The Chemistry of Plants

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Introduction

When I became a special education teacher, I wanted to be the type of teacher that provided opportunities for all students to learn. Becoming a teacher was exciting at first. I thought of all the good teachers I had when I was in school and all of the not so good experiences that I had when I was in school as well. I had a teacher that helped be gain a vast knowledge of science and I had another teacher that gave be a love for math which I still have today. But most of all, my teachers gave me the love to become a lifelong learner. I wanted to give my students that same passion, tenacity, and capability to become lifelong learners. I did not want to be a lecturer because students retain more information when they are engaged in meaningful hands on activities. Now that I am teacher, I realize that students are not the same type of students since I was in school several years ago. However, I still want my students to develop a true since of how learning takes place. In science, I provide students with many hands-on activities, guided notes and scaffolding learning groups.

School Background

I have been working in the Special Education Field since 2007. I have been teaching in the Charlotte Mecklenburg School System for about one year. I teach a self- contained classroom at a school located in the inner city of Charlotte, NC. All of my students have some form of a disability, ranging from Autism to severe depression. Many of my students suffer from ADHD, so it is very hard for them to stay engaged for long periods of time.

I teach at The Morgan School in the Charlotte-Mecklenburg School System, a large urban school district in North Carolina. The Morgan School is a public separate setting for students with behavioral and emotional disabilities. Our school embraces the philosophy that all students can learn new behaviors, new coping skills and master the North Carolina Standard Course of Study at the same time. Teachers are encouraged to use a variety of teaching techniques and strategies while meeting student's individual needs. We have the freedom to modify the course content either through the process by which we deliver the content or through the recognition of our student's individual readiness for the content that we are exploring. The school has approximately 100 students consisting of several different subgroups, including 81% African-American, 5% Hispanic, and 3% Multi-Racial, 1% Native American, and 10% White. Whether they are

female, male, economically disadvantaged, non- economically disadvantaged, and all of our students have some form of a disability.

According to Friend 2008, when a decision is reached for any type of separate education it is based on data about students academic and behavioral needs; educational placement changes are monitored carefully to ensure that the cost to the student of this decision is worth the benefit the student is receiving. Educational placement changes are reviewed and revised based on changing needs rather than rigidly scheduled for an entire school year; these changes are premised on the goal of reducing the separate service as soon as possible.

My particular class this year consists of 8 students. I have a very unique group of students. One of the students has multiple disabilities ranging from autism to bipolar disorder. Another student has autism and turrets, while another student has mild- cerebral palsy and autism. The other five students have a variety of severe emotional disabilities. The class consists of all male students of which, 5 are African American males and 3 are Caucasian male students. All of the students in my class have Individualized Education Plans (IEP's).

An IEP is a document prepared by a multidisciplinary team or annual review team that specifies a student's level of functioning and needs. IEP's also focus on instructional goals and objectives for the student and how students will be evaluated in each target area. The nature and extent of special education, related services, and supplementary aids and services the student will receive; and the initiation date and duration of the services are all included in an IEP. Each student's IEP is updated annually. IDEA (individuals with disabilities educational act) requires that every special education teacher monitor and report their students' progress quarterly at least four times each year.

Teaching students with disabilities can be challenging. An educator must use a wide variety of teaching techniques and strategies, to meet each students needs. Many of my students are years behind academically and it is hard for them to grasp new concepts easily.

Background Knowledge

According to the North Carolina standard course of study, students must be able to analyze photosynthesis and cellular respiration in terms of how energy is stored, released and transferred within and between these systems. Our state standards indicate that 10th grade biology students must meet this requirement. Yet most students believe that photosynthesis is just the process by which plants receive food.

According to Longman, cellular respiration is defined as the process by which food molecules are broken down to release energy. The study of cell origins primarily involves the question of how cells became individual units, separate from the external environment and capable of producing energy to sustain them. Cellular metabolism is the set of biochemical processes by which energy is either created or used in the cell, and energy resources in eukaryotic cells are regulated by two well-studied organelles: the mitochondrion and the chloroplast. Due to the widely held contention that these organelles once existed as separate organisms, the study of cell energy is inherently linked to the study of cell origins. All living organisms rely on cellular respiration to carry out all life functions so that their homeostasis is maintained.

Photosynthesis can be defined as the process by which autotrophs convert sunlight to a usable form of energy. The first organism capable of photosynthesis reportedly evolved over 3 billion years ago. Today photosynthesis supports 99% of the life on Earth.

"Sunlight plays a much larger role in our sustenance than we may expect: all the food we eat and all the fossil fuel we use is a product of photosynthesis, which is the process that converts energy in sunlight to chemical forms of energy that can be used by biological systems."[xi] Photosynthesis is carried out by many different organisms, ranging from plants to bacteria. The best known form of photosynthesis is the one carried out by higher plants and algae, as well as by cyanobacteria and their relatives, which are responsible for a major part of photosynthesis in oceans. All these organisms convert CO_2 (carbon dioxide) to organic material by reducing this gas to carbohydrates in a rather complex set of reactions. Electrons for this reduction reaction ultimately come from water, which is then converted to oxygen and protons. Energy for this process is provided by light, which is absorbed by pigments (primarily chlorophylls and carotenoids). Chlorophylls absorb blue and red light and carotenoids absorb blue-green light [xii], but green and yellow light are not effectively absorbed by photosynthetic pigments in plants; therefore, light of these colors is either reflected by leaves or passes through the leaves. This is why plants are green.

Virtually all oxygen in the atmosphere is thought to have been generated through the process of photosynthesis. Obviously, all respiring organisms (including plants) utilize this oxygen and produce CO_2. Thus, photosynthesis and respiration are interlinked, with each process depending on the products of the other. The global amount of photosynthesis is on the order of a trillion kg of dry organic matter produced per day, and respiratory processes convert about the same amount of organic matter to CO_2. A large part (probably the majority) of photosynthetic productivity occurs in open oceans, mostly by oxygenic prokaryotes. Without photosynthesis, the oxygen in the atmosphere would be depleted within several thousand years. It should be emphasized that plants respire just like any other higher organism, and that during the day this respiration is masked by a higher rate of photosynthesis.

In this curriculum unit we will explore and analyze the relationship between photosynthesis and cellular respiration and energy use in the cell. We also will analyze the overall reactions including the reactants and the products of photosynthesis and cellular respiration and factors which affect their rates (amounts of reactants, temperature, pH, light, etc.)

Photosynthesis is an example of an endothermic chemical reaction, and cellular respiration in an example of an exothermic reaction. Chemical reactions that require energy are called endothermic reactions and a reaction that gives off, or releases energy is called exothermic reactions. Photosynthesis is considered an endothermic reaction because during photosynthesis plants use the energy from the sun to convert carbon dioxide and water into glucose and oxygen.

"The discovery of the process of photosynthesis was the sequential effort of two scientists Nicholas de Saussure, and C.B.Van Niel. In 1804 Swiss Chemist, Nicholas de Saussure discovered that plants placed in carbon dioxide- enriched air grew better than those in normal air. In the 1930's C.B. Van Niel of Holland showed that light energy split water and released oxygen" [viii]. In the 1950's the American Scientist R. Emerson determined that photosynthesis involves two stages.

The first stage begins when light is absorbed in the grana of the chloroplast. The first stage is called the light dependent reactions stage. During the light-dependent reactions stage, water splits into Hydrogen ions, electrons, and oxygen (O_2). In this stage light reactions are used to form a compound called ATP (adenosine tri-phosphate), whose chemical bonds have the ability to store energy and release energy when it needs to. These reactions occur in different areas of the thylakoid, named the photo-system I and the photo-system II. The photo-system is a light collecting unit for the chloroplast.

The light dependent reactions require sunlight and water. In this stage a water molecule is in Photo-system II. Because the splitting of water release O_2, Hydrogen ions (H^+) and energized electrons (e^-). Most of the O_2 diffuses out of the plant and into the air that we breathe. The second stage follows the light dependent reactions. The products of the light-dependent reactions are NADPH and ATP, which are used in the Calvin Cycle.

In 1905 English physiologist, F.F. Blackman discovered that the dark reactions go faster when the temperature is increased up to 30°, but they slow down at higher temperatures. He was able to conclude that these reactions are controlled by enzymes [viii]. ATP is used to build simple sugars from carbon dioxide. The chemical energy of the ATP molecule is used to build simple sugars from carbon dioxide. The chemical energy of the ATP molecule is transferred to the bonds that hold the sugar molecule together. ATP looses one of it three phosphates and is converted to adenosine di-phosphate.

So where does cellular respiration come into the equation? Plants form food products using sunlight and carbon dioxide from the air. Oxygen allows animals to use the energy trapped inside this food. The oxygen that animals breathe in is used to burn the food to release the trapped energy. This process is called respiration. In respiration energy is released from the food materials, and carbon dioxide and water are given off. The process of cellular respiration is the exact opposite of the process of photosynthesis.

Photosynthesis	vs.	Cellular Respiration
Gives off oxygen		Uses oxygen
Makes sugar		Breaks down sugar
Needs sunlight		Does not need sunlight
Uses water		Gives off water
Uses carbon dioxide		Gives off carbon dioxide
Gets energy from the sun		Releases energy from sugar
Occurs in cells with chlorophyll		Occurs in all living cells

History

Scientist for many years wondered what allowed plants to make their own food while humans could not make their own food. Was it their green color? In 1817 two French scientist, Pierre Joseph Peletier and Joseph Bienaime Caventou isolated the green substance from plants and they named it chlorophyll, from the Greek word meaning "green leaf".

In 1915 German Scientist Richard Willstatter won a Noble Peace Prize for his works with chlorophyll. Willstatter discovered that there were two different types of chlorophyll. One, which he named chlorophyll A, which makes up three fourths of the chlorophyll in plants and a second , chlorophyll B, which accounts for the other one fourth. Willstatter also found that chlorophyll contained carbon, hydrogen, oxygen and nitrogen atoms.

The overall reaction for photosynthesis at that time was thought to be

CO_2 + H2O + light energy $\longrightarrow$ (CH2O) + O2.

Until the 1930's when C.B. Van Niel questions this chemical reaction, Van Niel was investigating the photosynthesis that occurred in different groups of bacteria, such as purple sulfur bacteria [viii]. Purple sulfur bacteria create carbohydrates, but they do not release oxygen. Van Niel proposed that it was not carbon dioxide that is broken up to produce oxygen gas during photosynthesis, but the water molecule that is being broken up into hydrogen and oxygen. So the proper equation for photosynthesis in algae and green plants is

$6\ CO_2 + 12\ H_2O \longrightarrow C_6H_{12}O_6 + 6\ O_2 + 6\ H_2O.$

When looking at this equation it is easy to notice that water appears on both sides of this equation and the total numbers of carbon, hydrogen, and oxygen atoms on the left side are equal to the corresponding sums on the right [viii].

Plants as Factories

Roots: Absorption of Water and Minerals

Soil contains minerals and water that plants need to grow. The minerals that are located in soil dissolve in water, just as sugar or salt dissolves in water. The roots of a plant contain thousands of tiny root hairs. These tiny root hairs absorb most of the water that plants take in. The more root hairs a plants has, the greater the surface area available to absorb water [viii].

Stems: Transportation of Minerals

Stems consist of two types of transporting materials, Xylem and Phloem tubes. A xylem tube brings water and minerals from the roots to leaves. Phloem tubes carry food from the leaves to all parts of the plant [viii].

Leaves: Natures food factory

Leaves are made up of many parts. Leaves are usually wide and flat, this gives leaves are larger surface in order for them to absorb as much as possible. The more leaves a plant has, the more sunlight they can absorb. The top and the bottom layers protect the inside of the leaf. The top layer of a leaf is clear, so that it can absorb sunshine. Beneath the outer layer is a layer of food making cells [viii].

Stomates: The gateways for gases

Stomates are tiny holes that allow Carbon Dioxide to pass through from the outsides of leaves. Stomates are surrounded by a pair of guard cells, when these guard cells are opened wide, gases can pass in and out of the stomates [viii].

Soil: The chemistry of soil

Soil is the top layer of the earth's crust in which organic matter grows. There are many components which determine a soil type such as pH, nutrient level and organic content. These factors can vary depending on the type of plant or crop which grows in the soil and

also on geographic location. The best way to determine soil quality is by conducting a soil test.

Rationale

Photosynthesis is an amazing process. I chose to teach this unit to my students because photosynthesis is a complicated process for them to understand. I want my students to have a cast understanding of photosynthesis and cellular respiration. This curriculum unit should be taught for three weeks.

Our state standards requires that 10^{th} grade biology students must be able to analyze photosynthesis and cellular respiration in terms of how energy is stored, released, and transferred within and between these systems.

Yet most students believe that photosynthesis is just the process by which plants receive food. According to the North Carolina standard course of study, students must be able to analyze photosynthesis and cellular respiration in terms of how energy is stored, released and transferred within and between these systems.

The purpose of this curriculum unit is to help my students gain a vast understanding of photosynthesis and cellular respiration. In this curriculum unit we will explore and analyze the relationship between photosynthesis and cellular respiration and energy use in the cell. We also will analyze the overall reactions including the reactants and the products of photosynthesis and cellular respiration and factors which affect their rates (amounts of reactants, temperature, pH, light, etc.).

Objectives

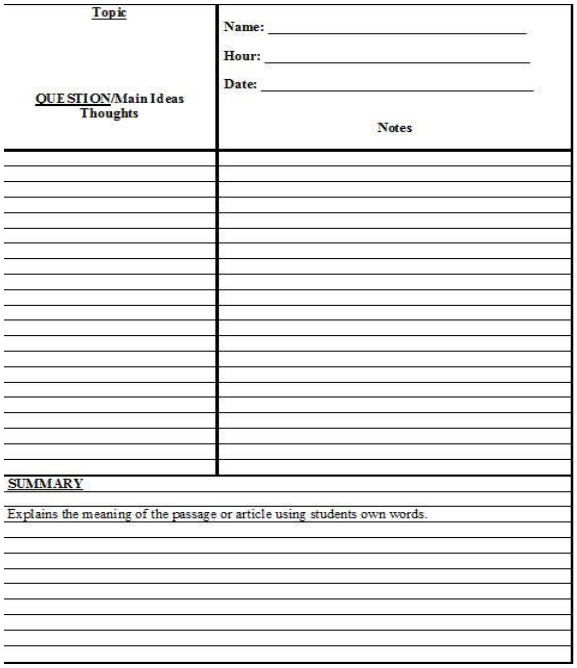
Essential Standard Clarifying Objectives Bio 4.2 Analyze the relationships between biochemical processes and energy use in the cell.

Bio.4.2.1 Analyze photosynthesis and cellular respiration in terms of how energy is stored, released, and transferred within and between these systems.
Bio.4.2.2 Explain ways that organisms use released energy for maintaining homeostasis (active transport).

Strategies

Cornell Note Taking

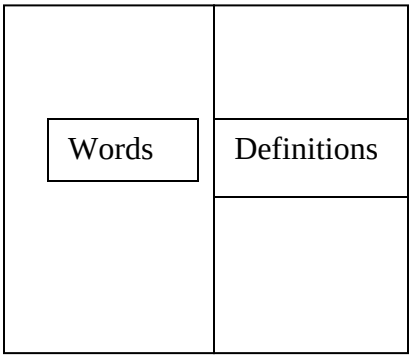
Cornell note taking is a note taking system that was designed by Walter Paulk, a professor at Cornell University. Cornell notes are divided into three sections. The first section is the questions section, which is located on the left hand side of a sheet of notebook paper. The second section is the notes section, this is the section where students and write any notes that they have taken. Last but not least is the third section, titled the summary section [xv]. The summary section is used as a tool for students to summarize the entire day's lesson. This is the time for students to focus on key ideas that were presented during the lesson. Students will use the Cornell Notes Handout, located in Appendix B .



Topic QUESTION/Main Ideas Thoughts	Name: _____ Hour: _____ Date: _____ Notes
SUMMARY	
Explains the meaning of the passage or article using students own words.	

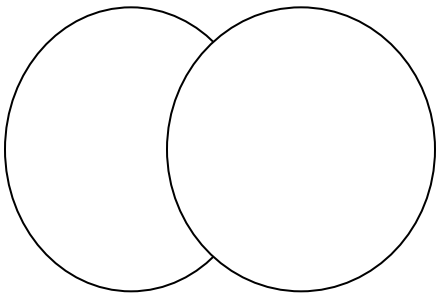
Vocabulary Foldable

Vocabulary foldable is used for students to write the unit's vocabulary and study the vocabulary when they need to review. A vocabulary foldable is used as a study tool for vocabulary words. Many students enjoy using a vocabulary foldable because they are easy to keep inside of their books or notebooks.



Graphic Organizers

There are two types of graphic organizers commonly used to compare different objects. A Venn- Diagram is used to compare two objects similarities to the objects differences. A Venn - Diagram provides students a visual display of the similarities and differences between two items. (Marzano) In this unit we will use a Venn-Diagram to compare cellular respiration to photosynthesis.



K-W-L Chart

As a warm up activity students will begin by completing a KWL chart. Students will brainstorm, K- what they know about photosynthesis and cellular respiration. W- what they want to know about photosynthesis and cellular respiration. L- what they have learned about photosynthesis and cellular respiration will be completed at the conclusion of this curriculum unit.(See Appendix B)

K- What I Know	**W- What I Want To Know**	**L- What I have Learned**

Students Activities

Activity 1: Photosynthesis in Our World Today.

As a warm up activity students will begin by completing a KWL chart. Students will brainstorm, K- what they know about photosynthesis and cellular respiration. W- what they want to know about photosynthesis and cellular respiration. L- what they have learned about photosynthesis and cellular respiration will be completed at the conclusion

of this curriculum unit.(See Appendix B) As an introduction to this unit on photosynthesis, I want to show my students two documentaries*: Biology Concepts for Students: Photosynthesis and* Discovery Educations' the *World of Plants: Photosynthesis*. The video questions can be found in Appendix A. Both of these videos have great explanations, and illustrations of how photosynthesis is directly related to our everyday lives. These videos offer a great explanation for the products that are produced as a result of photosynthesis and cellular respiration. Cellular respiration is better explained in Discovery Educations video titled "*Biology Concepts for Students: Cellular Respiration".*

Activity 2: Photosynthesis and Cellular Respiration on a much deeper level.

As a warm up activity students will begin creating their first vocabulary foldable. The 1st vocabulary foldable will consist of the following vocabulary words: photosynthesis, autotrophy, chlorophyll, chloroplasts, light dependent reactions, ATP, cellular respiration, and glycolosis. After discussing with my class the process of photosynthesis and how cellular respiration is directly related to photosynthesis. My students will go to the website "http://www.science-class.net/Biology/Photosynthesis.htm". WWW.scienceclass.net/Biology/Photosynthesis.htm where we are going to participate in several activities and quizzes as they relate to photosynthesis and cellular respiration. On this website, I want them to browse the link Slideshows: Photosynthesis & Respiration and *Photosynthesis & Respiration Quizzes.* One article found through this link details how food and breathing are related, because they are the two most important processes in all living organisms. The purpose of this activity is to assist my students in coming familiar with all of the chemical processes and their importance to photosynthesis and cellular respiration. Most of my students have no prior knowledge or concept of the chemical processes that take place during photosynthesis and cellular respiration.

Activity 3: Plant Research

Over the next five days students will conduct a series of lab activities with a variety of plants. The purpose of these activities are to help students gain a vast understanding of all the chemical processes that are related to plant growth, respiration and how these process relate to our everyday lives.

Experiment 1 *"What do plants need?"*

Materials
Four Flower Pots
Soil
Large-Mouth Jar
Water

Alfalfa Seedlings
Soda Lime

Procedure

1. Plant alfalfa seedlings in each of the four pots, each containing the same amount of soil.
2. Place the first pot in the light, but do not water it.
3. Water the second pot every day, but keep it in a dark closet.
4. Place the third pot in the light with a small cup of soda lime next to it. Water the pot, and cover the pot and the cup with the large mouth jar. (Soda lime takes carbon dioxide out of the air. The pot needs to be watered only at the beginning of the experiment because the jar keeps the water from evaporating.)
5. Place the fourth pot in the light, and water it regularly.
6. Compare the four plants daily for two weeks.

Experiment 2 *"Can we look at Xylem Tubes?*

Materials
Red Food Coloring
Water
Celery Stalk

Procedures
1. Place 10- 12 drops of food coloring into a half cup of water.
2. Cut off the bottom of a celery stalk.
3. Place the celery stalk in the colored water.
4. Let the celery sit in the colored water overnight.
5. Cut the celery in half to look at a cross section.

Experiment 3 *"Where are the stomates?"*

Materials
Plant from the geranium family.
Dark Closet
Sunny Area
Petroleum Jelly

Procedures
1. Place a geranium plant in a dark area for 3-5 days.
2. Once the plant has been inside a dark area for 3-5 days, set the plant in a sunny area.

3. Place petroleum jelly on the top of one of the leaves and on the bottom of a different leaf.
4. Observe the leaves everyday for five days.
5. Water the plant as needed.
6. Compare the petroleum- coated leaves with one of the leaves that were not coated on either side.
7. Record all findings.

Activity 4: *"Exploring the Chlorophyll?"*

Materials
Spinach Leaves
Cookie Sheet
Aluminum Foil
Paper Towel
Scissors
Glass Bowls
Cotton Balls

Procedure

1. Cover a cookie sheet with aluminum foil. Stack several sheets of paper toweling on top of the foil and set the cookie sheet aside. [ix]
2. Cut, tear or shred fresh geranium or spinach leaves into the tiniest pieces that you can manage--enough to measure about ½ cup. Put the leaf fragments into an old glass bowl. Do not use plastic bowls, because acetone dissolves some types of plastic. [ix]
3. Pour ¼ cup of acetone or nail-polish remover that contains acetone into the bowl of leaves. [ix]
4. Crush the leaves with the back of an old metal spoon as you stir the solution. Keep crushing and stirring until the liquid becomes a dark, deep green. [ix]
5. Filter the solid materials from the liquid by pouring it through cotton balls into another glass bowl. [ix]
6. Carefully pour the liquid by the teaspoonful onto the paper toweling on the cookie sheet. Set the sheet outside in the sun to allow the acetone to evaporate completely. The dark green residue that remains is extracted chlorophyll. [ix]

Activity 5: *"What other chemical processes are behind photosynthesis?"*

As a warm up activity students will begin by reading an article titled " *Endothermic Vs. Exothermic"* http://w-chemicals.com/endothermic-vs-exothermic/ Students will read this article and complete a page of Cornell Notes .(See Appendix B) As an introduction to

endothermic and exothermic reactions , I want to show my students two experiments that demonstrate endothermic and exothermic chemical reactions. The purpose of this activity is to assist my students in coming familiar with all of the chemical process of endothermic chemical reactions and exothermic chemical reactions. Photosynthesis is an endothermic reaction that occurs in plants, as they require external energy input within the form of sunlight or solar photons. Cellular respiration is an exothermic reaction by which the chemical energy of "food" molecules is released and partially captured in the form of ATP. Carbohydrates, fats, and proteins can all be used as fuels in cellular respiration, but glucose is most commonly used as an example to examine the reactions and pathways involved [IV.]

Experiment 4: *"Endothermic (Process) Reaction"*

Materials

2 cups heavy whipping cream
2 cups half-and-half cream
1/2 cup white sugar
2 teaspoons vanilla extract
1 bag crushed ice
4 cups coarse salt

For each student you'll need:

2 pint-size resalable plastic freezer bags
1 gallon-size resalable plastic freezer bag
Gloves or towel to protect fingers

Procedures

1. In a pitcher or large measuring cup, stir together the whipping cream, half-and-half, sugar, and vanilla extract until sugar has dissolved.

2. Pour about 1/2 cup of mixture into a pint-size plastic bag and seal carefully, squeezing out extra air. Place each sealed bag into a second pint-size bag, again squeezing out extra air. Seal carefully.

3. Fill each gallon-size plastic bag about halfway with ice and add 1/2 cup coarse salt. Place one sealed small bag into the large bag, squeeze out most of the air, and seal the large bag.

4. Wear mittens or thick gloves, or wrap the bag in a towel to protect hands against the extreme cold. Shake and massage the bag for about 5 minutes or until mixture thickens into ice cream. Add more salt and ice to the outer bag if ice cream hasn't formed after 10 minutes of continuous motion.

5. Remove the outer pint-size bag before you open the inner bag so you don't get any of the salty ice on your ice cream.

Experiment 5: *"Exothermic Reaction"*

Materials
Dish Detergent
Hydrogen- Peroxide
Yeast
Food Coloring
Large Outdoor Space
100mL Graduated Cylinder
Funnel

Procedures

1. Add 8 drops of your favorite food coloring into the bottle.
2. Add about 1 tablespoon of liquid dish soap into the bottle and swish the bottle around a bit to mix it.
3. In a separate small cup, combine the warm water and the yeast together and mix for about 30 seconds.
4. Use a funnel to pour the yeast water mixture into the bottle.

Activity 6 *"Why do leave Change Colors?"*

As a warm up activity students will begin by reading an article titled "Why *do leaves change colors?"* http://www.esf.edu/pubprog/brochure/leaves/leaves.htm

Students will read this article and complete a page of Cornell Notes. (See Appendix B) As an introduction to teaching students why leaves change colors. I want to show my students an experiment that demonstrates why leaves change colors and the chemical processes that are involved. The purpose of this activity is to assist my students in coming familiar with all of the chemical process involved with photosynthesis and cellular respiration. When leaves appear green, it is because they contain an abundance of chlorophyll. There is so much chlorophyll in an active leaf that the green masks other pigment colors. Light regulates chlorophyll production, so as autumn days grow shorter, less chlorophyll is produced. The decomposition rate of chlorophyll remains constant, so the green color starts to fade from leaves [xiii].

Experiment 6 *"Why do leaves Change Colors?"*

Materials

Leaves (different colors)

Small jar (a baby food jar work well)

Cover for jars or aluminum foil or plastic wrap

Rubbing alcohol

Paper coffee filter

Shallow pan

Hot tap water

Plastic knife or spoon

Procedure

1. Have your students collect 2-3 large leaves (different colors) from the same tree type. Students should tear or chop the leaves into very small pieces and put them into small jars. [xiv]
2. Add enough rubbing alcohol to the jar to cover the leaves. Using a plastic knife or spoon, carefully chop and grind the leaves in the alcohol. SAFETY NOTE:

rubbing alcohol can be harmful if mishandled or misused. Use in a well-ventilated area, and avoid contact with skin.[xiv]

3. Have your students cover the jar very loosely with a lid, plastic wrap or aluminum foil. Place the jar carefully into a shallow tray containing 1 inch of hot tap water.[xiv]
4. Keep the jar in the water for at least a half-hour, longer if needed, until the alcohol has become colored (the darker the better). Twirl the jar gently about every five minutes. Replace the hot water if it cools off.[xiv]
5. Have your students cut a long thin strip of coffee filter paper. Remove the jar from the water and uncovered. Place a strip of filter paper into the jar so that one end is in the alcohol. Bend the other end over the top of the jar and secure it with tape. [xiv]
6. The alcohol will travel up the paper, bringing the colors with it. After 30-90 minutes the colors will travel different distances up the paper as the alcohol evaporates. Your students should be able to see different shades of green, and possibly some yellow, orange or red, depending on the type of leaf. [xiv]

Activity 7 *"How are plants affected by the soils pH?"*
As a warm up activity students will begin by completing a KWL chart. Students will brainstorm, K- what they know about soil pH. W- what they want to know about soil pH. L- what they have learned about soil pH will be completed at the conclusion of this activity.(See Appendix B) As an introduction to the concept of soil pH, I want my students to read and create a presentation on soil pH. Students will read the following article: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/167187/soil-ph.pdf. This article offers a great explanation of soil acidity and how it affects plant growth.

Experiment 7 *"How are plants affected by the soils pH?"*
This lab can be found on the following webpage:
http://www.bgci.org/files/Canada/english_docs/rbg_soilph.pdf

Materials
Small Garden Tool for Digging
Small plastic bags or containers
Masking tape
Markers
Blue and red litmus paper
pH paper
Petri dishes (or other small dishes)
Eye droppers
Teaspoons

Preparation:

1. For this experiment, you will need a number of soil samples collected from locations in which different plant species are growing. For example, you may collect soil samples from under a pine tree, a maple tree, a spruce tree, a tomato plant, a radish, an azalea bush, clover, or goldenrod. When collecting your samples, you will want to ensure that soils collected from under a wide variety of plants species are represented.
2. You may collect these soil samples on your own ahead of time or you may choose to take your students on a soil gathering expedition around the school (this could be incorporated into a plant identification hike). You may also choose to assign this as a homework project, requesting that students bring in soil samples from home (you will want to encourage them to only gather soil from under plants that they can positively identify).
3. To collect your soil samples, use a trowel to dig down 10-15 cm into the soil (harming the plant as little as possible in the process). Place a soil sample into a small plastic bag or container. Label the container with the name of the plant using masking tape and a marker. Fill in the hole you have made as best you can.

Procedure:

This lesson works best as a small group activity.
1. Provide each group with one soil sample, a couple pieces of red and blue litmus paper, an eyedropper and two petri dishes.
2. Review with your students what litmus paper is for and how to read the results from this pH indicator.
3. Instruct the students to place a piece of blue litmus paper in one petri dish and a piece of red litmus paper in the other petri dish. The students should then place approximately a ½ teaspoon of their soil sample on top of each strip. Using the eyedropper, the students should then moisten the soil until the strips of litmus paper become wet. Finally, instruct the students to brush the soil away. Is their soil acidic or basic?
4. Have your students construct a table in their notebooks consisting of two columns titled Acidic Soil and Alkaline Soil. In the appropriate column, the students should record the name of the plant species under which their soil was found.
5. Instruct each student or group to display their soil sample (with the plant species name clearly visible) and the results of the litmus paper tests in their work area. Allow the students to circulate throughout the room, recording the findings for each soil sample.

Notes

[i] Educational Activities. *Biology Concepts for Students: Cellular Respiration*. From Discovery Education. Full Video. 1994. http://www.discoveryeducation.com/ (accessed 29 October 2011).

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Appendix A – Video Questions

Biology Concepts for Students: Photosynthesis

Name: _____ Date: _____

1. Would life still exist if animals only ate other animals? Explain your answer.

2. Green plants provide food for _____ and _____.
3. List the things that surround plants.

4. Does soil play a role in photosynthesis? Explain.

5. How would you prove that plant obtained or did not obtain its weight from the soil?

6. What minerals from soil are important to plant growth?

7. What is hydroponics?

8. What is energy?
9. What is the energy for photosynthesis?

10. What happens when plants don't receive water?

11. Why did the glowing splint burst into flame? Write an explanation.

12. Why did the yellow Brom-Thymol turn back to blue? Write an explanation.

13. Why did the section of the leaf which was exposed to sunlight turn blue-black when it was dipped in iodine? Why did the section of the leaf which was not exposed to sunlight remain white? Explain.

Appendix A – Video Questions

World of Plants: Photosynthesis

Name: _____ Date: _____

1. How do green plants get their food?

2. What are the raw materials that are needed for photosynthesis?

3. What are stomas?

4. What provides energy for photosynthesis?

5. What are chloroplasts?

6. What does chlorophyll do?

7. What does glucose contain?

8. What do plants do with glucose?

9. What other things does photosynthesis provide?

Appendix B- Handouts

KWL- Chart

K- What do you know about Photosynthesis and cellular respiration?	W- What do you want to know about Photosynthesis and cellular respiration?	L- What have you learned about Photosynthesis and cellular respiration?

Cornell Notes Page

Topics Questions/ Big Ideas/ Thoughts	Name : Date: Notes:

Conclusion :

[i] This video emphasizes the interconnections between photosynthesis and cellular respiration.

[ii] This video emphasizes the interconnections between photosynthesis and cellular respiration.
[iii] This video emphasizes the interconnections between photosynthesis and cellular respiration.
[iv] This book emphasizes on the interconnections of core concepts and the interactions among living things.
[v] This book emphasizes on the interconnections of core concepts and the interactions among living things.
[vi] This book offers many differentiation strategies for teachers.
[vii] This book offers many differentiation strategies for teachers.
[viii] This book emphasizes the interconnections between photosynthesis and cellular respiration.

[ix] This website offers a detailed lab on "how to extract chlorophyll".

[x] This book emphasizes on the interconnections of core concepts and the interactions among living things.
[xi] This book emphasizes on the interconnections of core concepts and the interactions among living things.
[xii] This book emphasizes on the interconnections of core concepts and the interactions among living things.
[xiii] This book emphasizes the interconnections between plant growth and soil pH.
[xiv] This website emphasizes the interconnections between plant growth and soil pH.
[xv] This website offers a good explanation of Cornell note taking.