Lesson Title	Successful Succession
Length of Lesson	Two (50 minute) class periods
Created By	Calista Guthrie
Subject	General Science
Grade Level	8th grade
State Standards	8th: 1b, 1c, 1d, 1e, 1g, 1h (Inquiry); 3e, 3h (Life Science); 4d, 4g (Earth & Space Science)
DOK Level	1, 2, 3
DOK Application	Recall, State, Draw, Report, Illustrate, Label, Infer, Collect and Display, Graph, Organize, Compare, Predict, Modify, Interpret, Make Observations, Draw Conclusions, Hypothesize, Explain Phenomena, Revise
National Standards	5-8: A (Inquiry); B (Physical Science); C (Life Science); D (Earth & Space Science)
Graduate Research Element	In the Winogradsky column, sulfide concentration increases as oxygen concentration decreases with depth in the column. This stratification is similar to the stratification found in wetland sediments. Oxygen is rapidly consumed in wetland sediments as microbes breakdown abundant organic matter. As oxygen is depleted, sulfate reducing bacteria can become dominant. Sulfate reducers produce H_2S which is toxic for seagrasses.

Student Learning Goal:

<u>MS 8th Grade</u>:

1. Inquiry: (b) Distinguish between qualitative and quantitative observations and make inferences based on observations. (c) Summarize data to show the cause and effect relationship between qualitative and quantitative observations. (d) Analyze evidence that is used to form explanations and draw conclusions. (e) Develop a logical argument defending conclusions of an experimental method. (g) Justify a scientist's need to revise conclusions after encountering new experimental evidence that does not match existing explanations. (h) Analyze different ideas and recognize the skepticism of others as part of the scientific process in considering alternative conclusions.

3. Life Science: (e) Explain energy flow in a specified ecosystem. 3(h) Describe how an organism gets energy from oxidizing its food and releasing some of its energy as heat.

4. Earth & Space Science: (d) Research the importance of the conservation of renewable and nonrenewable resources and justify methods that might be useful in decreasing the human impact on global warming. Relationships of the cycles of water, carbon, oxygen, and nitrogen

4(g) Justify the importance of continued research and use of new technology in the development and commercialization of potentially useful natural products.

National Science Education Standards of Content 5-8:
A: Inquiry: Use appropriate tools and techniques to gather, analyze, and interpret data. Develop descriptions, explanations, predictions, and models using evidence. Think critically and logically to make the relationships between evidence and explanations. Communicate scientific procedures and explanations. Understanding about scientific inquiry.

B: Physical Science: Electrical circuits provide a means of transferring electrical energy through chemical changes.

C: Life Science: Organisms must be able to obtain and use resources, grow, and reproduce while living in a constantly changing environment. For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. The number of organisms an ecosystem can support depends on resources available and abiotic factors such as soil composition. Lack of resources limit the growth of populations in specific niches in the ecosystem.

D: Earth and Space Science: Soil consists of weathered rocks and decomposed organic material from dead plants and bacteria. Soils are often found in layers, with each having a different chemical composition and texture.

Materials Needed (supplies, hand-outs, resources):
Clear PVC pipe or 12-20oz. bottles to make Winogradsky column(s), aprons, gloves, spoon or other stirring device, pans for mixing, carbon source (newspaper), sulfur source (boiled egg yolks), sand (optional), water and sediment from one source, rubber bands, plastic wrap, voltmeter, electrical wire, light microscopes, microscope slides and covers, distilled water, videos (see Teacher Notes)

Lesson Performance Task/Assessment:
Students will observe microbial succession first hand using a modified Winogradsky column - a simple tool used to culture a diverse microbial population. Students will work in groups or pairs to build columns taking note of materials used and why (i.e. paper is a carbon source, egg yolk is a sulfur source, sand increases permeability). The first 50-minute period will be used to build the column using the instructions in the How to build a Winogradsky Column video (see link in Teacher Notes). Students will record initial observations and volt readings. The columns will be left to sit in an adequately lit area that will not get to hot. Students will begin making observations, taking volt readings, and stating/modifying hypotheses once a week for 6 weeks. Have students put voltage readings in a table AND graph as they go to speed up data analysis later (see Teacher

Notes for sample graphs). Students will use the voltage meter to observe the increasing gradient between hydrogen sulfide and oxygen concentrations change over time in the column. After 6 weeks of observation, microscope slides will be prepared (by the teacher prior to class, see video in Teacher Notes) with samples from several depths of a column. Students will observe and draw microbes from different depths in the column taking note of where each sample was located. They will be asked to draw the column indicating sulfide and oxygen concentrations with depth and where each of the bacteria they drew was located in the column.

Lesson Relevance to Performance Task and Students:
The lesson will allow students to observe succession first hand with microbes. They will know the materials that were put into the column and why (i.e. paper=carbon source, egg yolk= sulfur source). Before students revisit the lab, they will have some ground knowledge on succession or the life of bacteria. Students will use electrodes to validate the increase of hydrogen sulfide and decrease of oxygen with depth in the column and use microscopes to look at different microbes found in the column. Students will record their observations and make inferences based on observations.

Anticipatory Set/Capture Interest:
The initial capture of building the column will be the first 1:20 of the Bronx video. For the second class period, the capture will be revisiting the columns and finally using the microscopes.

Guided Practice:
Students will build a Winogradsky column in the first 50-minute period. They will be sure to take notes on the method used to build the column and the reason for using the materials chosen. When the unit for life sciences on succession is started, students will learn about how organisms live. They will be learning about photosynthesis and how organisms get their energy. Resources available control what organisms can survive and organisms alter their surroundings by using these resources. These lessons will prepare them for drawing conclusions about the microbial development in their Winogradsky columns.

Independent Practice:
Students will work in groups or pairs to build their columns. Students see will form their own hypotheses and graphs throughout the observation period. Students will also be observing microbes. They will then compare the results they found and their hypotheses.

Remediation and/or Enrichment:
Remediation – Have students write the equation for photosynthesis and the equation for sulfate reduction. Tell them to write a sentence or two describing how these equations and microbes that employ them can explain the increase in sulfide concentration with depth.

Enrichment- Have students submit a formal lab report.

Check(s) for Understanding:
Students will compare results with hypotheses and draw conclusions based on appearance of the column, voltage change over time, and differences in bacteria. Students will be asked to draw the column indicating sulfide and oxygen concentration trend with depth and where bacteria samples observed were located in the column. The drawing should be accompanied by an explanation linking oxygen, sulfide, and differing microbes.

Closure:
For closure, the class will discuss their results. Students will be able to see this phenomena in scientific research as it is how I am able collect data in the field using electrodes. The discussion could be led with a series of questions.

Question 1: Why do microbes from different depths look different?
Question 2: What resources do the microbes in the column have to survive?
Question 3: What controls the microbial population growth?

Possible Alternate Subject Integrations:
Math (graphing)

Teacher Notes
How to build a Winogradsky Column
http://www.youtube.com/watch?v=ivRxB3w41I0&feature=related

Bronx Science Winogradsky Project for Pride (watch first 1:20 only)
http://www.youtube.com/watch?v=HHnIsKAP-eY&feature=related

How to Prepare a Wet Mount Slide
http://www.youtube.com/watch?v=jjevU-XMVzU\

Sample graphs: