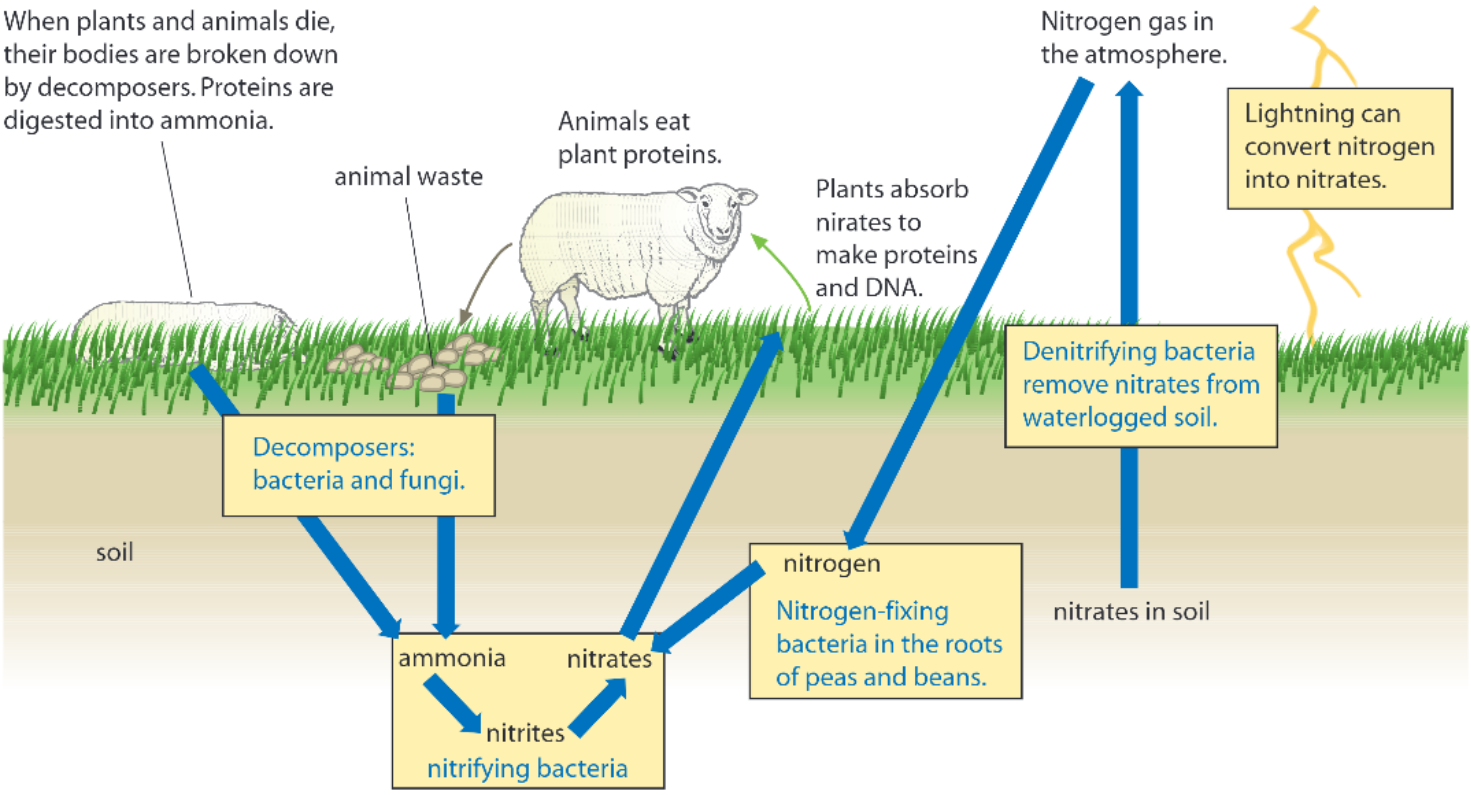
CONCEPT: NITROGEN FIXATION

- ***Nitrogen cycle*** – chemical cycle in which nitrogen is converted into a variety of forms, and moves through ecosystems
- Plants can't absorb N_2 even though its nearly 80% the atmosphere
- ***Nitrogen fixation*** – conversion of N_2 gaseous nitrogen into NH_3 by bacteria and archaea
  - □ NH_4^+ and NO_3^- are the main forms of nitrogen absorbed by plants
- Carnivorous plants make their own sugar, and use carnivory to supplement nitrogen intake
- ***Epiphytes*** – plants that live upon other plants absorb their water and nutrients from the air, rain, and debris around them

EXAMPLE:



- ***Nitrogenase*** – large multienzyme complex that reduces N_2 □ NH_3, and facilitates nitrogen fixation
- Extremely energy intensive process to convert 1 N_2 □ 2 NH_3, requires 8 high-energy electrons and 16 ATP

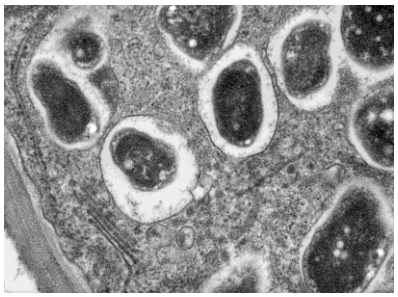
EXAMPLE:

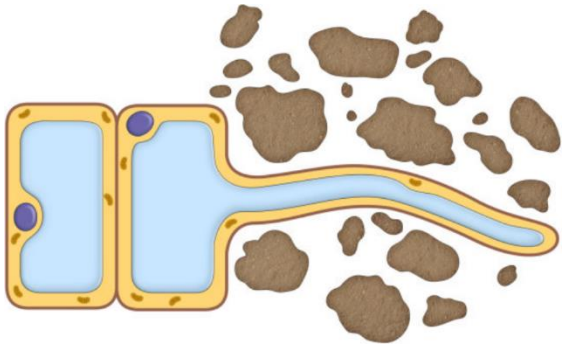
$$N_2 + 8\,H^+ + 8\,e^- + 16\,ATP \longrightarrow 2\,NH_3 + H_2 + 16\,ADP + 16\,P_i$$

CONCEPT: NITROGEN FIXATION

- Bacteria carry out nitrogen fixation inside plant roots, mostly from the legume family
    - □ ***Legumes*** – family of flowering plants (*Fabaceae*) that carry rhizobia bacteria in nodules in the roots
    - □ ***Rhizobia*** – Gram-negative soil bacteria that perform nitrogen fixation in the roots of legumes
        - ***Endophytes*** – fungi or bacteria that live inside other plants
- ***Nodules*** – swollen nodes in the roots where bacteria have infected the plant
    - □ Plants release flavonoids to signal rhizobia, which in turn release Nod factors
    - □ Nod factors touch root hair, cause morphological change that allows bacteria to infect cortex via infection thread
    - □ Mutualistic relationship plant provides carbohydrates and protection, bacteria provides usable nitrogen
        - ***Leghemoglobin*** – binds oxygen in nodules, protects nitrogenase from oxygen poisoning

EXAMPLE:





- ***Mycorrhizae*** – symbiotic "fungus-root", fungi and roots that live in close association
    - □ Hyphae increase surface area for absorption, and help plants acquire nutrients from organic matter in the soil
    - □ ***Ectomycorrhizae*** – hyphae on extracellular surface of plants that do not penetrate the cell wall
    - □ ***Arbuscular mycorrhizae*** – endophytes that penetrate the cortical cells in the roots of plants

EXAMPLE: