Basic Biological Factors of Soil Carbon and Nitrogen

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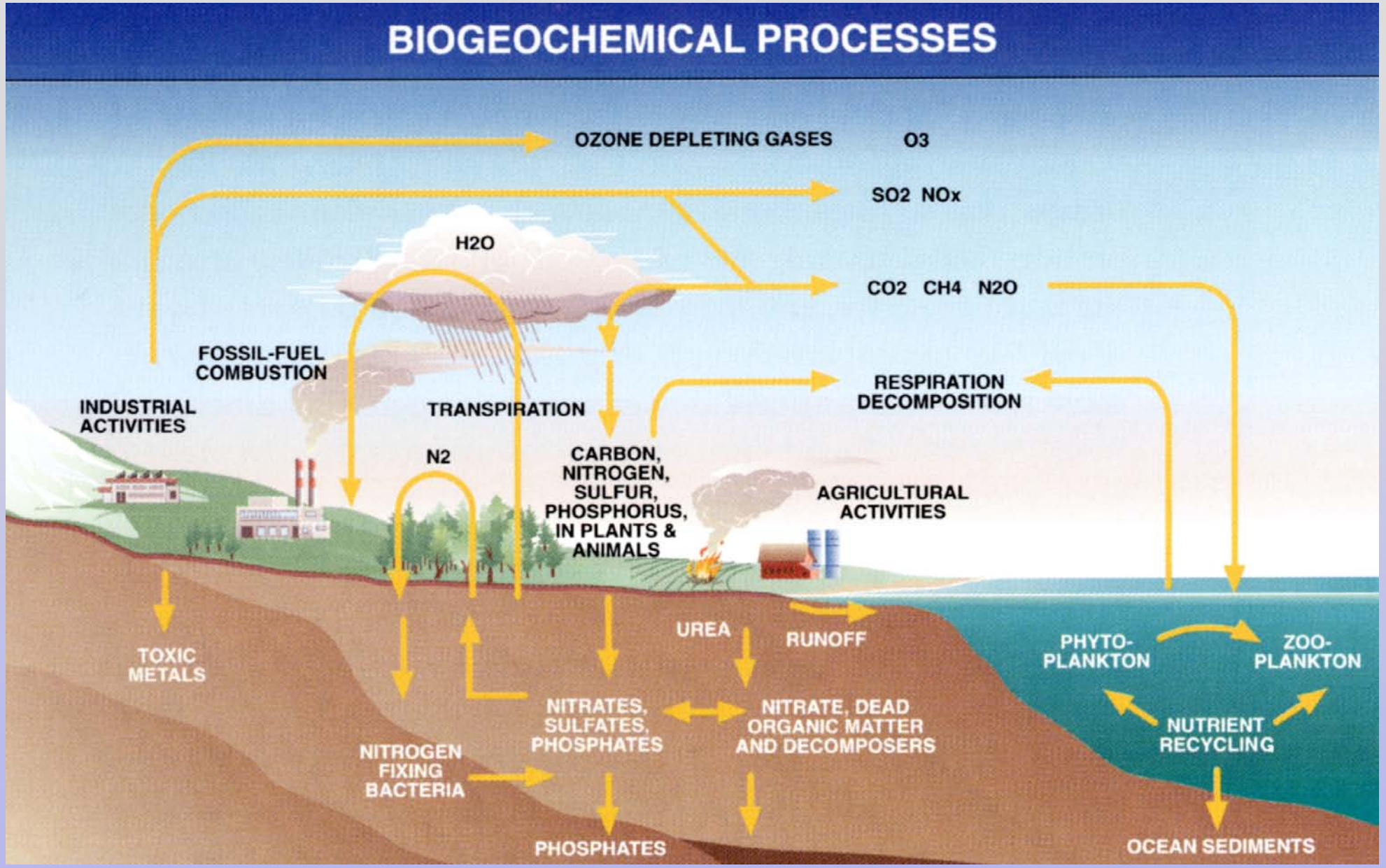
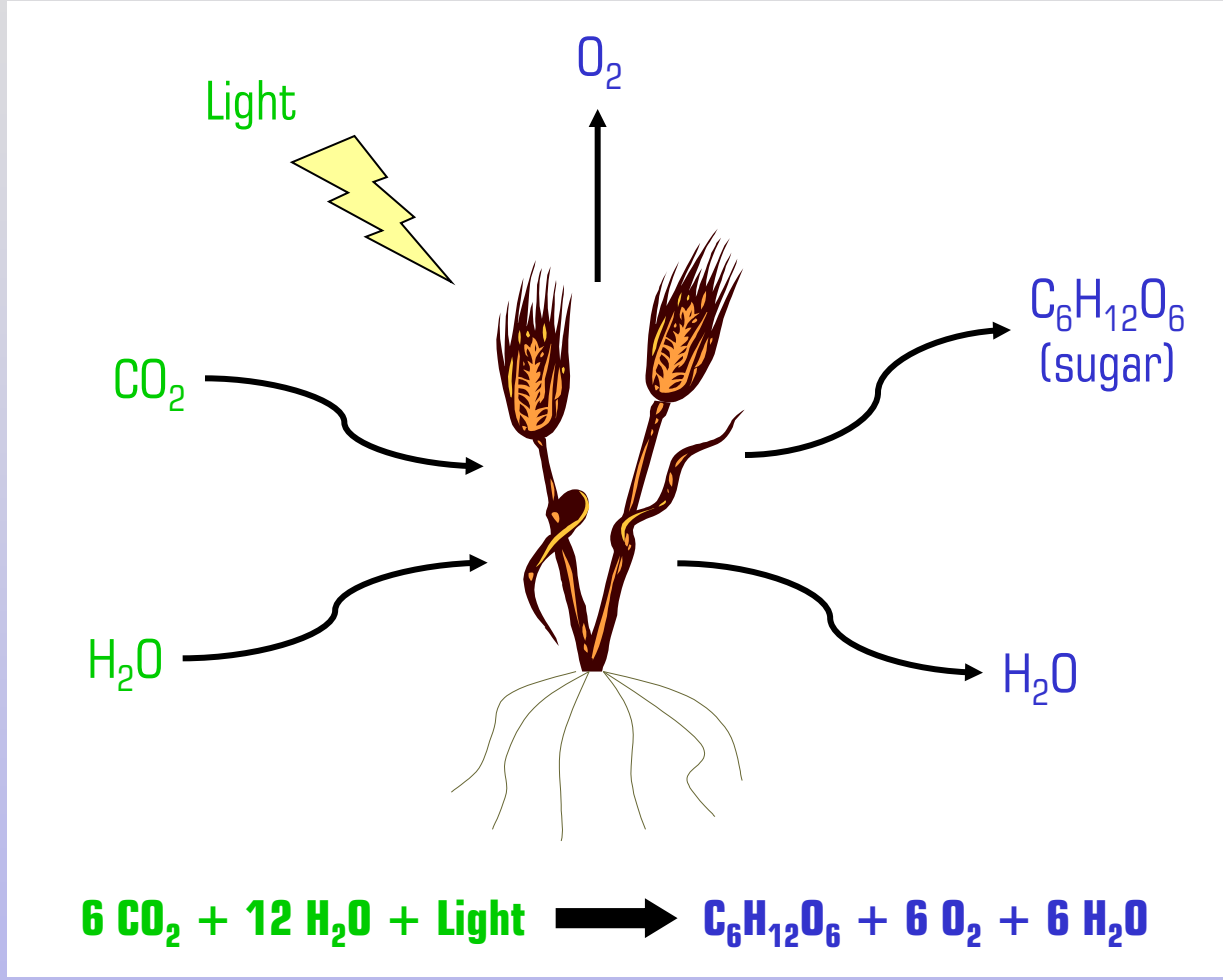
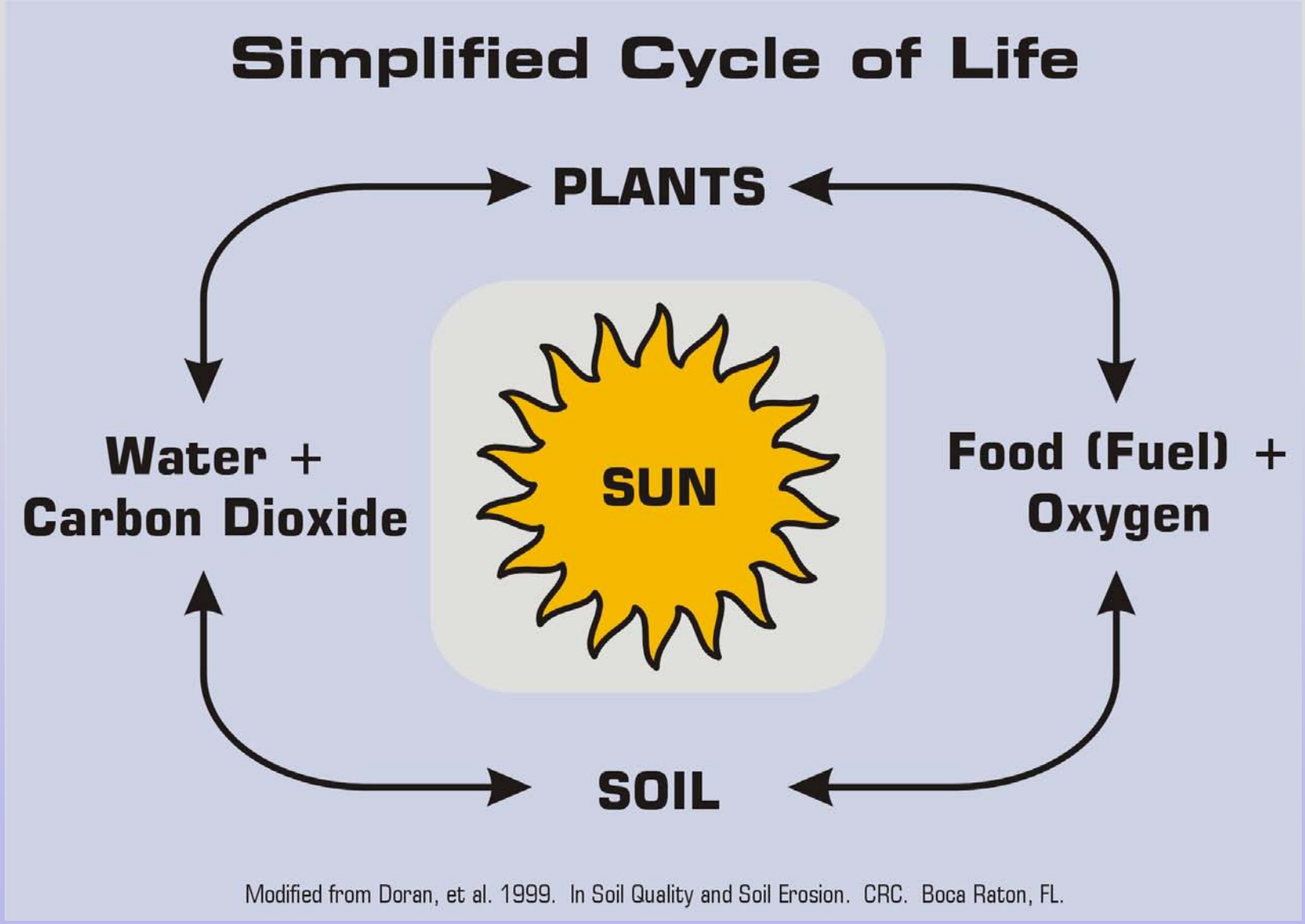


This diagram illustrates how connected life on Earth is.

Photosynthesis

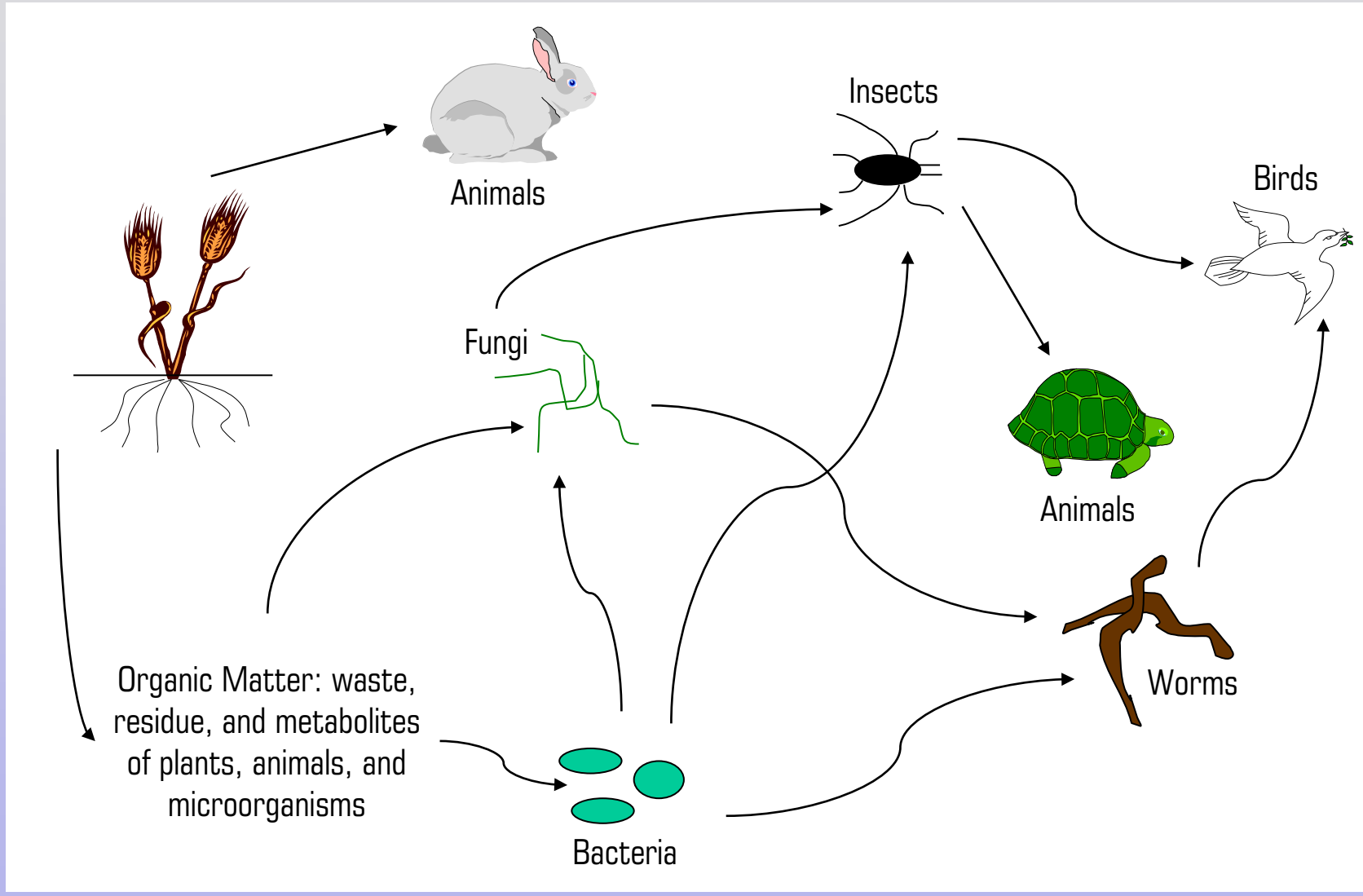


Through the process of photosynthesis, plants absorb CO_2 from the atmosphere, transform it into plant carbon, and sequester it in either above- or below-ground biomass and/or soil carbon.



Carbon is essential for life. Soil organic matter (SOM) contains the nutrients and energy organisms and plants need.

The Soil Food Web

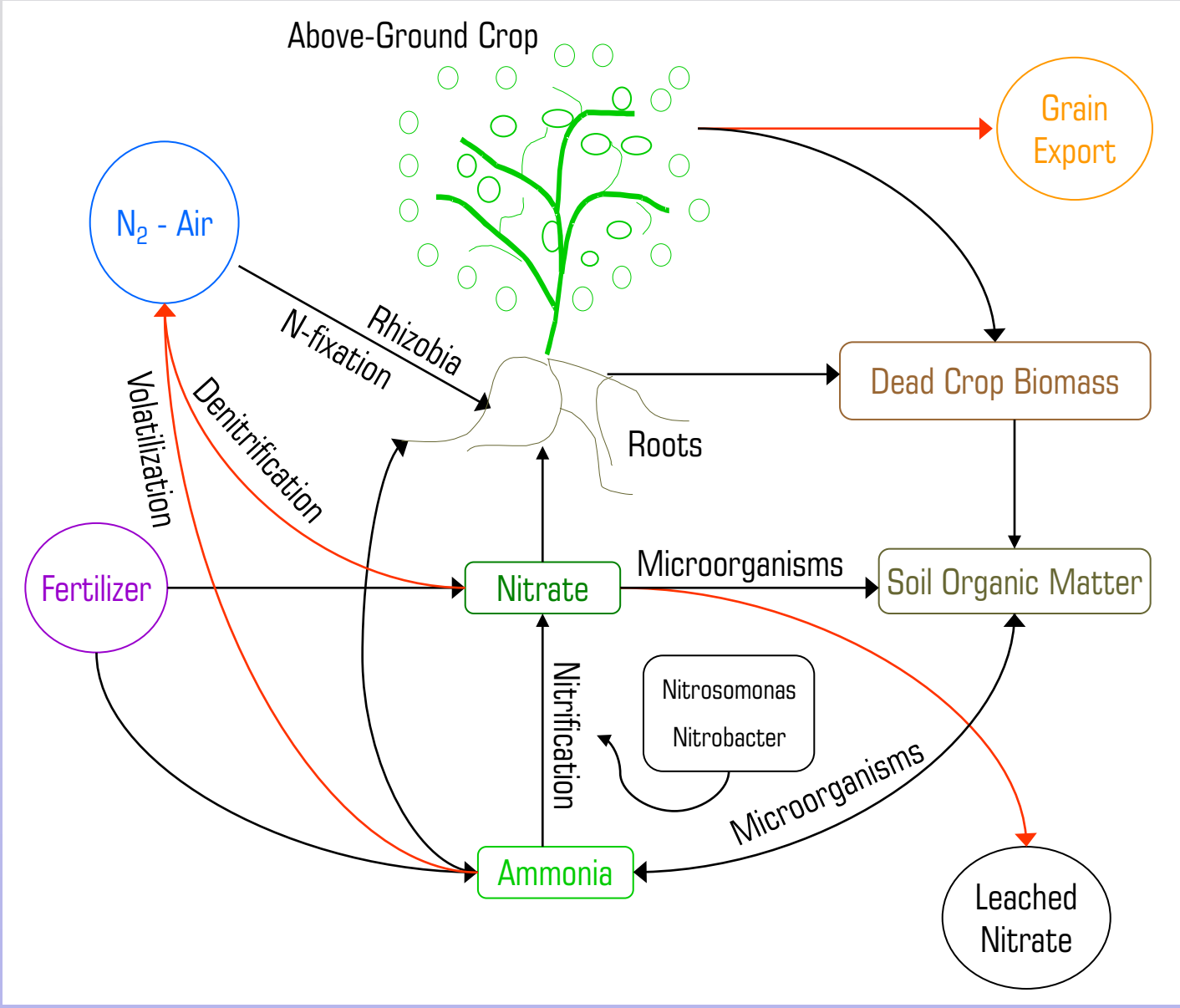


The Soil Food Web

- Soil organisms are responsible for the transformation of plant material to humus. Plant and animal residue make up a large portion of organic matter (OM) in soil. SOM or humus is the glue that helps hold soil into aggregates. Plant cover helps stop both wind and water erosion as does the aggregation effect of SOM.

- Burrowing animals, insects, and earthworms mix, help form aggregates, and add nutrients to the soil. When animals die, they decompose returning nutrients to the soil. Insects chop up plant and animal residue which increases the surface area available to microorganisms for decomposition.

Nitrogen Cycle



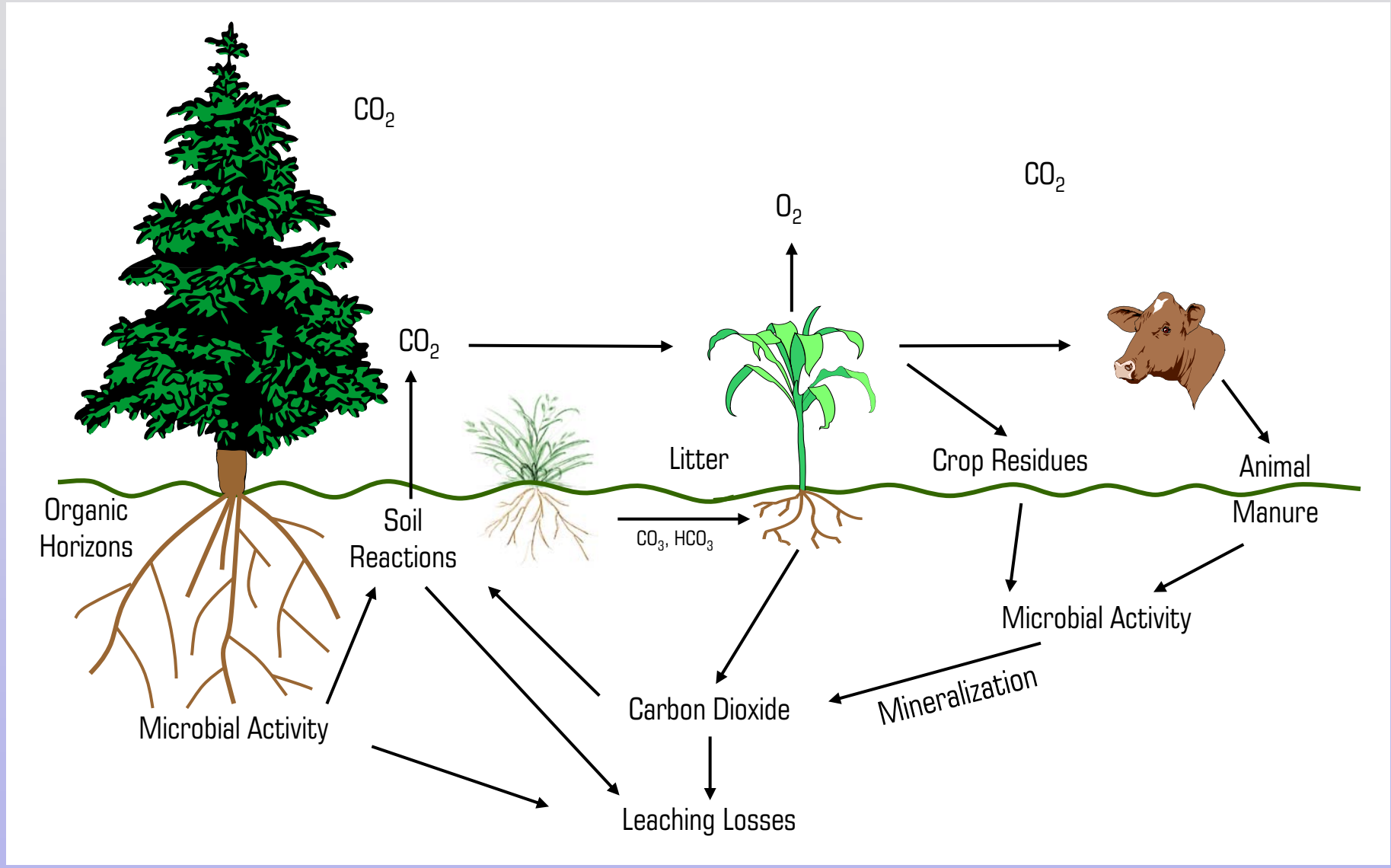
Nitrogen Cycle

- Plants take up inorganic nitrogen (NH_4, NO_3).
- At harvest, nitrogen may leave the farm in commodities or can be returned if livestock consume the crops and the manure is returned to the fields.
- Precipitation adds small amounts of nitrogen to the soil.
- N_2 gas in the atmosphere is converted to NH_4 by chemical and biological processes (nitrogen fixation).
- Crop residues and green and animal manures contain organic N.
- The conversion of organic N to inorganic N is mineralization.

Nitrogen Cycle

- The opposite of mineralization is immobilization.
- Nitrification is the conversion of NH_4 (ammonia) to NO_3 (nitrate), carried out by 2 microorganisms -- Nitrosomonas and Nitrobacter.
- Ammonia can be volatilized (turned to gas) and lost to the atmosphere.
- When NO_3 is converted to nitrous oxide, it is called denitrification.
- Nitrate is mobile in soil and therefore easily leached.
- Erosion and runoff remove N from the agricultural field.

Carbon Cycle



Carbon Cycle

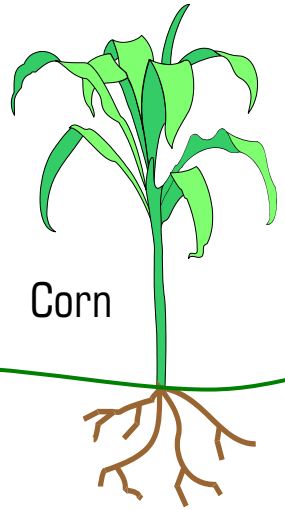
- CO_2, through photosynthesis, is converted to plant material.
- When the crop is harvested and removed from the farm, carbon is lost. If livestock consume the crop, the carbon may be returned to the soil in the form of manure.
- Crop residue, roots, and manure are a carbon (energy) source for microorganisms.
- Converting organic carbon to CO_2 is mineralization of carbon. When microorganisms respire, CO_2 is released to the atmosphere.

Carbon Cycle

- Short-term SOM is residue that is readily decomposed. Short-term SOM is a source of nitrogen, phosphorus, and sulfur for plants. Short-term SOM lasts 1 to 3 years.
- Long-term SOM (humus) is the carbon form that resists decomposition and may last for greater than 1000 years.
- Soil carbon losses are exacerbated through erosion and, to a lesser extent, may be lost through leaching of dissolved organic carbon (DOC).
- **The basic processes of the carbon cycle are: CO_2 in through photosynthesis, and CO_2 out through decomposition.**

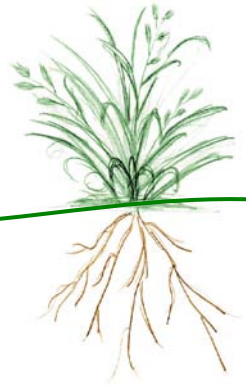
Carbon / Nitrogen Ratio

High C/N ratio



Corn

Low C/N ratio



Legume

- Decomposition is slower.
- Microorganism will deplete soil of nitrate and ammonium until they die and release nitrate and ammonium.

- Decomposition is rapid due to higher nitrogen within the plant.
- Microorganisms are satisfied with plant N. When microorganisms die, nitrate and ammonia are released, increasing soil N.

Carbon / Nitrogen Ratio

- Carbon / Nitrogen (C/N) ratios are important. Plant and animal residues that have a C/N of 30:1 and over, have too little N to allow for rapid decomposition. Therefore, the microorganisms will take ammonium and nitrate out of the soil to fuel decomposition. This depletes the soil of nitrate and ammonium. Plants and animal residues with low C/N ratios (20:1 and less) have sufficient N for the microorganisms to decompose the residues without taking from the soil.