BIOL 695

SULFUR

Chapter 8
MENGEL et al, 5th Ed

SOIL SULFUR

- Inorganic form is SO_4^{-2}
  - arid regions: $CaSO_4$, $MgSO_4$, Na_2SO_4
  - humid regions: soluble compounds, sorbed to sesquioxides, clay min's
    - sorption strength decreases with increasing pH
- Anaerobic soils: FeS, FeS_2, H_2S
- Oxidation of S forms H_2SO_4

SOIL SULFUR

- **Organic form - major soil reservoir for S**

  C-bonded: phenolic & choline sulfates
  Non C-bonded: amino acids & other

- **Soil OM C:N:S = 125:10:1.2**

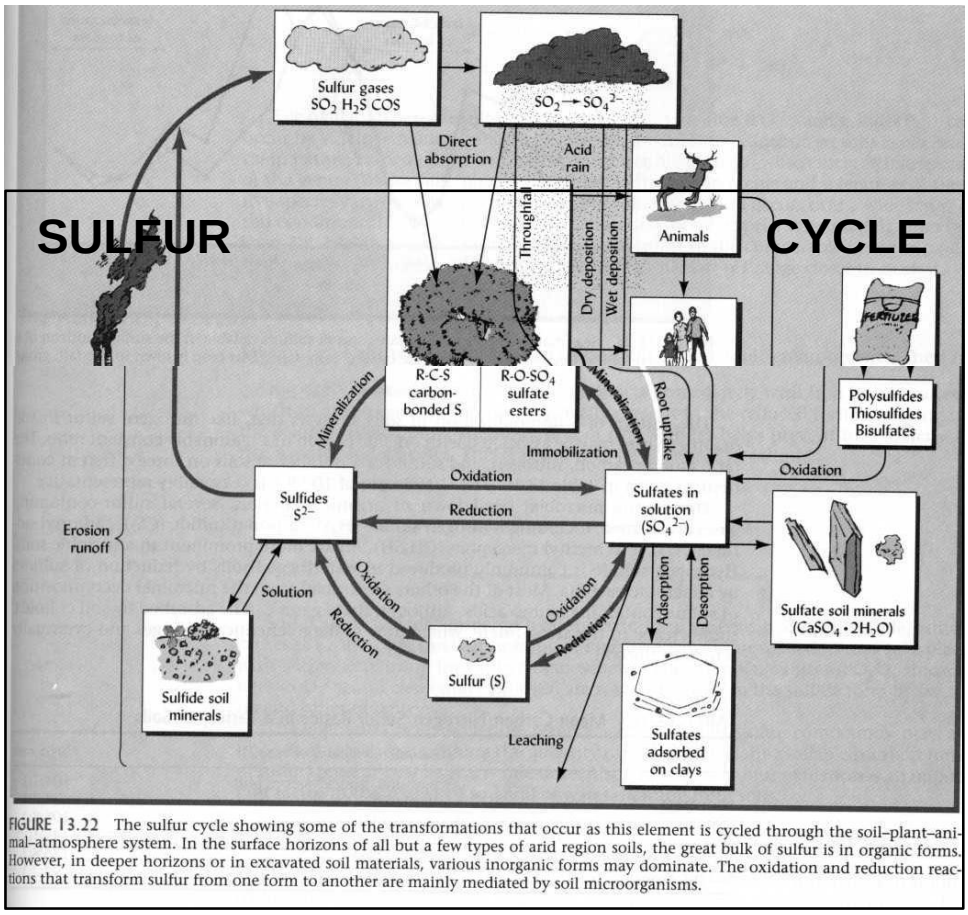


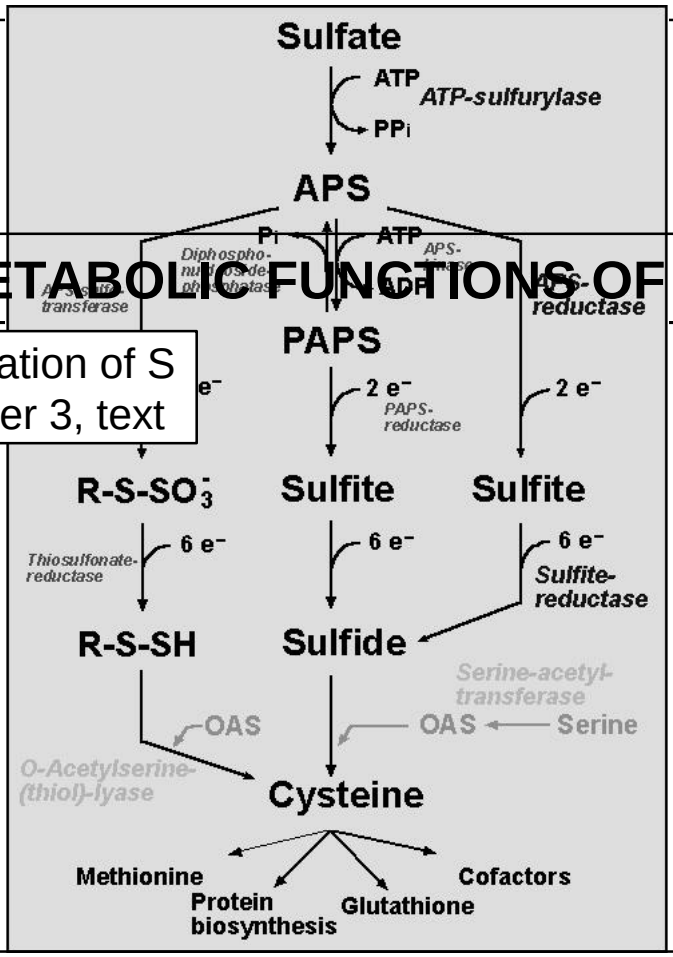
FIGURE 13.22 The sulfur cycle showing some of the transformations that occur as this element is cycled through the soil–plant–animal–atmosphere system. In the surface horizons of all but a few types of arid region soils, the great bulk of sulfur is in organic forms. However, in deeper horizons or in excavated soil materials, various inorganic forms may dominate. The oxidation and reduction reactions that transform sulfur from one form to another are mainly mediated by soil microorganisms.

UPTAKE & TRANSLOCATION OF S

- **Absorption**
  - **in form of SO_4^{-2}**
  - **not very pH sensitive**
  - **not affected by most ions except selenate**
  - **active process**
- **Mainly acropetal transport**
- **Plants can absorb SO_2 from atmos**

METABOLIC FUNCTIONS OF S

Assimilation of S
- Chapter 3, text



METABOLIC FUNCTIONS OF S

- Cysteine & methionine - most important s-containing amino acids
- Major function of S in proteins or polypeptides is in formation of disulfide bonds between polypeptide chains

  - bonds stabilize polypeptide structure
- Ferridoxins
  - impt group of s-containing compound
  - a type of non haem Fe-S protein

METABOLIC FUNCTIONS OF S

- Constituent of Coenzyme A (CoA), biotin & thiamine

  CoA is carrier of acetyl groups, involved in fatty acid & lipid metabolism
- Volatile compounds in plants are S-containing
  - primarily di- or polysulfides
  - garlic contains diallyldisulfide
- Mustard oils contain S
  - gives high S content to *Cruciferae*

METABOLIC FUNCTIONS OF S

- Plant tissue content ~ 0.2-0.5% S (dry wt.)
- Most plant species, excess S stored as SO_4^{-2}
- Species that synthesize mustard oils, excess S stored as organic-S
- During senescence S released from proteolysis & amino acids can be oxidized to SO_4^{-2} (unlike organic N)
- N:S generally ~ 30:1 to 40:1

SULFUR DEFICIENCY

- S deficiency causes inhibition in protein synthesis
- Non S-containing amino acids accumulate in S-deficient plants
  -asparagine, glutamine & arginine
- N:S higher in S-defic tissues (70:1-80:1)
  - guide to S deficiency

SULFUR DEFICIENCY

- **Deficiency symptoms:**
  - **Reduced growth**
  - **Plants often rigid & brittle with thin stems**
  - **Chlorosis occurs first on younger leaves**
  - **Severe defic, all leaves ultimately turn yellow**

SULFUR DEFICIENCY

Schefflera arboricola

SULFUR DEFICIENCY

Apple shoot

Normal S-deficient

SULFUR DEFICIENCY

Peach

Normal S-deficient

SULFUR TOXICITY

- Plants generally insensitive to high SO_4^{-2}
- Toxicity may occur in saline soils
- Reduction in growth & dark green color
- High conc in atmos may be toxic
  - annuals ~ 120 $\mu g\ m^{-3}$
  - perennials (include trees) ~ 60 $\mu g\ m^{-3}$
  - normal atmos conc ~ 10-40 $\mu g\ m^{-3}$

SULFUR TOXICITY

- Industrial areas may have very high SO_2 concentrations
- Sulfurous acid forms in moisture on leaf surface of mesophyll cells in stomatal cavities
- Apparently high conc's of SO_2 can uncouple photophosphorylation

SULFUR TOXICITY IN CITRUS

Salinity damage to orange leaves due to sulfate & chloride excess

SULFUR BALANCE

- **SO_4^{-2} not as strongly bound to soil as PO_4^{-3}**
- **Significant input from atmosphere**
- **SO_2 absorbed by foliage**
- **May be sig leaching losses w/ high rainfall**
- **SO_2 content in atmos is decreasing**
  - may necessitate reg use of S fert.

SULFUR APPLICATION

- **Low soil S & S defic occurs in many areas of the world & US; esp. areas remote from sea or industry**
- **Protein-rich crops have high S req'mt**
- **Fertilizers:**
  - **-gypsum ($CaSO_4 \cdot 2H_2O$)**
  - **-superphosphate (phos. rock + H_2SO_4)**
  - **-NH_4SO_4, K_2SO_4, $KMgSO_4$**
  - **-rates of 10-50 kg S ha^{-1}**