

**University of Salahaddin
College of agriculture
Dept. of Soil and Water**



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second -year Students
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soil chemistry L2

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What are the main phases of soil?

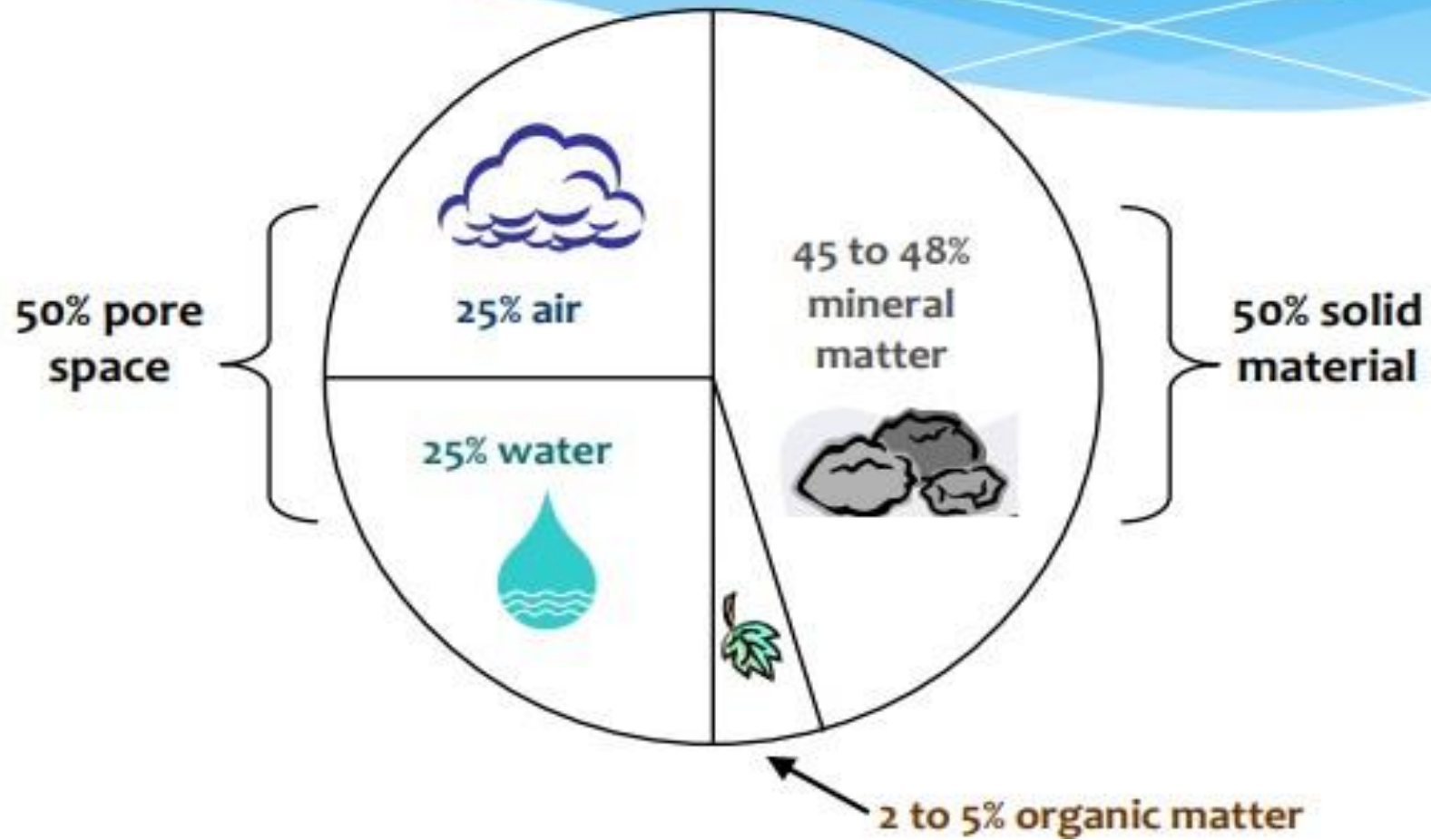
- 1-Solid phase =Mineral component
Organic⁺component
- 2-Air or Gaseous phase
- 3- Water or liquid phase

What is the most important phase that was not mentioned in scientific references? Why?

- It is the microorganism phase because it is difficult to determine its weight, and volume due to its very low values cannot be determined in the lab.

What are the numbers of soil phases?

Volume Composition of a Desirable Surface Soil



- Solid phase makes up only about 50% of Soil volume
The other half is filled with water air
- Since the density of O.M is about 0.5 g/cm^3 and mineral material = 2.7 g/cm^3 .
- The gas phase occupies about a fourth of soil volume.
- CO_2 in good drain soil = 0.1% ,
while in Bad aeration (Poor aeration) soils = $5 - 10 \%$
and May rise to 20% in frozen soil horizon they replace all O_2 .
- Trace or rare gas also occurs in soil (Ne , Kr , Ar ,Xe).
- Is the chemical composition of the soils similar?

- **Solid phase:** Soil material less than 2 mm in size constitutes the soil sample. It is broadly composed of **inorganic** and **organic** constituents.
- Soils having more than 20% of org. constitutes are arbitrarily designated organic soils.
- Where inorganic constituents dominate, they are called mineral soils. It accounts for nearly 50% of the total volume and 95% of the solid phase is made up of inorganic or mineral matter.
- The remaining 5% weight comprises O.M which is mainly derived from dead parts of the vegetation and animals.

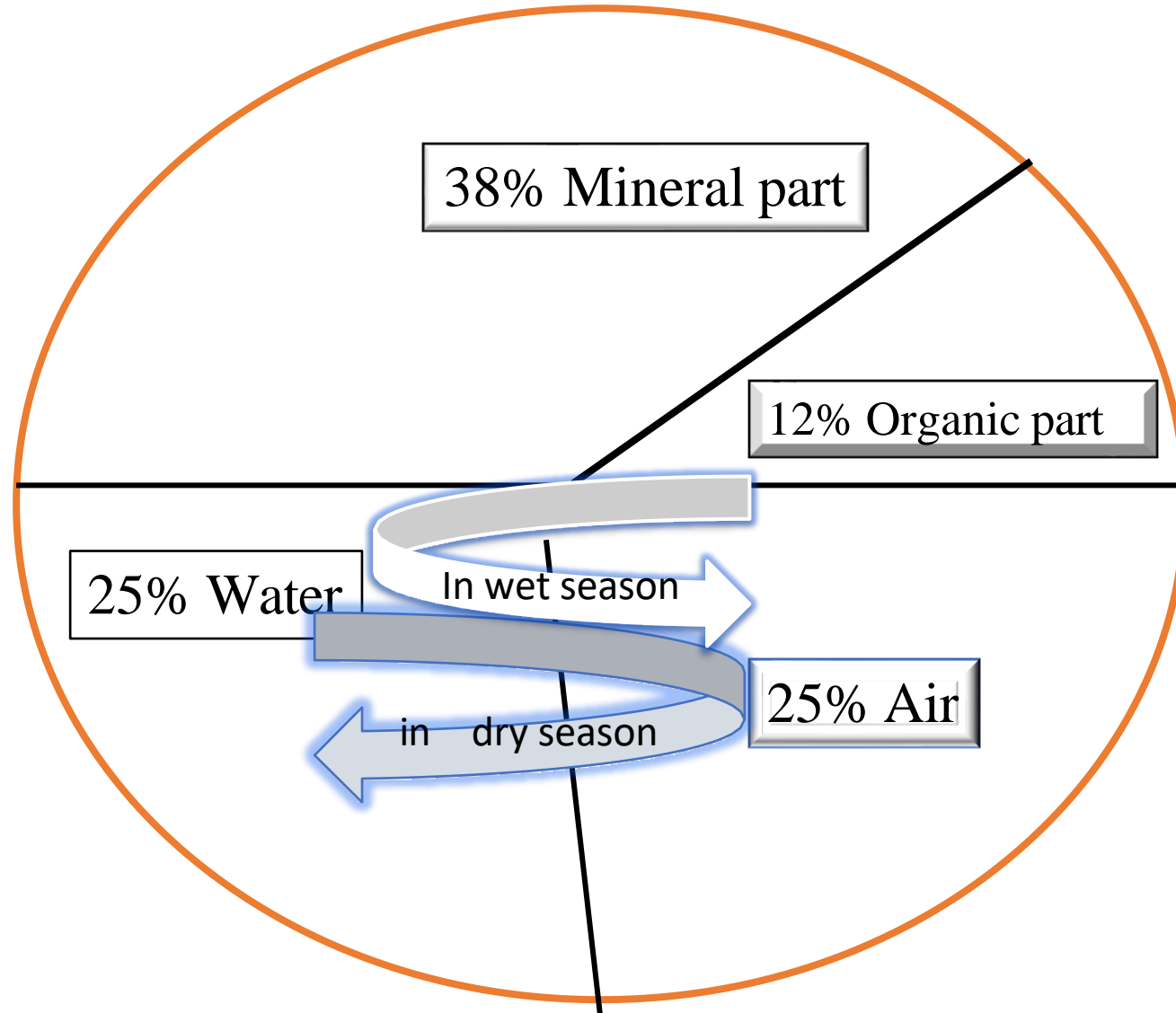


Figure (2.2) Explains soil phases(volume).

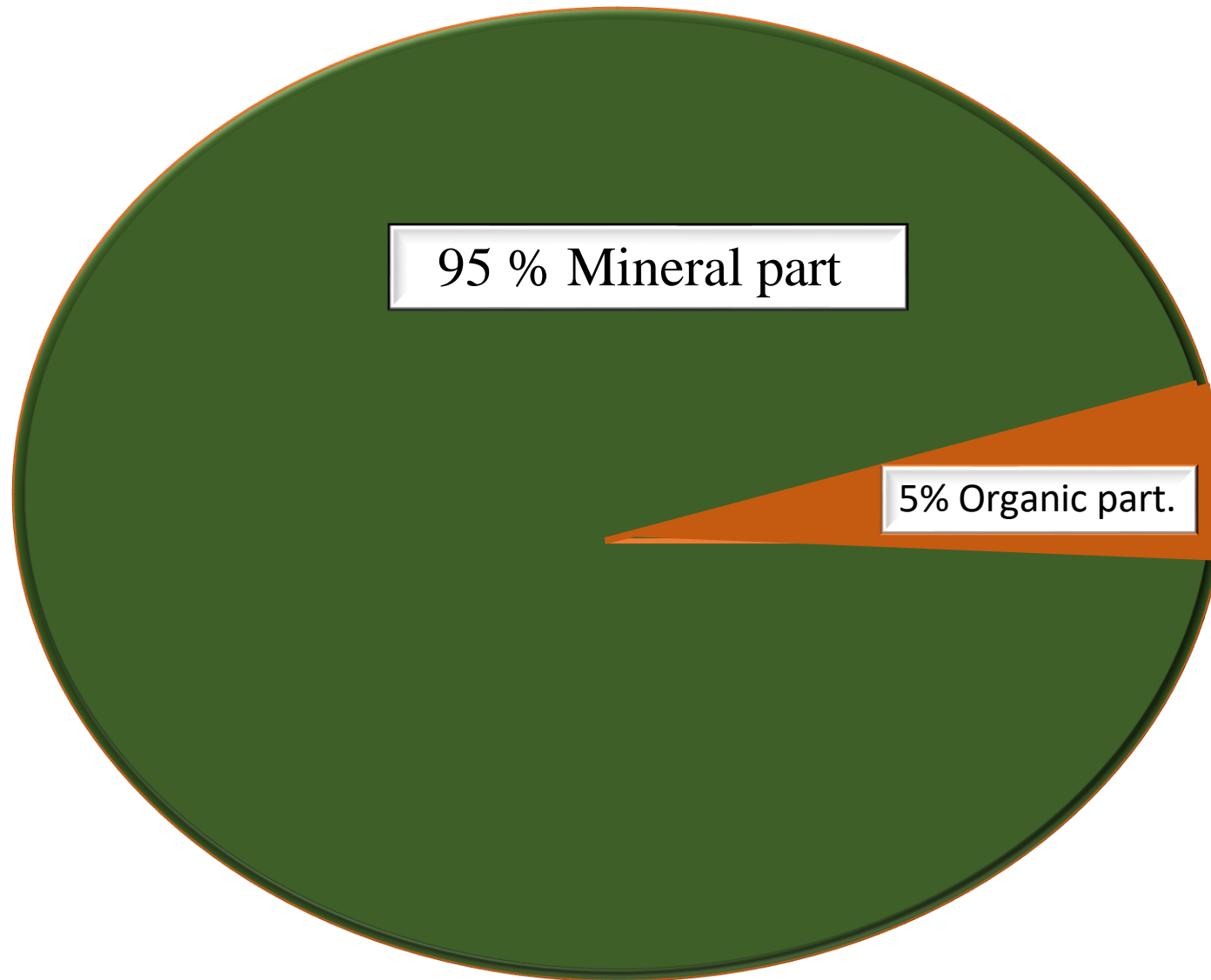


Figure (2.3) Soil phases (oven dry weight)

Composition of the Earth's Crust

Table(1) main elements of earth crust and their radius (Angstrom):

	Weight %	Atom %	Ionic Radius	Volume %
O	46.60	62.55	1.40	93.8
Si	27.72	21.22	0.42	0.9
Al	8.13	6.47	0.51	0.5
Fe	5.00	1.92	0.74	0.4
Ca	3.63	1.94	0.99	1.0
Na	2.83	2.64	0.97	1.3
K	2.59	1.42	1.33	1.8
Mg	2.09	1.84	0.66	0.3
Total	98.59	100.00		100.00

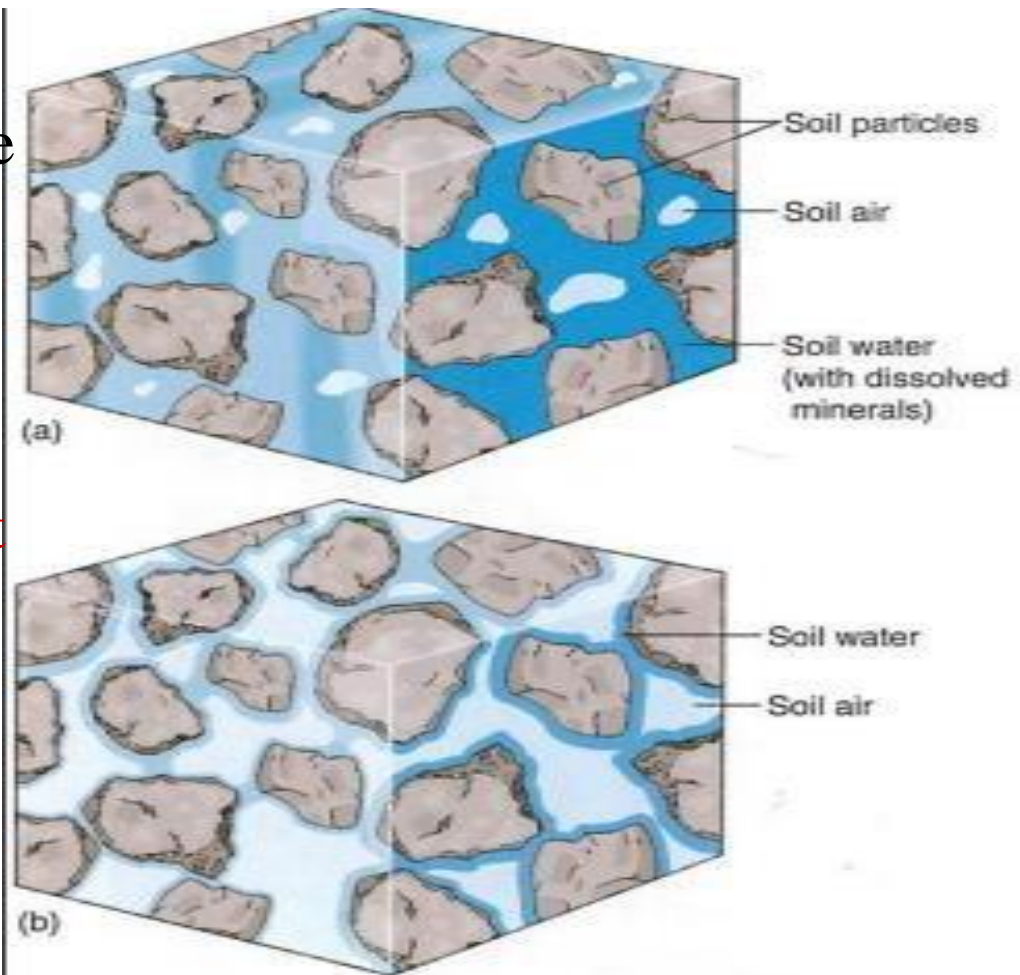
Other elements 1.41%

2- **Liquid phase:** About 50% of the bulk volume of the soil body is generally occupied by voids or soil pores which may be completely or partially filled with water.

- The soil acts as the reservoir for supplying water to plants for their growth.

3- **Gaseous phase:** The air- filled pores constitute the gaseous phase of the soil system and are dependent on that of the liquid phase.

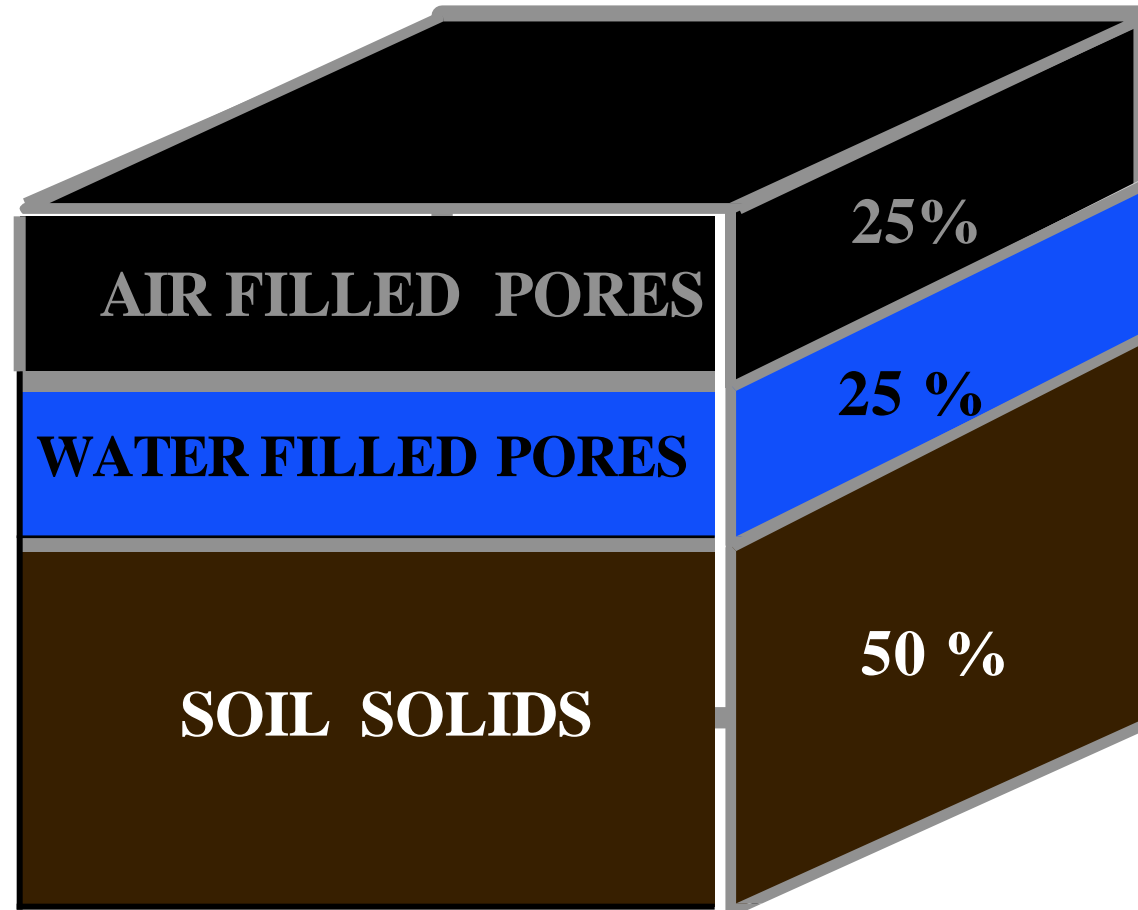
-The N and O₂ contents of soil air are almost the atmospheric air **but the concentration of CO₂ is much higher (8 – 10 times more)** which may be toxic to plant roots. This phase supplies O₂ and thereby prevents CO₂ toxicity.



The three phases of the soil system have definite roles to play. **The solid phase** provides mechanical support for and nutrients to the plants. **The liquid phase** supplies water and along with it dissolved nutrients to plant roots. **The gaseous** phase satisfies the creation (O_2) need of plants.

SOIL COMPONENTS

idealized soil



Mechanisms of ion-soil interaction:

This mechanism can remove and replace ions in the soil solution. The mechanism of ion entry into the soil solution includes:

1 Mineral weathering.

2 Organic matter decay. 3-Rain.

4Irrigation water.

5 Release of ions retained by soil colloidal or clay fractions of soils.

Soil Solution

soil water, including dissolved solutes, is referred to as the soil solution and is the lifeblood of soil. All chemical reactions, mineral precipitation/dissolution reactions, ion exchange reactions, redox reactions, and nutrient uptake by plants occur in soil solution. Without soil water(soil solution), very few chemical or biological reactions would occur in soil; in fact, there would be no life on this planet.

The soil and soil solution are the heart of soil. Atmosphere --

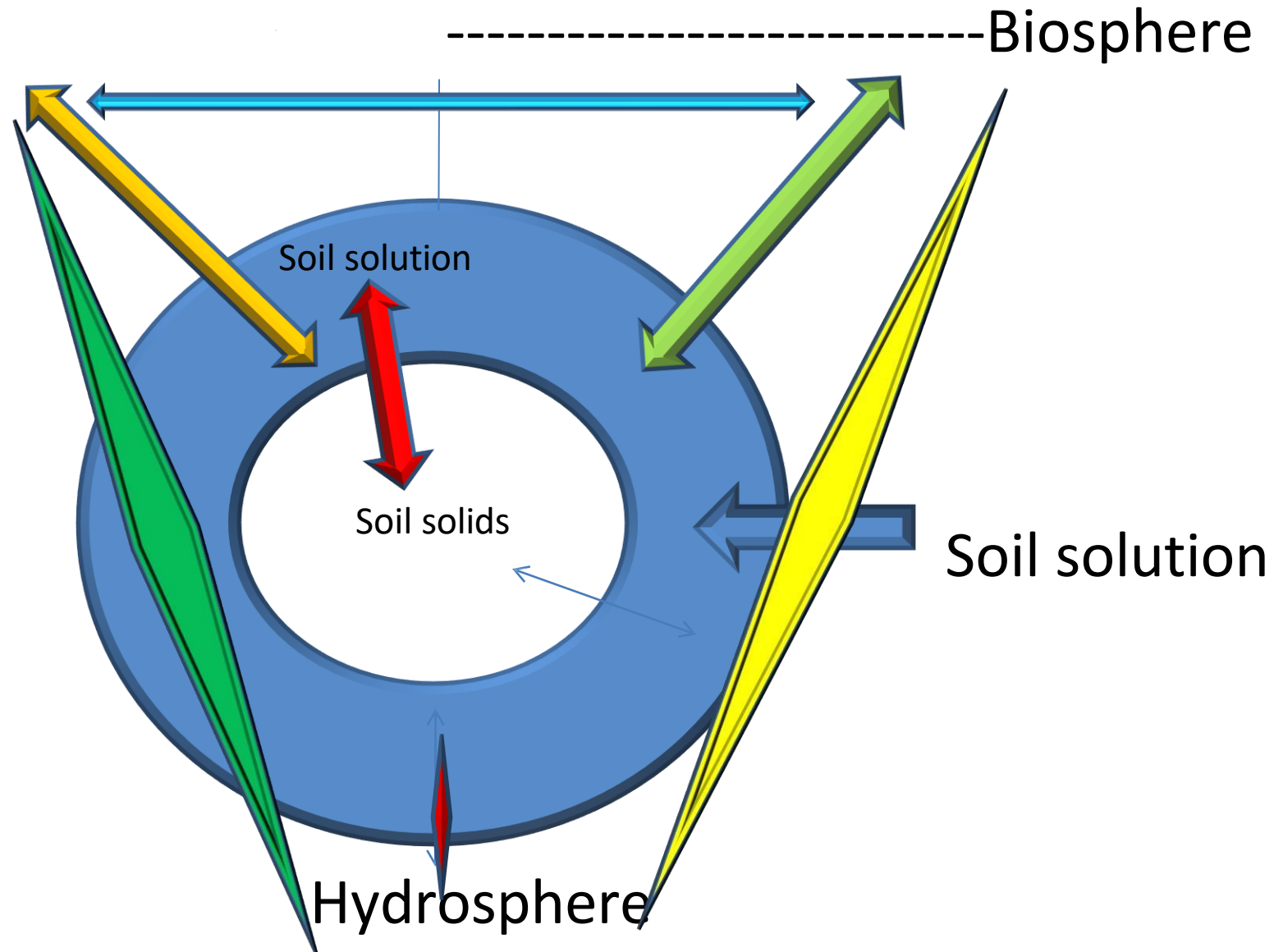
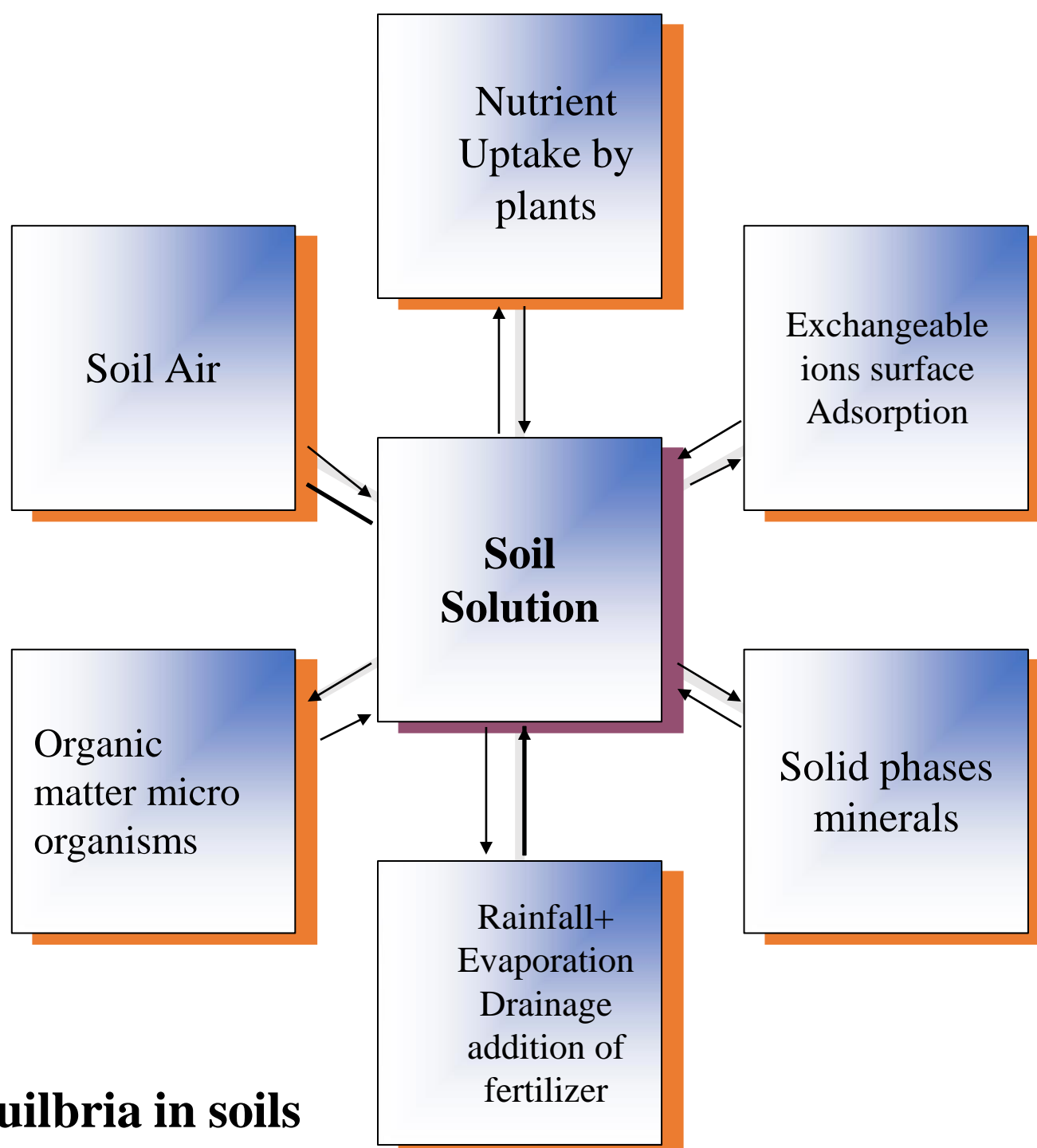


Figure :The soil and soil solution are the heart of the environment.

Chemical equilibria among soil phases:

There are three types of equilibrium

- 1 Static equilibria
- 2 Dynamic equilibria.
- 3 Thermodynamic equilibria.



Dynamic equilibria in soils

What are the main soil chemical properties?

The main soil chemical properties are:

1Electrical conductivity (EC).

2Soil pH.

3Ion exchange.

4Soil minerals

A- Soil calcium carbonate content.

B- Soil gypsum content.

6Concentration of cations and anions.

7 Concentration macronutrients, micronutrients, and trace elements.

Which chemical property regarded as the best one? Why ?

pH regards as the best one due to its effect on nutrients availability, microorganisms activity and CEC.

1) Electrical conductivity (EC)

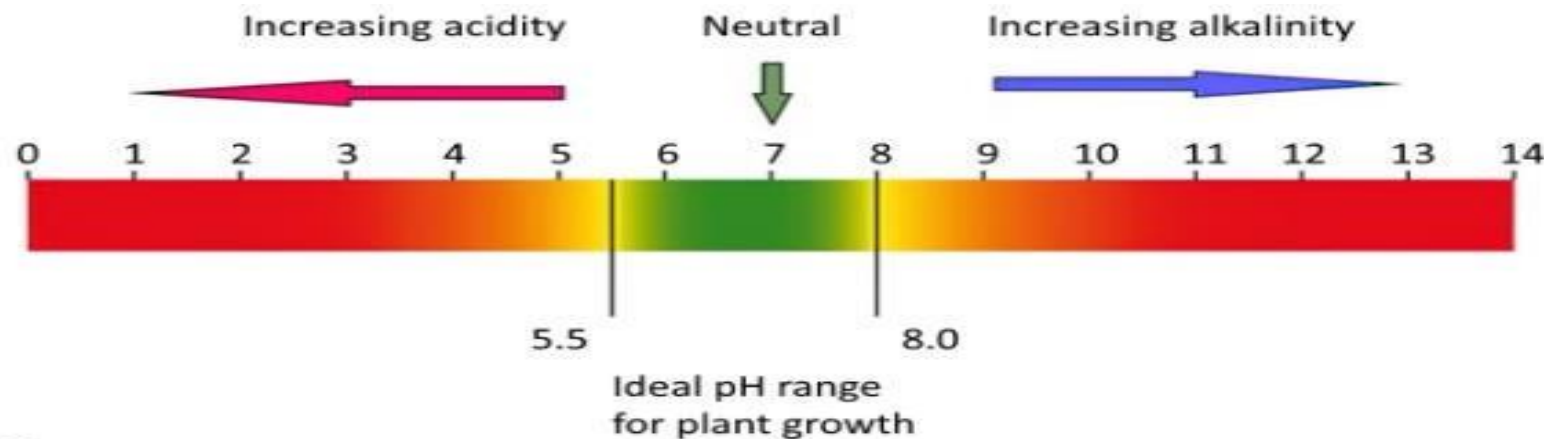
Soil electrical conductivity (EC) is a measure of the amount of salts in soil (salinity of soil). It is an excellent indicator of nutrient availability and loss, soil texture, and available water capacity.

2) Soil reaction (pH)

Soil pH is considered the single most important chemical property of soil because it affects plant growth, nutrient availability, and microorganisms activity.

Soil pH is a measure of the soil solution (soil water) acidity and alkalinity. pH is the negative logarithm of the hydrogen ion concentration {H+}

$$\text{pH} = -\log \{H^+\}$$



Ion exchange

- Ion exchange is the exchange of ions between soil solution and colloidal complex
- Cations and anions in soil solution adsorbed by soil colloids such as silicate clays, hydrous oxides of Fe, Al and Humus

