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SOIL NUTRIENT CYCLING

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Grade Level: 6-8

Introduction: A vast array of organisms live on and in soils. These organisms have a number of roles in the ecosystem, including a critical role in nutrient cycling. These organisms include insects, worms, bacteria, and fungi. An incredible diversity of plants is supported by these soil communities. Students will examine several examples of nutrient cycling in the tropical montane cloud forest ecosystem.

Major Themes: Decomposition, nutrient cycling

Connections to National Science Education Standards: Populations and ecosystems (C); structure and function in living systems (C); diversity and adaptations of organisms (C); structure of the earth system (D).

Time: 60 minutes (10 minutes for Opening, 5 minutes to read handout introduction, 10 minutes to complete "Detritus" and "Decomposition" sections, 5 minutes to read and discuss "Nutrients" section, 25 minutes for "Nutrient Cyclers" section , 5 minutes for closing)

Materials: Students will visit the "Bugs on White –Beetles" album (under "Media," "Photographs") and will view the following Canopy in the Clouds videos:
Panorama 1: Ground video 5
Panorama 2: Ground video 5
Panorama 3: Ground video 5, canopy video 2

Computers with internet access (at least one, preferably enough for one per pair of students)
LCD projector (recommended)
Student handouts (*Soil Nutrient Cyclers* and *Soil Nutrient Cyclers: Student Assessment*)
Microscopes and prepared slides (optional)
Books featuring photographs of nutrient cyclers (optional)

Objectives: Students will be able to: (1) define "decomposition" and "nutrient cycling" and use them in appropriate contexts, (2) explain the role of nutrient cycling and identify nutrient cyclers, (3) learn basic plant nutrients and relate specific nutrients (carbon, nitrogen, phosphorus) to the organisms involved in cycling them.

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Potential Misconceptions:

(1) Soil is not dirt, although laypeople often use the words interchangeably. Soil is composed of both inorganic and organic (presently or formerly living) material that forms a thin layer at the Earth's surface. Dirt is a more general term, thought to originate from a word meaning excrement, that does not describe all the properties of soil.

(2) Organic material is any matter that is living or used to be living. Students may think that once an organism is no longer living, it ceases to be organic. Students may also think that if an object is manmade, it cannot be considered organic. A piece of wood that is used to make a ruler *is* organic, because it originated from a once-living tree.

(3) Nutrients cycle quickly though tropical montane soils, thus the layer of nutrient-rich soil is very shallow. Key nutrients actually spend very little time in the soil here compared to nontropical ecosystems.

PROCEDURE

Opening: Show students the side of a cereal box that contains nutritional information about the product. Ask students to work with a partner to make a similar nutrient label for a plant supplement (i.e. a fertilizer for plants). Allow no more than 5 minutes for students to complete their labels, then solicit volunteers to share their ideas. Record student ideas on the board. Once students are content that they have an exhaustive list, make note of the valid nutrients and provide clarification around any element or substance that is not related to essential plant functioning.

Essential nutrients include carbon, hydrogen and oxygen (from the atmosphere and water), nitrogen, phosphorous and potassium (primary macronutrients from soil), calcium, magnesium and sulfur (secondary nutrients from soil) along with boron, iron, manganese, copper, zinc, molybdenum and chlorine (micronutrients from the soil).

Finally, ask students how these nutrients become available to plants. Solicit volunteers to share their thoughts, then tell students that today they will focus on a "hidden" world that holds the answer.

Development: Distribute the *Soil Nutrient Cyclers* student handout. Solicit volunteers to read the introduction of the handout aloud. Address any student questions or comments. If students have completed the *Tropical Montane Soils* lesson, ask them to share what they remember about the properties of these soils. Otherwise, move on to the "Detritus" and "Decomposition" sections. Using the computer and LCD projector, watch Panorama #1 (low elevation forest), ground video #5 to view a video about leaf litter on the forest floor. Allow time for students to answer the handout questions, share responses, then move on to the next video (Panorama #2, ground video #5). Again allow students to

answer the handout question, share responses, and move on to the last two videos (Panorama #3, ground video #5 and Panorama #3, canopy video #2).

When students have answered the final question, go on to the "Nutrients" section of the handout. Read this aloud as a class. When students are ready to begin the "Nutrient Cyclers" section, you may allow them to work on their own (or in pairs) if enough computers are available. If you are using a single computer, work through the remainder of the handout together as a class. If students are working alone or in pairs, circulate around the room and stop to interact with every student (or pair) at least once.

You may wish to provide students with books relating to insects, worms, bacteria, and fungi. The more colorful and detailed pictures they include, the better. Field guides would be an excellent choice.

In place of the "Explore more!" video links, you may want to provide microscopes and prepared slides for student use. Videos and still images can provide a lot of information, but there is no substitute for viewing the actual organisms. If using microscopes and prepared slides, have students sketch what they see and encourage them to ask questions as they explore.

Closing: Have students count off by sixes. Assign the 1s as insects, 2s as worms, 3s as actinobacteria, 4s as nitrogen-fixing bacteria, 5s as saprophytic fungi, and 6s as mycorrhizal fungi. Pair up 1s with 4s, 2s with 5s, and 3s with 6s. Ask students to introduce themselves to their partner as the organism to which they were assigned, and to explain their nutrient cycling role in the soils of Monteverde.

Suggested Student Assessment: Assign *Soil Nutrient Cyclers: Student Assessment* handout as homework or use it as a quiz after students have had several days to work with the material. Collect completed assignments, grade them, and return them to students. Provide an answer key, allow students to meet in small groups to discuss their answers, and/or go over the answers together as a class. Be sure to allow some class time in the near future to revisit the themes of this lesson and to address any components of the assessment with which students had difficulty.

Extending the Lesson: Students can create Winogradsky-style soil columns and observe the growth of microbial colonies over the course of the school year. To set up a soil column, take a transparent, colorless container (2-liter soda bottles work well) and fill it with mud or very dark, rich soil. Supplementing the mud or soil with strips of newspaper (cellulose) can speed up bacterial proliferation. Place a cover loosely on the top of the container (the bacteria will create a lot of gas and your container may explode if the lid does not allow it to escape!). Place the soil column in a very sunny window and/or under bright lights (such as desk lamps directed towards the column). Within 2-3 months distinct colonies of bacteria will be visible with the naked eye.

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Vocabulary: detritus, organic, sustain, nutrients, ingest, excrete, aerated, margin, elements, macroscopic, microscopic, surface area, byproducts, symbiotic

WORKSHEETS: *Soil Nutrient Cyclers, Soil Nutrient Cyclers: Student Assessment*