday UC Cooperative Extension!**

**&**

**Thank You to All Who Work With Us and  
Support Our Work!**

# Improving *Your* Soil Quality



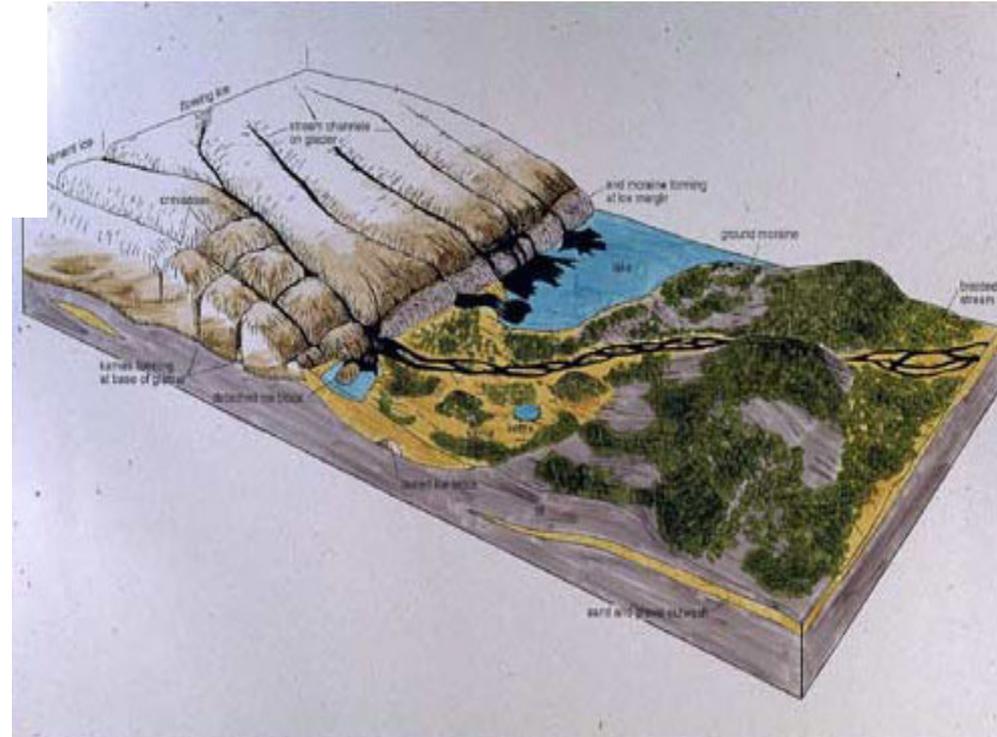
**Rob Bennaton**

Bay Area Urban Agriculture Advisor

University of California Cooperative Extension

# Soils Formation

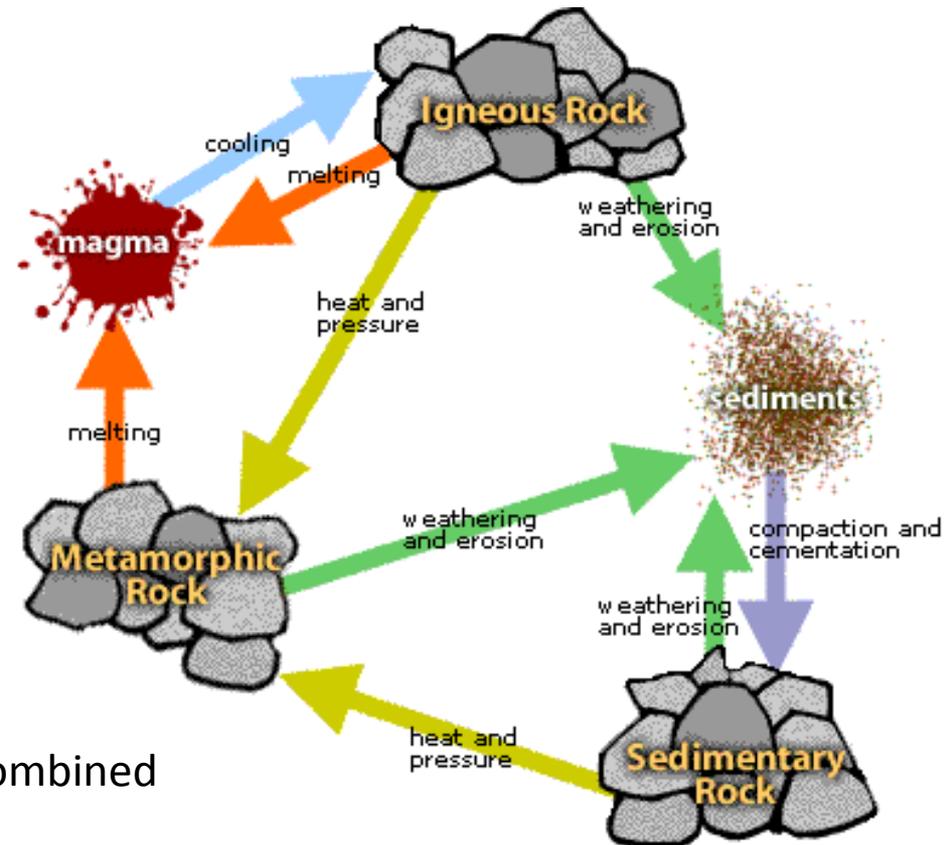
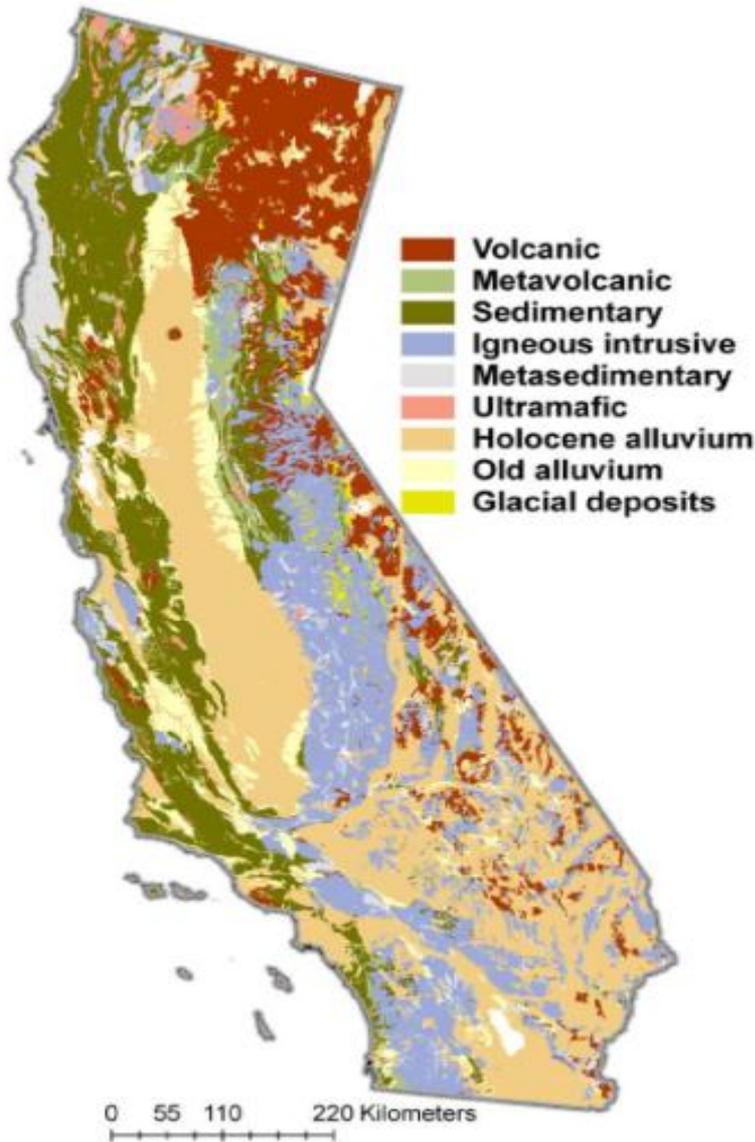
## -Weatherization and Glaciation



# Soil Formation

Concept:

- Parent Material → Particle Size/Density



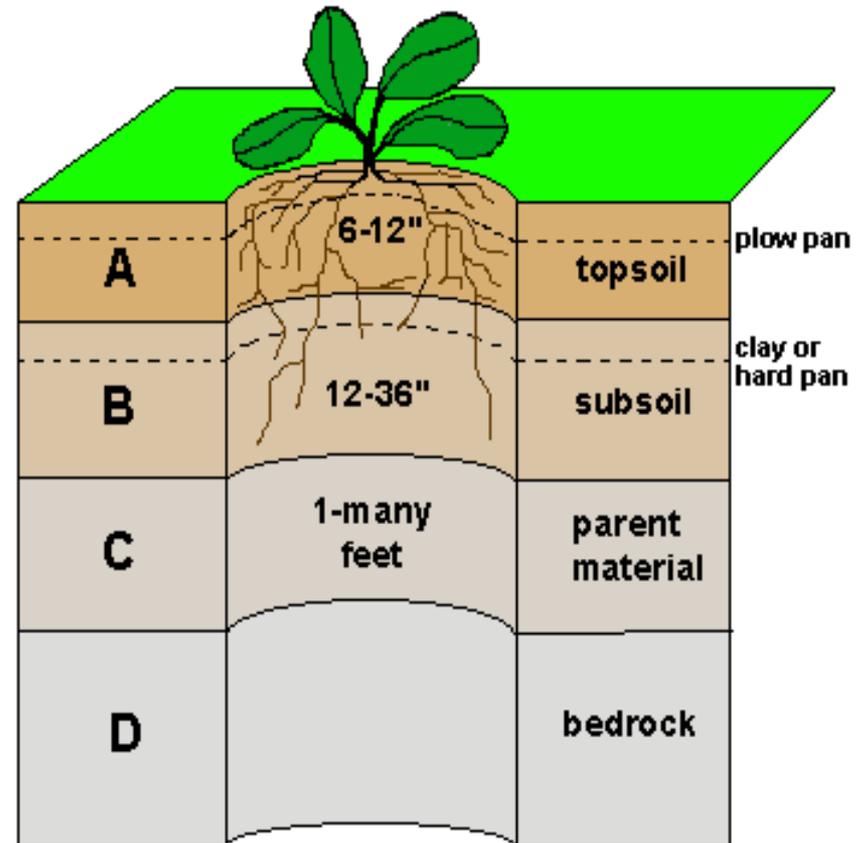
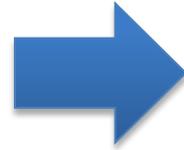
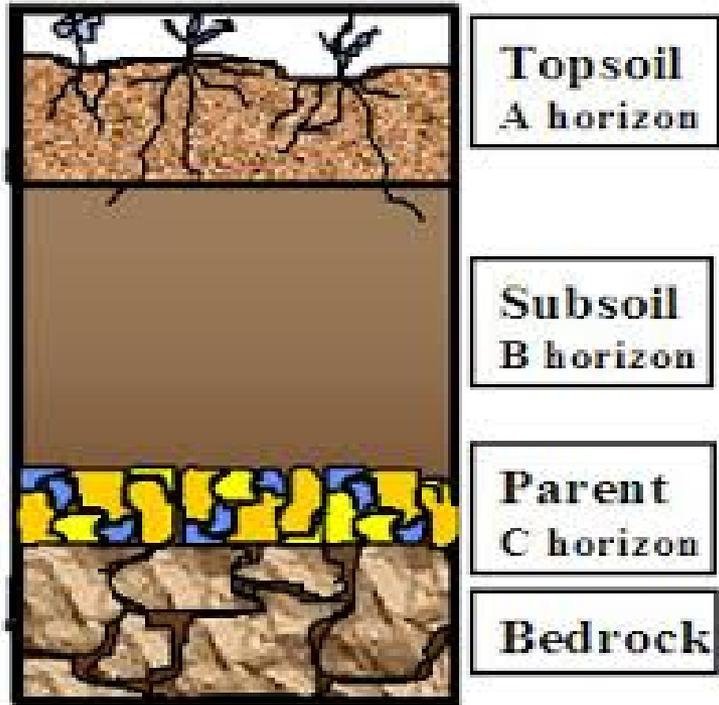
Based on Temperature, Pressure, Weather Combined

# Soil Formation



Concept:

- Particle Size, Pore Size and Organic Matter  
→ Aggregate Stability



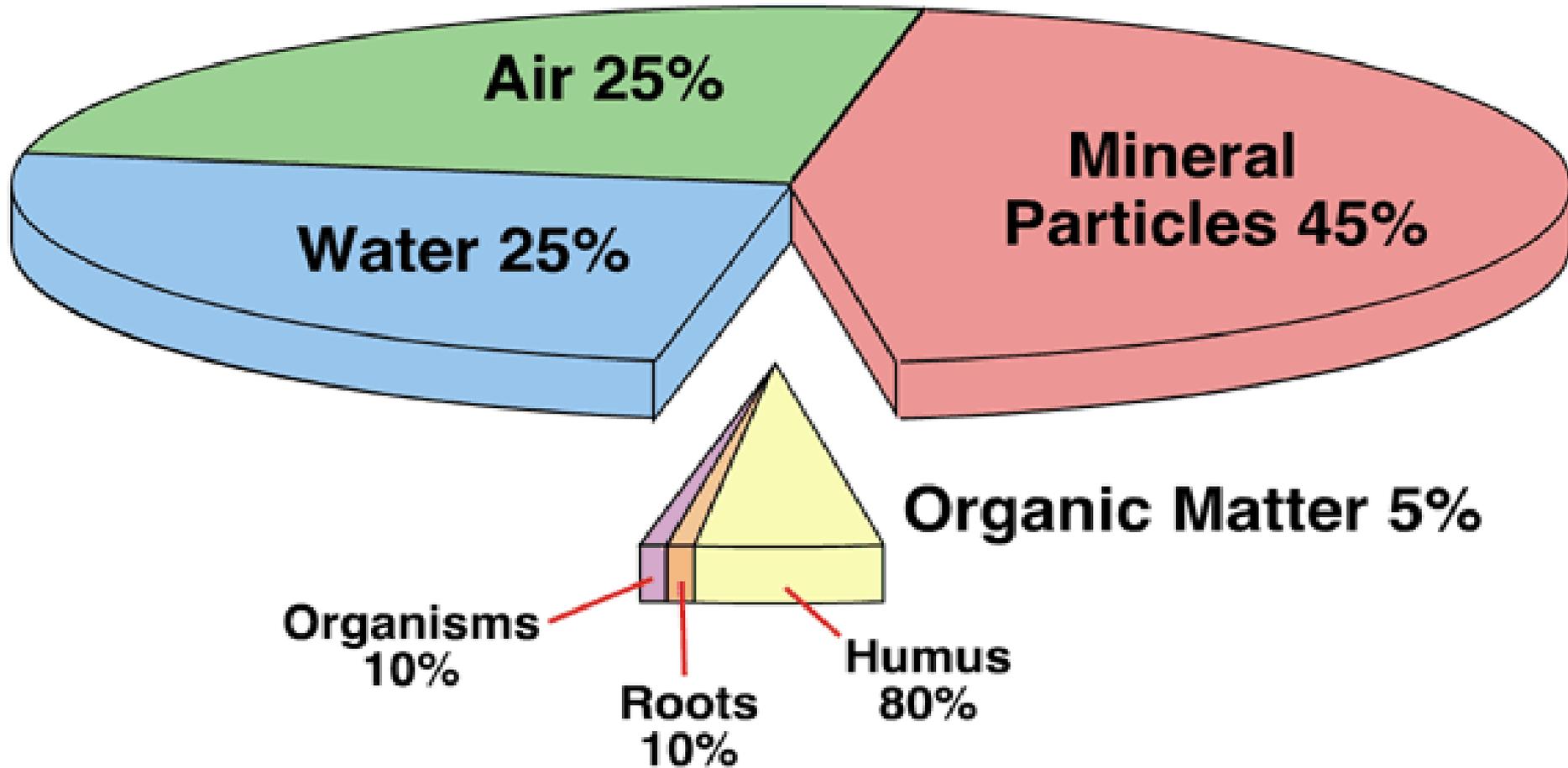
# Your Goal:



# *The Four Things Plants Need?*

- Water → H<sub>2</sub>O
- Sunlight → Energy
- Nutrients → Macro-, Micro-
- O<sub>2</sub> → For Respiration

# *The Soil Matrix Pie Chart*

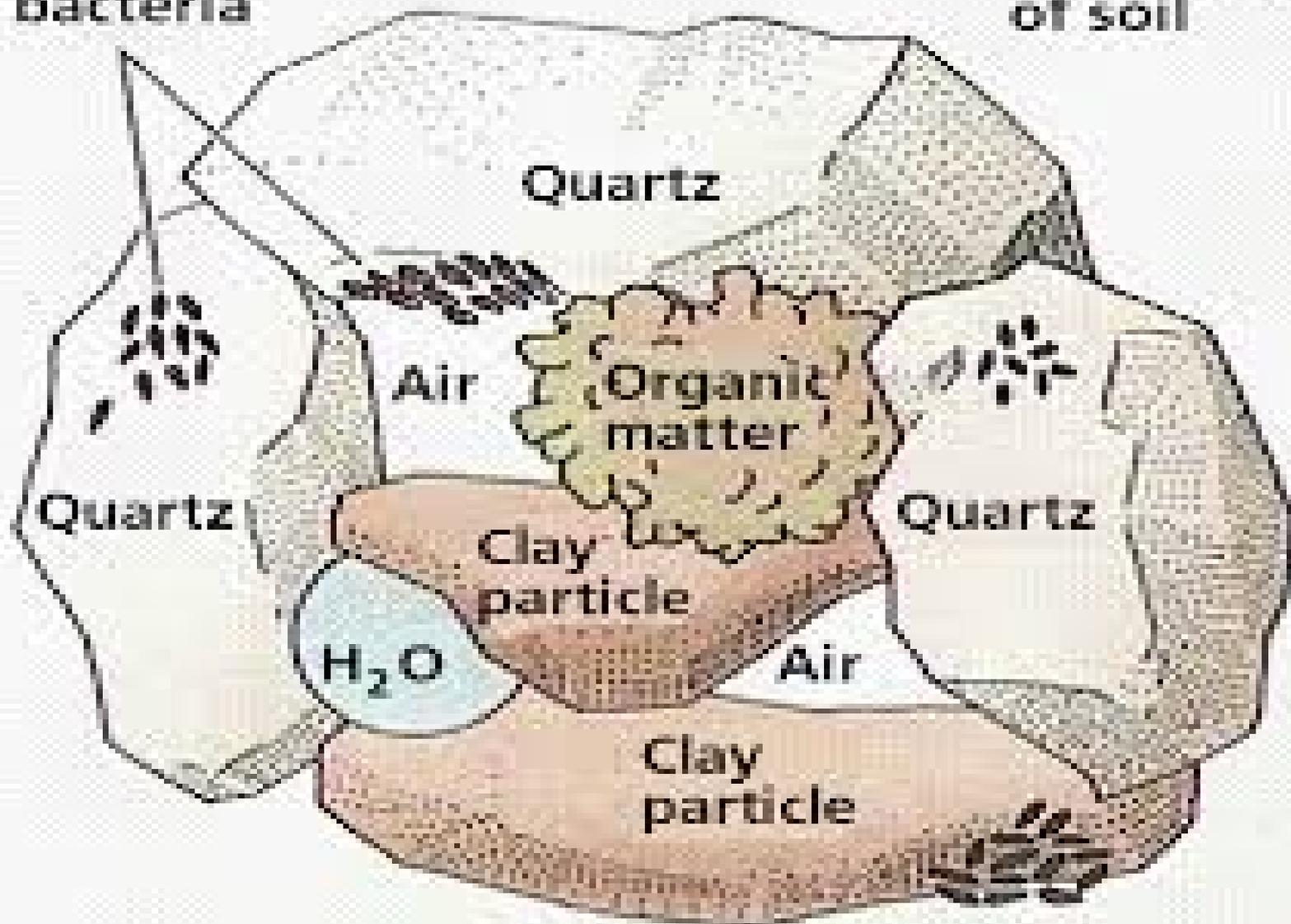


*Soil is a matrix of minerals, Organic Matter, O<sub>2</sub>, H<sub>2</sub>O & living organisms.*

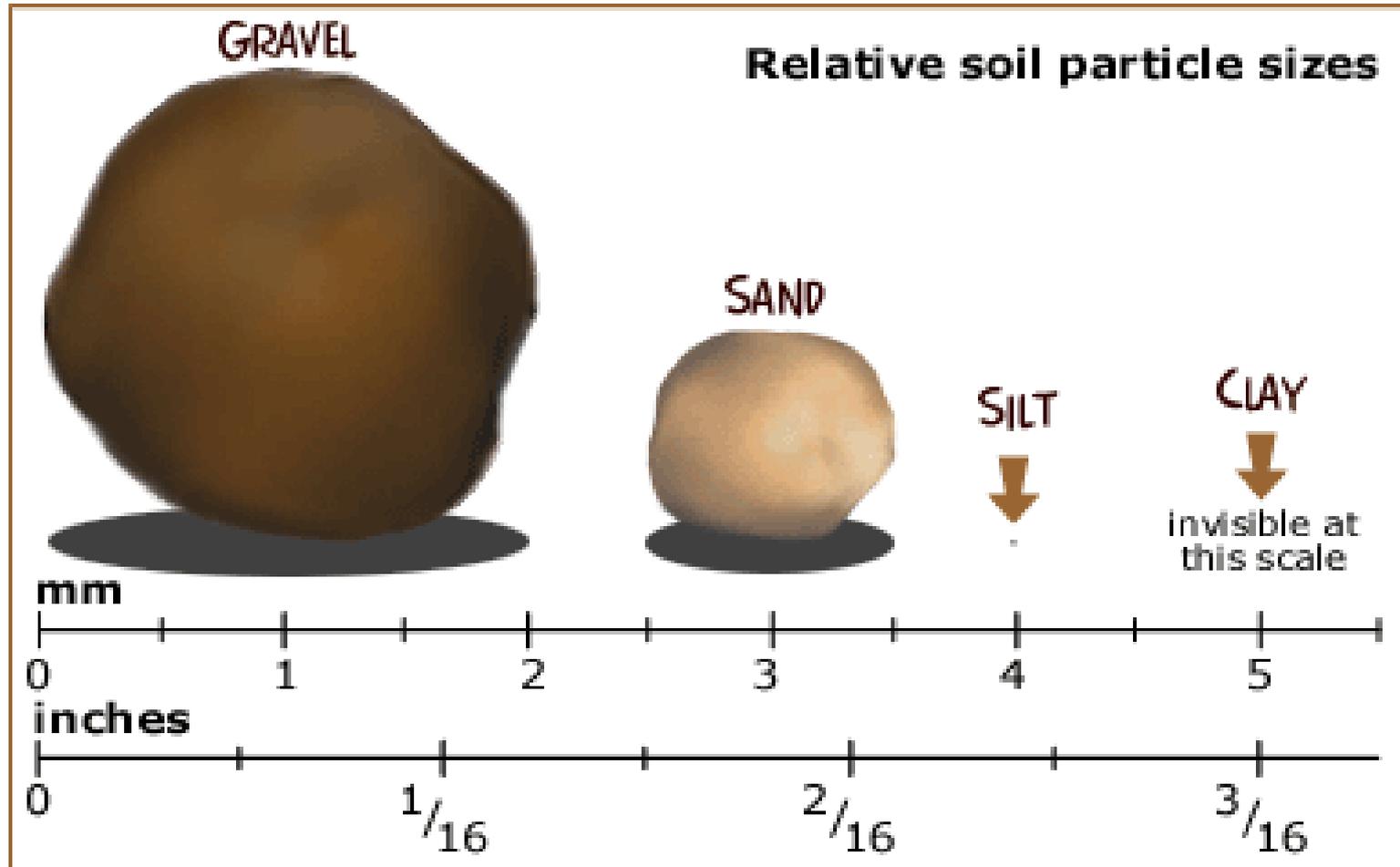
# *The Soil Matrix*

Microcolonies  
of bacteria

The complexity  
of soil



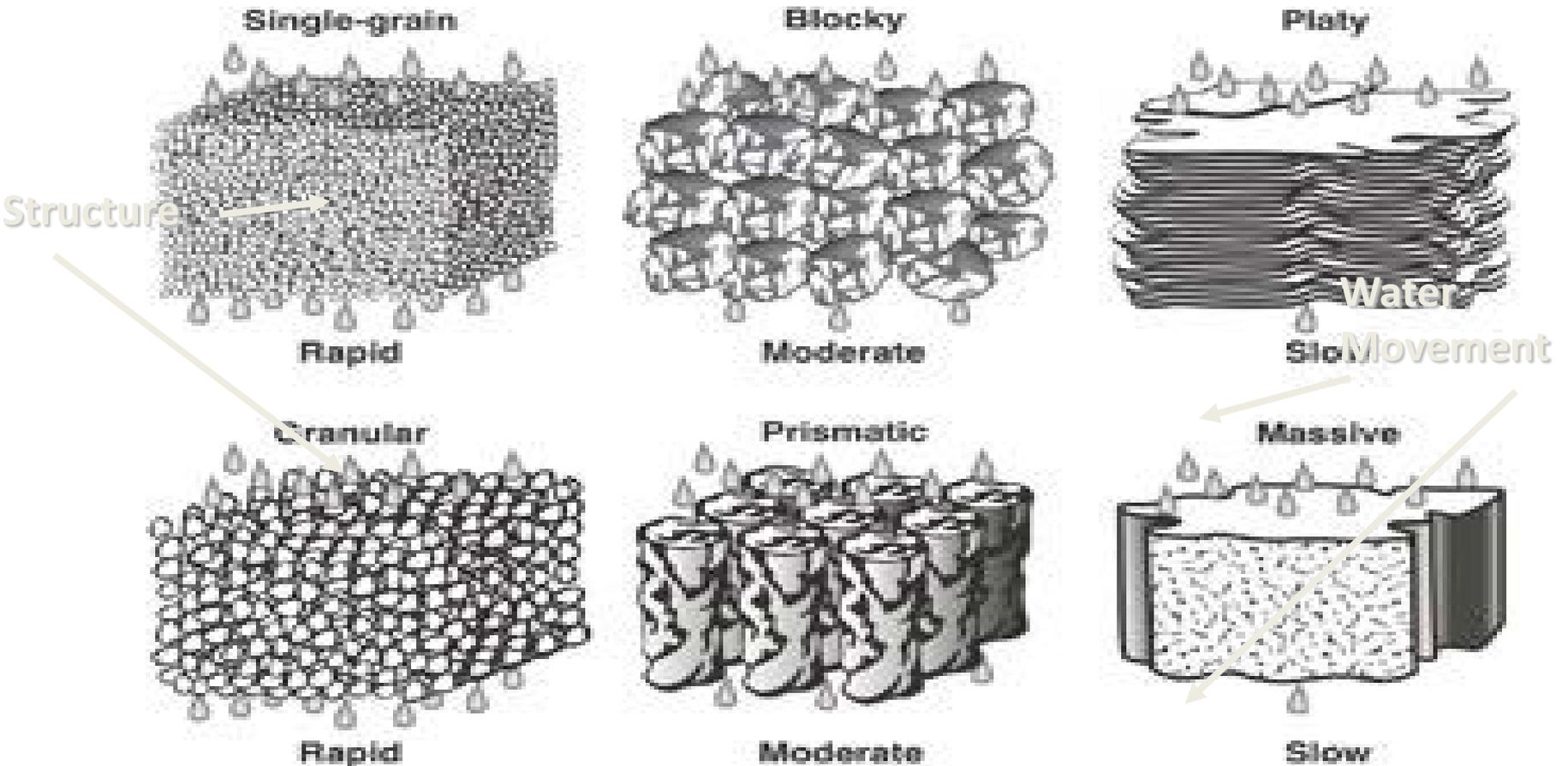
# Particle Size

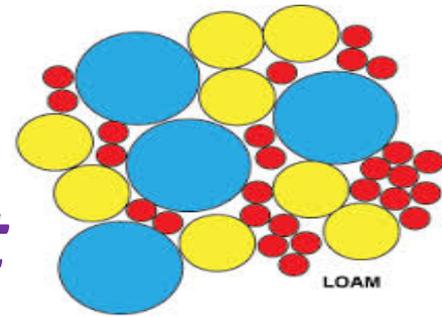


# Porosity

- *Soil porosity* is the % of a soil that is pore space or O<sub>2</sub>/H<sub>2</sub>O.
- The average soil has a porosity of about 50%
- Sands have larger pores, but less total pore space than clays.
  - Bulk Density: dry weight of soil divided by its volume.
  - -includes the volume of soil particles and of pores in between.
  - -Expressed in g/cm<sup>3</sup>

# Concept: Think About Water & Air Movement





***CONCEPT: How does structure affect water movement in soils?***

- In soils with good structure, the pore space that occurs between peds is relatively large and facilitates water and air movement.
- Well-developed structure is very important in clayey soils.
- Clayey soils with poor structure restrict water and air movement.

# *Physical Indicators of Soil Quality*

- **Color** -Visual Test
- **Soil Texture**
  - Texture-by-Feel
  - Ribbon Test
  - Soil Suspension/Sedimentation Test: % of Sand, Silt & Clay



Soil Texture is the single most important physical property of the soil.

It helps the grower recognize:

1. Water flow potential & holding capacity
2. Fertility potential
3. Suitability for urban uses like bearing capacity



*Physical Indicators of  
Soil Quality*

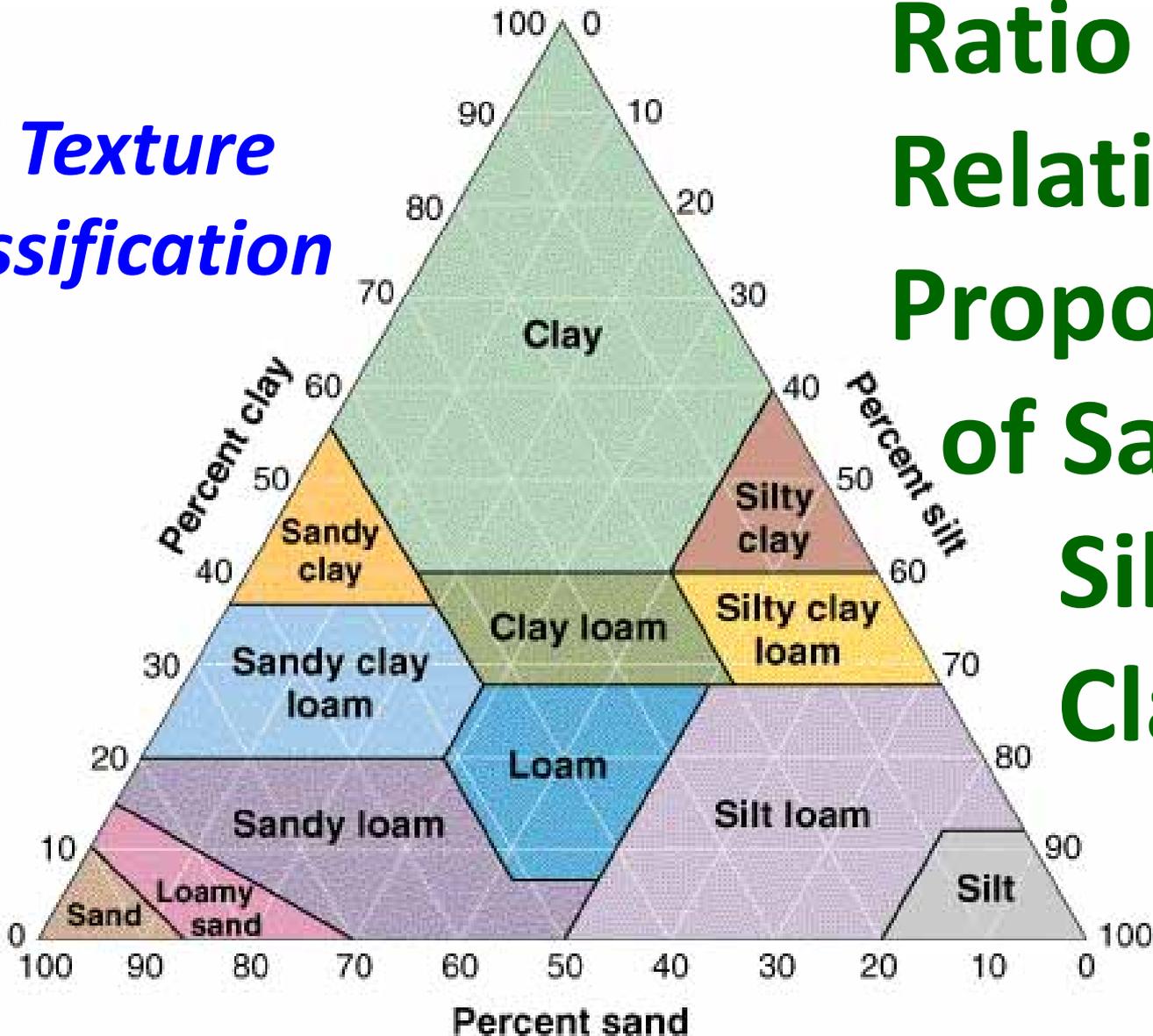
*See Soil*

*Suspension/Sedimentation*

*Test Instructions*

# Physical Indicators of Soil Quality

## Soil Texture Classification



**Ratio or  
Relative  
Proportions  
of Sand to  
Silt to  
Clay**

# *Chemical Indicators of Soil Quality*

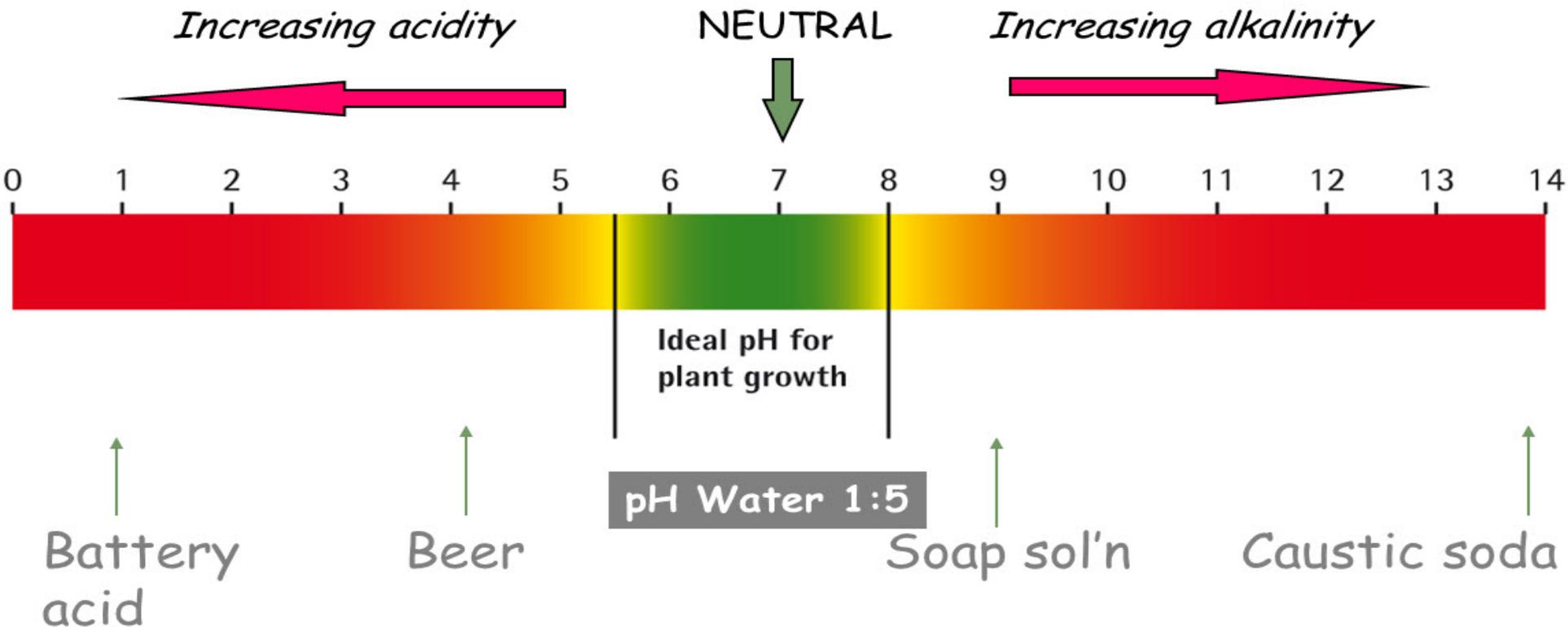
- pH Test (Range: 0-14)
- Electro-Conductivity Test for Soluble Salts (Unit: PPM)
- Cation Exchange Capacity

# Chemical Indicators of Soil Quality

- **Soil pH Scale**

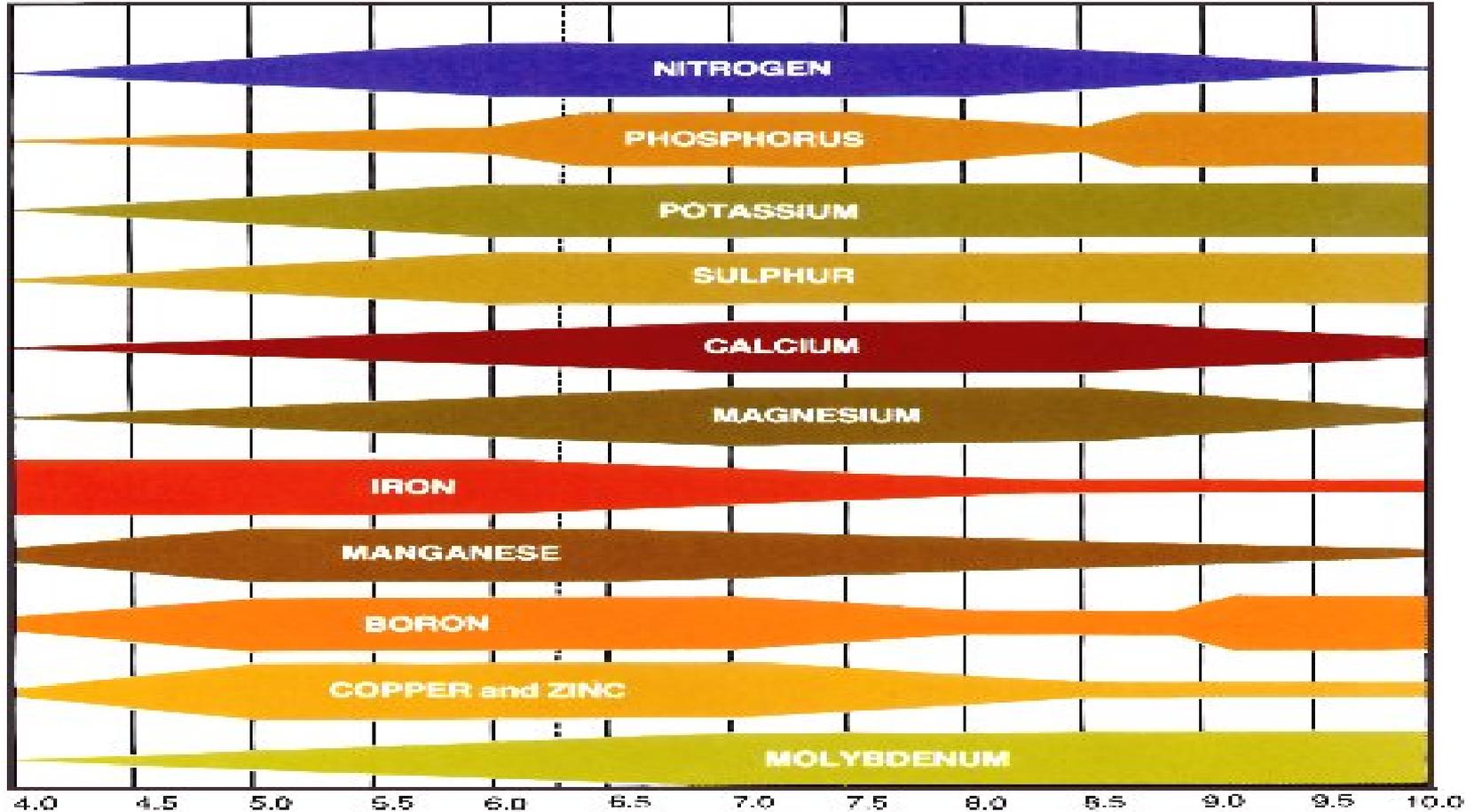
## Soil pH - what is it?

- measure of the acidity or alkalinity of a soil
- concentration of hydrogen ions ( $H^+$ ) in the soil solution

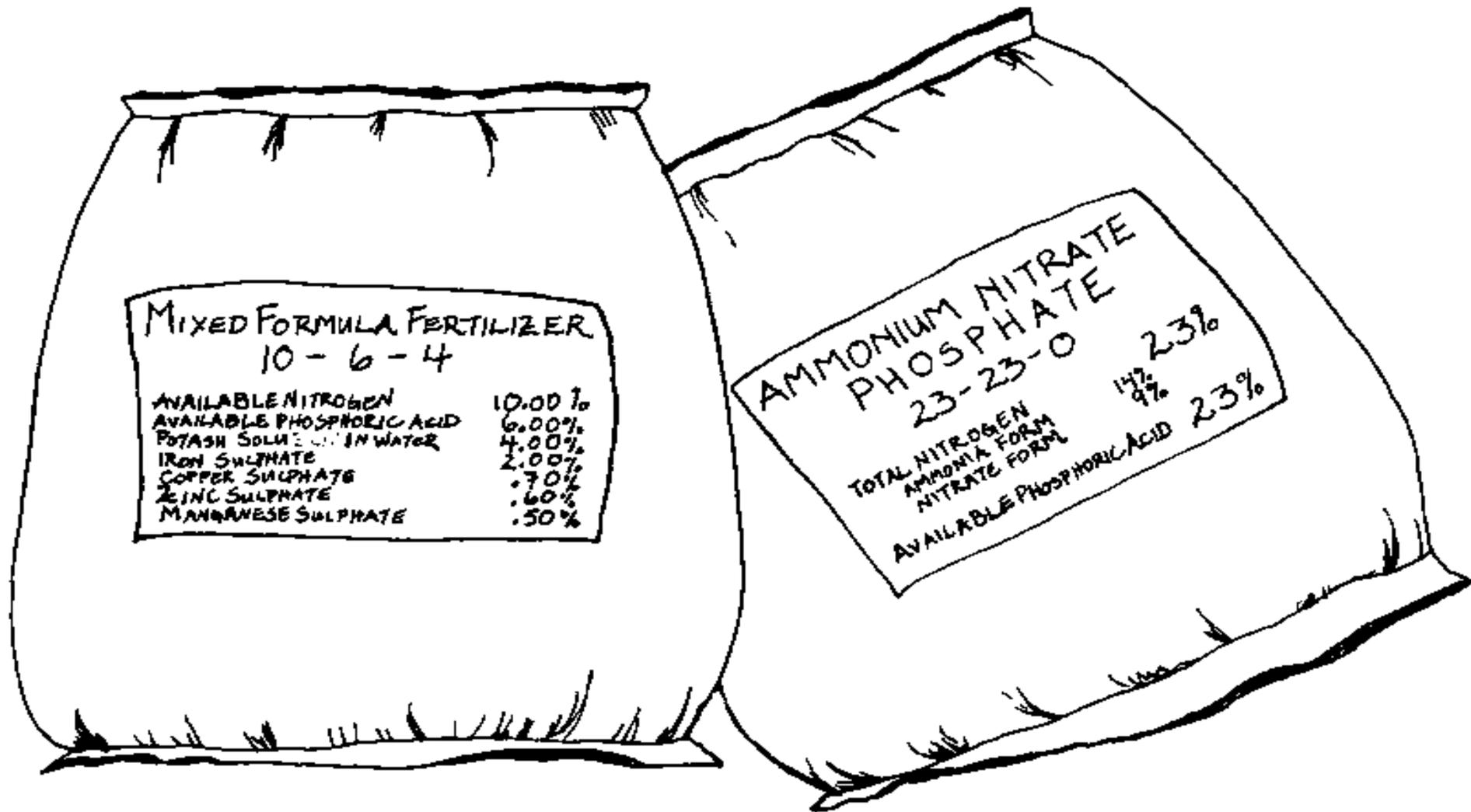


# *Chemical Indicators of Soil Quality*

*pH ~ Macro/Micro-Nutrient Absorption*



# N P K



Mixed Formula Fertilizer  
10-6-4

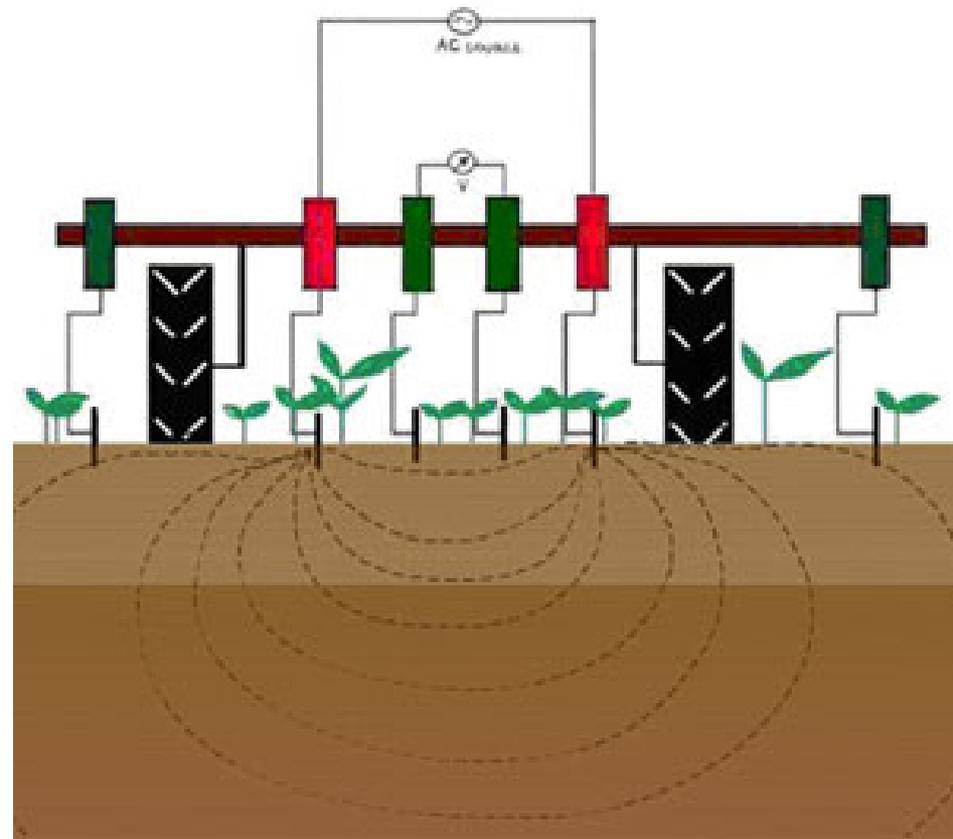
AVAILABLE NITROGEN	10.00%
AVAILABLE PHOSPHORIC ACID	6.00%
POTASH SOLUBLE IN WATER	4.00%
IRON SULPHATE	2.00%
COPPER SULPHATE	.70%
ZINC SULPHATE	.60%
MANGANESE SULPHATE	.50%

AMMONIUM NITRATE  
PHOSPHATE  
23-23-0

TOTAL NITROGEN	14%	23%
AMMONIA FORM	9%	
NITRATE FORM		
AVAILABLE PHOSPHORIC ACID		23%

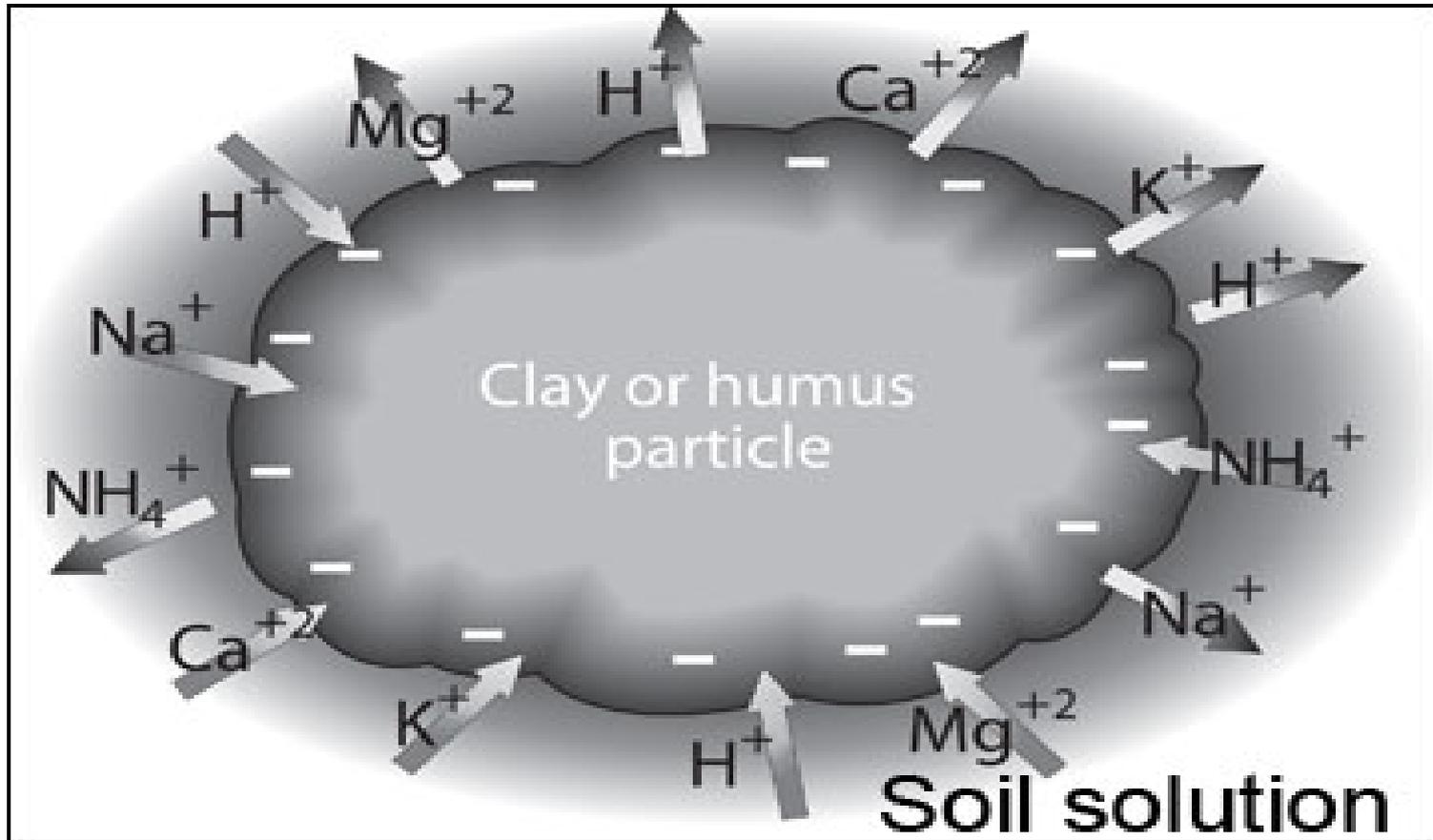
# *Chemical Indicators of Soil Quality*

*Electro-Conductivity Measures  
Soluble Salts and Fertilizer Tie Up (PPM)*

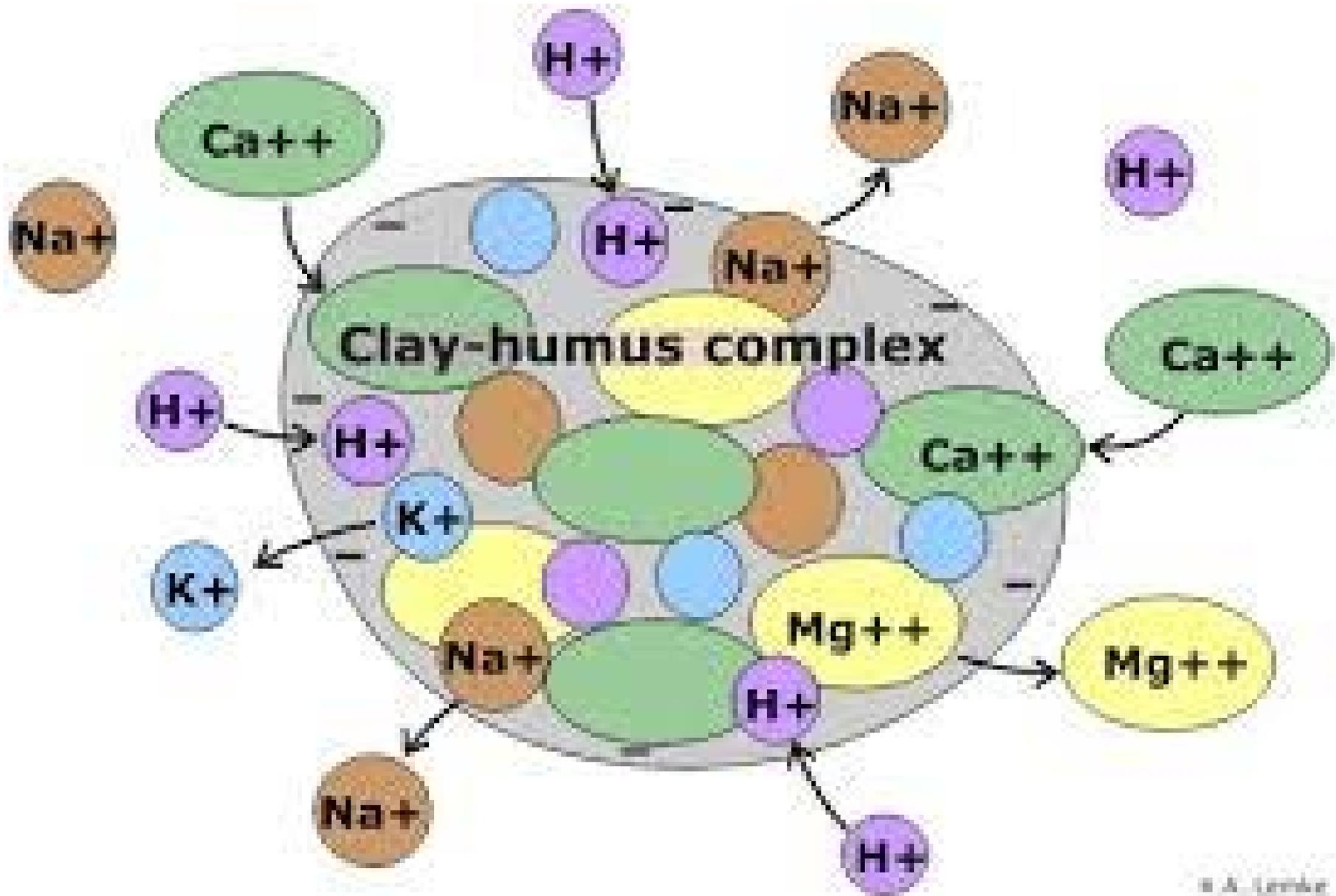


# *Chemical Indicators of Soil Quality*

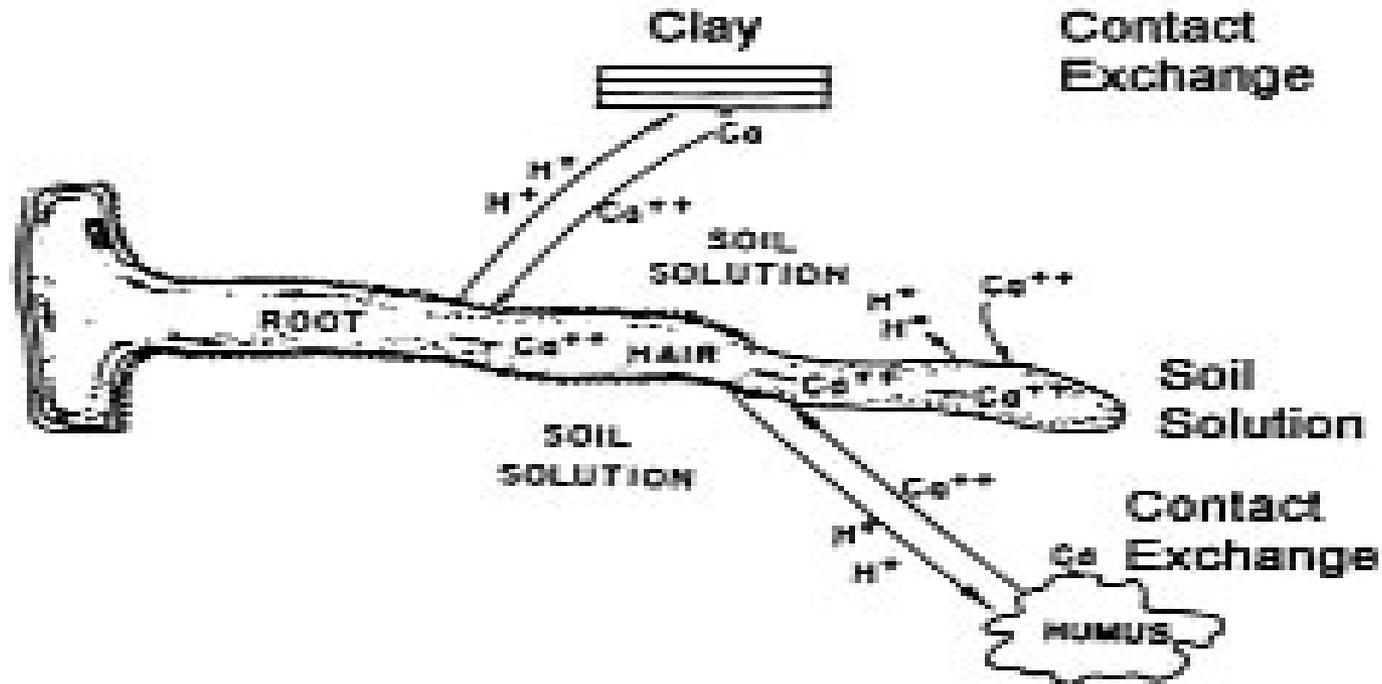
## *Cation Exchange Capacity*



**Soil CEC measures a soil's negative charge!**



# Cation Exchange at Root Tip



*Diagrammatic scheme showing how root hair takes in nutrients from exchangeable ions on a clay crystal and on humus, and from soil.*

# Concept:

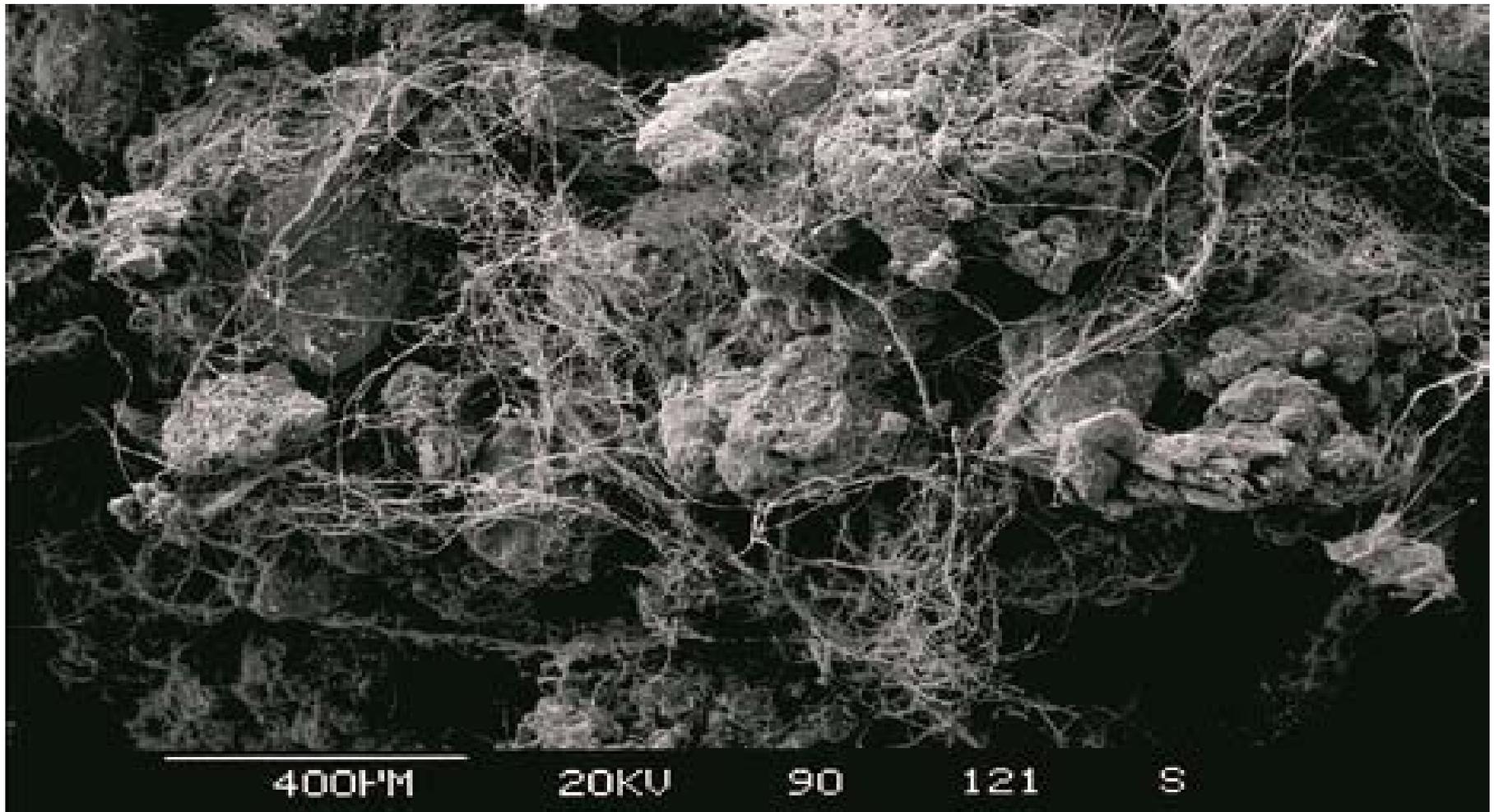
## Organic Matter (and Clay)

- Has a Large Surface Area
- Incorporating OM Enhances Nutrient Exchange in Root Zone
- $\uparrow$  % *Organic Matter*
- $\uparrow$  *Cation Exchange Capacity*

## *What is Organic Matter?*

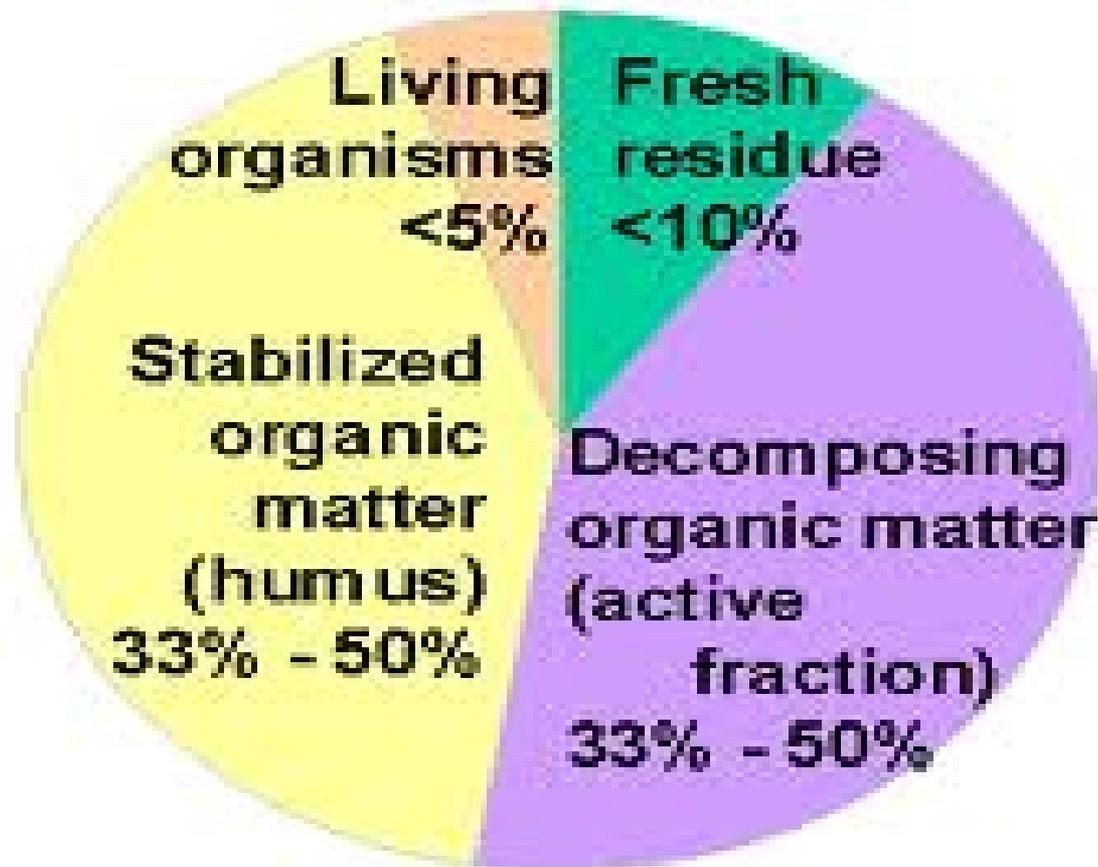
- **H**      **Hydrogen**
- **O**      **Oxygen**
- **N**      **Nitrogen**
- **C**      **Carbon**

***HONC Your Horn!!!***



**Fungal networks:** *Threadlike fungal networks hold soil particles and micro aggregates onto the surface of crop residues as part of the formation of stable soil aggregates. Cultivation disrupts soil aggregates whereas minimum till combined with stubble retention enhances aggregate stability, stimulates microbial growth and improves soil structure.*

# Your Goal



# *Chemical Indicators of Soil Quality*

## ***CONCEPT:***

***Cation Exchange Capacity (CEC)***

***→ ~SOIL FERTILITY***

***by Affecting Water Holding Capacity  
& Nutrient Holding Capacity***



# *Biological Indicators of Soil Quality*

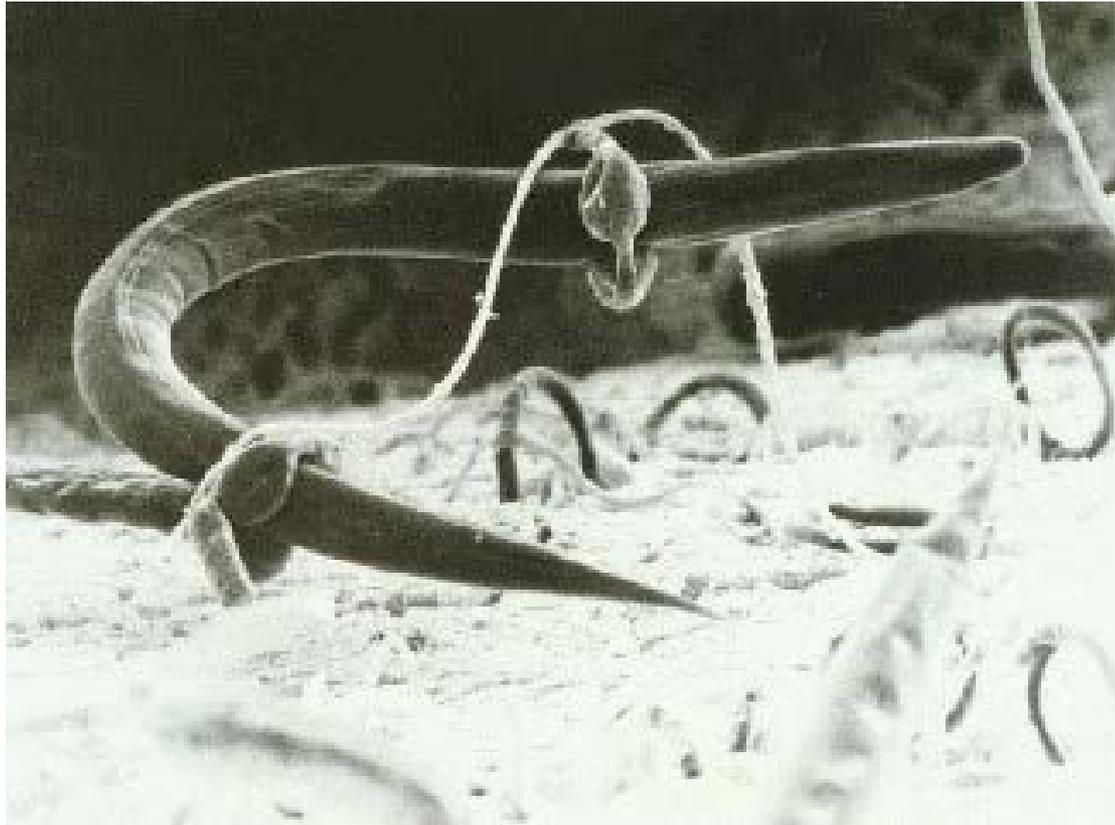
*Secret:*

*(Soil Biodiversity)*

*Bacteria, Worms, Pill Bugs, Centipedes &  
Millipedes, etc.*

*SSShhhhhhhhh.....*

*Don't scare the Micro-Ecosystems!*



*A root feeding nematode is trapped by a fungus; the fungus gives off a substance similar to that given off by the roots of plants.*

<http://organicsoilsolutions.com/education-center/the-soil-food-web/>

# *Limiting Factor*

- *Limiting Factor for Plant Growth=Nitrogen*
- *Limiting Factor for Plant-Nitrogen Availability=Carbon*
- *Carbon:Nitrogen Ratios (3:1 or 2:1)*  
*(Think Compost Piles)*

# *Soil Amendments to Improve Fertility*

- *Manures*
- *Compost*
- *Nitrogen (Greens):Carbons (Browns),  
& Nitrogen Tie-Up*
- *Organic Amendments: Blood Meal & Bone Meal*
- *Water Solubility & Synthetic Fertilizers*
- *Embedded Energy*

# Effects of Soil Compaction

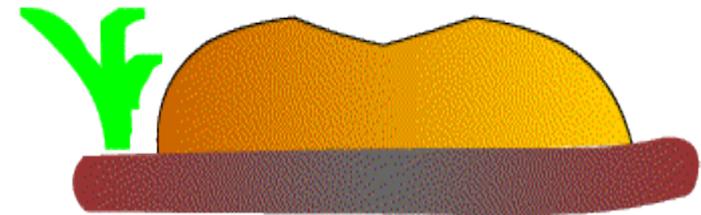
- *Reduced Root Penetration & Water Infiltration/Permeability*
- *Decreased Pore Size and Root Zone Soil-Temperature (Think Tomatoes)*

**RESPONSE: RAISED BEDS**

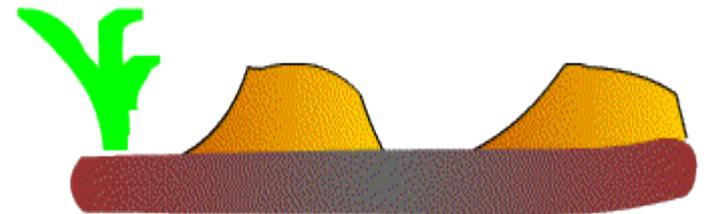
Raised Bed Styles



Flat, for light, sandy soil



Rounded for good humus



Trench in the middle, more drainage

***Soil Amendments for  
Managing Compaction:  
Mulches***

***Of Many Kinds.....***

***Soil-Protection  
& Watering***

***Cover Crops, Inter-Planting  
& Companion Planting***

# Sources of Heavy Metal/Lead Exposure

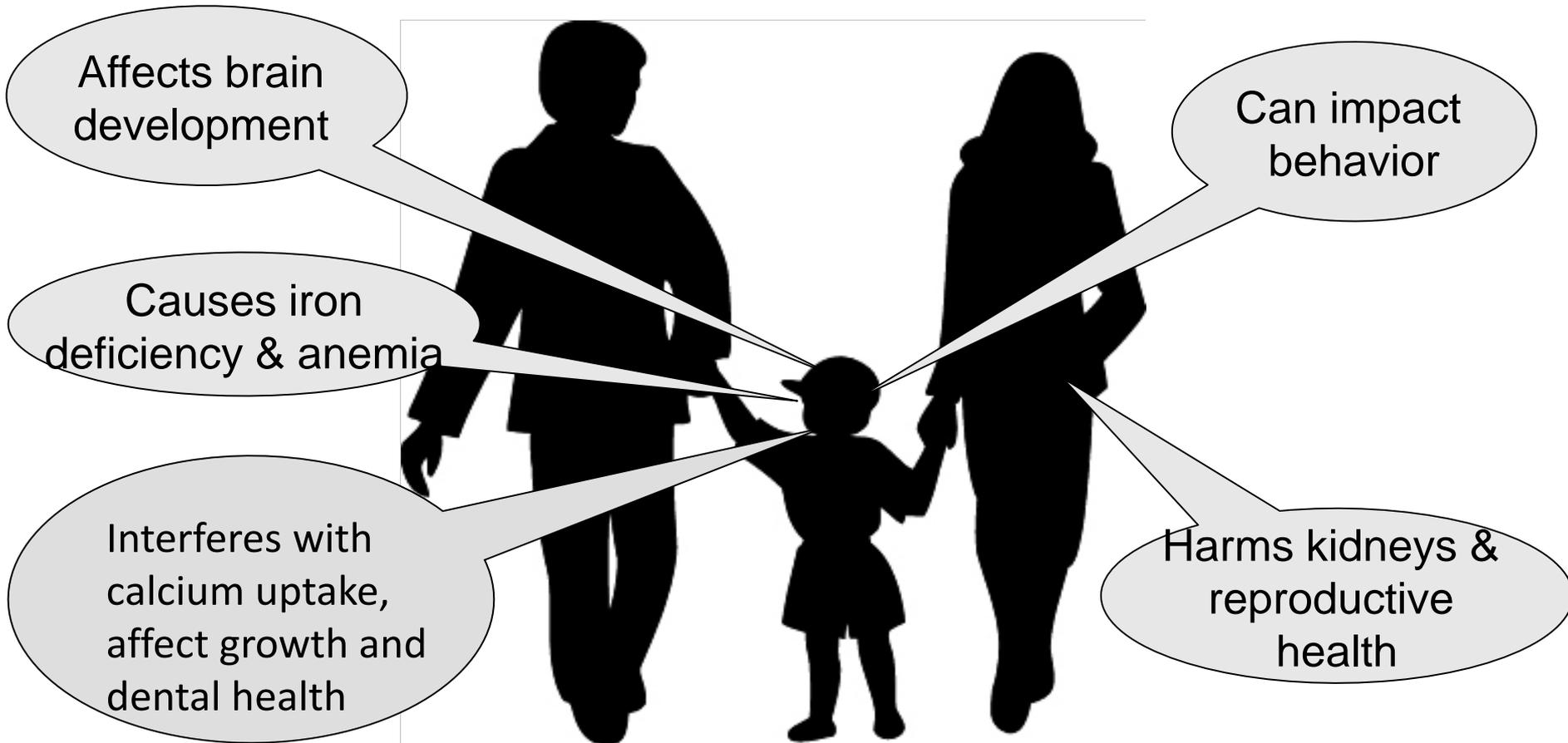
- Lead **paint** hazards  
→ lead **dust** in homes;  
from exterior prep work  
& friction of windows
- Bare **soil** in yards with  
lead contamination from  
house paint or previous  
use of leaded gasoline
- **Take-home** lead dust  
from construction work  
or other occupations



# Understand: How do we get lead into our body while growing food?

- **Hands contaminated with leaded soil**  
*Contaminated hands touch mouth, food, drink container, cigarette*
- **Hands contaminated with leaded paint**  
*Hands touch damaged lead paint and its dust. Then hands touch mouth, food, drink container, cigarette, etc.*
- **Eating lead-containing soil or paint dust on unwashed produce, or eating produce that has lead uptake**

# How Lead Toxicity Affects Health!!!



**Children at most risk-** their brains & bodies are still developing (& fetus, because lead easily crosses placenta).

## *Site History:*

### *Possible Sources of Lead Risks*

- *Contamination in existing soil from unknown sources*—particles from previous leaded gasoline use, demolition of building, etc.
- *History of Industrial Use*
- *Pre-1979 buildings with Chipping Paint*

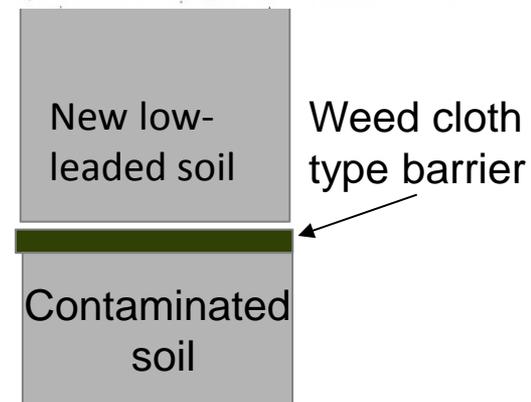
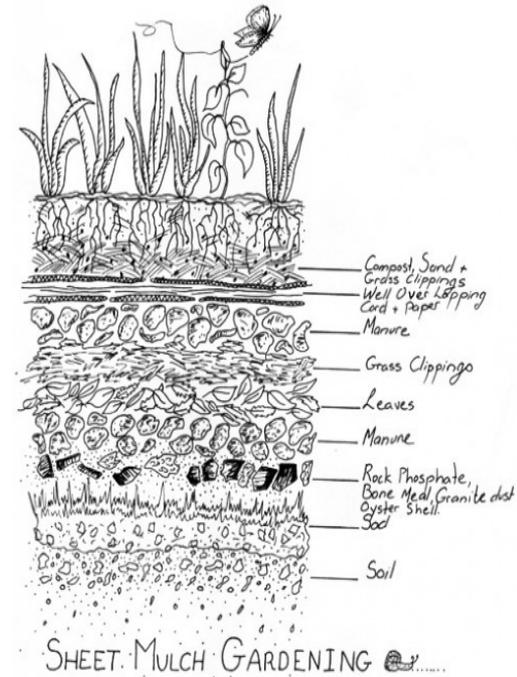
# Best Practices to Reduce Heavy Metal Exposure from Growing Food

- *Wear Gloves & Practice Good Personal Hygiene*
- *Garden in low-leaded soil when possible*
  - *Buy Organic Materials Review Institute (OMRI)*
  - *Test soils to confirm lead is < 80 ppm*
- *Don't Let Kids Garden/Play in > 80 ppm Soils*
- *Be Aware of Soil Contamination →*

***Watch for Site Risks!!!!!!!!!!!!***

# Ways To Garden Using New Soil

- **In Raised Beds:**  
***No Pressure-Treated Wood,***  
***or Recycled Painted Materials*** ☹️
- **12-18” New Soil on top of the existing soil with a barrier in between, such as a weed cloth**



# Other Gardening Practices

## Best Practices: UC Davis ANR Publication 8424:

- Amend Soil with OM: Clean Compost, Decomposing Leaves, Well-Rotted Manure
- Maintain Neutral pH: Add Limestone if Soil too Acidic

## “Cleaning” Lead-contaminated Soil:

### EPA Experiment in West Oakland:

EPA is adding imported fish bones from Alaska to bind lead into large molecules (pyromorphites) that plants cannot uptake. The lead-bound molecules then remain in the soil.

- Phyto-remediation: Grow plants that are good at lead uptake, such as sunflowers and dispose of plants offsite (rather than in your site-based compost pile)



# UC Cooperative Extension

Serving the People of the  
San Francisco  
Bay Area Counties!!!

By Rob Bennaton,  
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Caption: 8-22-2015 Workshop at the Gill Tract



University of California  
Agriculture and Natural Resources

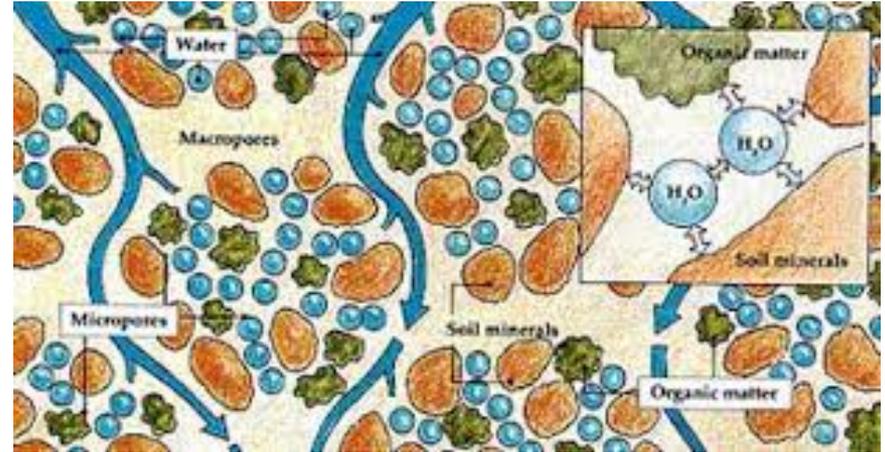
*Happy & Safe*

*Growing!*

*From*

*UC Cooperative*

*Extension!*



*We are all Connected, Like NY Telephone!*

