Chemistry 20 - 3

Composting Chemistry

Objective: To explore the chemistry of composting

Introduction: In the process of breaking down compostable materials, a number of chemical reactions occur. The goal of this lesson is to familiarize students with some of the chemistry that occurs in the compost pile, allowing for the cycling of nutrients.

Curriculum Connections:

Students will learn the process of breaking down compostable materials.

Supplies / Materials:

- Compost samples (ask a gardener friend!)
- Computers and/or handouts with chemical molecules
- Paper and writing utensils
- Magnifying glasses
- Paper towel (for small compost sample)

Hook: Give students compost samples to smell, feel and observe. How did we go from dead plant/organic material to this? (For simplification we will focus on plant material only)

SCIENCE FOCUS

Lesson Subject

Chemistry 20

Topic

Compost chemistry

Location

Classroom

Length

50 mins

Intro Activity: Have students list and sketch out an example of these biological macromolecules (**Resource** 1) that make up the majority of plant biomass

a) Proteins (amino acid polymers)

b) Carbohydrates (sugar polymers)

Main Activity:

The ideal compost process is the breakdown of molecules in plants (and animals) by aerobic microorganisms. We want the end result of the composting process to produce a result that is within an ideal range on the spectrum of toxicity. If it is too toxic that we can't sell our compost to be used in landscaping or gardening. Soil sample results are used to analyze toxicity levels among other components. They oxidize C for energy and break down N (and other nutrients) for cellular construction.

1) Have students write out an equation and/or draw out the molecular structure for the breakdown of cellulose (reduction into sugars). Which end is the reducing end (single hydroxide) and which is the non-reducing end – if molecule is drawn?
    a. (C6H1205)n + nH20 --- (H+)--- nC6H12O6
    b. Reducing end is the one with the single OH-
2) Have students write out the equation for cellular respiration:
    a. C6H12O6 + 6O2 ----- 6CO2 + 6H2O + ATP (energy)
    b. This is why a compost pile needs sufficient oxygen
3) Plant proteins are broken down by decomposers and then incorporated into cellular structures. Have students look into the Nitrogen cycle in **Resource** 2. Have students draw out the molecules in the cycle and/or research equations in Nitrogen cycling.
4) When there is limited oxygen present in the compost pile fermentation happens instead. One of the products is methane. Have students try to figure out what happens to the glucose molecule in this case. C6H12O6 --- 3CO2 + X X = 3CH4
5) Ammonia (NH3) is another by-product of aerobic fermentation. How is ammonia formed? 00C-NH2 +H+ --- NH3. What type of equation is this? (Reduction)

Conclusion / Review: How can humans manipulate the compost process? How can we use technology to create the products we want? There are new machines that are used to manage the chemical process of these compost piles. Anaerobic digesters can be added to take oxygen out to speed up the process, and machines can be used to turn compost piles to add more air if needed.

Homework: Have students research how water is important to compost chemistry, why would we need to water our compost piles? What happens when our piles have too much moisture?

Resources:

1. The Molecules that Make Plant Cells Different: http://www.bio.miami.edu/dana/226/226F08_2print.html
2. Compost Gardener – the Nitrogen Cycle: http://www.the-compost-gardener.com/nitrogen-cycle.html#bacteria\
3. Compost Facility Operator Manual: a compost facility operator training course reference and guide. John Paul and Dieter Geesing

Extension: Have student's design aerobic and anaerobic composters. Have them measure different variables such as temperature, moisture levels, smell, colour changes, production of gases (oxygen), and pH levels. You can also get your students to compare the two processes of aerobic and anaerobic composting.

A sample experiment is outlined here: https://www.acs.org/content/dam/acsorg/greenchemistry/education/resources/chemistry-and-compost.pdf