Principles of Soil Science

Lec-4-

Soil Chemistry

- The chemistry of a soil determines its

*- Ability to supply available

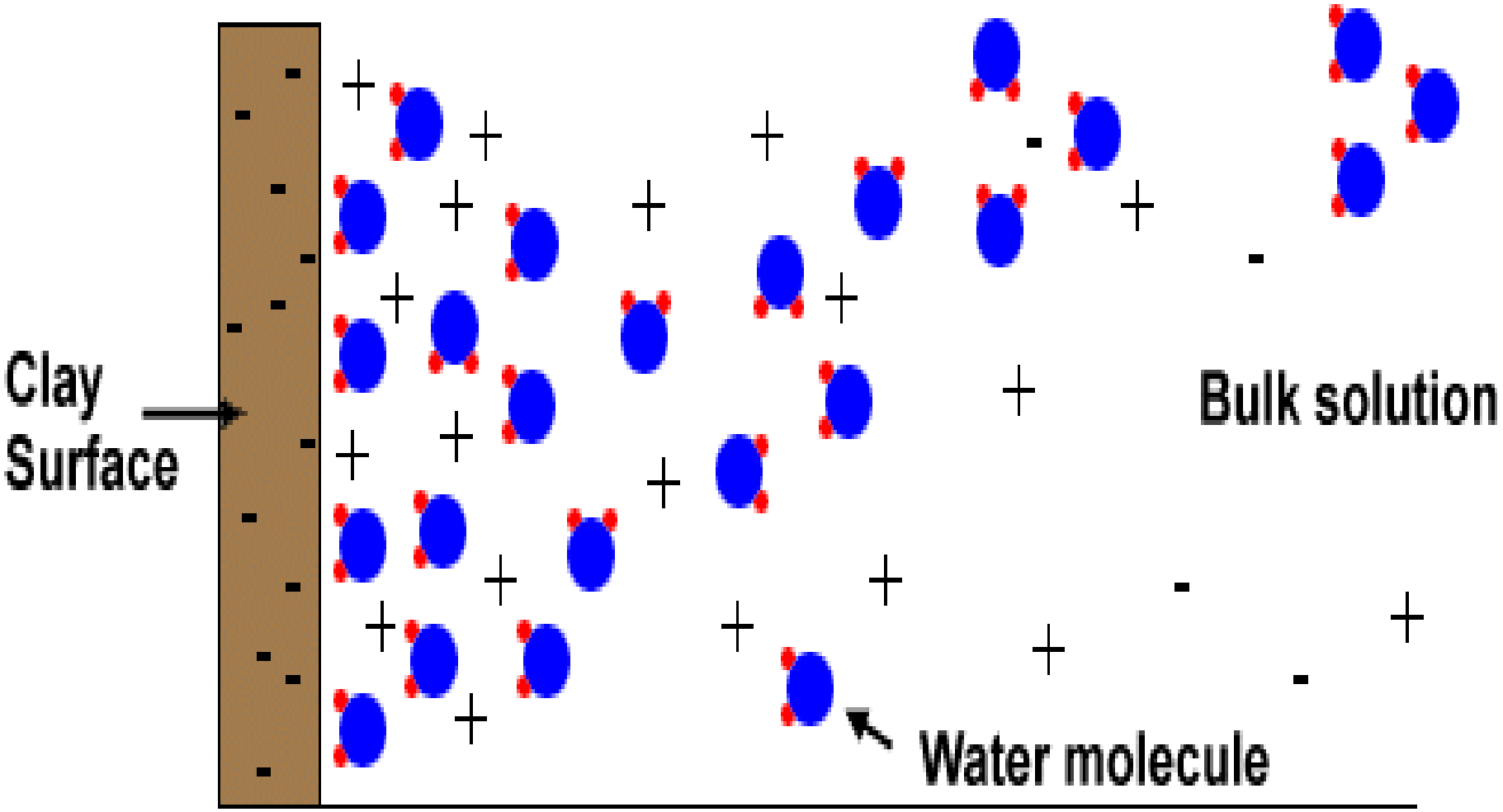
plant nutrients and

Affects its physical properties

and the health of its microbial population.

*- In addition, a soil's chemistry also determines its corrosivety, stability, and ability to absorb pollutants and to filter water.

- It is the surface chemistry of mineral and organic **colloids** that determines soil's chemical properties.



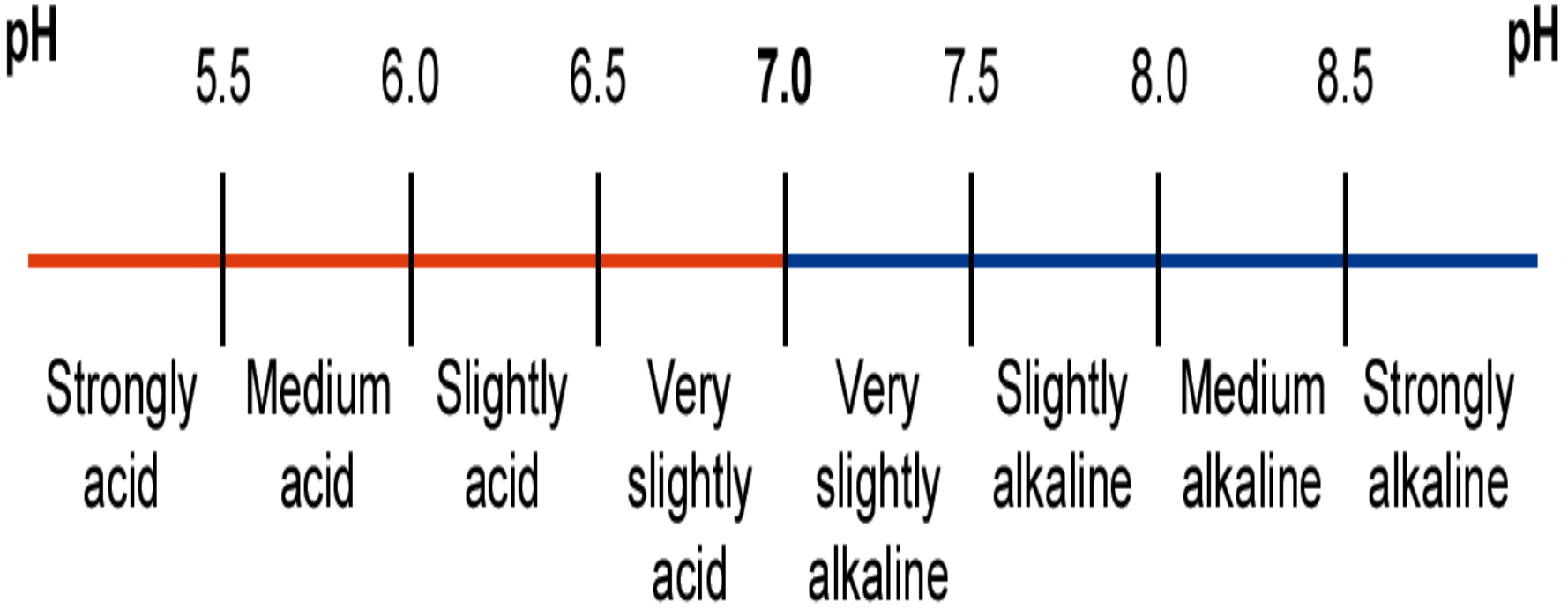
Interaction of water molecules with clay surfaces, and cations and anions in soil

Soil Reaction (pH)

- **Soil reaction is the degree of acidity or alkalinity of a soil, usually expressed as a pH value.**
- **Soil pH = – log $[H^+]$**
- **Soil pH is an indicator of physical, chemical and biological properties in soil.**
- **Soil pH is also related to the cations present on the exchange complex.**

pH of Common Materials

- **Milk of magnesia: ~10.5**
- **Bicarbonate of soda: ~ 8.3**
- **Pure water: 7.0**
- **Milk: ~ 6.8**
- **Natural rain: 5 to 6**
- **Beer/coffee: ~ 4**
- **Lemon Juice: ~ 2**



Descriptive terms for Soil pH ranges

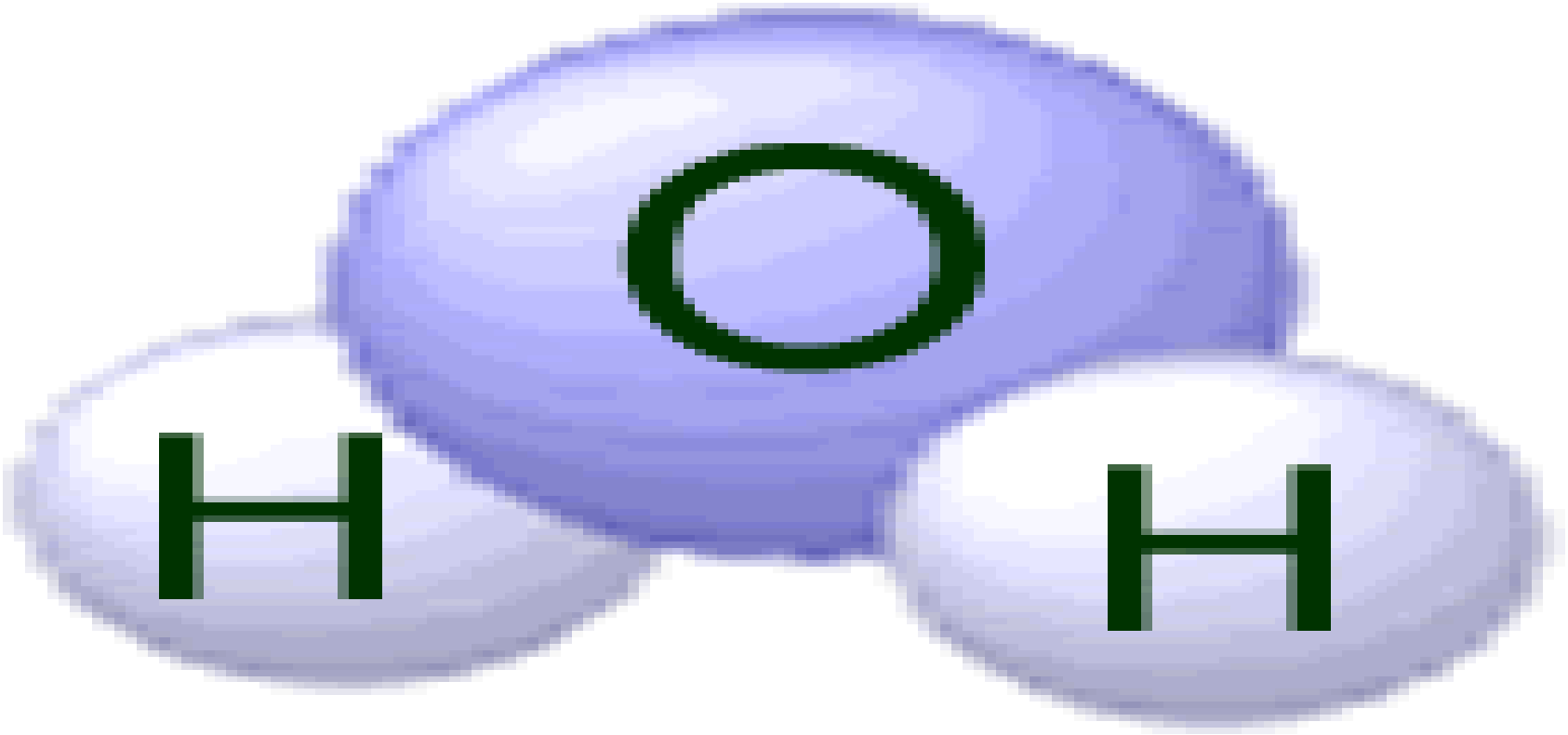
Soil pH…

- This gives a measure of the acidity or basicity of a soil. **0-7 = acidic**; **7-14 = basic.**
- Acidity is measured by determining the concentration of Hydrogen (H^+) ions in the soil.
- Higher concentration of H^+ ions = high acidity, higher concentration of OH^- ions = high basicity.
- In general, the ideal pH for plant growth is about

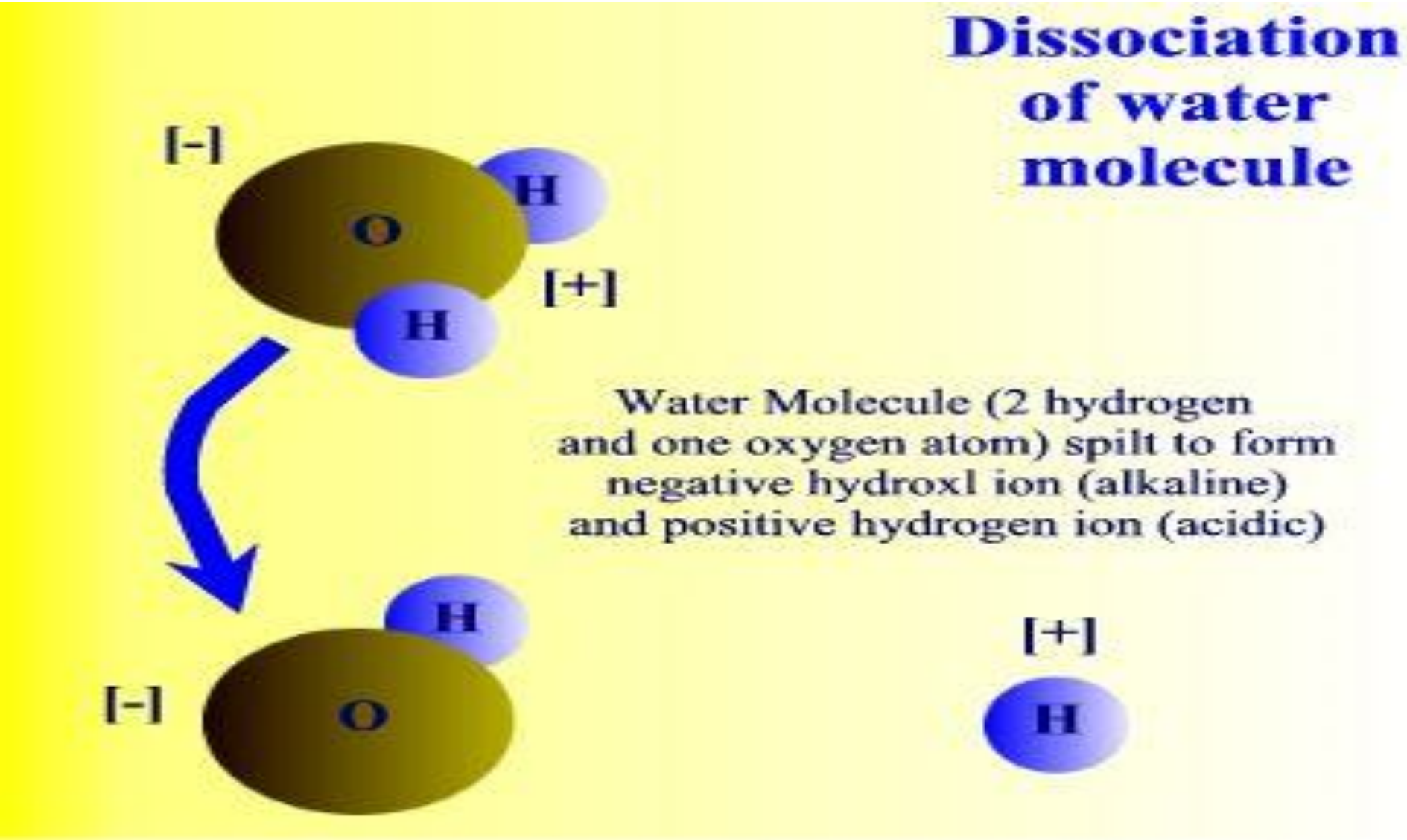
5.5 in organic soils and

about **6.5** in mineral soils.

WATER MOLECULE



Where do H^+ and OH^- ions come from?



Why is soil pH important?

- Affects solubility of minerals.
- Affects type, numbers and activity of microorganisms.
  - Fungi tolerate acidity better than bacteria. Bacteria often negatively affected by high acidity (i.e. low pH).
  - Indirectly affects aggregate stability.
- Determines what happens to many soil pollutants.
- CEC increases with soil pH.

Soil Buffering Capacity…

- The tendency of soils is to resist changes of the pH of the soil solution.
- This resistance is termed “buffering”.
- Soils have different buffering capacities.
- Generally,

  (Higher CEC = greater buffering capacity).
- Buffering capacity indicates dynamic equilibrium of soil solution.

Changes of all types tend to be resisted by the system.

Buffering Mechanisms

- Oxidation of pyrite and reduced S minerals; dissolution of minerals: pH **2** to **4**
- Aluminum compounds: pH **4.0** to **5.5**
- Cation exchange: pH **5.5** to **6.8**
- Organic matter and minerals: pH 6.8 to 7.2
- Ca and Mg carbonates: pH 7.2 to 8.5
- Exchangeable Na^+; Dissolution of solid sodium carbonate: pH 8.5 to 10.5

Percent Base Saturation

- Basic cations : Ca^{++}, Mg^{++}, Na^{+}, K^{+}
- Acidic cations: Al^{+++}, H^{+}
- Percent base saturation: A measure of the proportion of basic cations occupying the exchange sites of a soil

Formula

- Cation exchange capacity is the sum of all cations on the exchange complex

$$\% \text{ Base Saturation} = \frac{\Sigma\,(Ca^{++}, Mg^{++}, K^{+}, Na^{+})}{\text{Cation Exchange Capacity}} \times 100$$

Soil Acidity Types

- Active acidity:

  The activity of hydrogen ions in solution.

- Reserve acidity:

  The acidity that is associated with the exchange complex. It is neutralized by lime or other alkaline material.

Soil structure and pH

- **Soil structure**

  = A measure of soil's "clumpiness"

  * A medium amount of clumpiness is best for plants

  * Repeated tilling compacts soil, decreasing its water-absorbing capabilities.

- **Soil pH**

  = affects a soil's ability to support plant growth

  – Soils that are too acidic or basic can kill plants

  – pH influences the availability of nutrients for plants

Q/ Write only the pH unit?

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