Plant Growth

Classwork/homework due ____
circle one

Name _____
Class _____ Date _____

I. Introduction When kids grow, their bodies get the materials or molecules they need from the foods they eat. Plants need molecules to grow too. People say that "plants make their own food," but where do the molecules come from?

2. Make a Hypothesis On the lines below, list two to four sources that a plant could use to make its own food. Guess how much of the plant comes from each source.

Source of molecules:	**% of plant's weight from source, for example 20%**
1. (rain) water	_____ %
2. _____	_____ %
3. _____	_____ %
4. _____	_____ %
	total = 100 %

3. Experiment A simple but famous experiment was done back in the 1630s by a Dr. Van Helmont from Belgium. He planted a willow branch weighing five pounds into some soil weighing 200 pounds. (He had dried and weighed the soil beforehand.) Van Helmont watered the plant regularly. Five years later, he carefully separated the tree from the soil and weighed each of them again. The tree had gained 165 pounds!

4. Results with the Soil Remember, Van Helmont's soil weighed 200 pounds at the start. Use your own hypothesis to predict what the soil's weight would be at the end of his experiment. Circle the answer below that is close to the percent you predicted; guess if you didn't list soil above.

If the plant received . . . **(Circle the pounds close to your prediction.)**

100% of its weight from the soil, then the soil should now weigh 35 pounds.

70% of its weight from the soil, then the soil should now weigh 84.5 pounds.

50% of its weight from the soil, then the soil should now weigh 117.5 pounds.

30% of its weight from the soil, then the soil should now weigh 150.5 pounds.

10% of its weight from the soil, then the soil should now weigh 183.5 pounds.

1% of its weight from the soil, then the soil should now weigh 198.35 pounds.

Calculation: Original weight of soil – (% from soil x weight of tree) = final weight of the soil

For example: 200 - (70% x 165) = 84.5

Van Helmont found that the soil weighed 199.875 pounds. He wrote that two ounces were lost.
Therefore we can calculate that his willow tree took about 0.08 percent of its weight from the soil. Less than one percent of the plant's weight came from the soil. How close was your own prediction?

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5. Conclusion The soil lost only about two ounces or 0.125 pounds. Meanwhile, the willow tree gained 165 pounds. Where did all that material come from? Van Helmont concluded, as we must too, that the soil could not have contributed much of anything to the plant's weight. He concluded that the plant's material must have come from the water.
Note: Van Helmont did not consider air as a possible source of material for his plant.

6. Further Discussions

A) Did you consider air as a possible source of the plant's molecules?
Why or why not? _____

_____

_____

B) Most people do not think of air as a possible source of molecules for plants. After all, plants are made of solid materials. Air is different – it's a gas. However, air is still made up of molecules. Air is a mixture of many different kinds of gas molecules including nitrogen, oxygen, and carbon dioxide. Each of these molecules has some mass or weight, although it is a tiny amount. Air contributes weight to plants when it is concentrated in the plant.

C) To understand this look at the equation for plant photosynthesis.

$$6CO_2 + 6H_2O \xrightarrow{\text{sunlight}} C_6H_{12}O_6 + 6O_2$$

carbon dioxide — water — sugar — oxygen

Sugar molecules are produced. These sugar molecules are put together to make wood as well as other plant molecules. The sugar molecules add weight.

1) Where did the carbon dioxide molecules come from? _____

2) What (besides oxygen) does photosynthesis produce? _____

3) What can sugar become? _____

4) Energy is needed for photosynthesis to take place. Where did the energy come from?

_____

7. Reflection

What idea became clearer to you with this worksheet? _____

_____

Team Equation Sheet

Directions: Fold on the dotted line. Keep the printing on the outside. Day 1: Write the photosynthesis equation on the line. Build the molecules for the equation. Place your models on the table below this sheet.

Lesson 1

Photosynthesis

Light

Names _____ _____

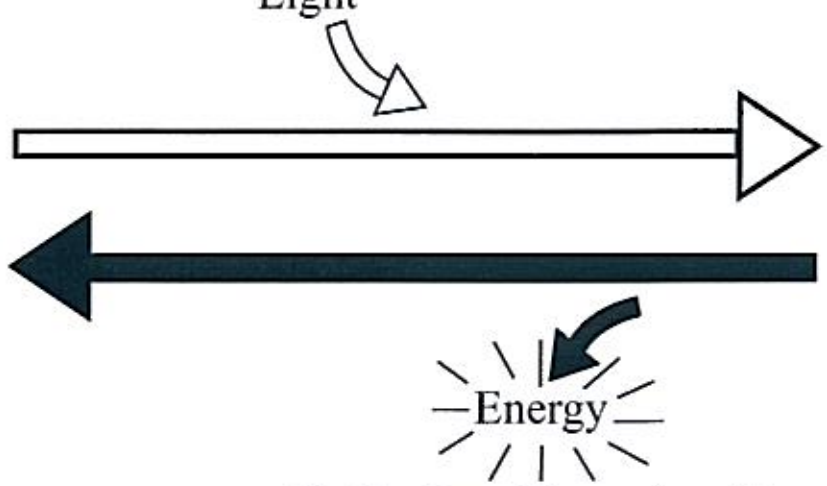
Directions:

Day 2: Write the photosynthesis equation on the top line. Build the molecules. Write the cellular respiration equation on the line at the bottom of the page. Use your models to build the glucose model following the directions in the Student Instructions. What do you have left? Why?

Lesson2

Photosynthesis

Light



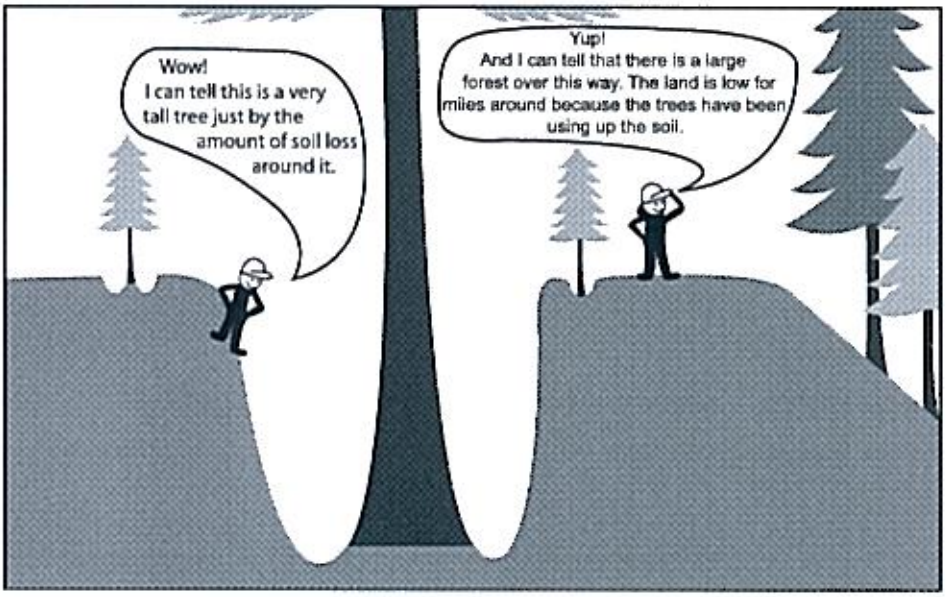
Cellular Respiration

Photosynthesis and Soil

Classwork/homework due ____
circle one

Name _____
Class _____ Date _____

Directions: Read the cartoon. Answer the question "What is wrong with this picture?"



What is wrong with this picture? _____

_____

_____

_____

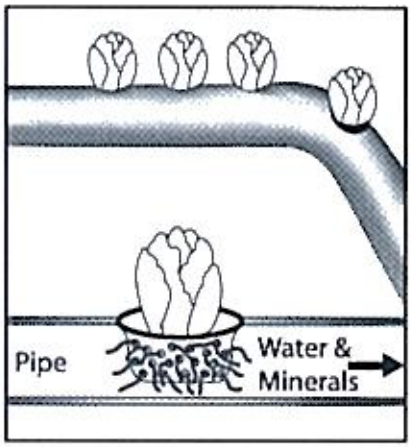
_____

Directions: Read the following paragraphs and answer the review questions.

As the cartoon illustrates, plants do not actually need large amounts of soil to grow! OK, then what do roots take from the soil? A plant's roots absorb water. The roots can also absorb tiny amounts of dissolved minerals in the water as well. These minerals are used in trace amounts by the plant in the same way vitamins and minerals are used by your body in trace amounts. The minerals are not used for food.

Plants manufacture their own food by taking in molecules from the air; they do not use soil molecules. The leaves of plants have many tiny openings where the air molecules can enter and exit. Plants use carbon dioxide molecules from the air and some water molecules from the soil to make their own food molecules. This food making process is called *photosynthesis* and occurs in the leaves of the plant. The food made in the leaf is *glucose*, a kind of sugar molecule. Isn't it interesting that we don't notice plants taking in lots of carbon dioxide molecules to make their own food? We can't see the gas, so we don't think of it. Air has lots of available molecules in it.

Growing Plants Without Soil



Did you know that plants can be grown without any soil at all? This technique of growing plants without soil is called *hydroponics*. Hydroponic lettuce and other vegetables can be purchased at some grocery stores.

To grow this lettuce, the roots are immersed in water with dissolved minerals or fertilizers. Fertilizers are sometimes called plant food, but they are not really plant food! They are minerals like phosphorous, zinc, nitrogen, and potassium. Many vegetables are now grown without soil in greenhouses.

Review Questions

1) Very tall trees do not create deep depressions in the ground. Why not? _____

_____

_____

_____

2) What does a plant take from the soil? _____

3) Where does a plant's food come from? _____

_____

4) What is the food making process called? _____

5) What kind of food molecule is made in the leaves of a plant? _____

6) Name the molecule that plants take from the air to make food. _____

7) What is hydroponic lettuce? _____

_____

Photosynthesis and Cells

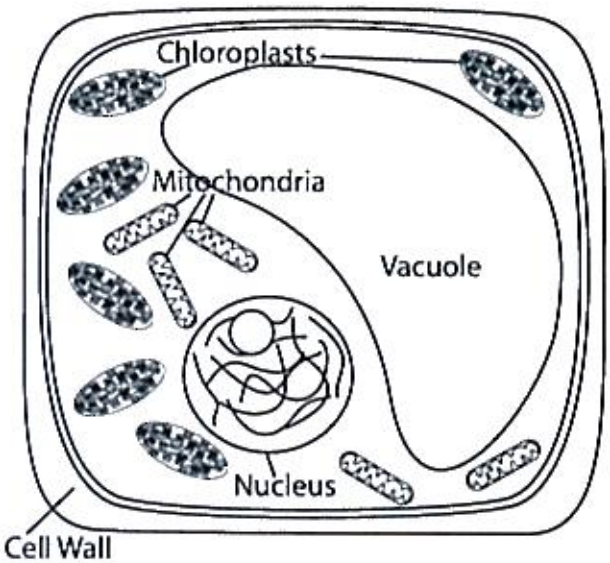
Classwork/homework due ____
circle one

Name _____
Class _____ Date _____

Directions: Coloring can be a strategy for studying. Color the parts of the cell as listed below. Take your time. Notice the shapes and details, as well as the names of the parts.
Chloroplasts – green Mitochondria – yellow Nucleus – purple Cell wall – brown

Next, look at the equations in the boxes:

1) Color the photosynthesis box green. Draw an arrow from this box to a chloroplast.
2) Color the cellular respiration box yellow. Draw an arrow from this box to a mitochondrion. (One is called a mitochondrion. More than one are mitochondria.)



Photosynthesis  light energy

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

Cellular Respiration

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

energy for the cell

Directions: Read the following paragraphs and answer the questions on the back.

Chloroplasts

Chloroplasts in the cell are actually green! Green-colored molecules inside the chloroplasts give them this color and the molecule is named chlorophyll. This special molecule has the job of capturing energy from sunlight. The energy from the Sun is necessary to put together H_2O and CO_2 to create a more complicated, larger molecule of glucose. The glucose molecule now has the energy stored in it. That is why glucose is called food. You know your body uses sugar for energy, don't you? Plants make their own food in the chloroplasts and this food is glucose, a kind of sugar.

Mitochondria

How does the cell get energy out of its glucose molecules? Cells have specialized structures called mitochondria. Mitochondria are often called the "powerhouses" of the cell. A process called cellular respiration takes place in the mitochondria. (Cellular respiration is different from breathing.) In cellular respiration, glucose molecules are combined with oxygen molecules. As a result, the glucose molecule breaks down into smaller molecules, and the energy comes back out for the cell to use.

Both Plant and Animal Cells need Oxygen

Did you notice that mitochondria need oxygen to break down glucose? (Look at the formula for cellular respiration again.) Both plants and animal cells have mitochondria and need oxygen. Many students do not realize that plants need oxygen because they are only thinking about photosynthesis, where CO_2 is the gas that plants need. Remember – plant cells have mitochondria and need oxygen to get the energy out of food molecules.

Mitochondria and Chloroplasts Recycle Atoms

You probably have noticed that photosynthesis and cellular respiration are opposite reactions. So, the atoms in these processes are continually being recycled in nature. This cycle is powered by the Sun's energy.

Questions

1. What part of the plant cell is responsible for photosynthesis? _____

2. What molecule is produced in photosynthesis and is called food? (It stores energy.)

_____

3. What part of the cell is called the powerhouse? _____

4. What process occurs in the powerhouses of the cells? _____

5. What two molecules are required for the process of cellular respiration? _____

_____

6. What else is produced besides H_2O and CO_2 from cellular respiration? _____

7. Do both plants and animals need oxygen molecules? Yes or No. Explain. _____

_____

_____

_____

_____

Writing Chemical Formulas

Name _____
Class ____ Date ____

Project A: Small Molecules

Directions: Each student has a worksheet and builds his or her own compounds or molecules. Students are in teams of two with one LEGO kit.

Step 1. Build a compound with about 10 LEGO bricks. Build any shape or color you like. Don't worry about whether the atoms would really bond together or not. (If your teacher wants you to use the standard chemistry bonding rules, they will be explained.)

Step 2. Write the formula for your compound here: _____
Use subscripts and symbols. Elements should be in this order: carbon, hydrogen, and oxygen.

Step 3. Trade LEGO compounds with your teammate.

Step 4. Write the formula for your teammate's compound here: _____
Use subscripts and symbols. Elements should be in this order: carbon, hydrogen, and oxygen.

Step 5. Check answers with your teammate. Do your formulas agree?
Resolve any differences you may have. Correct your answers and then continue.

Step 6. Build another compound. Both of you need to build a second compound for practice.

Step 7. Write your second compound's formula here: _____

Step 8. Trade LEGO compounds with your teammate.

Step 9. Write the formula for your teammate's compound here: _____

Step 10. Check answers with your teammate. Do your formulas agree?
Resolve any differences you may have. Correct your answers.

Project B: Classroom Display of Chemistry Constructs by Teams

Directions: Design a chemistry construct (molecules or groups of molecules) together with your teammate. A time limit will be set by the teacher.

Next, choose one team member to circulate first and check the other chemistry displays as directed by your teacher. Write the formulas on the other side of this paper. Then, choose if the construction is an Element, Compound, or Mixture. When time is called, switch roles. Both team members will have completed page 2 of this sheet.

Chemistry Displays:

(circle one) Element Compound Mixture Team name

Formulas of all molecules present: ______________________________

(circle one) Element Compound Mixture Team name

Formulas of all molecules present: ______________________________

(circle one) Element Compound Mixture Team name

Formulas of all molecules present: ______________________________

(circle one) Element Compound Mixture Team name

Formulas of all molecules present: ______________________________

(circle one) Element Compound Mixture Team name

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(circle one) Element Compound Mixture Team name

Formulas of all molecules present: ______________________________

(circle one) Element Compound Mixture Team name

Formulas of all molecules present: ______________________________

(circle one) Element Compound Mixture Team name

Formulas of all molecules present: ______________________________

Photosynthesis Learning Assessment

Name _____

Classwork/homework due ____ Class _____ Date _____

circle one

Directions: Compare your understanding about photosynthesis – what you knew **before** starting this unit, to what you know now. Remember there are many topics to write about: what molecules plants use to make their food, glucose, energy, cellular respiration, the parts in the plant cell, openings on a plant leaf, and so forth. On the lines below, explain four ideas that have become clearer to you.

Example: Before I thought that . . . plants did not need to breathe oxygen. But now I know that . . . plants need oxygen. Plants need oxygen to be able to get the energy from glucose. Cellular respiration takes place in plant mitochondria.

1) Before I thought that . . . /I didn't know that . . . /I was unsure about . . .

_____

_____

Now I know that . . .

_____

_____

_____

2) Before I thought that . . . /I didn't know that . . . /I was unsure about . . .

_____

_____

Now I know that . . .

_____

_____

_____

3) Before I thought that . . . /I didn't know that . . . /I was unsure about . . .

Now I know that . . .

4) Before I thought that . . . /I didn't know that . . . /I was unsure about . . .

Now I know that . . .