LEARNING ACTIVITY:

Nitrogen Connection

Grades 9-12

Materials

- Computer with Internet connection
- Soil from yard or garden (may be repeated with sandbox sand)
- 200 to 250 ml containers with air-tight seals
- Household ammonia cleaning solution
- Nitrate-containing fertilizer (check label), e.g., Miracle-Gro® or Peter's Professional®
- Sugar
- Nitrate water-quality test strips, e.g., Lamotte 2996®, EM Quant®, or Industrial Test Systems®
- Distilled water

All biological organisms require certain nutrients to live. Plants require carbon, hydrogen, and oxygen from air and water, as well as nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, zinc, nickel, chloride, boron, and molybdenum from soil. Animals require a few others. Conversions and transformations of nutrients in the environment result from chemical reactions, biological activity, or both.

Nitrogen, which has several valence states, is present in the environment as dinitrogen (N_2), nitric oxide (NO), nitrous oxide (N_2O), and ammonia (NH_3) gasses, as the ions ammonium (NH_4^+), nitrite (NO_2^-) and nitrate (NO_3^-), and in organic forms such as proteins and enzymes. Nitric and nitrous oxides are greenhouse gasses that contribute to the brownish haze in smog. Nitrate and nitrite may contaminate surface or ground water. Most nitrogen in soil is present in organic forms, and most of the transformations are mediated by soil microorganisms.

Most soil-supplied nutrients are weathering products of rocks and minerals, but nitrogen is not found in naturally occurring minerals or rocks. And, although 78% of the atmosphere is dinitrogen, plants cannot use it. Plants use nitrate and ammonium to make amino acids, the building blocks of proteins. Nitrogen gas from the atmosphere can be converted to plant-usable forms, or "fixed," by lightning in the atmosphere, soil microorganisms such as *Rhizobium* and *Azotobacter,* and industrial processes.

Soil Science Society of America

Source: Soil Science Society of America. Adapted with permission.

Procedure

1. Visit www.soils4teachers.org/esw for complete details and instructions for this activity.
2. As directed in instructions, use qualitative nitrate test strips to investigate some possible fates of nitrogen in the soil. The test strips change color when exposed to nitrate; the color deepens as nitrate concentration increases. Add ammonia and nitrate sources, water, and sugar to soil in various combinations. After incubation, measure nitrate with test strips.
3. Discuss: The control soil measures the background nitrate concentration for comparison. If the ammonia treatment has no more nitrate than the control, ammonia was lost to the atmosphere as a gas. If the ammonia treatment has more nitrate than the control, ammonia was converted to ammonium, then converted to nitrate by *Nitrosomonas* and *Nitrobacter.* In anaerobic conditions, denitrification may occur and nitric or nitrous oxides lost to the atmosphere. If so, there may be a noticeable odor when the containers are opened, and the nitrate levels may be less. What did you find?