

GES175, Science of Soils

Lecture 10

Phosphorus

Phosphorus Soil-Plant Relations

- * Energy and reproduction
- * Growth and development
 - ☉ root growth
 - ☉ maturity (seed set, flowering,...)
- * Maintained by organic matter cycling

Water Quality

- accelerated eutrophication
- P (often) promotes algae growth
 - may promote anoxia and lead to 'dead' zones
- P from point and nonpoint sources

Phosphorus Fixation (retention)

* Limited Biological Availability

- P reacts strongly with soil material
 - limits bioavailability
 - limits transport through soil
 - movement occurs via erosion
- Adsorbs and precipitates

Retention Reactions

- * Strong adsorption on soil minerals
 - adsorption on Fe- and Al-oxides
 - adsorption on 'edge' sites of silicate clays (dominantly kaolinite)
- Precipitates with soil constituents
 - Al and Fe under acidic conditions
 - Ca and Mg under alkaline conditions

Volcanic Ash ↖ ↗



Inorganic P Compounds

(precipitates)

Acid soils



Fe and Al phosphates



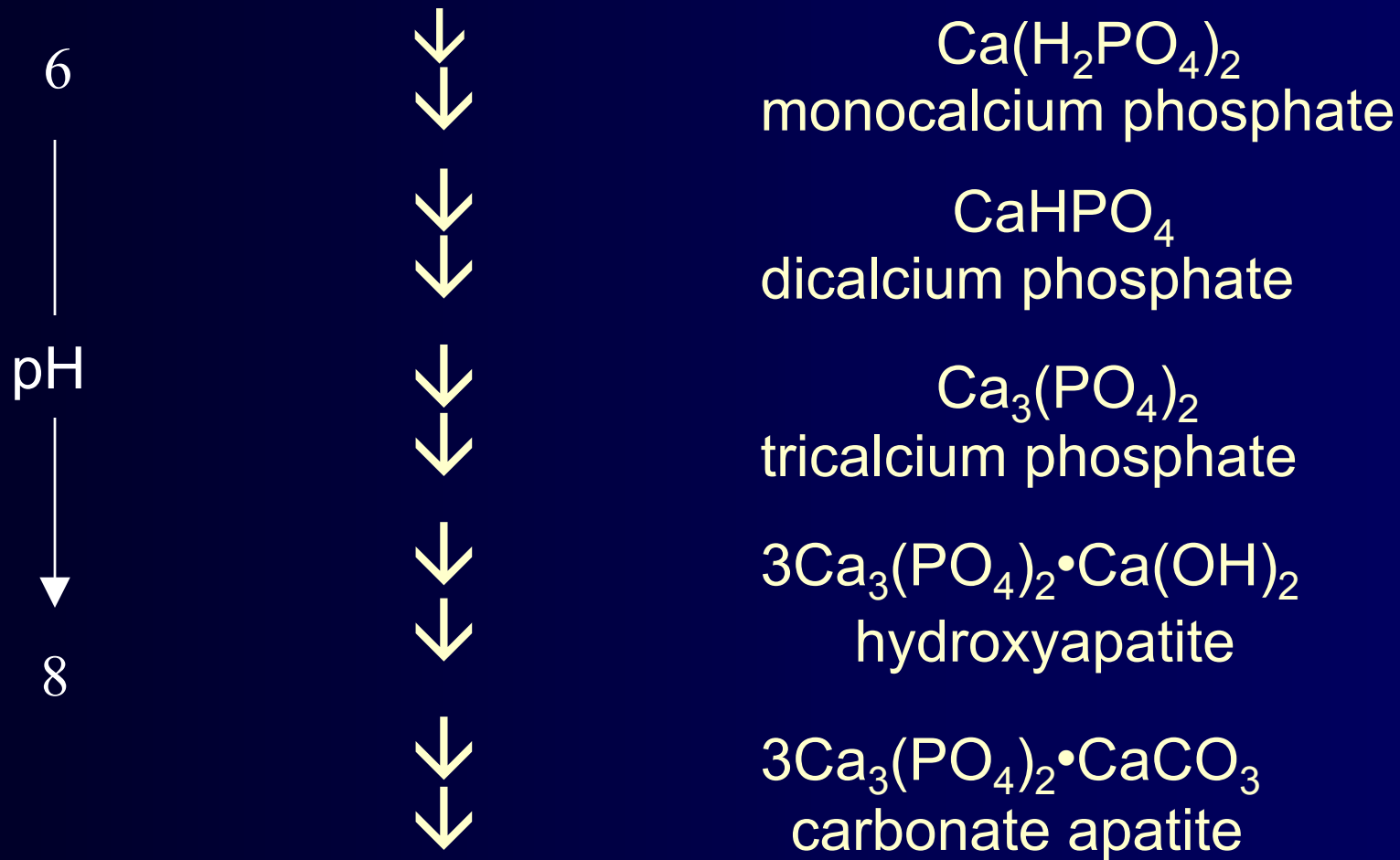
Alkaline soils



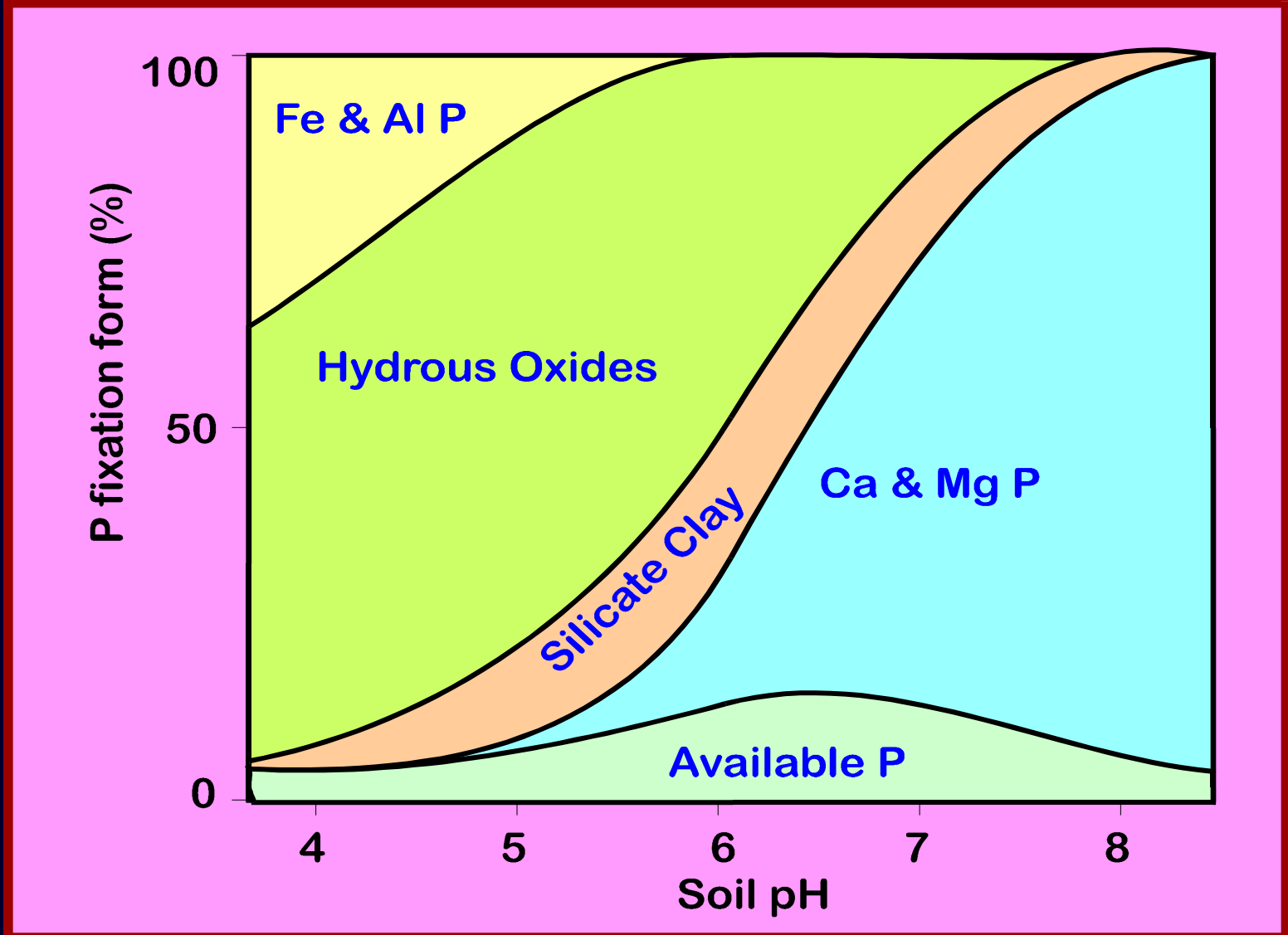
Ca and Mg phosphates

Inorganic P Compounds

decreasing solubility



Most Available P between pH 6 - 7



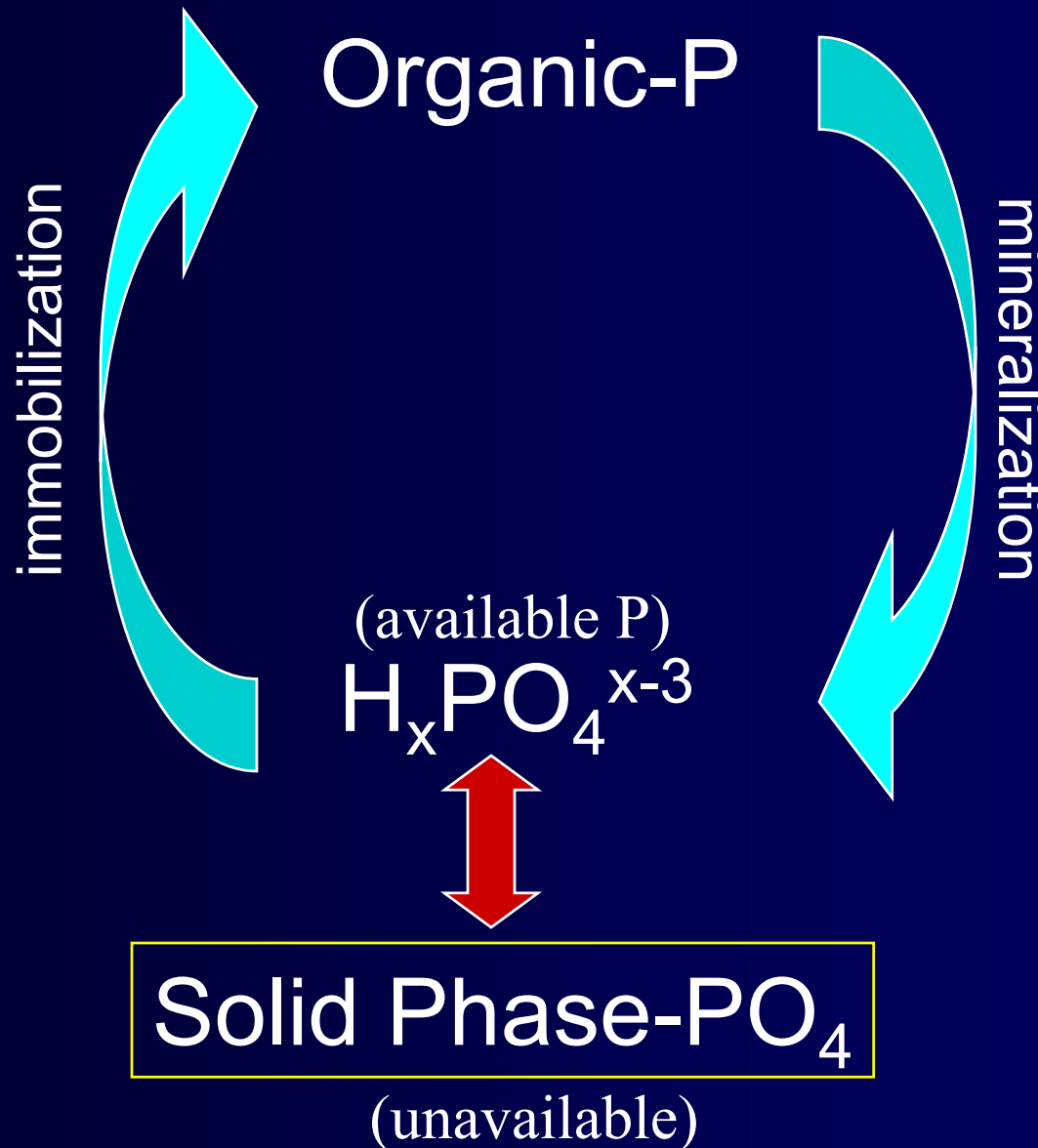
Organic Soil Phosphorus

- * 20 - 80 % of total soil P is organic
- * Mostly inositol phosphates,



- 10 - 50 % of organic-P
- some nucleic acid and phospholipids

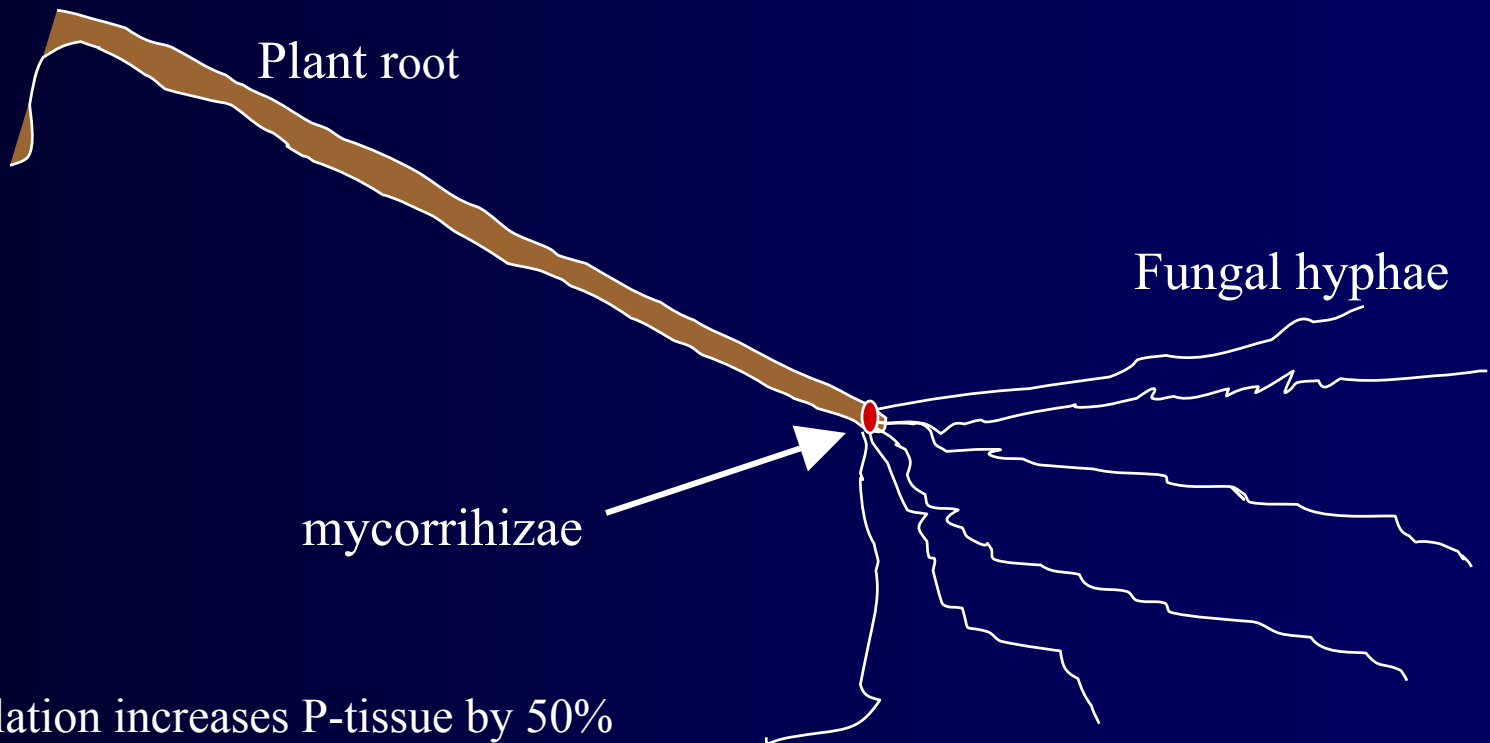
Cycling: A slow release mechanism





Symbiotic Relation: Fungi and Plants

Mycorrhizae root infections, a key to phosphorus uptake



Corn inoculation increases P-tissue by 50%

Mycorrhizae

- Extension of root system
- Enhances nutrient and water intake
- Minimal biomass needed for extension
- High surface area



Nearly 90% of native plants have mycorrhizae association

Fertilizer Rating

◆ N-P-K

- P as P_2O_5 !
- $\%P = \%P_2O_5 * 0.43$

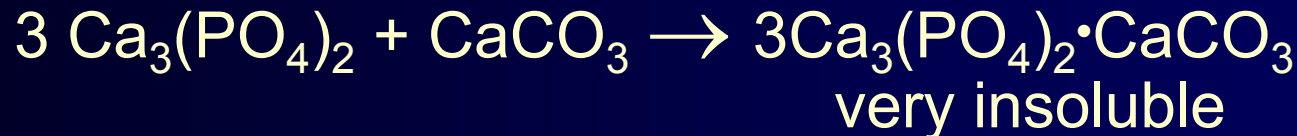
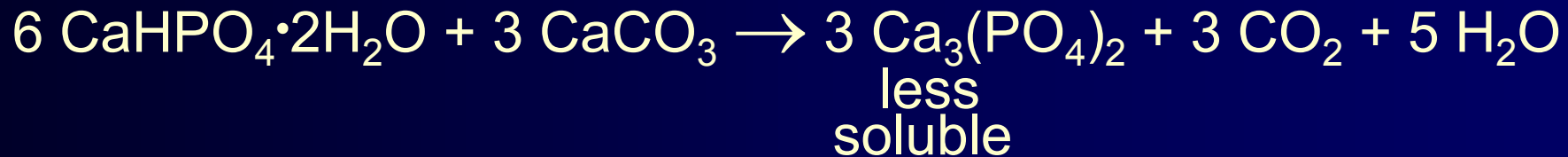
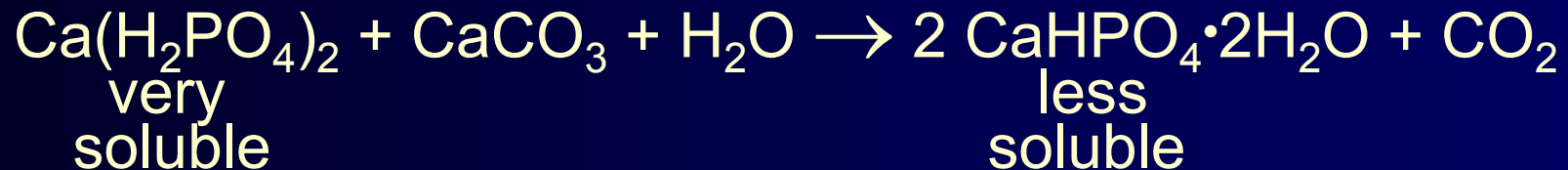
◆ Fertilizers

- Triple Super Phosphate: $Ca(H_2PO_4)_2$
 - ◆ 44-53% P_2O_5
- Monoammonium Phosphate: $(NH_4)H_2PO_4$
 - ◆ 12-62-0
- Diammonium Phosphate: $(NH_4)_2HPO_4$
 - ◆ 21-53-0
- Rock Phosphate
 - ◆ 25-40% P_2O_5

The End

Reactions at High pH Values

- * P converts to less soluble
Ca and Mg compounds



- most serious in calcareous soils of arid regions

Nomenclature

H_3PO_4 = phosphoric acid

H_2PO_4^- = monobasic

HPO_4^{2-} = dibasic

PO_4^{3-} = tribasic

Phosphate Ion: Protonation

