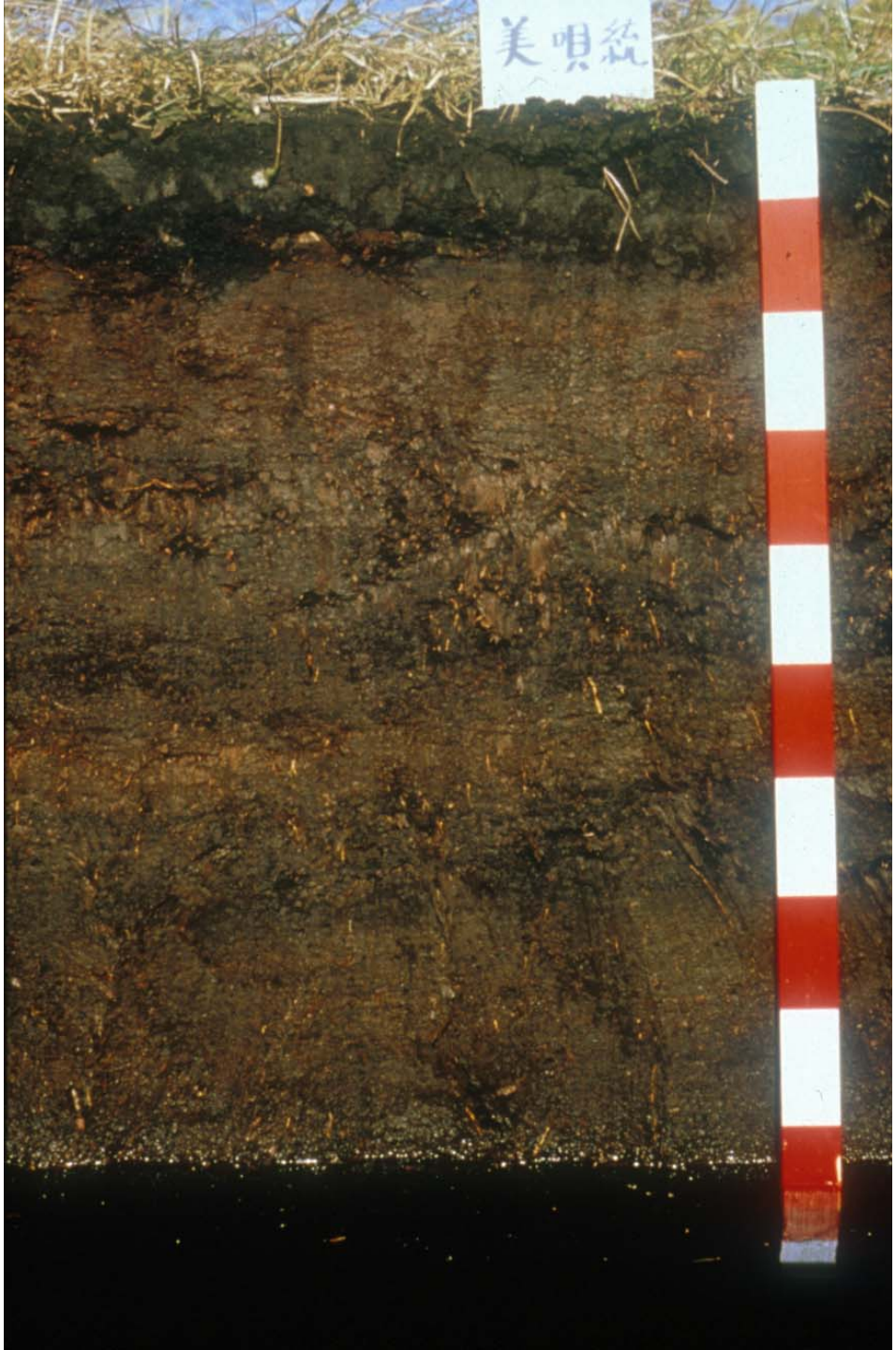
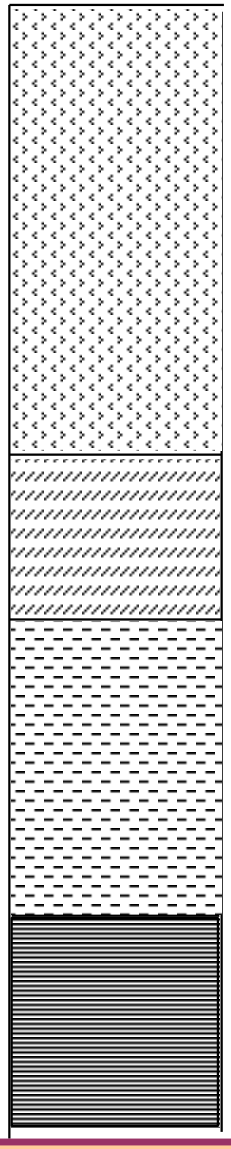
Red pine forest
(Yaotsu, Gifu prefecture)

Brown forest soil B_B type（Yaotsu, Gifu）

Litter layer of forest soil (O, A_0 layer)



Peat soil in Bibai



High moor peat

Sphagnum, sedges, cranberry

Intermediate moor peat

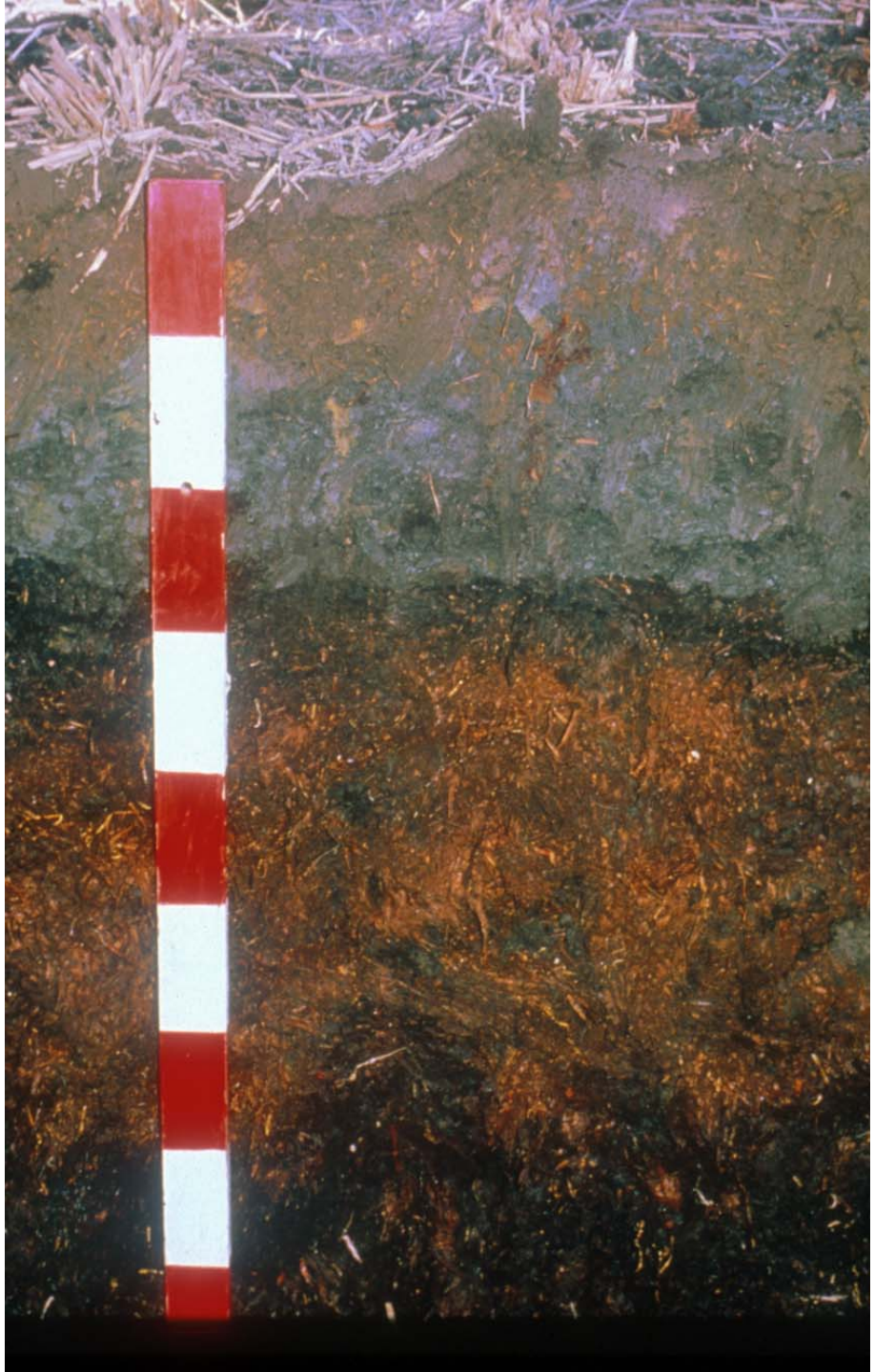
Purple grass, reed, wetland willow

Low moor peat

Reed, alnus

Clay layer

High moor peat soil profile in Bibai



Peat soil with dressed soil
（Nanporo town）

Asel forest near Hildesheim, Germany

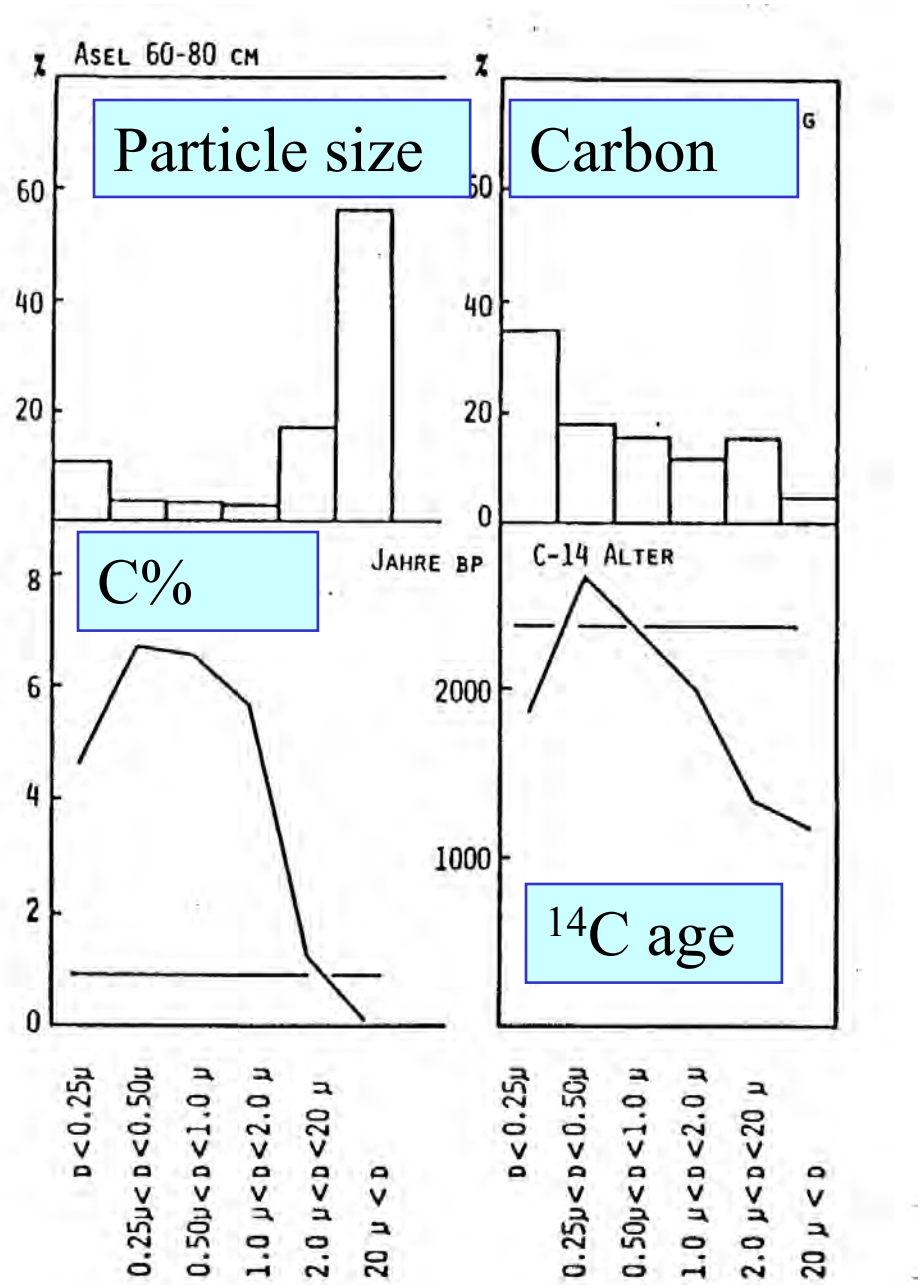
Black soil in Asel forest, Germany

Wheat field in Soellingen/Germany

Black soil in Soellingen upland field

Soil organic matter stabilization on different size of soil particles

Organic matter bound to clay lasts long in soil



Stabilization and abundance of organic matter constituents in soil

Constituents	Abbreviation	Mean Residence Time	S (kg)	A_0 (kg)
Fresh organic matter (yearly imput)				1000
Decomposable Plant Material	DPM	1	10	10
Refractory Plant Material	RPM	3.9	470	120
Biomass	BIO	25.9	280	10.8
Physically stabilized organic matter	POM	94.8	11.3×10^3	119
Chemically stabilized organic matter	COM	2565	12.2×10^3	4.76
Whole Soil Organic Matter	SOM	1334	24.3×10^3	265

Jenkinson and Rayner, Soil Scinece 123, 6, 1977

S (kg) : Expected accumulation of organic matter after 10000 years

when 1000kg ha^{-1} of fresh organic matter is incorporated every year.

A_0 (kg) : Yearly gain of soil organic matter (kg ha^{-1}) ,

Calculated from S and meanage. A_0 = S/Average Age

Accumulation of organic matter in soil

$$S = (1/\log_e 2)\, A_0\, H$$
$$= 1.44\, A_0\, H$$

S: Accumulated amount of organic matter after infinite years

A_0: Added amount of organic matter in one year

H: Half life of organic matter

1.44H: Mean residence time

Roles of Soil Organic Matter

Function of humic substance

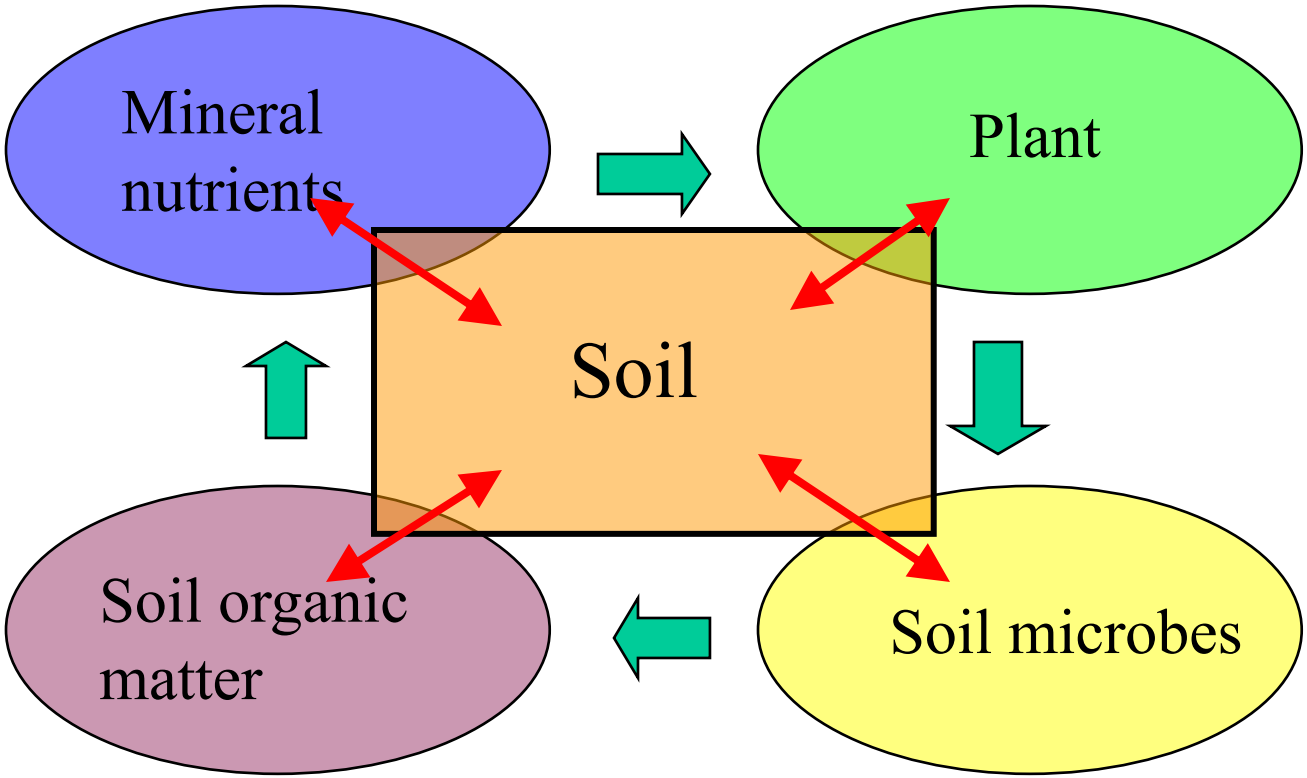
- Largest pool of carbon on the surface of earth
- Repress global warming
- Nutrition supply to plant and microbes
- Hold nutrients and water
- Improve soil physical properties
- Promote plant growth

Humic substance is not almighty, however.

- Humic substance can not support the growth of crops by itself.
- Optimum pH
- Favorable moisture condition
- Sufficient mineral nutrients
- No growth inhibiting substance

should be the background for the effect of humic substances

Role of soil organic matter



Role of Soil Organic Matter

Improvement in

a . Soil Physical properties

b . Chemical & Biological prpperties

c . Plant Growth Promotion Effects

Change in concept of plant nutrition

- J.Tull (early 18th century） Importance of plowing
- A. von Thaer （early 18th century ）

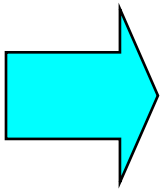
  Theory of humus nutrition
- Theodore de Saussure （early 19th century ）

  Importance of mineral nutrition.

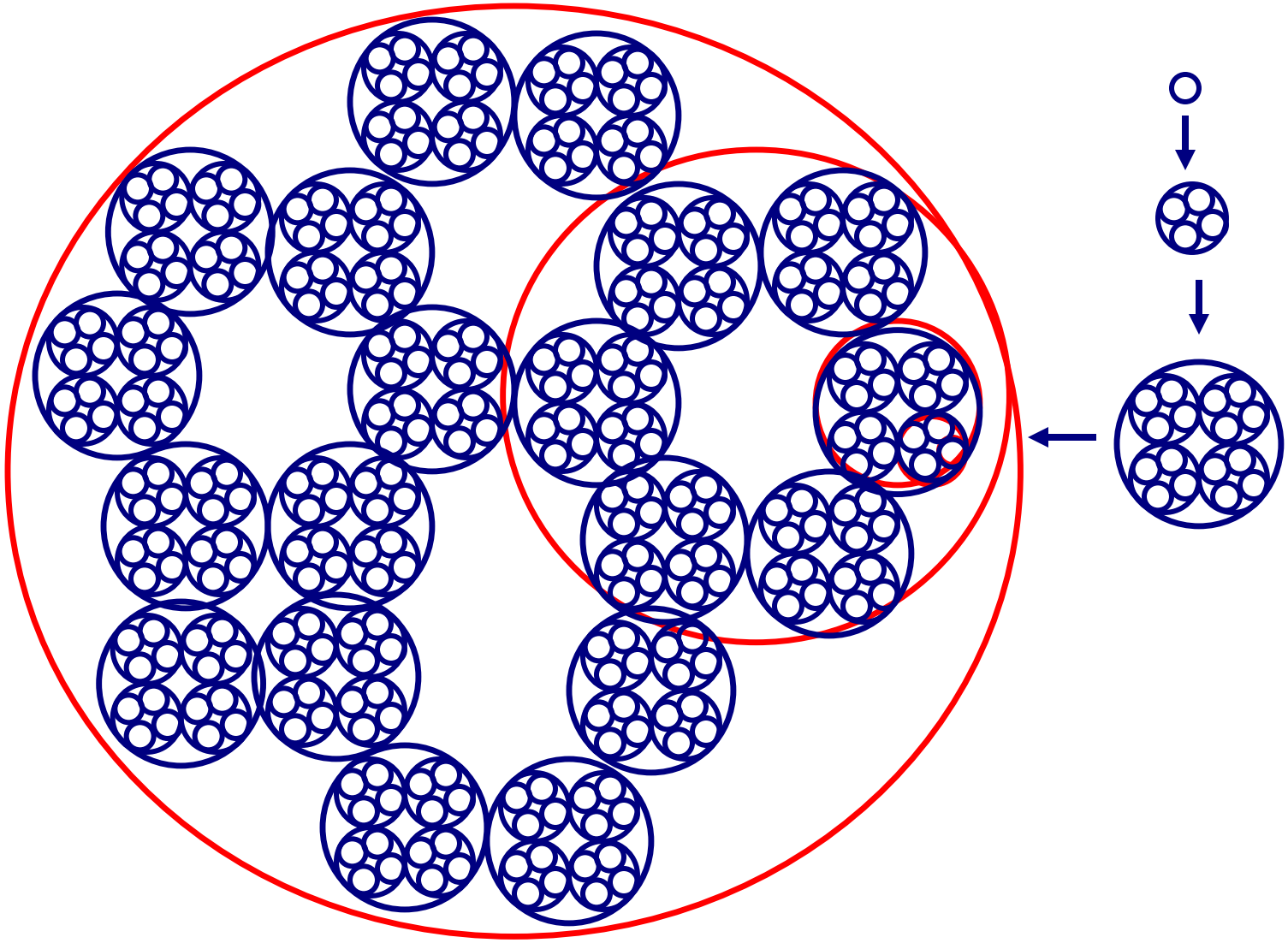
  Discovery of photosynthesis
- J.B. Boussingault (1834) Discovery of nitrogen fixation
- J. von Liebig (1840) Mineral nutrition theory

a． Improvement of Soil Physical properties by soil organic matter

Hyphae of fungi
Polysaccharide
Humic substance

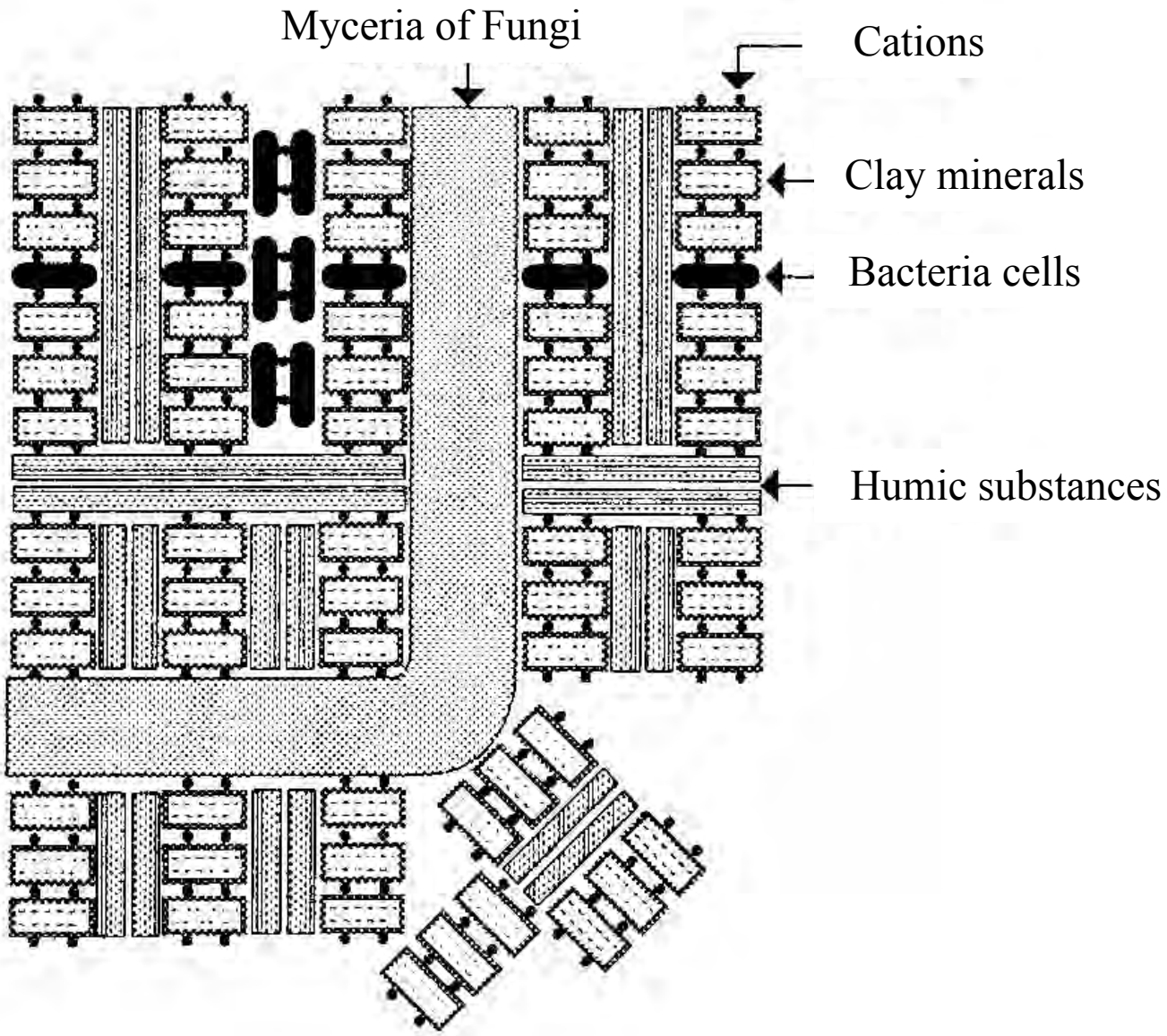


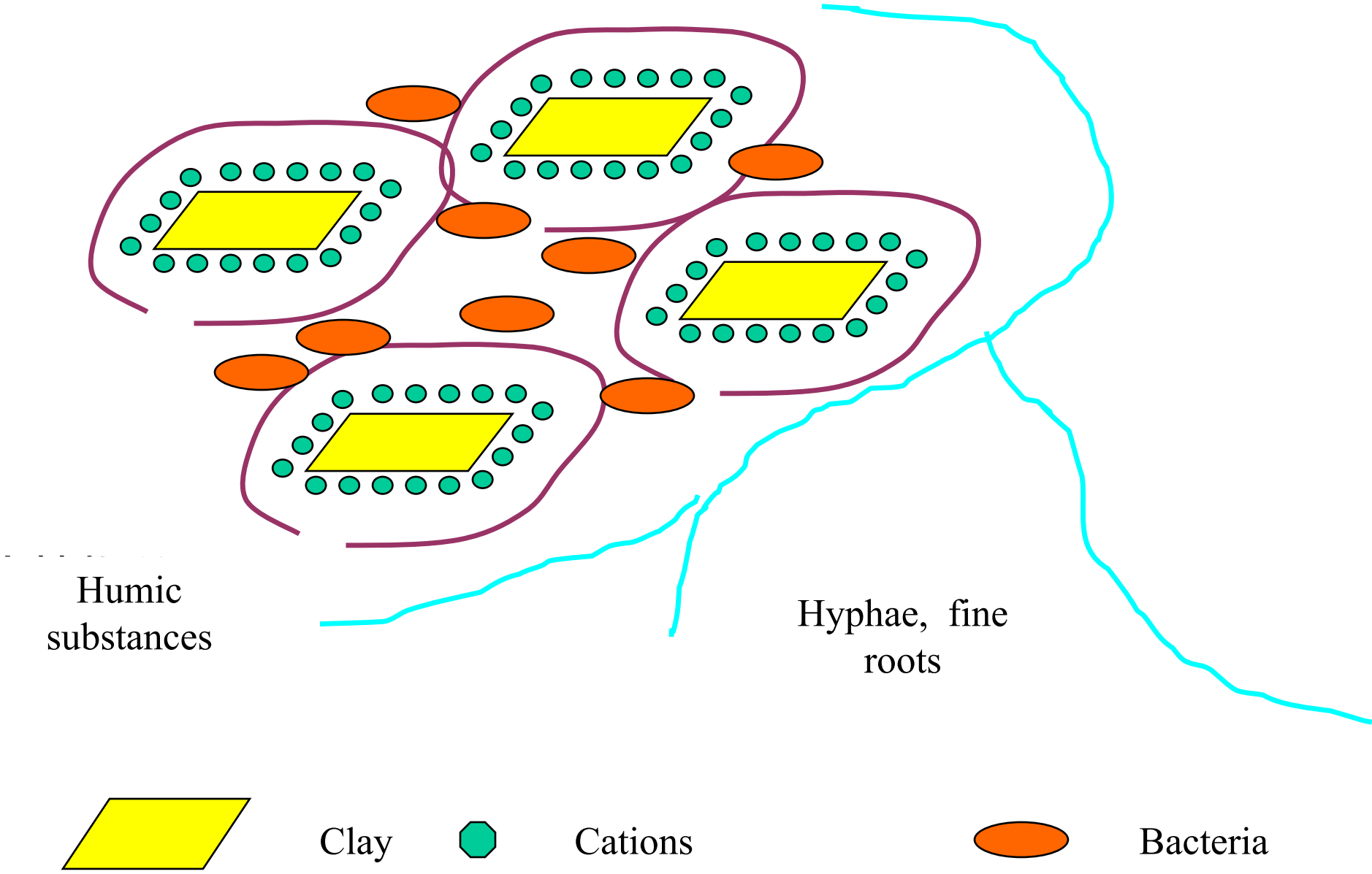
Aggregate structure
Aeration and Drainage
Mitigation of soil erosion
Soil water retention
Increase in specific heat
Increase in soil temperature



Hierarchical structure of soil aggregates

Forming process of soil aggregates





Mechanism of soil aggregate formation

Role of Mycorrhizal fungi

- Promotion of nutrient absorption
  （P absorption）
- Promotion of aggregate formation
  Large sized aggregate

b． **Improvements in chemical and biologicalproperties**

Retention of cations and anions
Transport and translocation of mineral nutrients
Binding and inactivation of harmful artificial organics
Mitigation of the effect of pollutants
Donor of Proton （H^+）
Physiologically active substances
Nutrient supply in good balance
Source of nutrients for
heterogeneous microbial communities
Competition with pathogenic germs

c . Plant growth promotion effects

Promotion of germination and root initiation
Promotion of the growth of root and stem
Complex formation with nutrient elements
Promotion of nutrient absorption by plants
Hormone-like activity
Promotion of permeability of cell membrane
Promotion of photosynthesis, respiration,
and enzyme activity
Suppress protein and increase sugar contents in plants

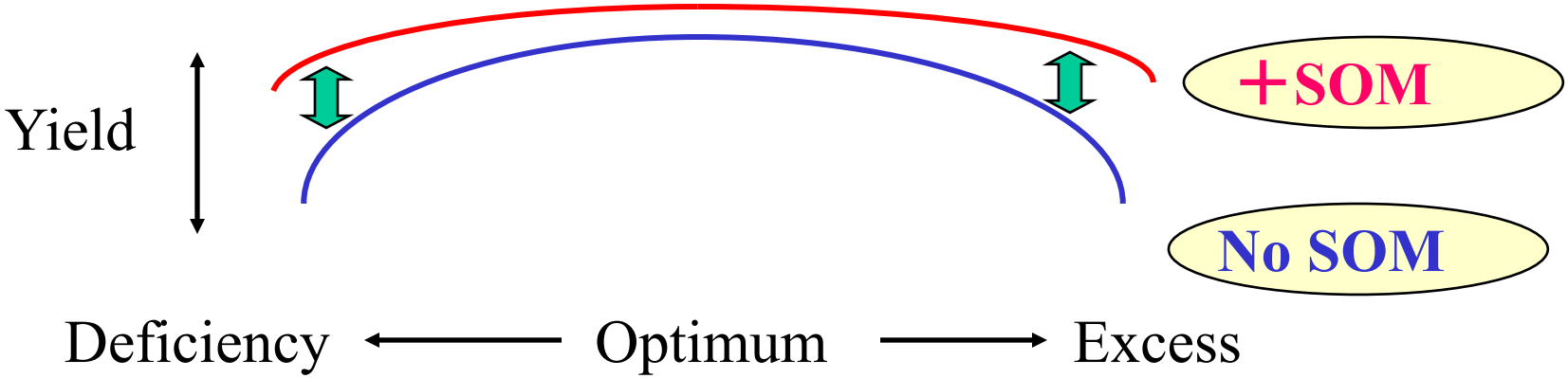
Alleviation of plant growth inhibition under
cold weather and irregular meteorological conditions

Plant growth promotion effects

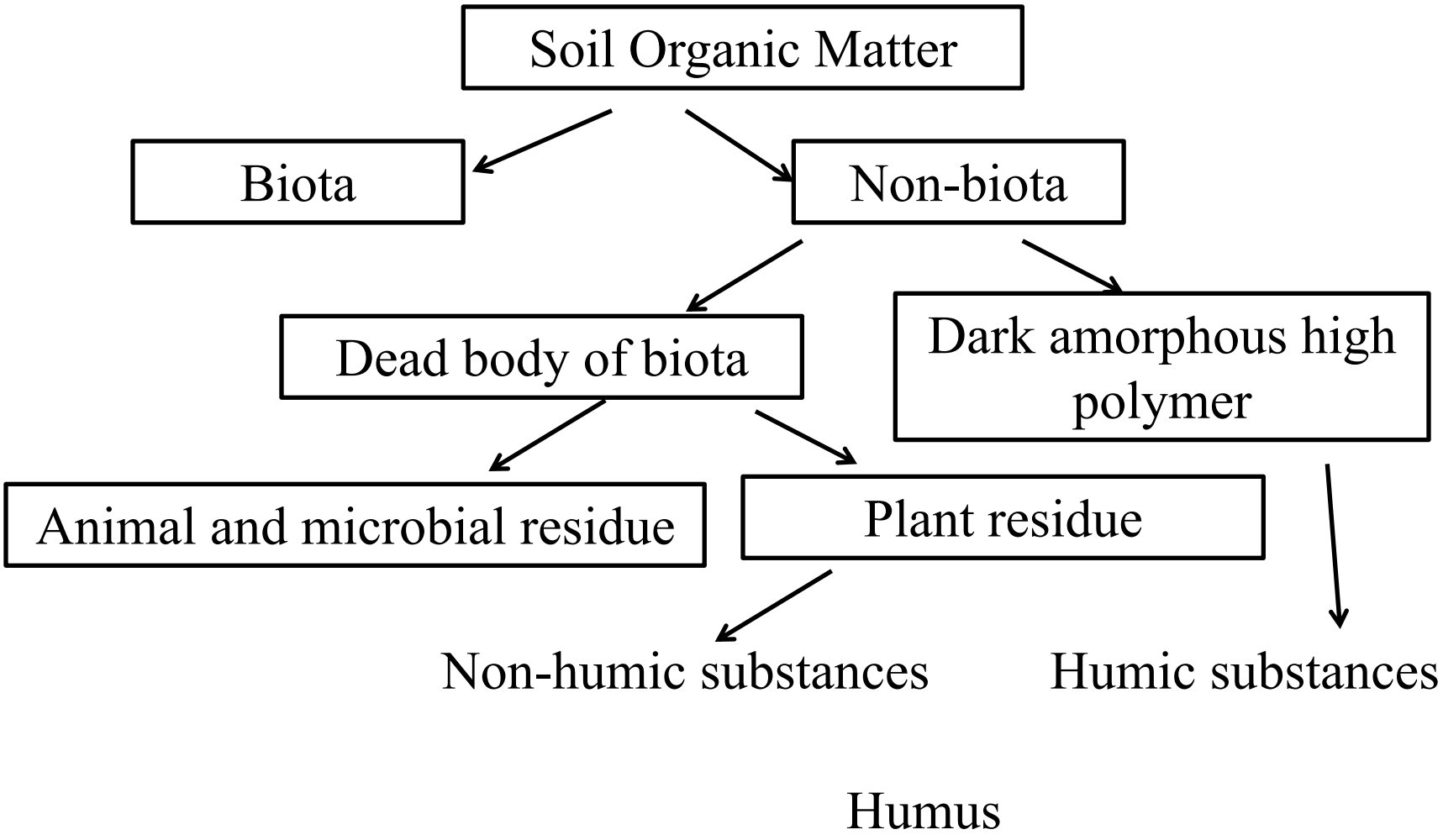
Plant hormone activity

Cold tolerance

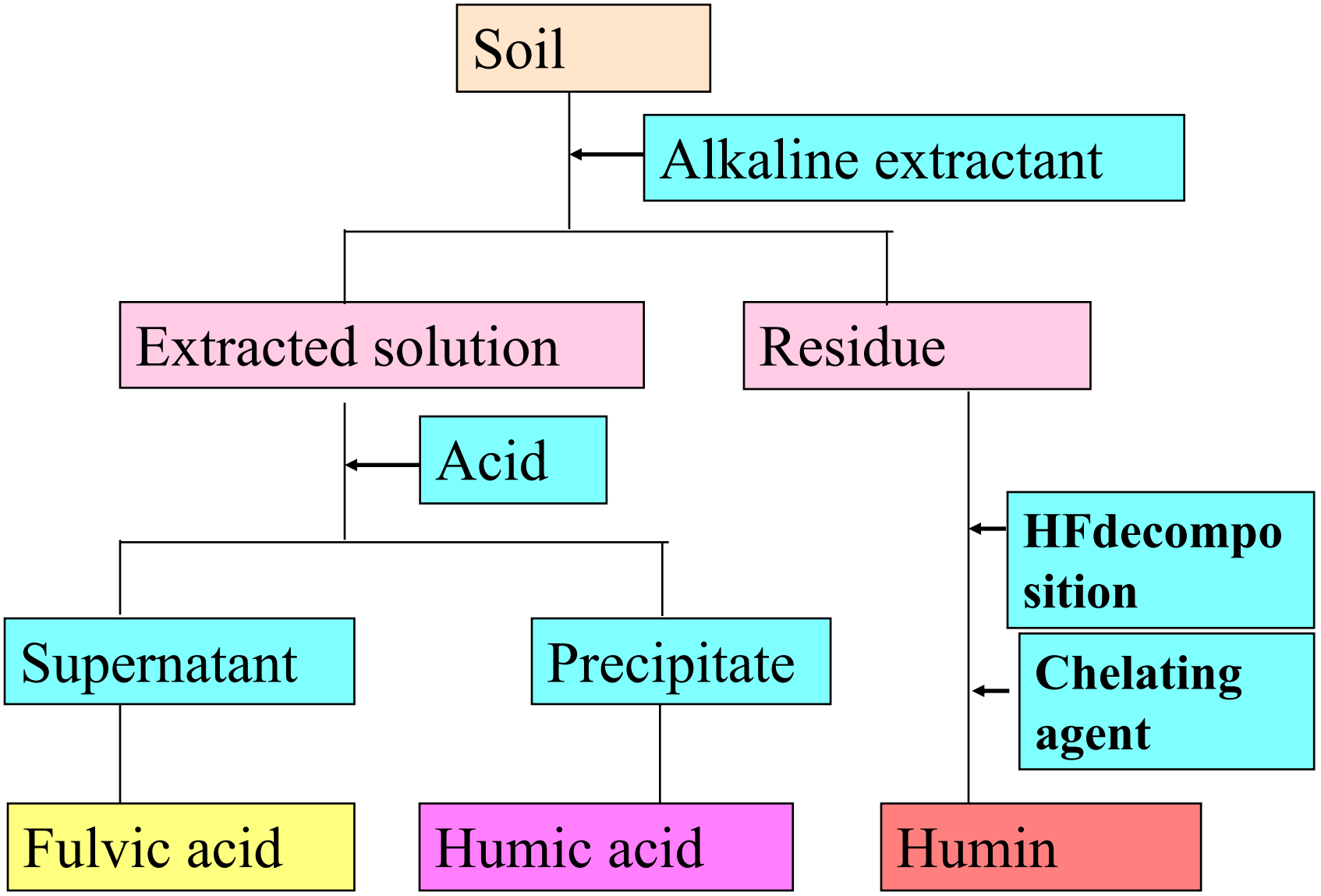
Stable production under deficiency and excess of nutrients



Characterization of soil organic matter



Division of soil organic matter（Takai, 1977）



Fractionation of humic substances