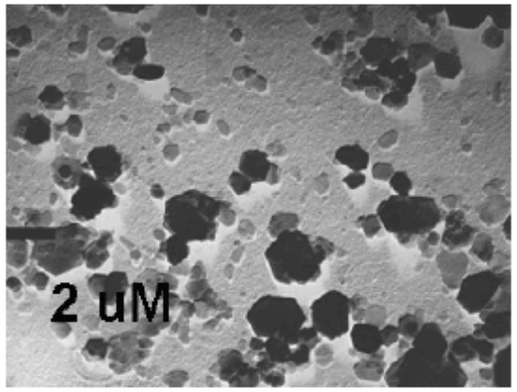
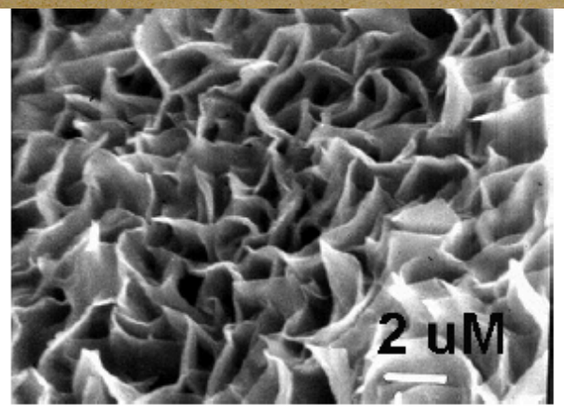
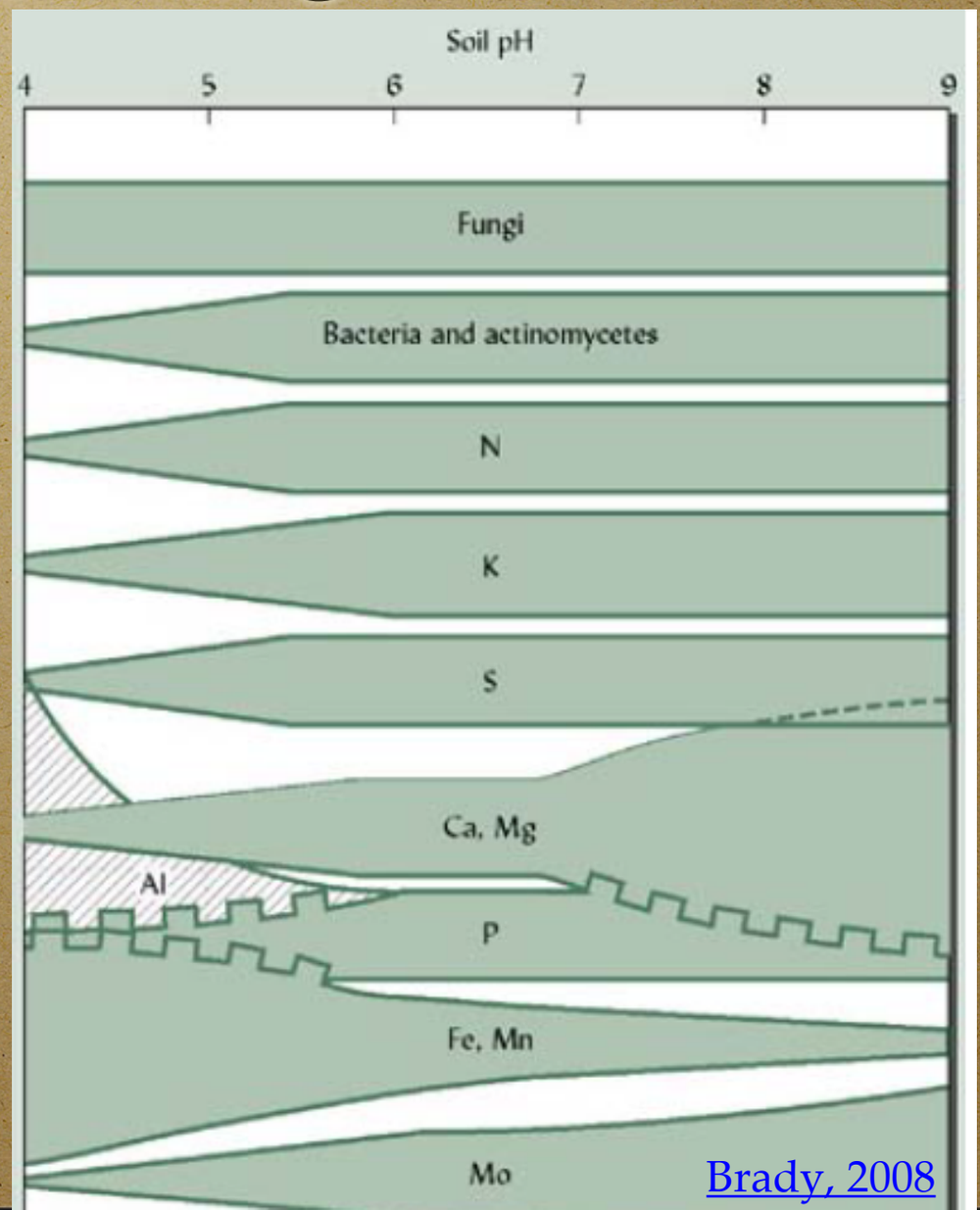
Soil Structure, Soil Materials, and Soil Chemistry



1: 1 kaolinite



2:1 smectite



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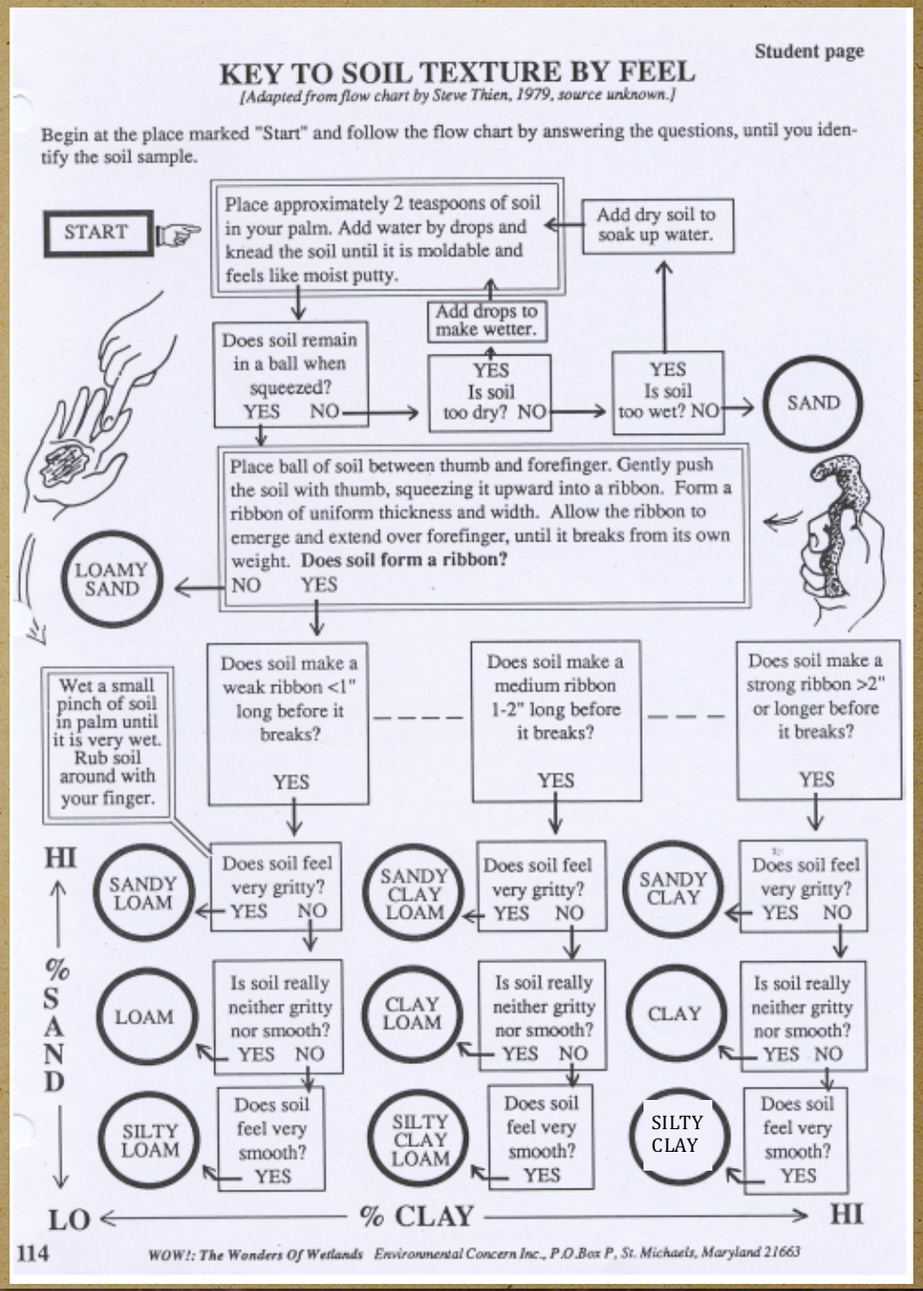
Soil Texturing Activities

- Hand Texturing
- Soil Texture in a Jar
- Rapid Quantitative Soil Texture through Seiving and Settling in Water



Student page

KEY TO SOIL TEXTURE BY FEEL

[Adapted from flow chart by Steve Thien, 1979, source unknown.]

Begin at the place marked "Start" and follow the flow chart by answering the questions, until you identify the soil sample.

START

Place approximately 2 teaspoons of soil in your palm. Add water by drops and knead the soil until it is moldable and feels like moist putty.

Add dry soil to soak up water.

Add drops to make wetter.

Does soil remain in a ball when squeezed? YES NO

YES Is soil too dry? NO

YES Is soil too wet? NO

SAND

Place ball of soil between thumb and forefinger. Gently push the soil with thumb, squeezing it upward into a ribbon. Form a ribbon of uniform thickness and width. Allow the ribbon to emerge and extend over forefinger, until it breaks from its own weight. **Does soil form a ribbon?** NO YES

LOAMY SAND

Wet a small pinch of soil in palm until it is very wet. Rub soil around with your finger.

Does soil make a weak ribbon <1" long before it breaks? YES

Does soil make a medium ribbon 1-2" long before it breaks? YES

Does soil make a strong ribbon >2" or longer before it breaks? YES

HI

% SAND

SANDY LOAM — Does soil feel very gritty? YES NO

SANDY CLAY LOAM — Does soil feel very gritty? YES NO

SANDY CLAY — Does soil feel very gritty? YES NO

LOAM — Is soil really neither gritty nor smooth? YES NO

CLAY LOAM — Is soil really neither gritty nor smooth? YES NO

CLAY — Is soil really neither gritty nor smooth? YES NO

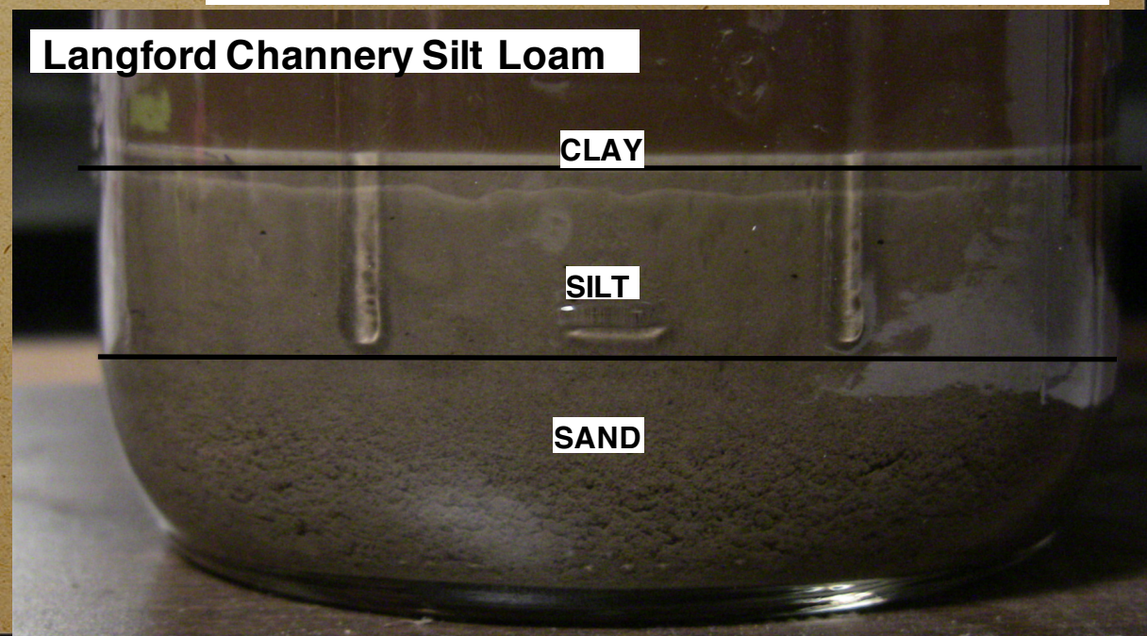
SILTY LOAM — Does soil feel very smooth? YES

SILTY CLAY LOAM — Does soil feel very smooth? YES

SILTY CLAY — Does soil feel very smooth? YES

LO ← % CLAY → HI

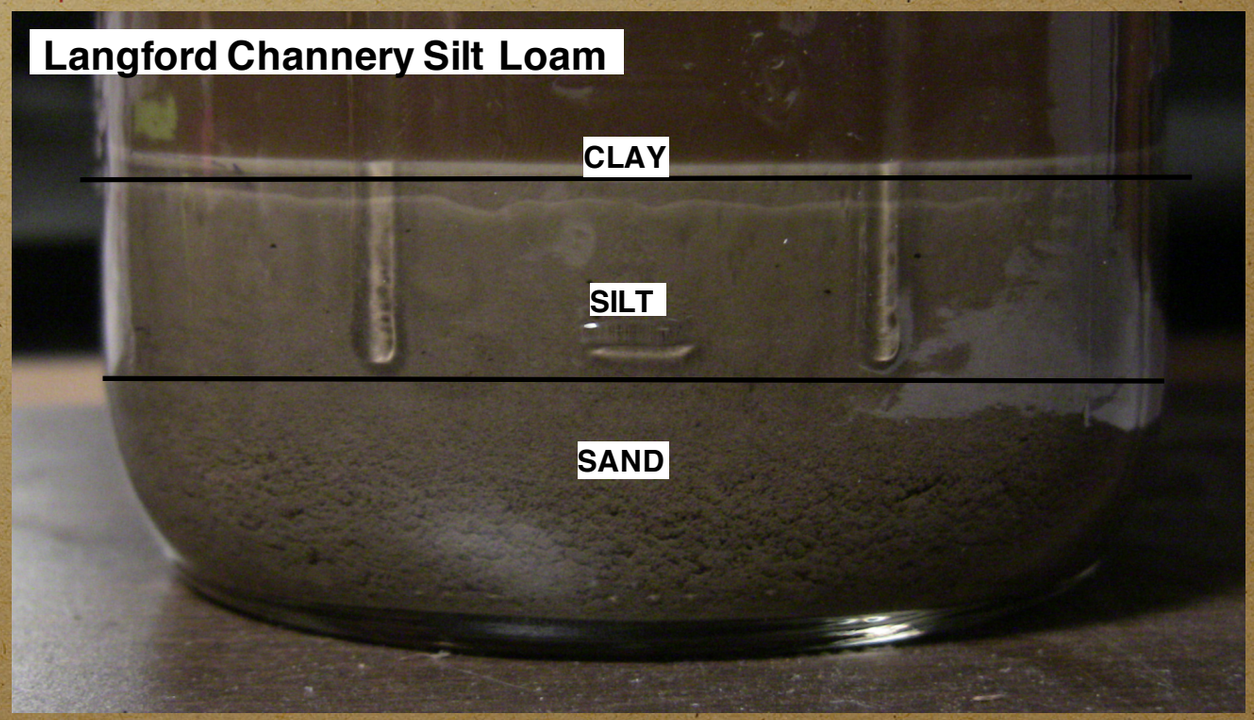
WOW!: The Wonders Of Wetlands Environmental Concern Inc., P.O.Box P, St. Michaels, Maryland 21663



Soil Texture in a Jar

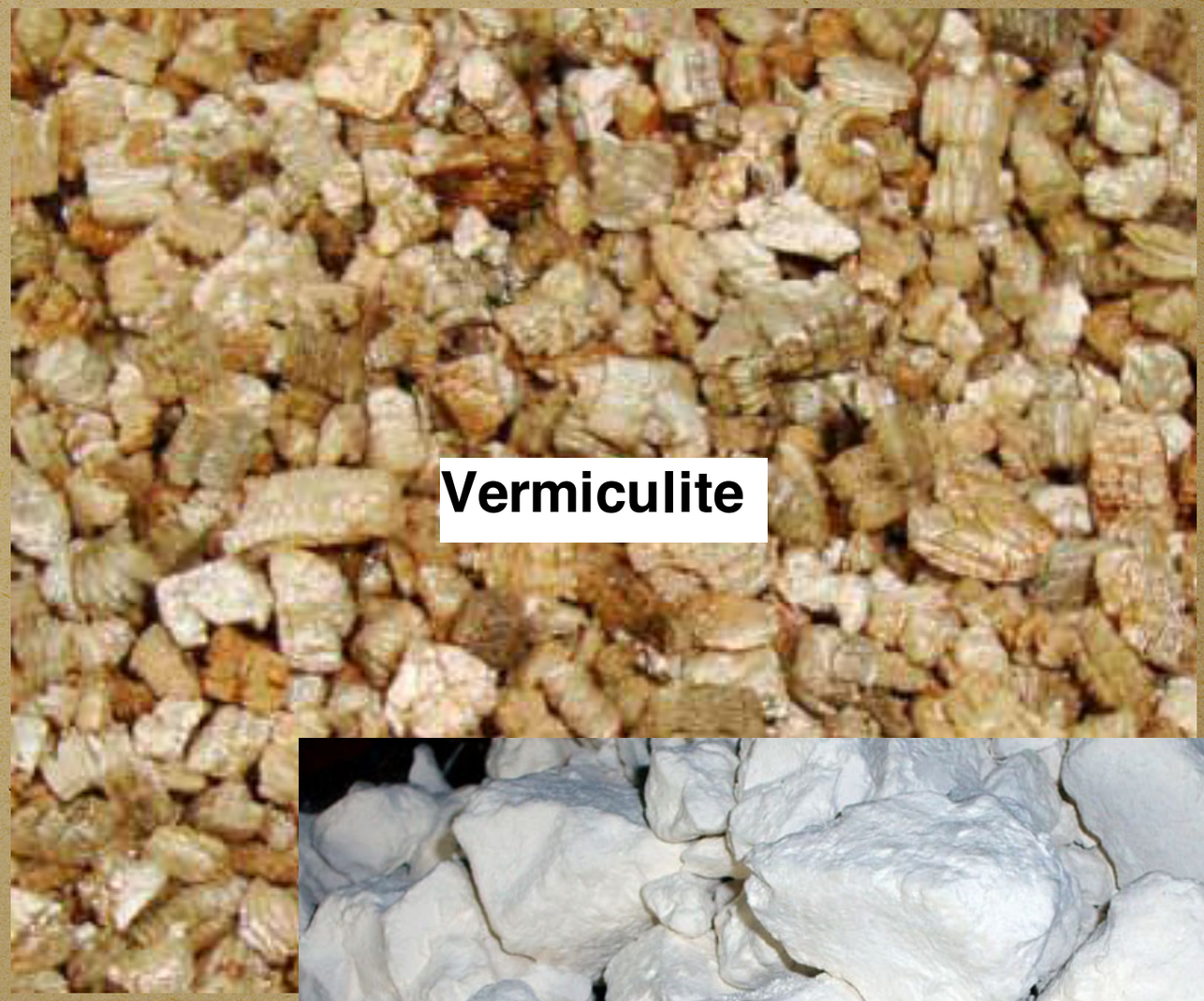
- **Dispersants:** Sodium Hexametaphosphate, Sodium bicarbonate (baking soda), or Sodium carbonate (washing soda), powdered electric dishwater detergent (e.g. cascade)

- **Protocal:**
- 1) Fill quart jar ¾ full with distilled water
- 2) Add 1 teaspoon of dispersant
- 3) Add roughly a cup of sieved soil
- 4) Shake well for a couple minutes (to disperse soil)
- 5) After 1 minute draw a line (this is sand)
- 6) After 2 Hours draw a line (this is silt)
- 7) The clay can take days to settle out



Clay Introduction

- **Clay:**
- Size definition and mineralogy definition
- <.002mm or <2μm
- Secondary Mineral
- 1mm of mica = 1,000,000 layers of mica sheets
- "Clay has 10,000-100,000x as much surface area as an equal weight of sand"
- "spoonful of clay may have the surface area the size of a football field"

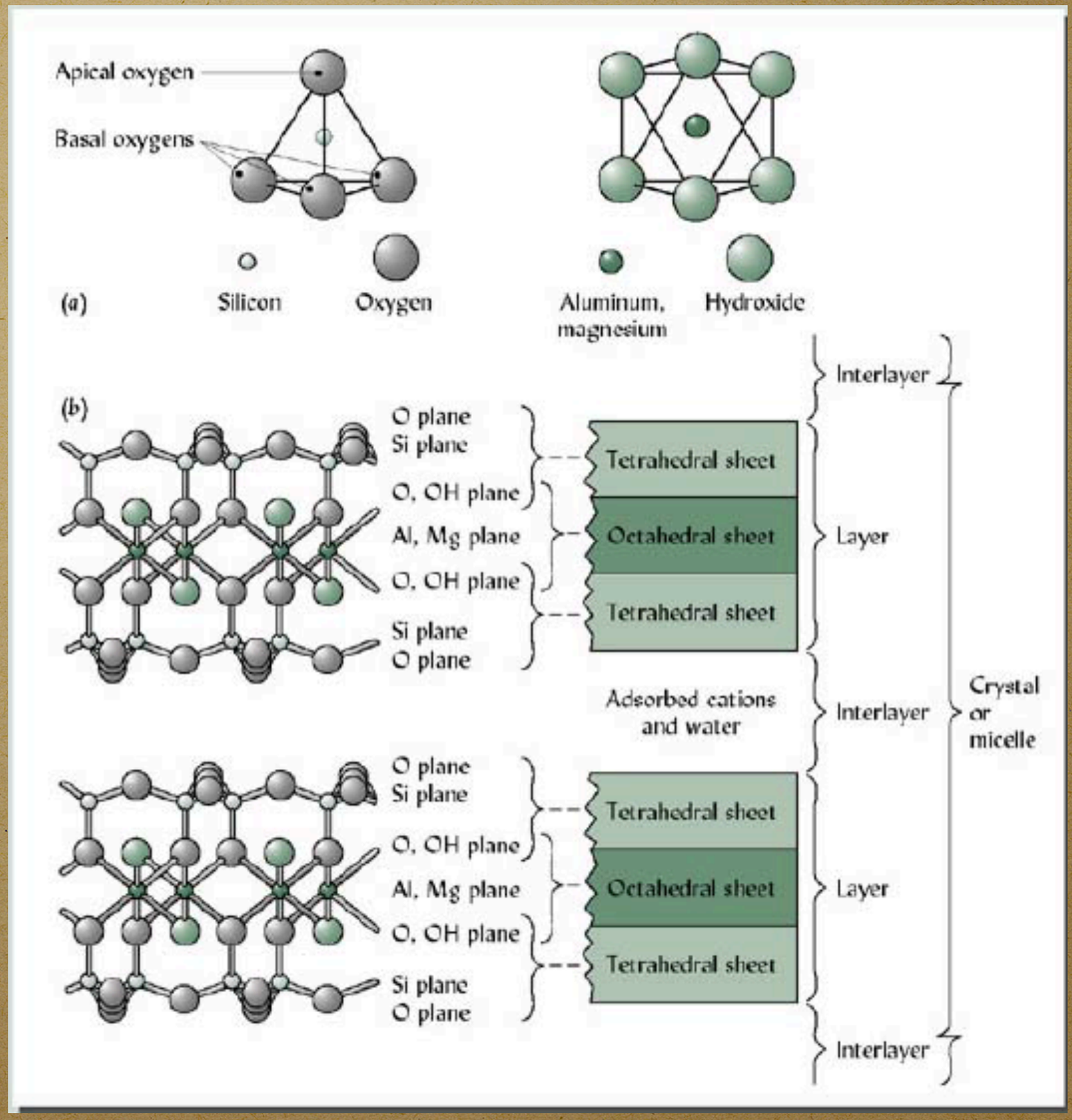


Clay Introduction

- **Clay:** <.002mm

- Tetrahedral Sheets
- Octahedral Sheets

- **Types of Clays:**
- 2:1 Clays: Illite, Vermiculite, Smectite
- 1:1 Clays: Kaolinite
- 1 Oxides: Iron and Aluminum Oxides



Types of Clays

Types of Clays:

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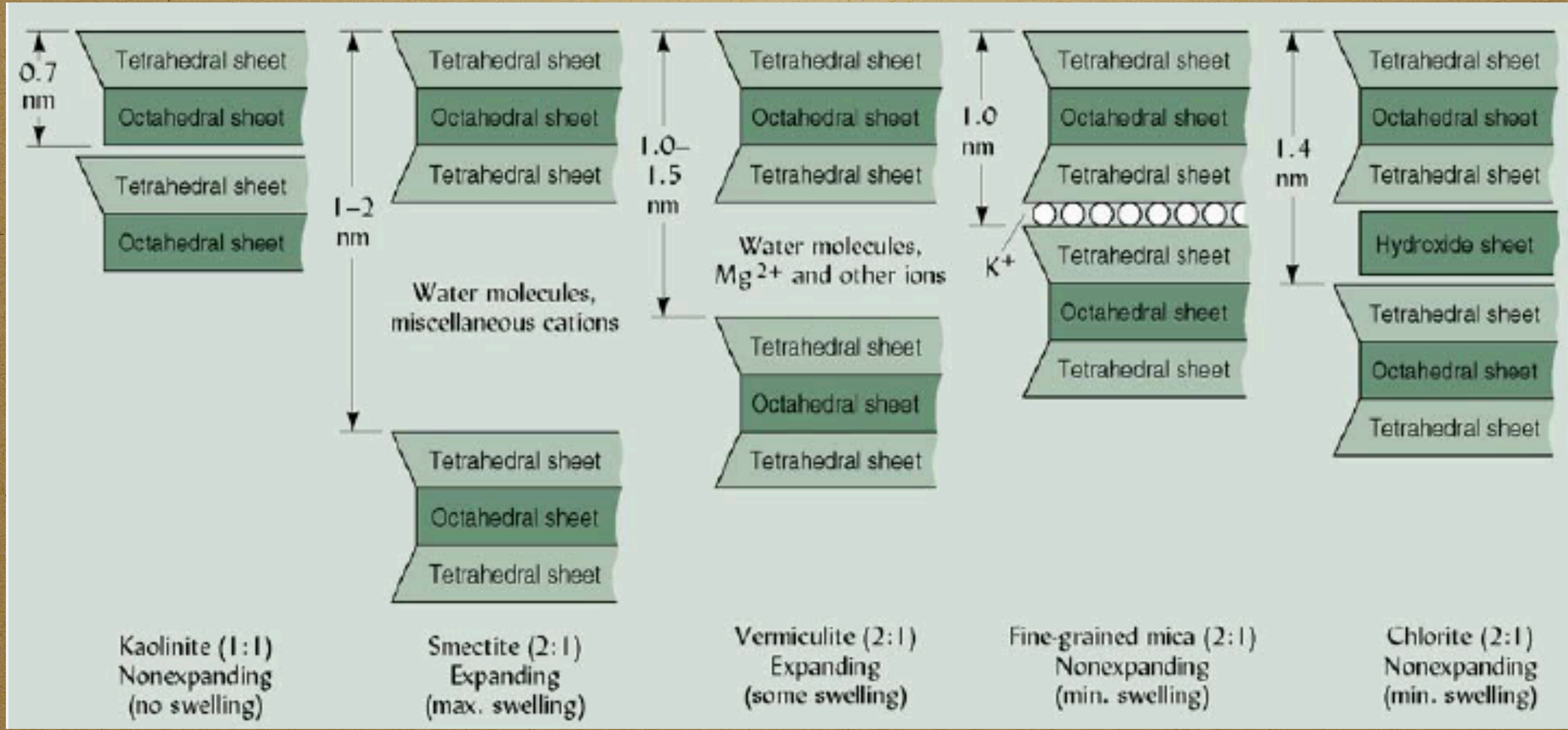
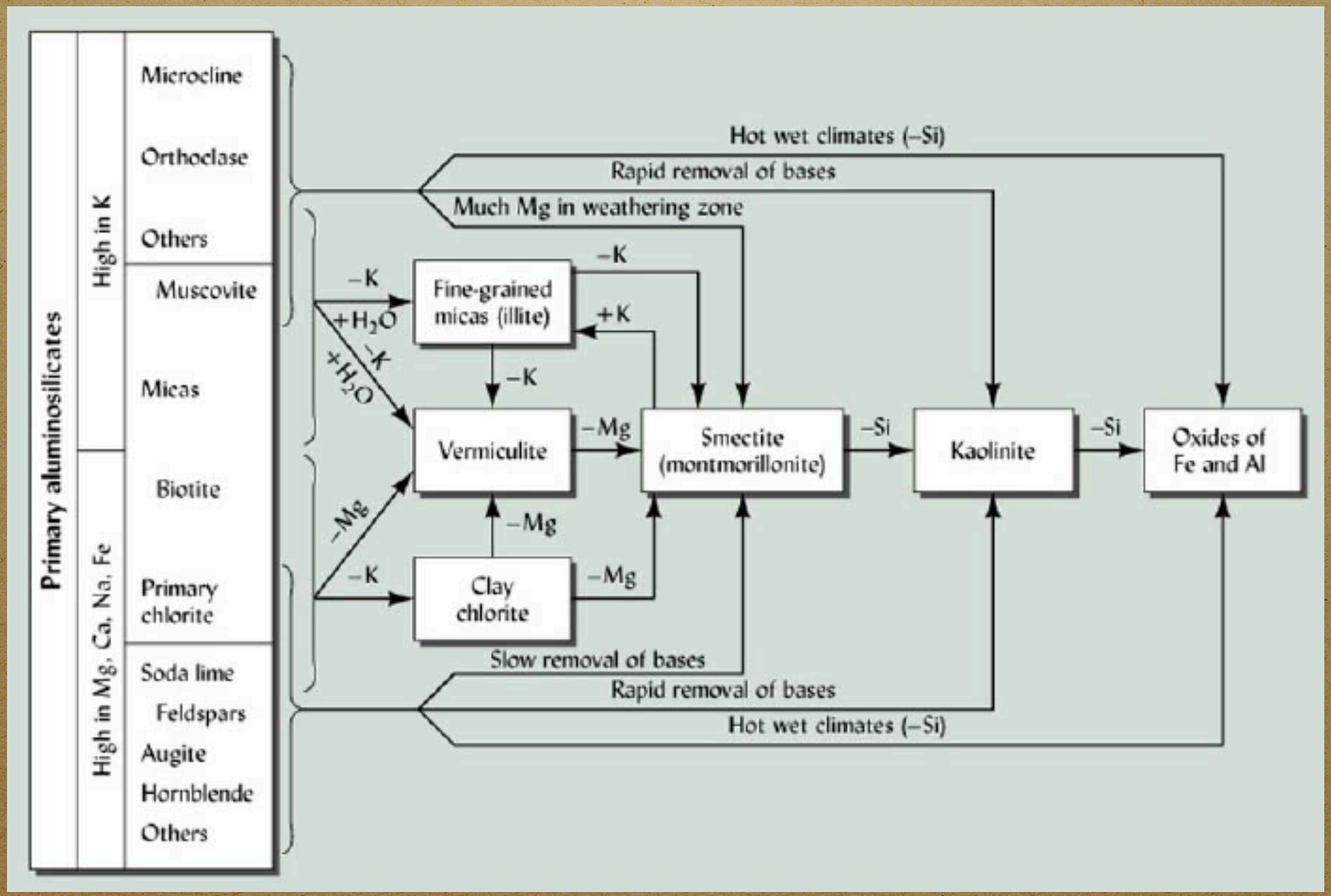


Sequence of Clay Formation

Types of Clays:

- 2:1 Clays: illite, Vermiculite, Smectite
- 1:1 Clays: Kaolinite
- 1 Oxides: Iron and Aluminum Oxides



Soil Nutrients

- **Plant Nutrients by Dry Weight →**
- **Carbon, Oxygen, Hydrogen: come from O_2, H_2O, CO_2**
- **Nitrogen comes from N_2 (atmosphere)**
- **K, P, Ca, Mg, S, Fe, B, Mn, Zn all initially come from Minerals**
- **The majority (+90%) of N, S in soil is in organic matter**
- **P is cycled through organic matter and stored in/on minerals**
- **Whereas K, Ca, Mg, Mn, Fe are stored in minerals or adsorbed to minerals**

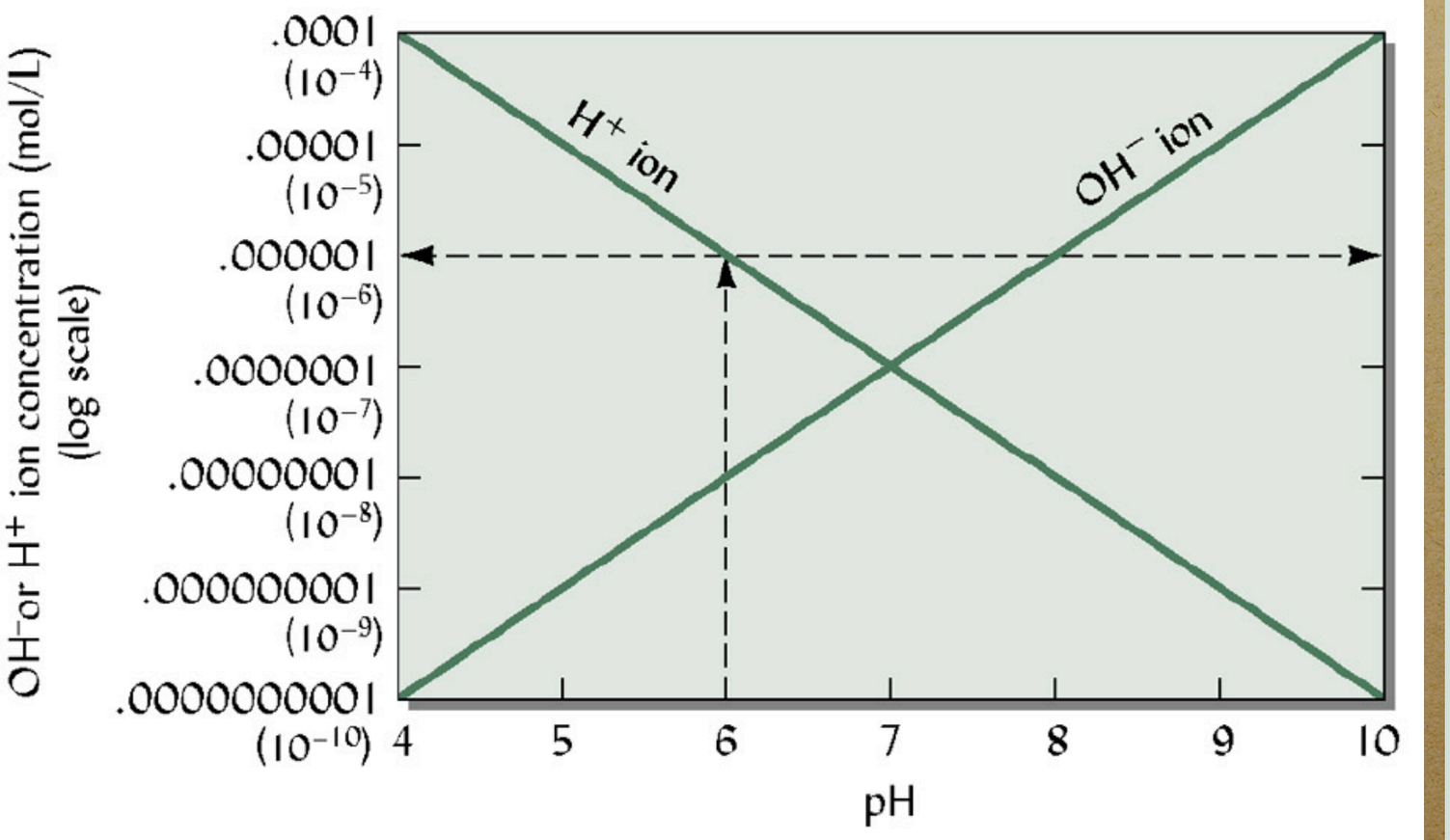
Average Plant Nutrient Concentrations (Dry Weight)

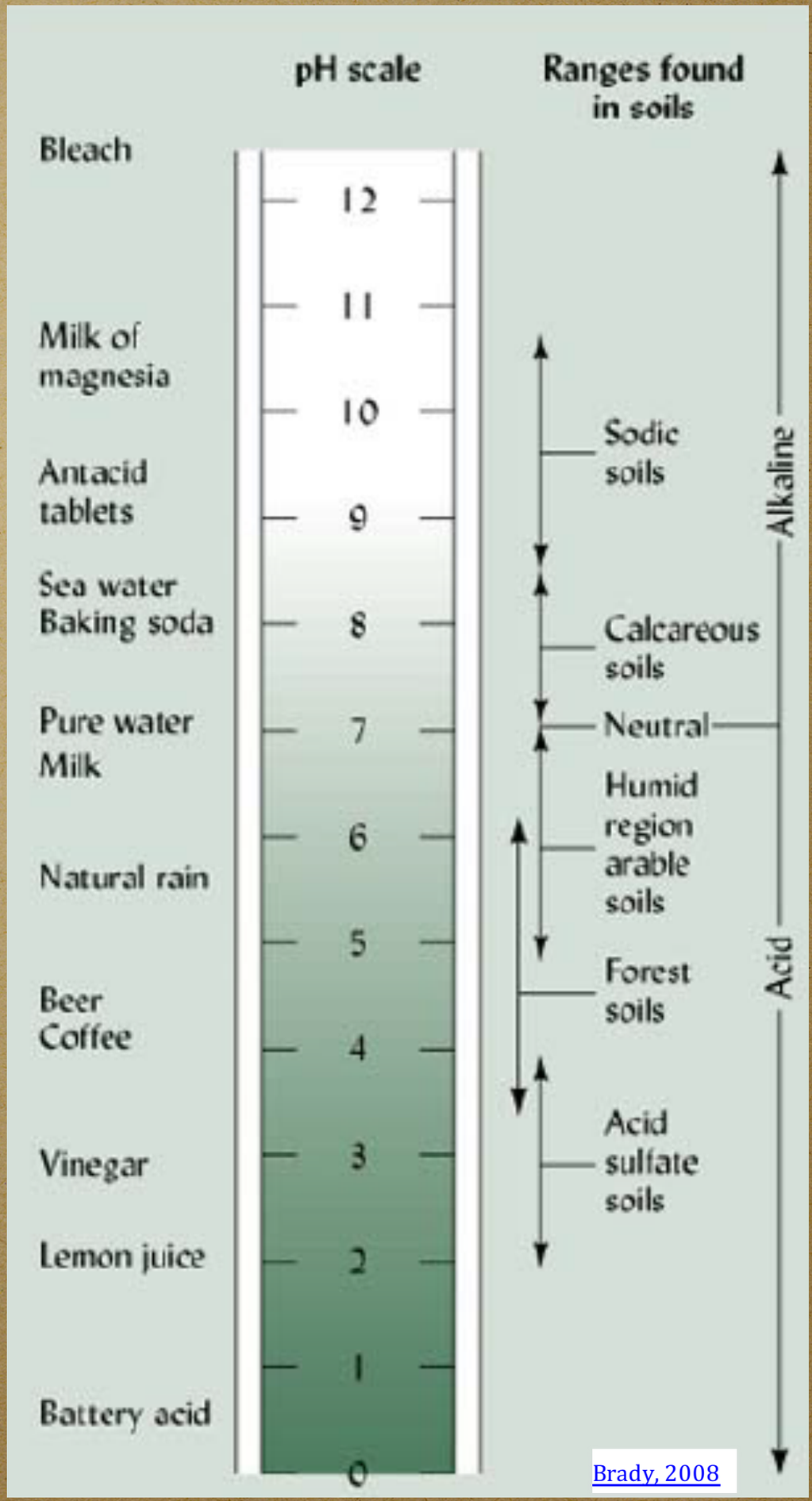
Type	Nutrient			Concentration in Plants
	Name	Symbol	Inorganic Form in Soil	Average % (dry weight)
Macronutrient ⊞	Carbon	C		45%
	Oxygen	O		45%
	Hydrogen	H		6%
	Nitrogen	N	NO_3^-, NH_4^+	1.5%
	Potassium	K	K^+	1%
	Phosphorus	P	PO_4^{3-}	0.2%
	Calcium	Ca	Ca^{2+}	0.5%
	Magnesium	Mg	Mg^{2+}	0.2%
	Sulfur	S	SO_4^{2-}	0.2%
Micronutrient ⊞	Chloride	Cl		0.01%
	Iron	Fe		0.01
	Boron	B		0.002%
	Manganese	Mn		0.005%
	Zinc	Zn		0.002%

Adapted from *Soil Fertility and Fertilizers, 2005*

Soil pH

- **What is Soil pH?**
- **Higher H+, More Acidity, Lower pH**
- **Lower H+, More Alkaline, Higher pH**
- **What are natural and anthropogenic acidifying processes?**





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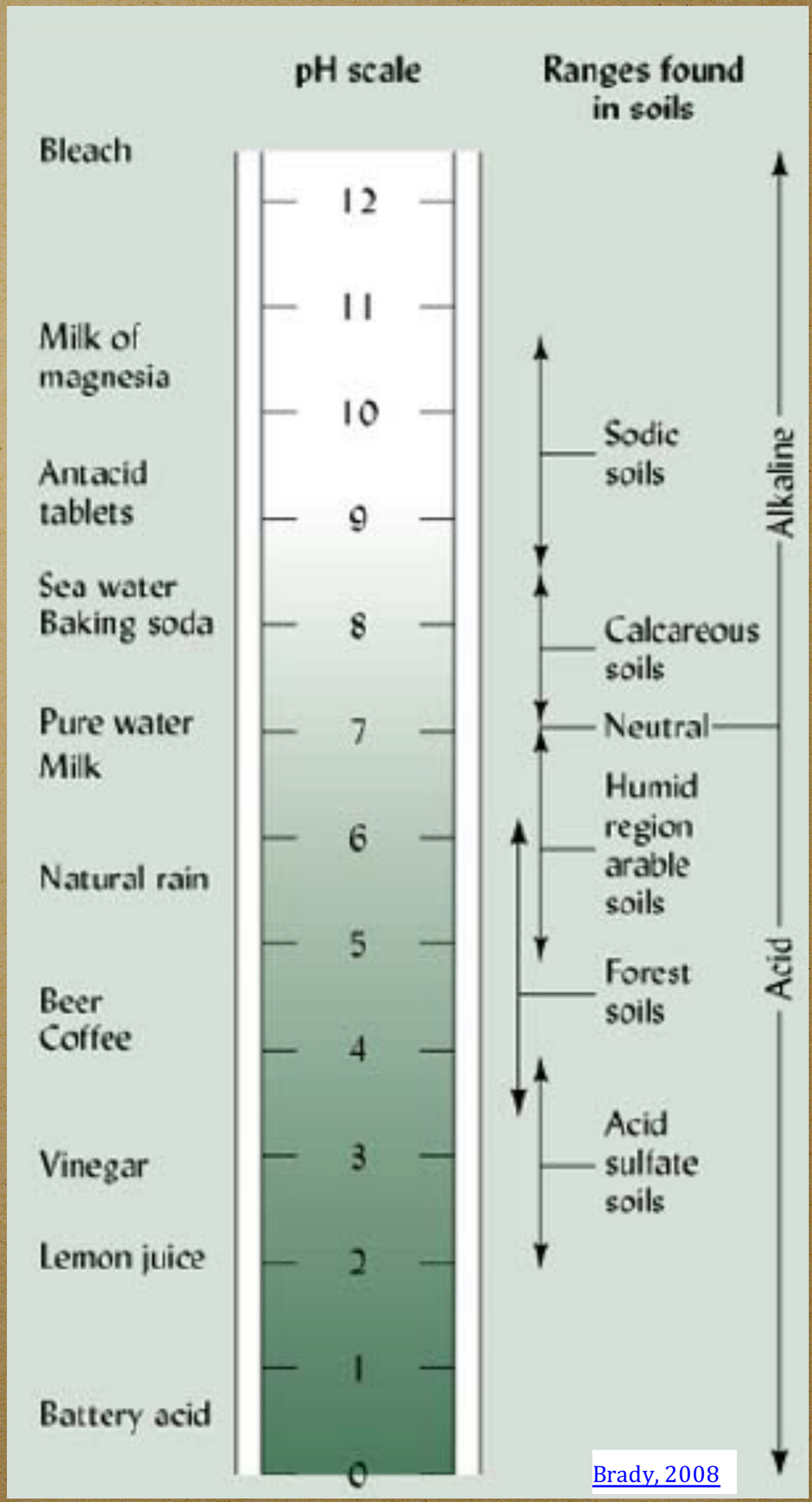
Soil pH

- **Why is Soil pH important?**



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What Determines the Nutrient Availability in Soils?

- **What is CEC (Cation Exchange Capacity)?**

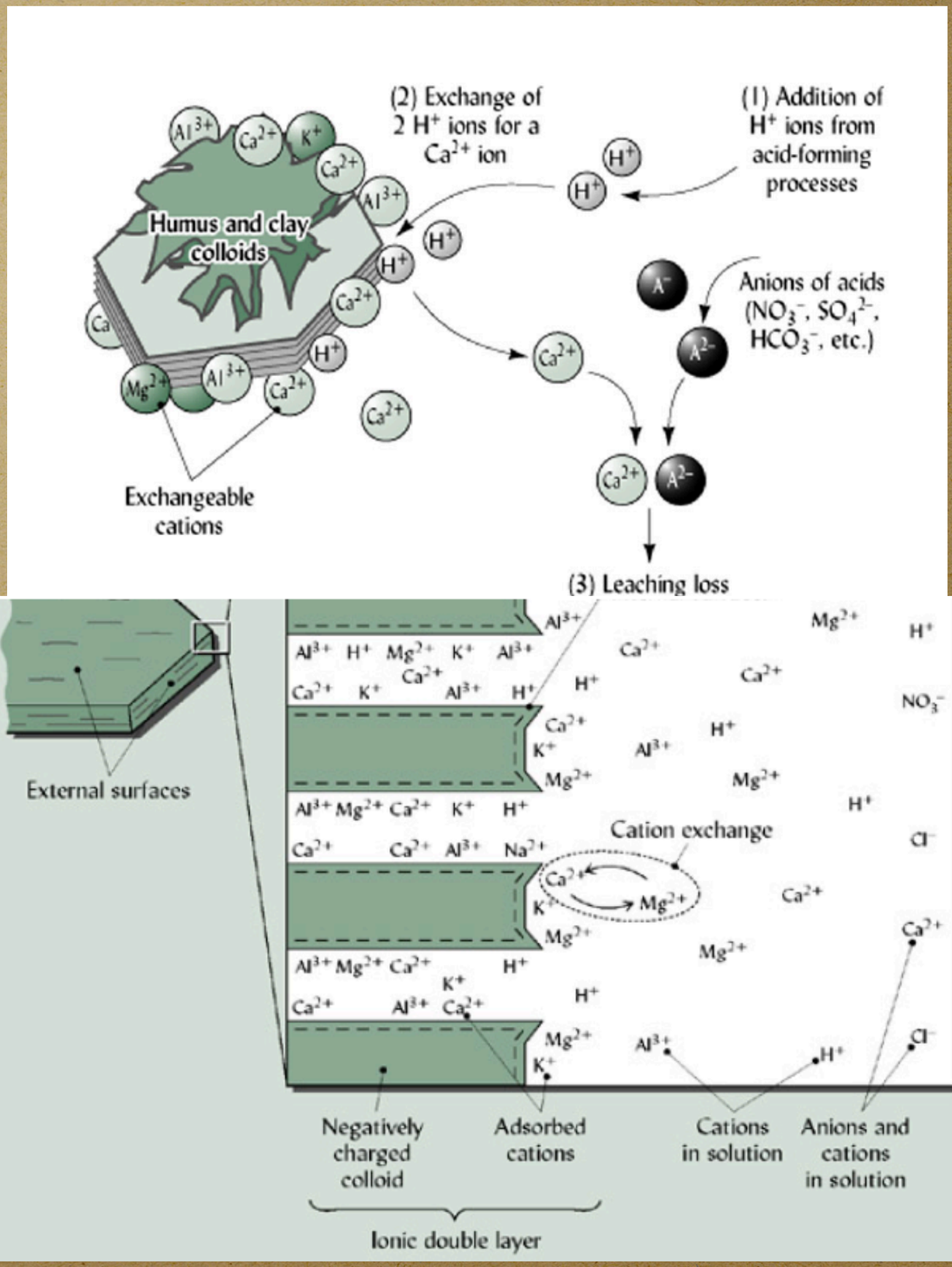
- **Clay and Organic Matter Colloids have a net negative charge, hence a CEC**

- **Cations (Positively Charged Ions)**
- **Anions (Negatively Charged Ions)**

- **Base Cations: Ca, Mg, K (nutrients)**
- **Acid Cations: H, Al (acidify the soil)**

- **Active Pool (Ions in solution)**
- **Exchangeable Pool (Ions on the cation exchange complex)**
- **Cations trapped in Soil Minerals: Slowly released by chemical weathering of minerals**

- **The Ions in Solution and on the Cation Exchange Complex are in equilibrium**



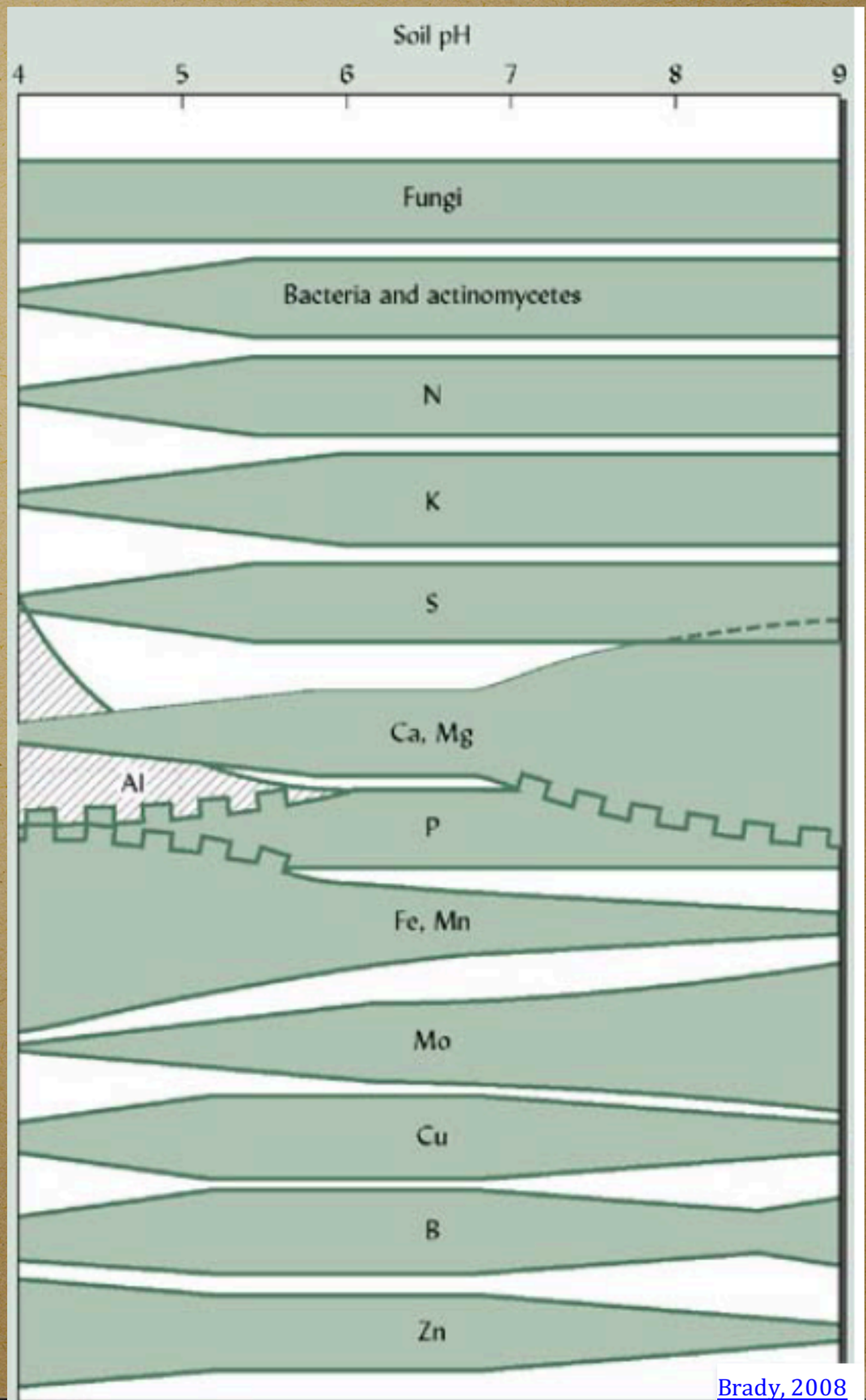
Optimum Soil pH

- **pH is a master variable for nutrient availability in soils**

- **Major Trends:**
- At Low pHs (high acidity): availability of macronutrients is reduced

- While availability of metal micronutrients increases: Fe, Mn, Zn. Aluminum also becomes soluble, aka available for plant uptake

- **Are you interested in any particular nutrient availability story?**



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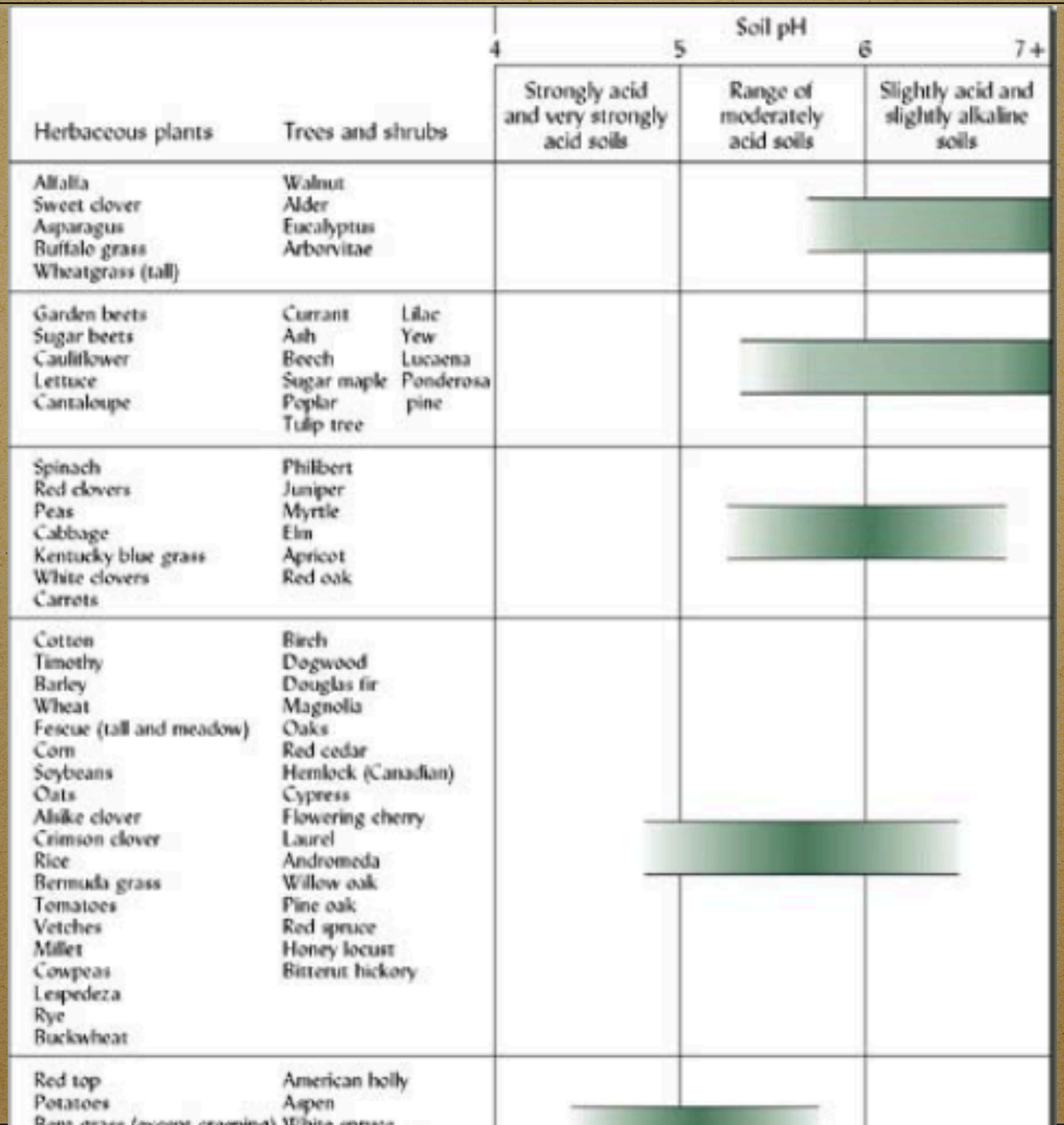
Optimum Soil pH for Different Plant Species



pH Test Kits

- **Use Distilled or Deionized water for pH**
- **Use just 1 or 2 drops of indicator solution**