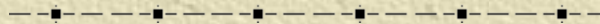




*Marketing
Healthy Soils for
Healthy Plants*

David M. Crohn

Department of Environmental Sciences
University of California, Riverside



Soil Nutrients: macronutrients

✦ Total N

- Organic N

- Available N (nitrate and ammonia-N)

✦ Total P

✦ Total K

Soil Nutrients : micronutrients

✦ Boron

✦ Chlorine

✦ Cobalt

✦ Copper

✦ Iron

✦ Manganese

✦ Magnesium

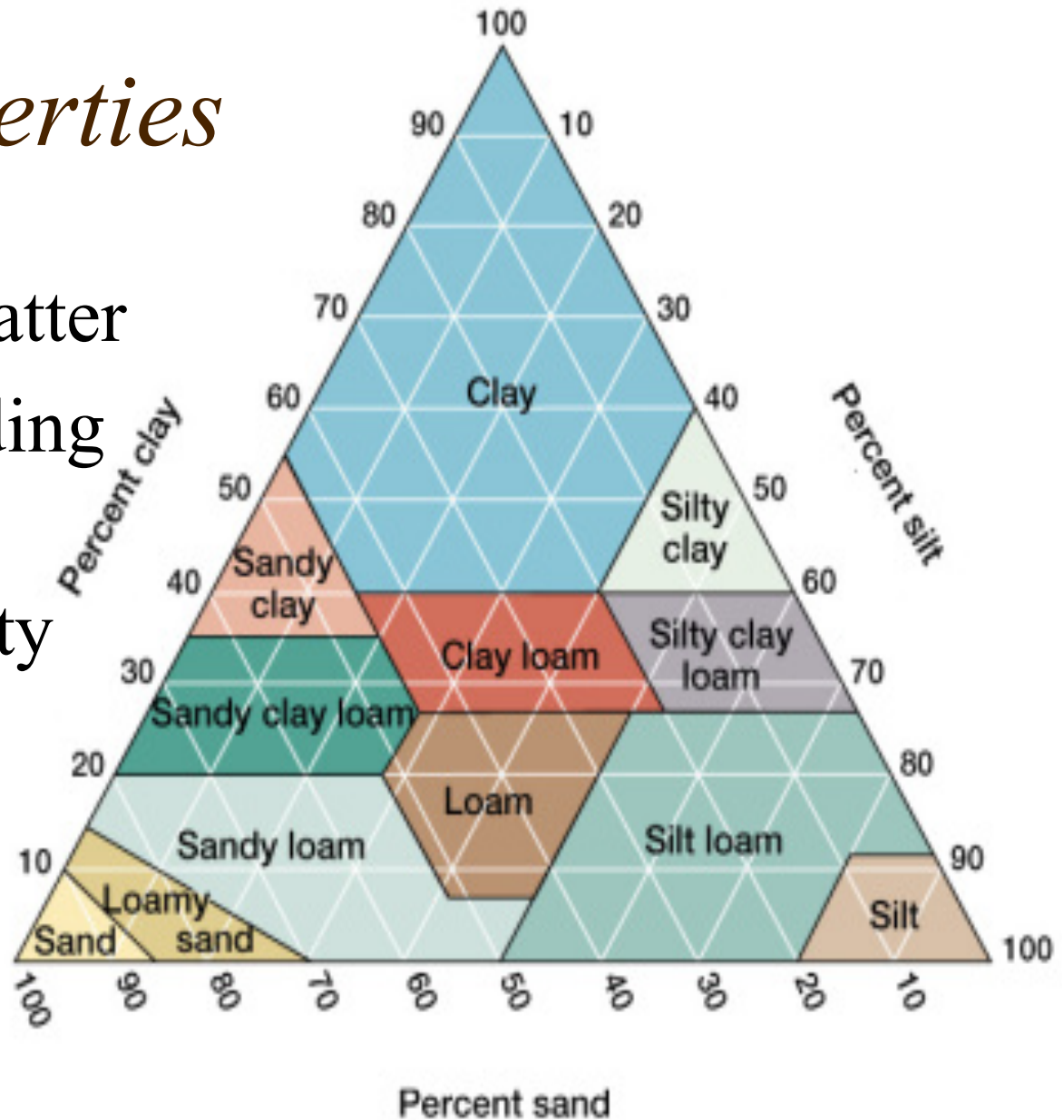
✦ Molybdenum

✦ Sulfur

✦ Zinc

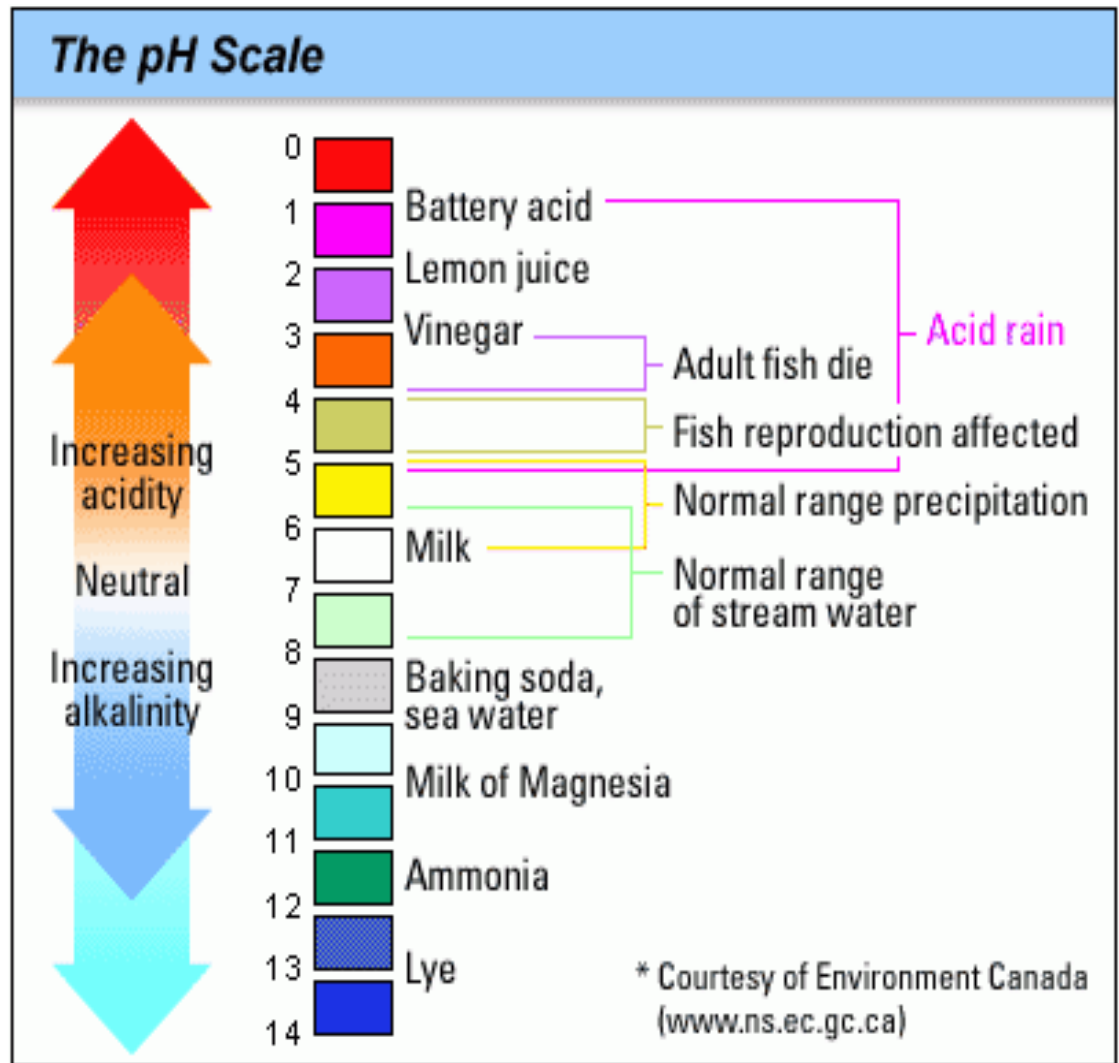
Soil properties

- ✦ Organic matter
- ✦ Water holding capacity
- ✦ Bulk density
- ✦ Structure
- ✦ Texture
- ✦ ECe
- ✦ pH



pH

- ✦ Low pH = acid soil
- ✦ High pH = alkaline soil
- ✦ Neutral pH = 7





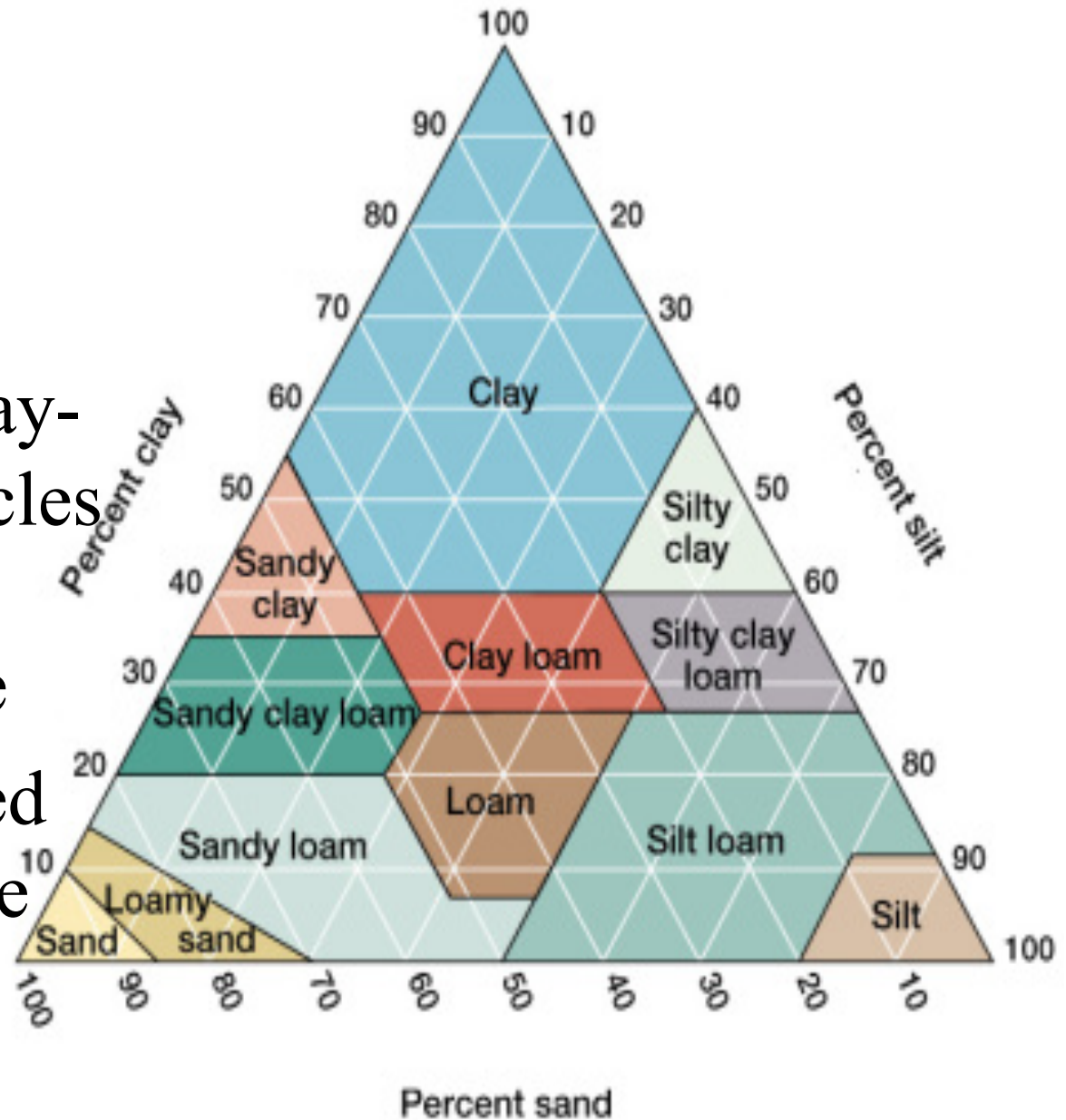
ECe = salinity

- ✦ ECe stands for Electrical Conductivity
- ✦ Salts conduct electricity and this is used to measure them in soils
- ✦ High ECe soils may have trouble germinating seeds and supporting growth
- ✦ ECe is a water management indicator, more than a soil property

Texture

✦ The sand, silt, and clay-sized particles determine soil texture

✦ Not affected by structure or OM



Bulk density

- ✦ Soil mass
Soil volume
- ✦ Dense soils
 - Retard water movement
 - Hold less water
 - Impede air exchange
 - Stop root development



Structure

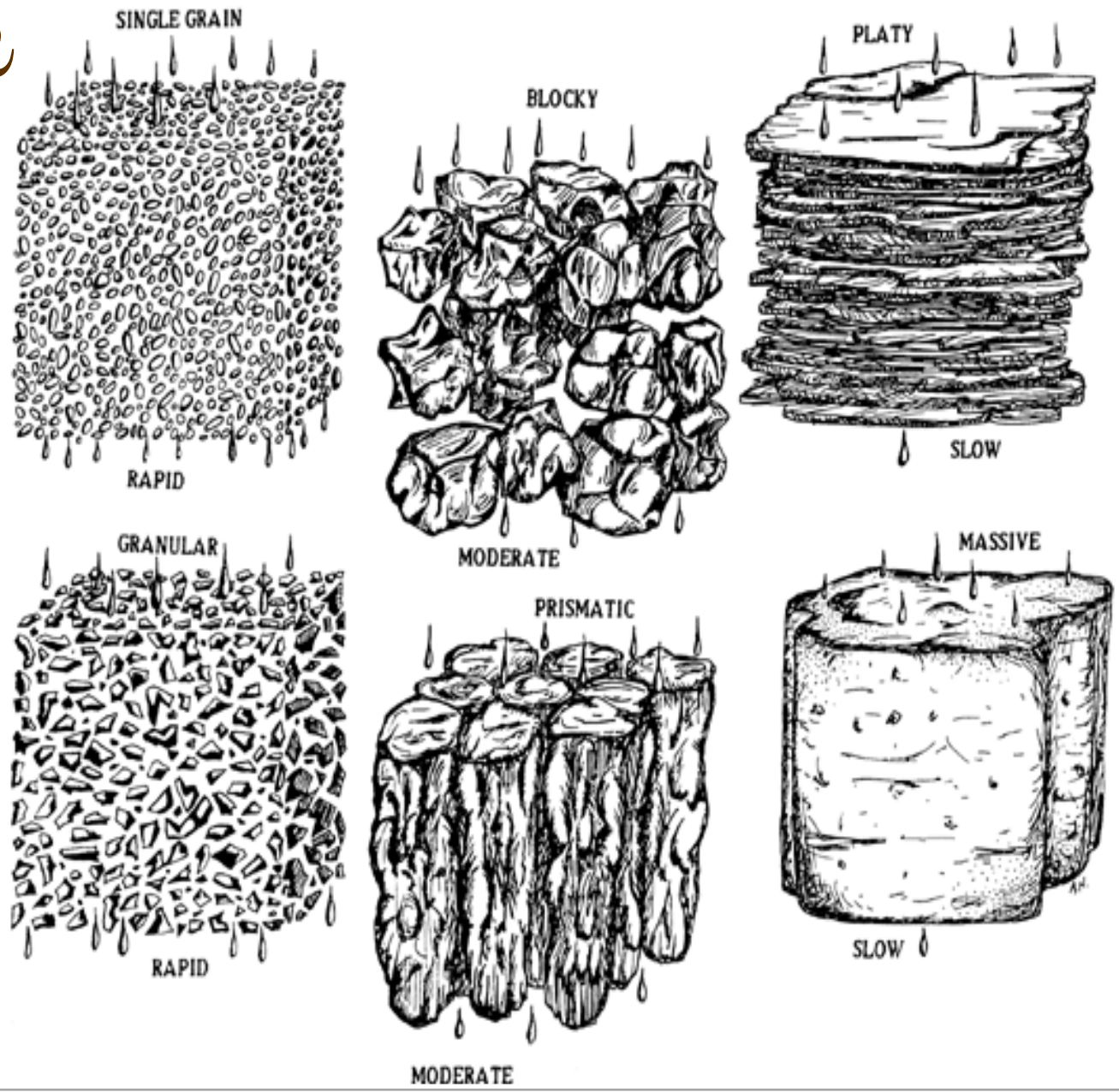
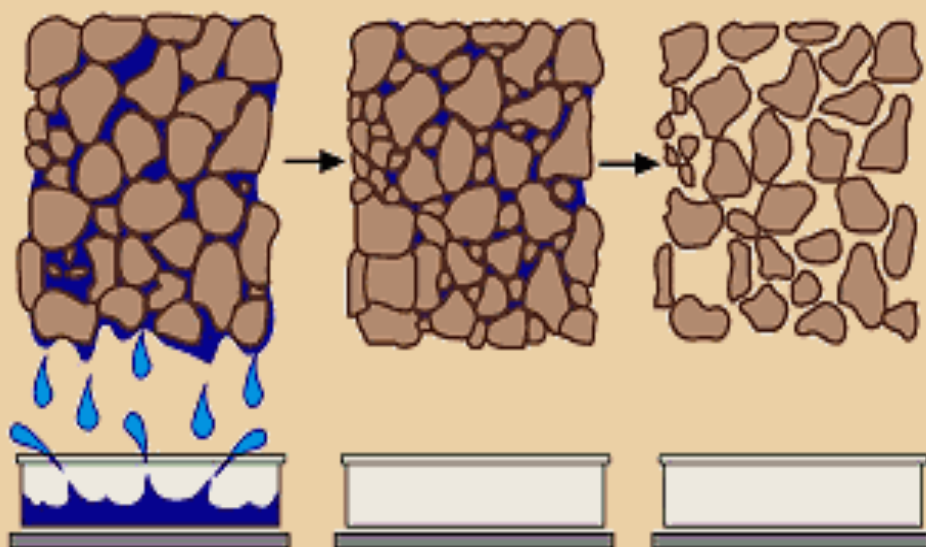


Fig. Engle et al. WSUE

Water holding capacity



Saturation
All pores are full of water. Gravitational water is lost

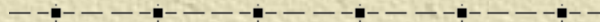
Field Capacity
Available water for plant growth

Wilting Point
No more water is available to plants

Available Water Capacity by Soil Texture	
Textural Class	Available Water (in/ft soil)
Coarse sand	0.25–0.75
Fine sand	0.75–1.00
Loamy sand	1.10–1.20
Sandy loam	1.25–1.40
Fine sandy loam	1.50–2.00
Silt loam	2.00–2.50
Silty clay loam	1.80–2.00
Silty clay	1.50–1.70
Clay	1.20–1.50



*How
Composts Benefit
Soils*



Why compost

Active Composting

✦ **To eliminate disease organisms**

✦ *Animal • Plant • Human*

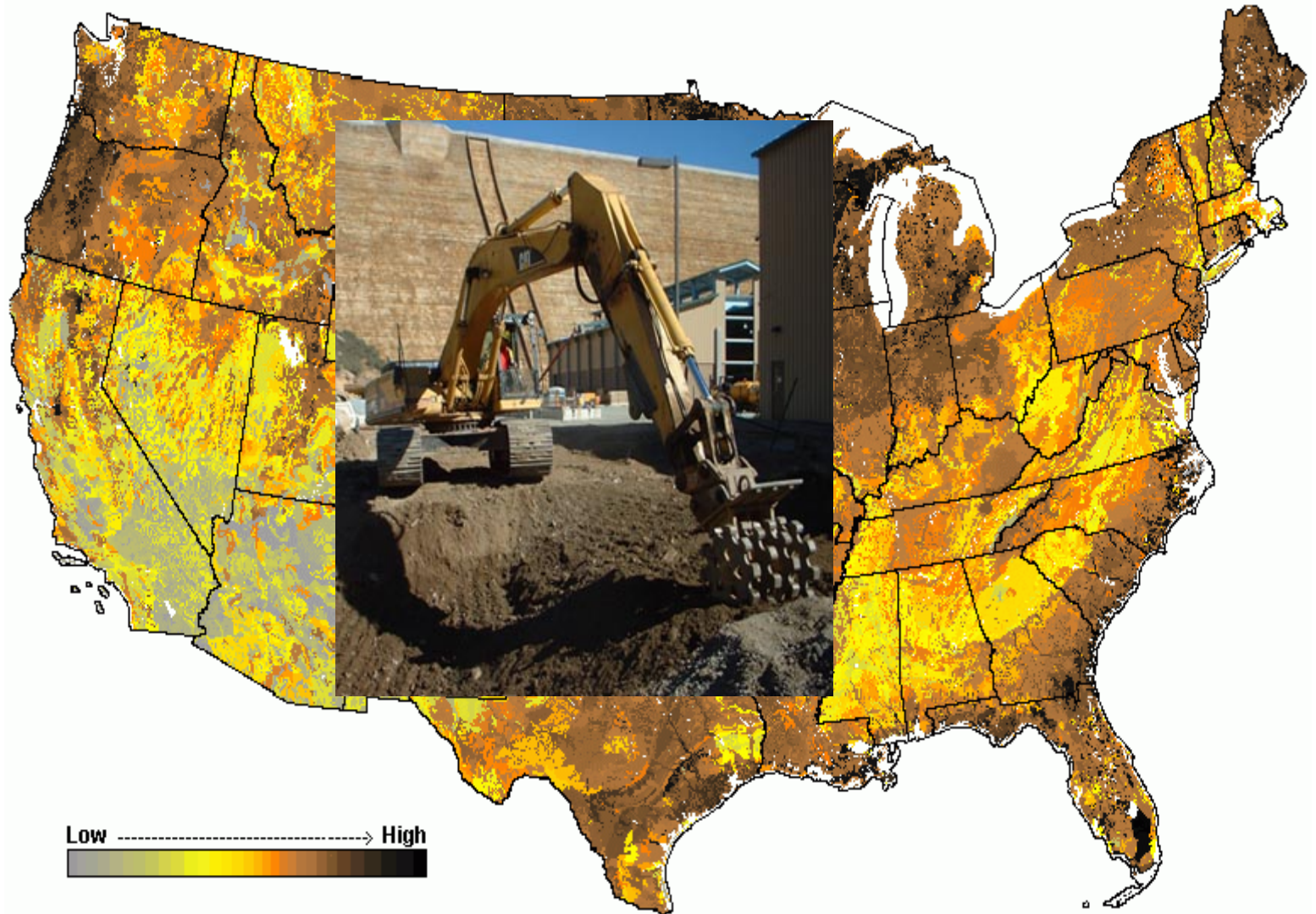
✦ **To produce a stable and safe soil amendment**

✦ *Nutrients • Odors • Phytotoxins*

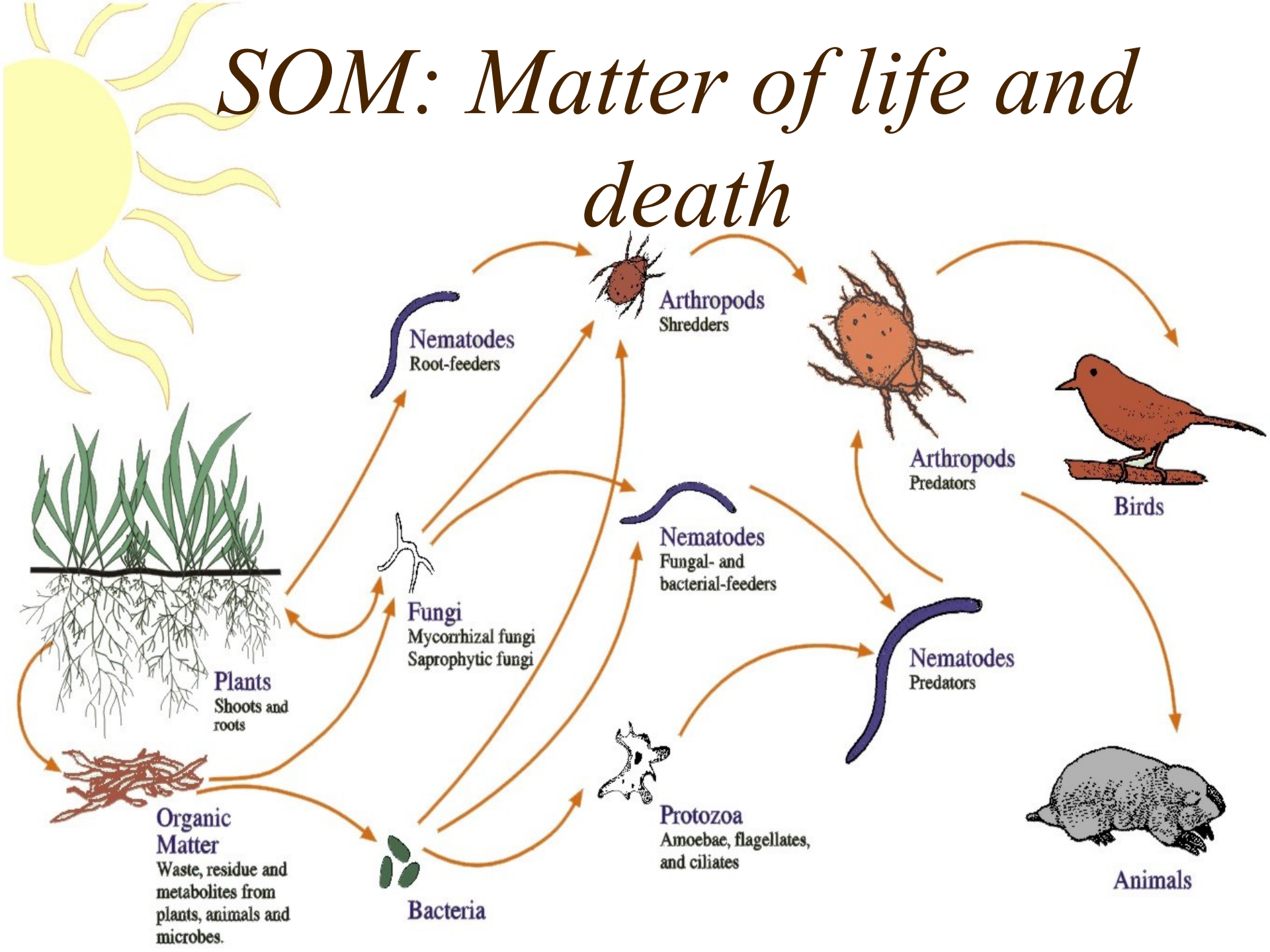
Curing



Organic matter: What you are selling



SOM: Matter of life and death



Carbon

- ✦ **Source of energy for microbes**
- ✦ **Not all forms are equally available**
 - **sugars (more available)**
 - **fats, waxes, proteins**
 - **cellulose**
 - **lignin (less available)**



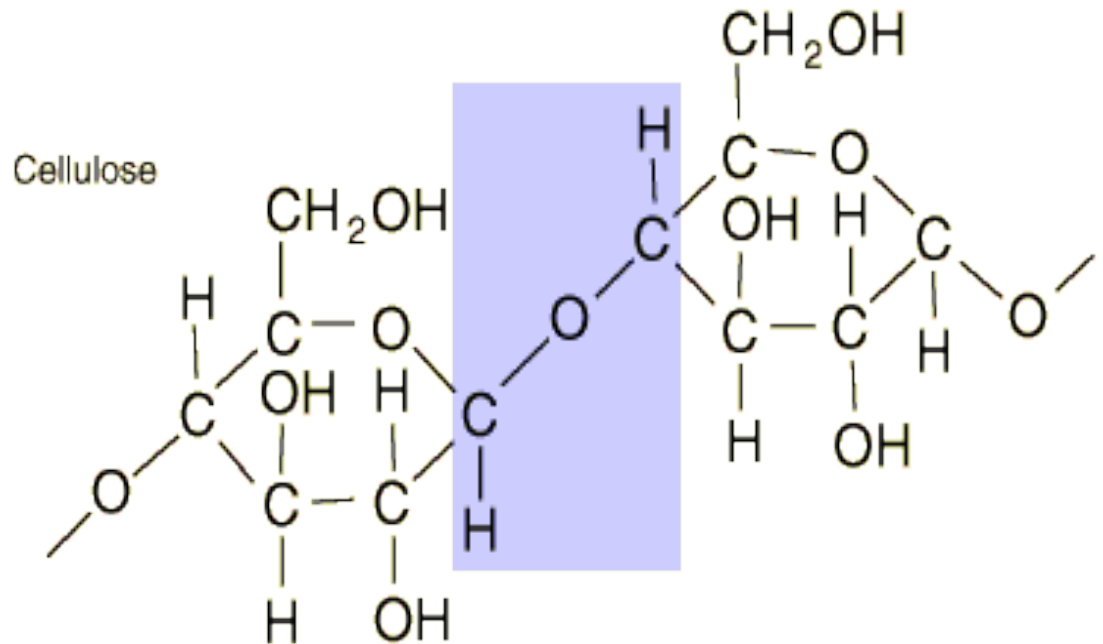
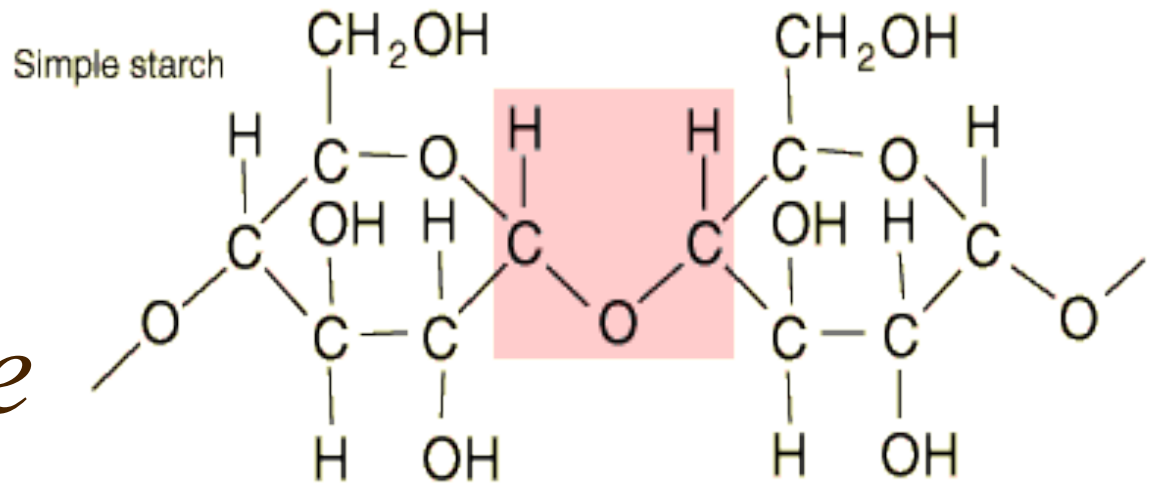
Starches

- ✦ Used by plants and animals for intermediate energy storage.
- ✦ A carbohydrate $(\text{CH}_2\text{O})_x$
- ✦ Readily metabolized by microbes
- ✦ Decomposed during composting

Cellulose

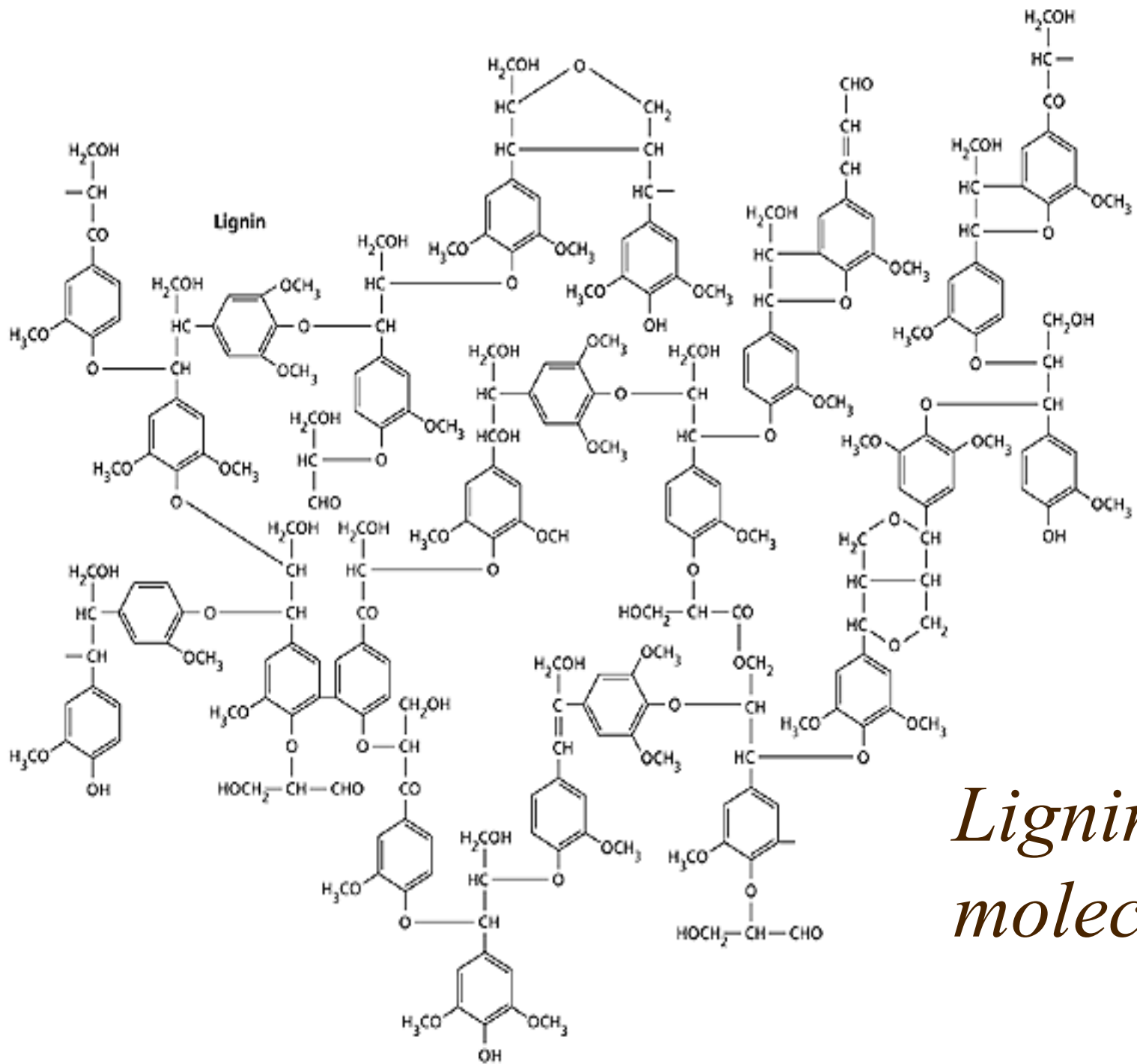
- ✦ Most abundant organic compound on Earth
- ✦ Examples: paper, cotton, cellophane, rayon
- ✦ Like starch, a carbohydrate composed of chains of glucose molecules (polysaccharides), but joined by β -linkages
- ✦ Cellulose is used by plants for construction of cell walls
- ✦ Tend to be structured in straight lines
- ✦ Can be metabolized by bacteria, fungi
- ✦ Ruminants, termites use bacteria to break down cellulose

Starch *and* *Cellulose*



Lignin

- ✦ Second most abundant organic compound on Earth
- ✦ Has a complex structure
- ✦ Along with cellulose is used by plants for construction of cell walls
- ✦ Can be metabolized by fungi



*Lignin
molecule*



Soil Nutrients: macronutrients

✦ Total N

– Organic N (*slow release*)

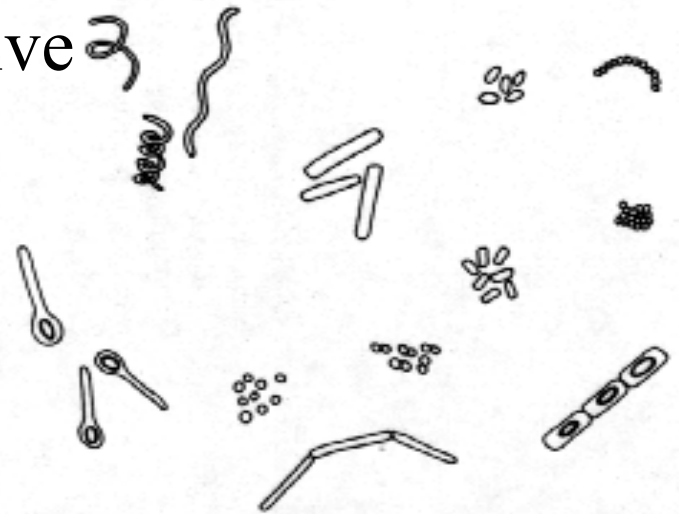
– Available N (*variable*)

✦ Total P (*often rich*)

✦ Total K (*variable*)

Bacteria

- ✦ 80 – 90% of the microbial community is bacteria
- ✦ Small: 0.5 – 3 μm diameter
- ✦ High surface:volume ratio. Important for moving nutrients in and waste products out
- ✦ C:N ratios on the order of 4.3:1 to 6:1
- ✦ Soil species differ from active compost species
 - 0 - 40°C: mesophyllic
 - 40-65 °C: thermophilic



Fungi

- ✦ Fungi include molds and yeasts
- ✦ Larger than bacteria
- ✦ Grow more slowly
- ✦ Able to metabolize lignin
- ✦ $C_{10}H_{17}O_6N$
- ✦ C:N ratios on the order of 9:1



*Fungi on
lignin*





N

Nitrogen

- ✦ Vital nutrient for both microbes and plants
- ✦ Microbes are better than plants at accumulating N
- ✦ C:N ratio
 - Compost feedstock initially about 35:1
 - About 10:1 to 20:1 in cured product
 - About 8:1 in a soil

N

Soil Nutrients : micronutrients

✦ Boron

✦ Chlorine

✦ Cobalt

✦ Copper

✦ Iron

✦ Manganese

✦ Magnesium

✦ Molybdenum

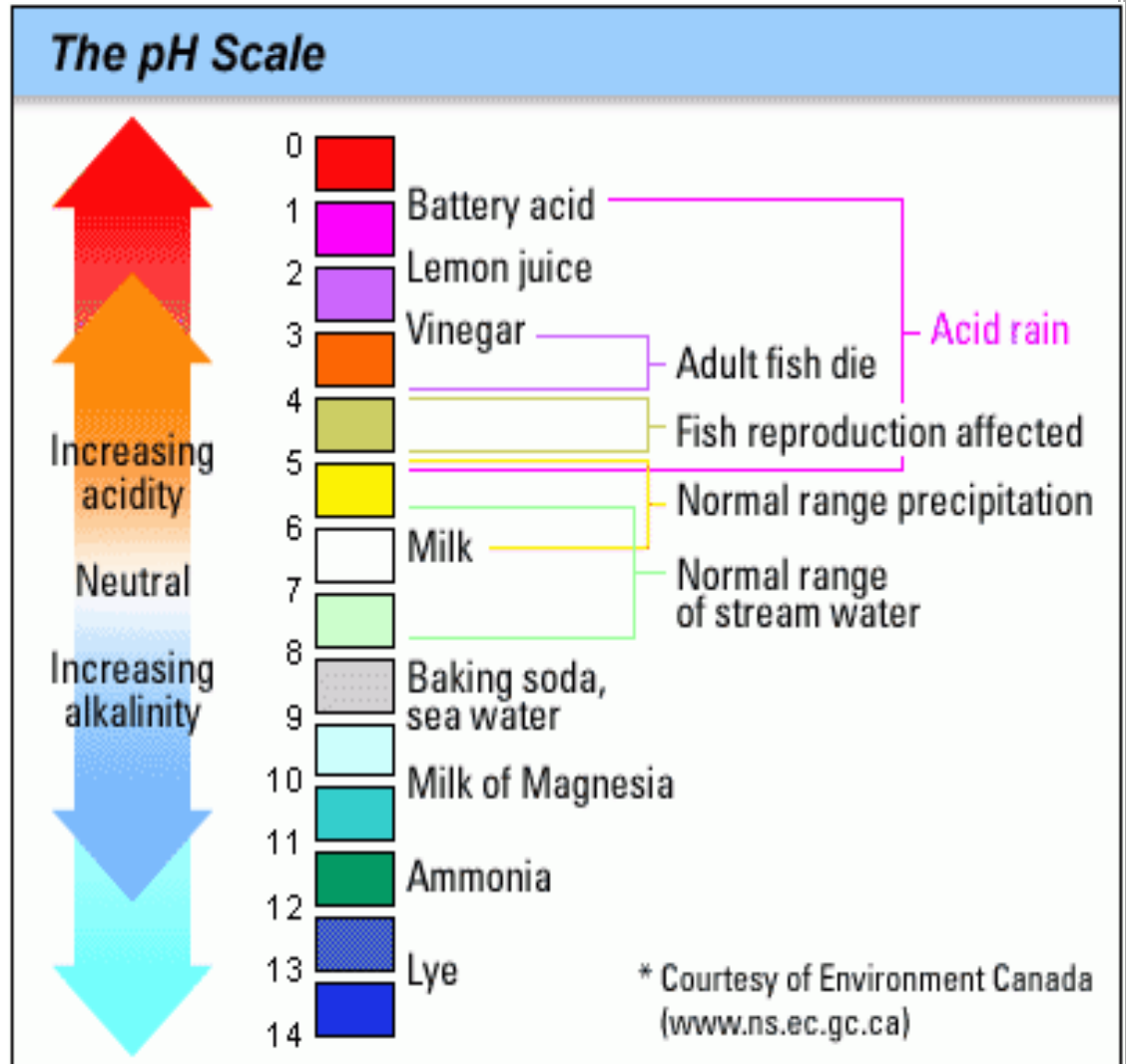
✦ Sulfur

✦ Zinc

*(Variable,
depending on
source)*

pH

- ✦ Low pH = acid soil
- ✦ High pH = alkaline soil
- ✦ Neutral pH = 7
(buffers pH)





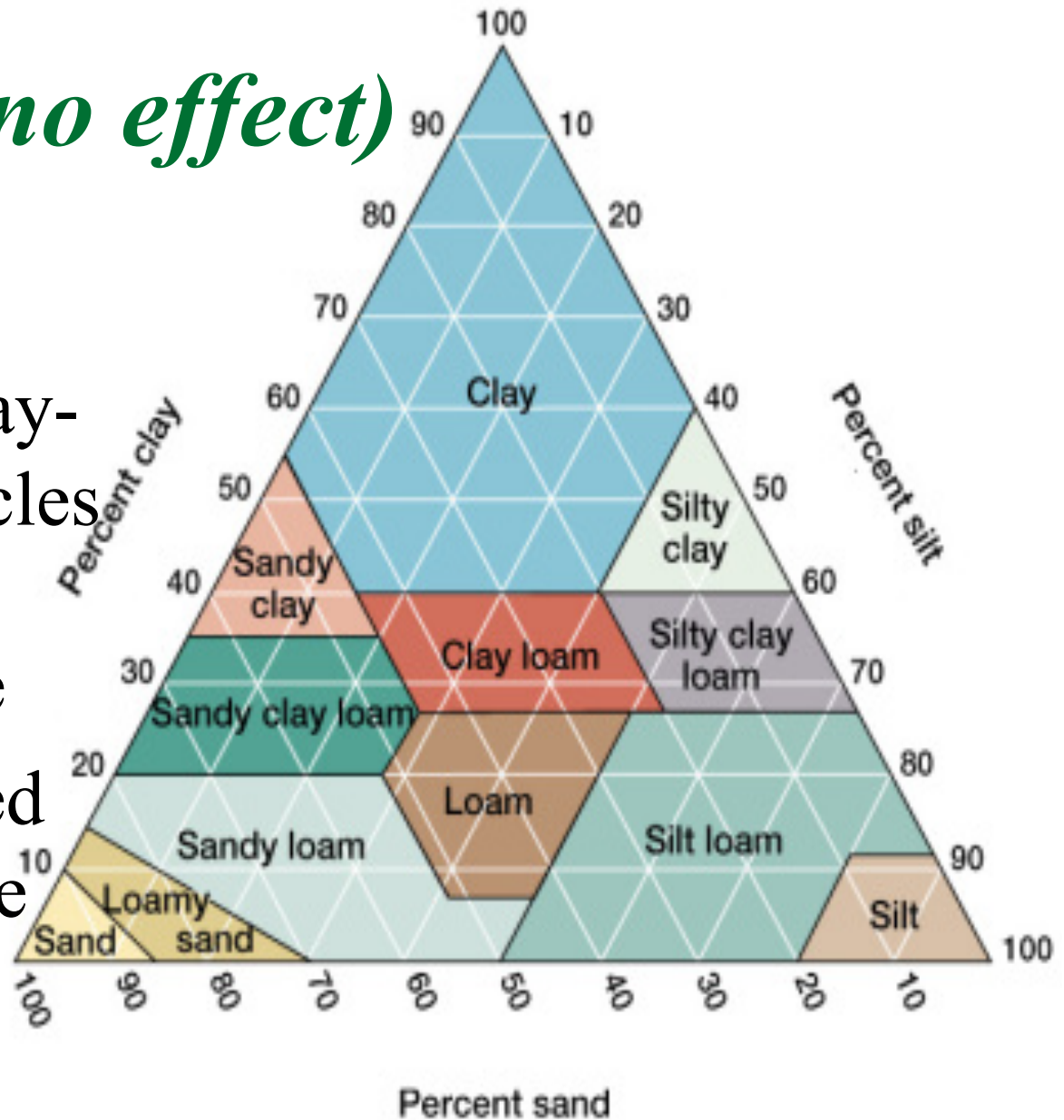
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- ✦ ECe stands for Electrical Conductivity
- ✦ Salts conduct electricity and this is used to measure them in soils
- ✦ High ECe soils may have trouble germinating seeds and supporting growth
- ✦ ECe is more of a water management indicator
*(Contains salts, some of which are nutrients.
Improves tilth so salts can leach away)*

Texture (no effect)

✦ The sand, silt, and clay-sized particles determine soil texture

✦ Not affected by structure or OM



Bulk density (decreases density)

✦ Soil mass
Soil volume

✦ Dense soils

- *Improves* water movement
- Holds *more* water
- *Increases* air exchange
- *Promotes* root development



Bacteria and fungi

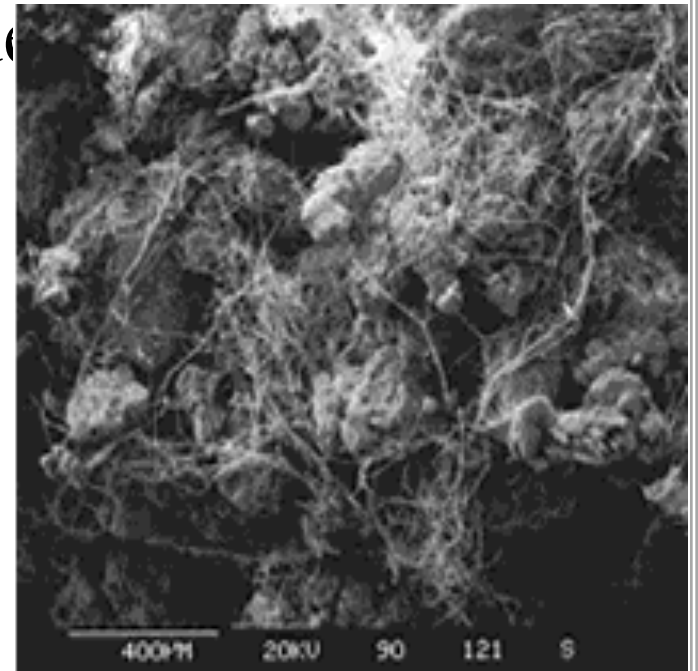
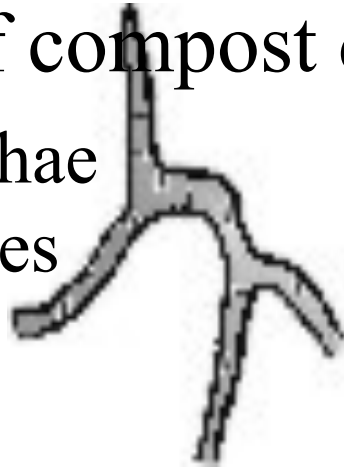
- ✦ Bacteria are much smaller than fungi
- ✦ Both decompose composts in the soil





Compost in soil

- ✦ Encourages the formation of soil aggregates
- ✦ Aggregates are soil clusters held together as a result of compost decomposition
 - Fungal hyphae bind particles together
 - Bacterial polysaccharides serve as glue



Structure

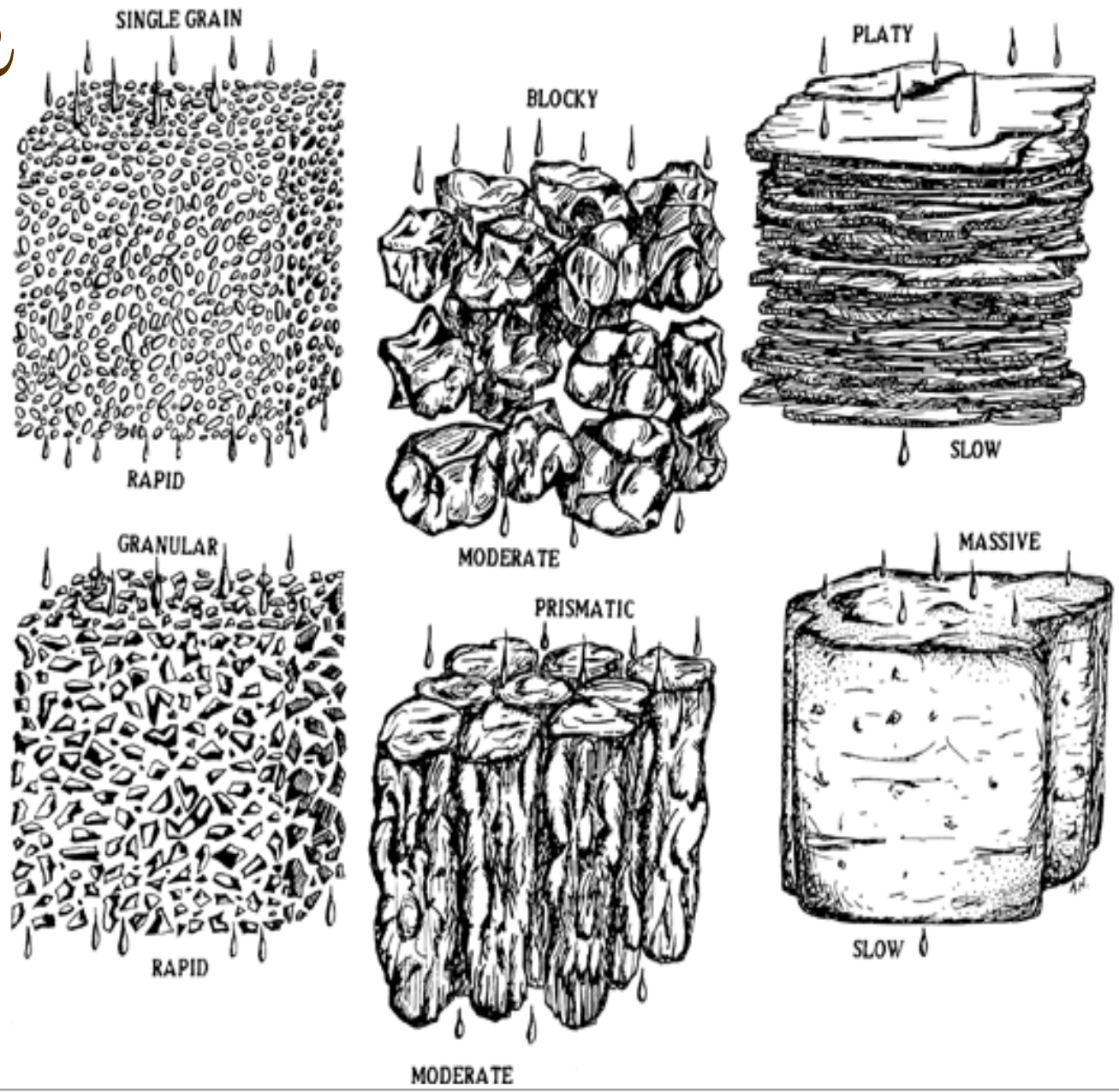


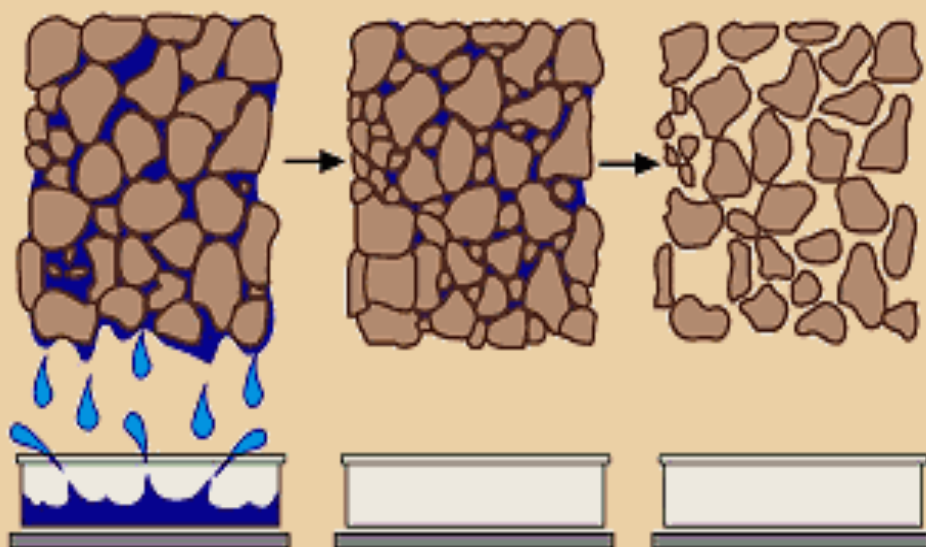
Fig. Engle et al. WSUE

Aggregated soils

- ✦ Hold water while allowing air to penetrate
- ✦ Facilitate drainage and salt removal
- ✦ Allow roots to penetrate
- ✦ Are more stable, resisting
 - Sheet
 - Rill



Water holding capacity



Saturation
All pores are full of water. Gravitational water is lost

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Overcome worry...
...with knowledge and information







Questions?
Questions?



Think long-term.
Focus on the soil
and your plants
will thrive.