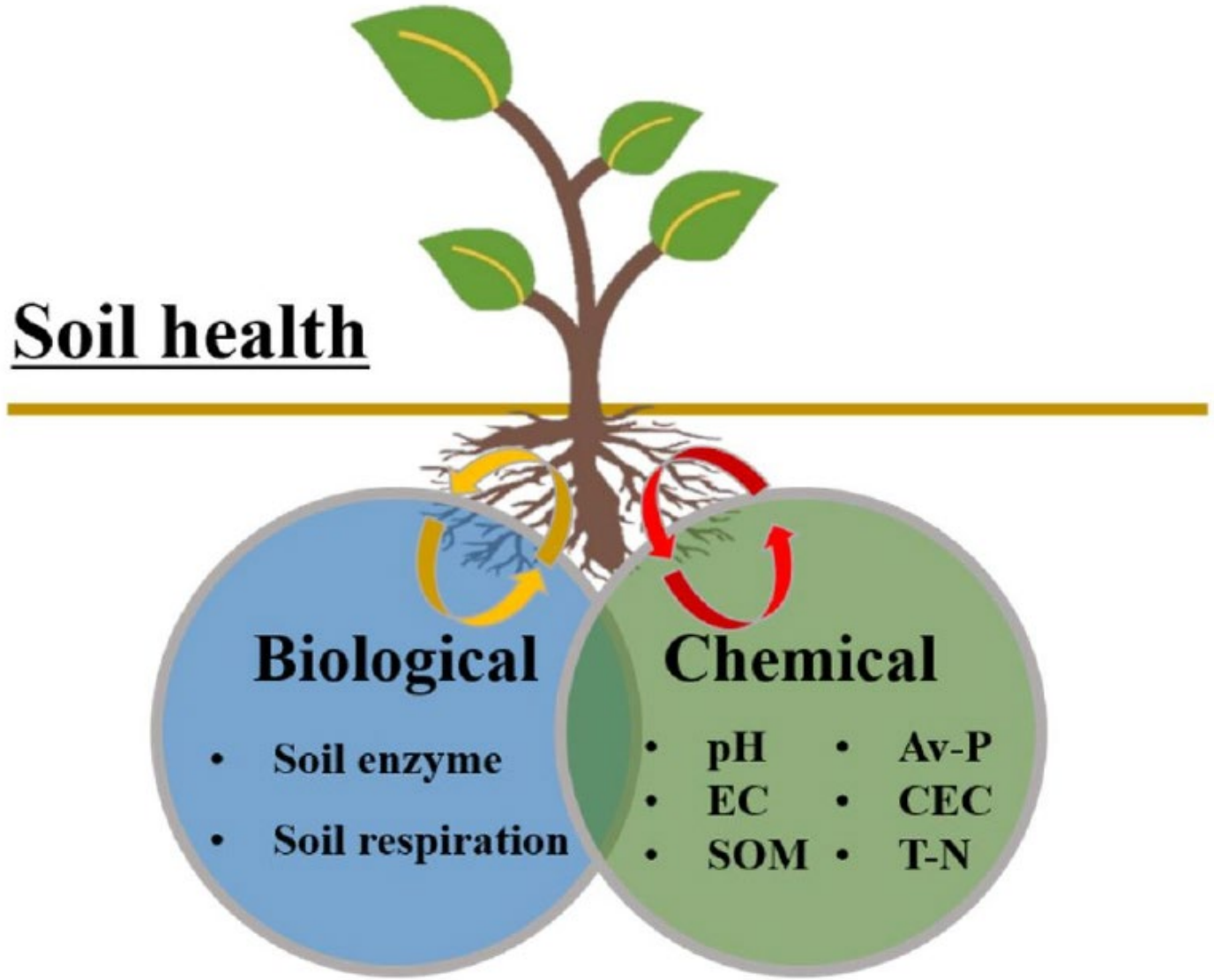
Soil Chemistry and Agriculture

Soil Chemistry

- Colloids
  - Clay and humus
  - Large surface area
- Humus
  - Partial decay of organic material
- Clay and humus are sites for the majority of soil chemical reactions

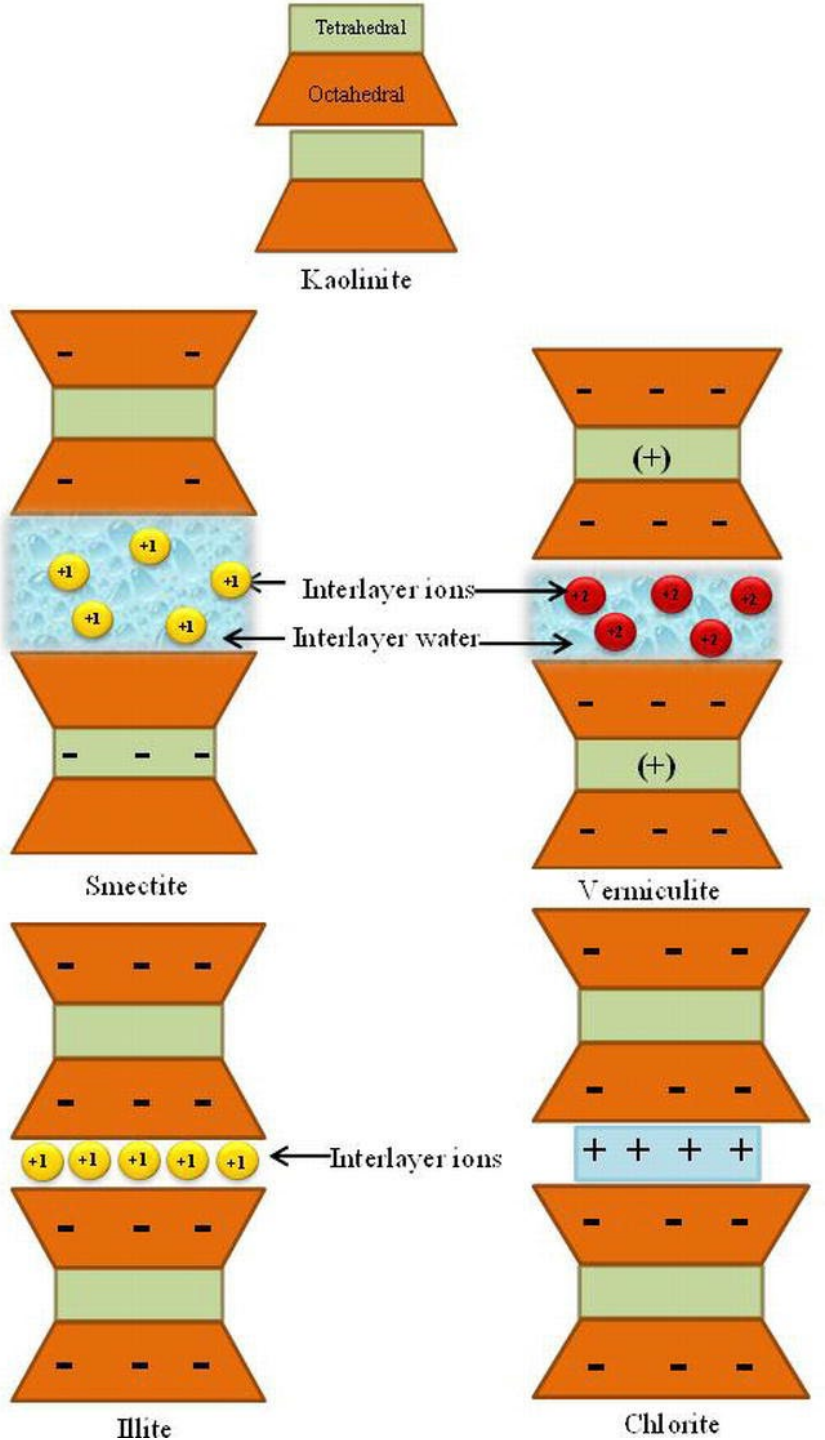
Soil chemical properties

- Mineral solubility
- Nutrient properties
- Soil pH
- Cation exchange
- Buffering action



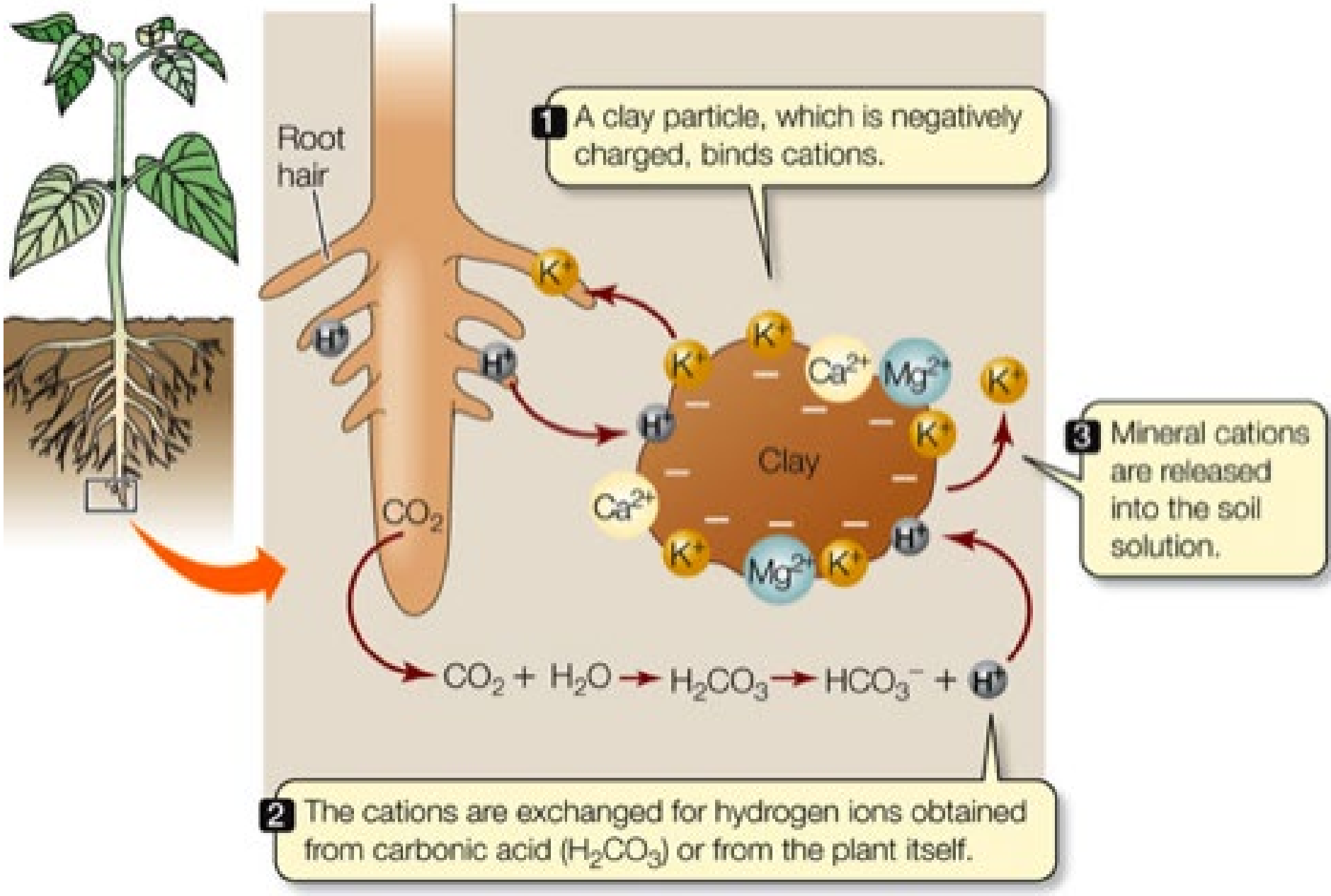
Clay

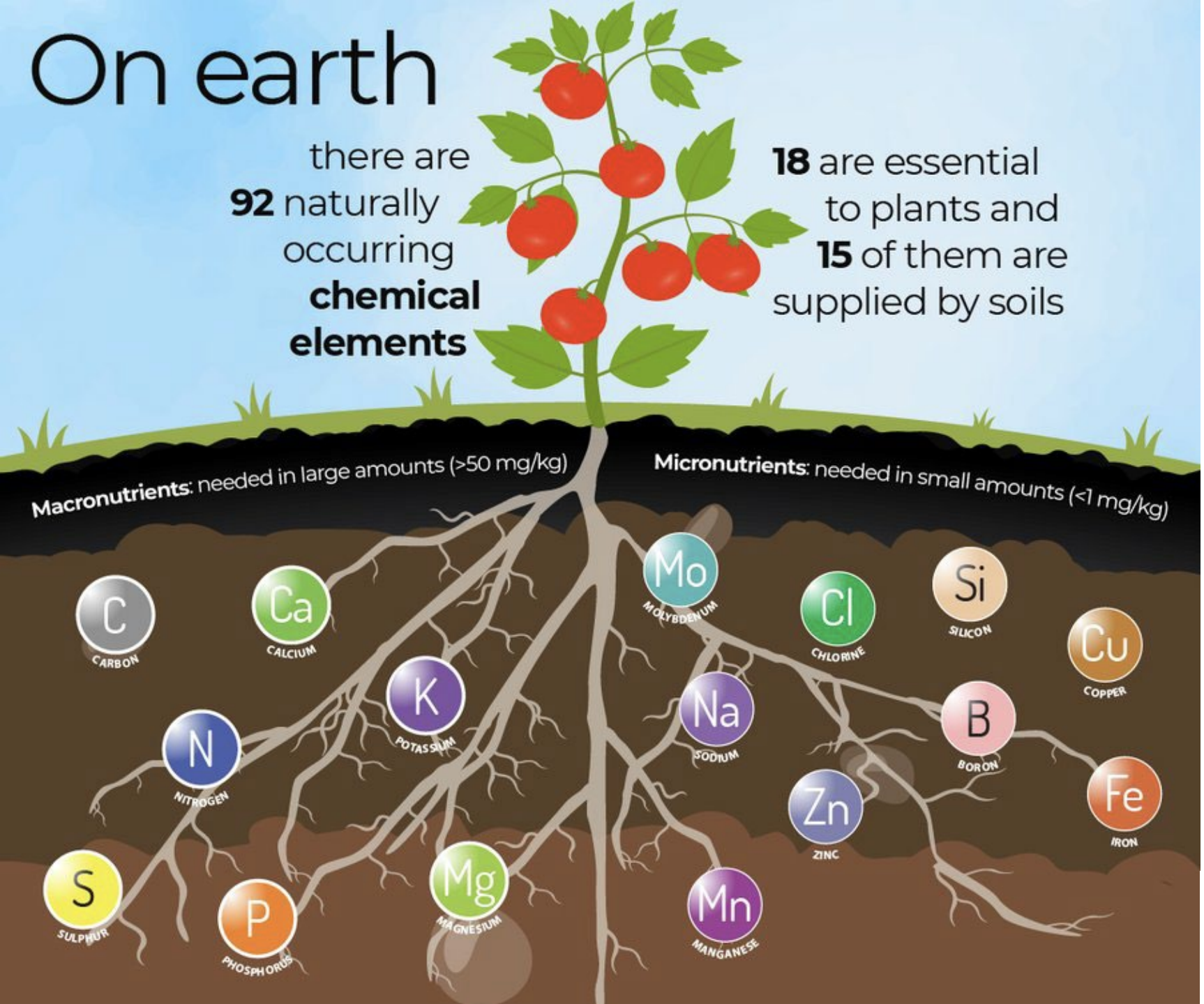
- Many types each with different properties
  - Kaolinite (no shrink swell, no CEC)
  - Montmorillinite (shrink well, high CEC)
  - Illite
  - Smectite
- Clays have negatively charged sites that attract and hold cations
- Cation Exchange Capacity (CEC)
  - The number of cations that can be held by a soil mass



Common soil cations

- K
- Na
- Ca
- Mg
- H
- Al
- $Al(OH)_2$





Macronutrients (x>50 mg/kg)

C, Ca, N, K, S, P, Mg

Micronutrients (X<1 mg/kg)

Mo, Na, Cl, Si, Cu, B, Zn, Mn, Fe

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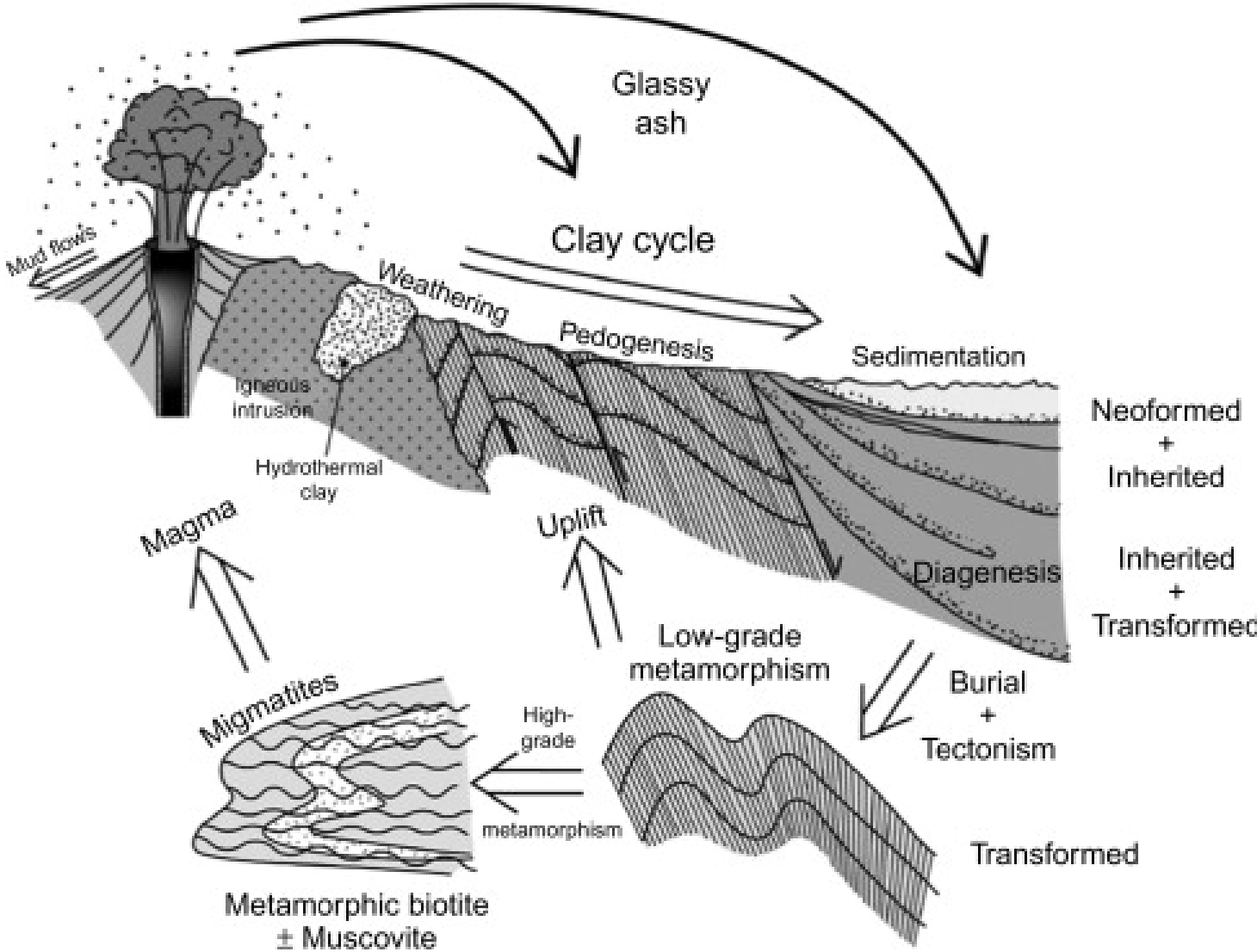
GLOBAL SOIL PARTNERSHIP

Clay origins

- Inherited
  - Introduced through deposition followed by stabilization and soil development
- Modified
  - Weathered from parent material
- Neo-formed
  - New clay formed through crystallization of soil solutions

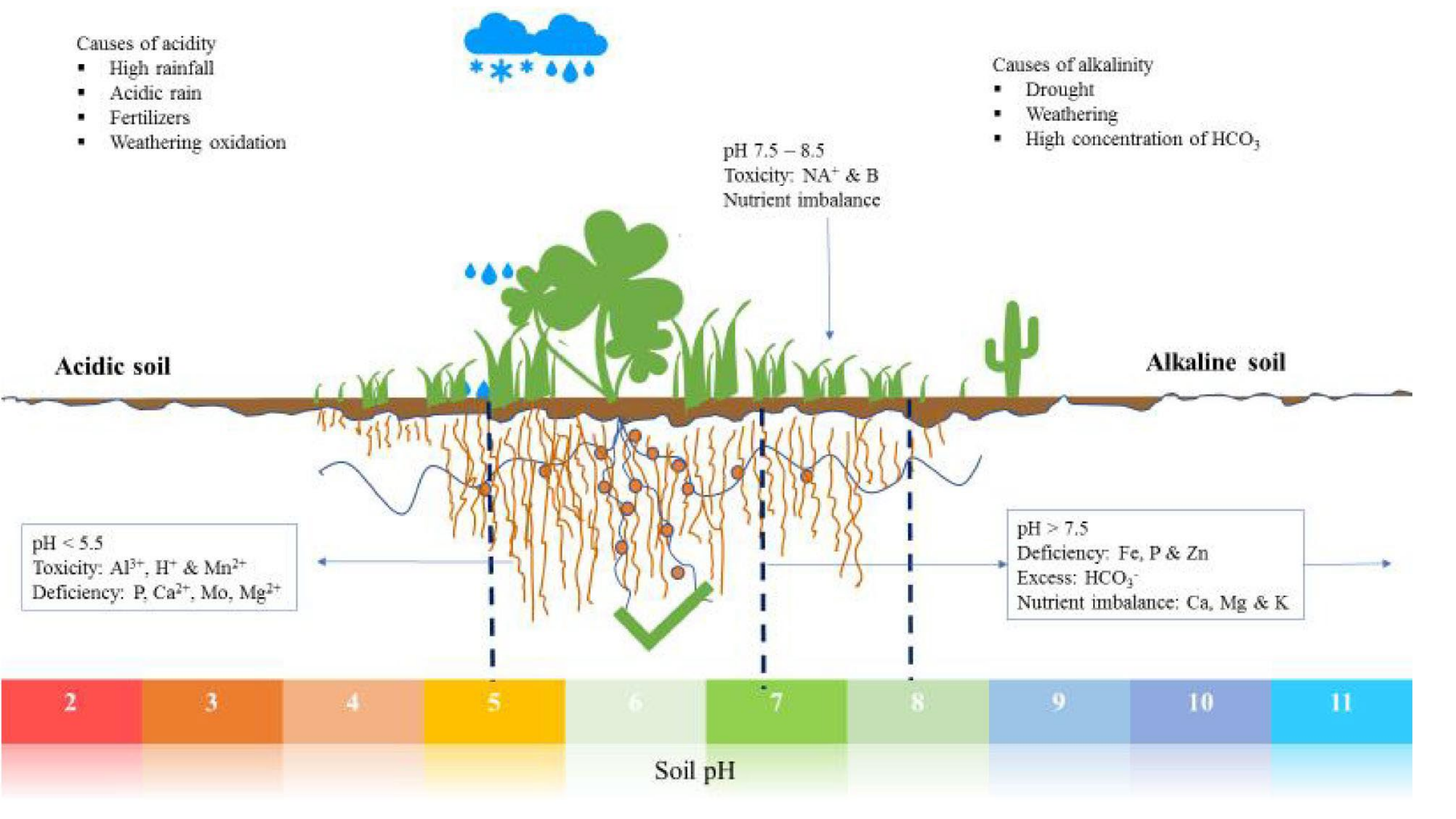


Developments in Clay Science Volume 5, 2013, Pages 83-126

Galan and Ferrell

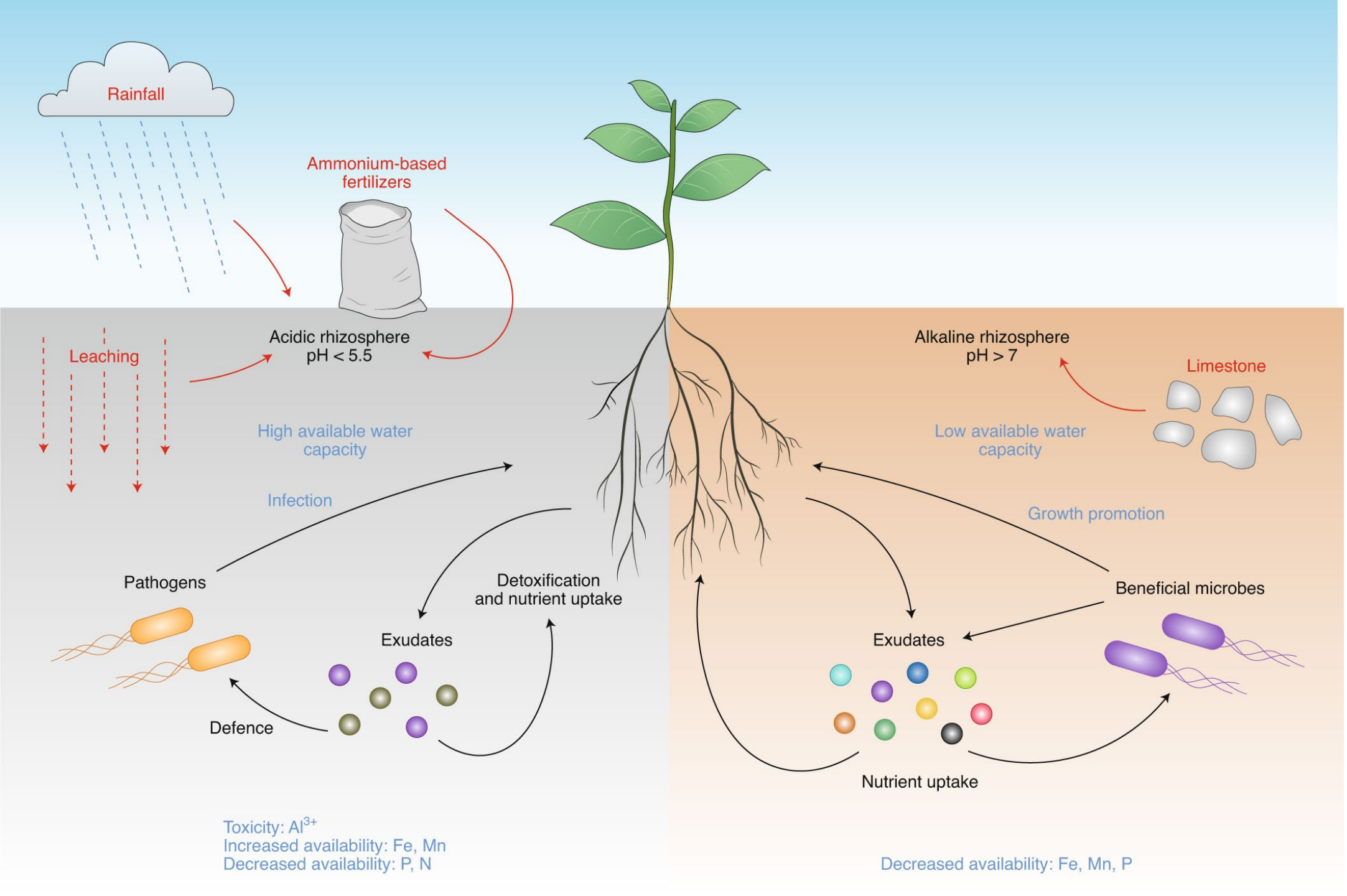
Soils, H^+ and pH

- Plants can excrete H^+
- The H+ can discharge/mobilize cations from lattice exchange sites
- Allowing the cation nutrients to be taken up by plant roots
- High amounts of $Al(OH)_2$ leads to acidic soils
- Soil pH range = 4 to 10
- Most crop plants grow best between pH 5 and 8


Causes of acidity
High rainfall
Acidic rain
Fertilizers
Weathering oxidation
Causes of alkalinity
Drought
Weathering
High concentration of HCO_3
pH 7.5 – 8.5
Toxicity: NA^+ & B
Nutrient imbalance
Acidic soil
Alkaline soil
pH < 5.5
Toxicity: Al^{3+}, H^+ & Mn^{2+}
Deficiency: P, Ca^{2+}, Mo, Mg^{2+}
pH > 7.5
Deficiency: Fe, P & Zn
Excess: HCO_3^-
Nutrient imbalance: Ca, Mg & K
2
3
4
5
6
7
8
9
10
11
Soil pH

Importance of soil pH

- Influences plant growth by influencing microorganism activity
  - Nitrogen fixing legume bacteria become inactive in acidic soils
  - Fungi can handle acidic conditions better than other microbes
- pH helps to mobilize cation nutrients


Rainfall
Ammonium-based fertilizers
Leaching
Acidic rhizosphere
pH < 5.5
High available water capacity
Infection
Pathogens
Detoxification and nutrient uptake
Exudates
Defence
Toxicity: Al^{3+}
Increased availability: Fe, Mn
Decreased availability: P, N
Alkaline rhizosphere
pH > 7
Limestone
Low available water capacity
Growth promotion
Beneficial microbes
Exudates
Nutrient uptake
Decreased availability: Fe, Mn, P