

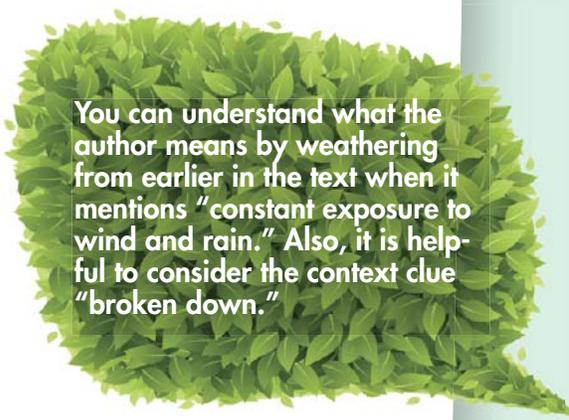
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Fertile soil means capable of producing vegetation or crops.



The prefix 'in-' means 'not.' Inorganic means not living.



You can understand what the author means by weathering from earlier in the text when it mentions "constant exposure to wind and rain." Also, it is helpful to consider the context clue "broken down."

Properties

We don't usually think about soil, but it plays a big part in our lives. When we call it 'dirt,' we are usually referring to something we wash off our hands. In reality, soil is essential to our survival. Our planet is mostly made of rock with an iron-nickel core. Plants and animals, including us, occupy a thin layer on its surface. Our existence is possible because of the thin layer of soil between the planet's rocky interior and us. Topsoil is the upper, outermost layer of soil.

The weathering of rock slowly produces soil. Constant exposure to wind and rain cause the rocky crust to break down slowly into smaller particles. It can take centuries to produce **fertile** topsoil. As rainwater seeps into cracks, temperature extremes cause the water to freeze and thaw. The rock expands, contracts, and fractures. Organisms that live on and in the soil help along the weathering actions by breaking down the crust, too. Soils are composed of organic material, or material of living and dead organisms, plus material from rock and **inorganic** material. Both are important to help plants grow. Some scientists believe that without life, soils are just dirt. Topsoil usually has the highest concentration of organic material and microorganisms, which makes it perfect for farmers' crops.

As organic material is broken down by **weathering** and soil organisms, particles of various sizes are produced. Soil texture is how to describe the small particles that make up the soil.

es of Soil

Soil scientists study soil formation, classification, and mapping.

Agronomists study the science and technology of producing plants for human use, like food and fuel. These are just two of many careers involving soil.

Scientists classify soil particles into three categories.

The smallest particles, which measure less than 0.002 millimeters, are called clay. Clay is important in holding nutrients. The next largest particles are called silt. Silt particles range in size from 0.002 millimeters to 0.06 millimeters. Sand refers to the largest particles. Sand grains range in size 0.06 millimeters to 2 millimeters. Soils vary in the amount of clay, silt, and sand they contain. In one area of the country, some soil contains a lot of clay and very little sand. In other areas, the soil contains plenty of silt and sand but very little clay. What is the soil like at your school?

The soil's ability to accept and **retain** water is largely determined by the amounts of clay, silt, and sand present. Porosity is the amount of space in the soil that can hold either air or water. Soils with the most desirable properties for farming are called loams. Loamy soils typically contain 50 percent air space, which allows roots to obtain oxygen properly. The solid half of loamy soils is about 90 percent minerals and 10 percent organic material. Usually, loamy soils have more names that accurately reflect their composition, such a clay loam or silt loam.

Using context clues, a reader can determine that retain means "to hold." Water is very important in order to have healthy plants. Different plants and crops require different amounts of water.

Pop Quiz!

- Which of the following is not a category scientists use to classify soil particles:
 - Clay
 - Silt
 - Sand
 - Humus
- Loamy soils have about _____ percent of air space and organic material combined.
 - 50
 - 10
 - 60
 - 70
- It can be devastating to an area if the top soil is depleted or washed away. Considering what you just read, why is it important to take care of the soil an area has?





SOIL LOGIC PUZZLE



CLUES

1. When pouring water on her sample, Haley's soil held very limited moisture and the water moved rapidly through the soil.
2. Tiffany's soil was fun to mold into a long ribbon; the soil retained lots of water and had small pores, so it held together well.
3. Rick's soil looked like it would hold water moderately well, and he decided that his soil was the type the class should use in their garden. It has mostly small pores.

Students in Mrs. Nitrogen's class learned the importance of soil, soil testing, and fertilizer. After carefully planning the school garden, each student was assigned soils to examine. To find out who has which soil, use the clues and soil descriptions below to fill in the chart. When you find a match, write **YES** in the appropriate box. If it does not match, place an **X** in the box.

Student	Clay	Silt	Sand
Haley			
Tiffany			
Rick			

Soil Properties:

Property	Clay	Silt	Sand
Porosity*	Mostly small pores	Mostly small pores	Mostly large pores
Permeability**	Slow	Slow to moderate	Rapid
Water-holding capacity	Large	Moderate	Limited

***Porosity** is a measure of how much of soil is open space.

****Permeability** is a measure of the ease with which a fluid, like water, can move through the soil.



Fun Soil Facts



One tablespoon of soil has more organisms in it than there are people on earth.



Just one acre of cropland is home to more than 1.4 million earthworms.



It takes anywhere between 200 to 500 years to make one inch of topsoil.



Scientists have found more than 75,000 different types of soil in the United States alone!

Secret Word Scramble

How do soils help plants grow?

1. Soil provides support for plants' _____ (**ootr**) systems.
2. Soils also provide _____ (**snitnuret**) for the plants to be healthy.
3. Soils hold _____ (**trwae**) that is used by plants.
4. Farmers grow _____ (**spcor**).
5. _____ (**utgslihn**) helps with photosynthesis.

1. _____

2

2. _____

3

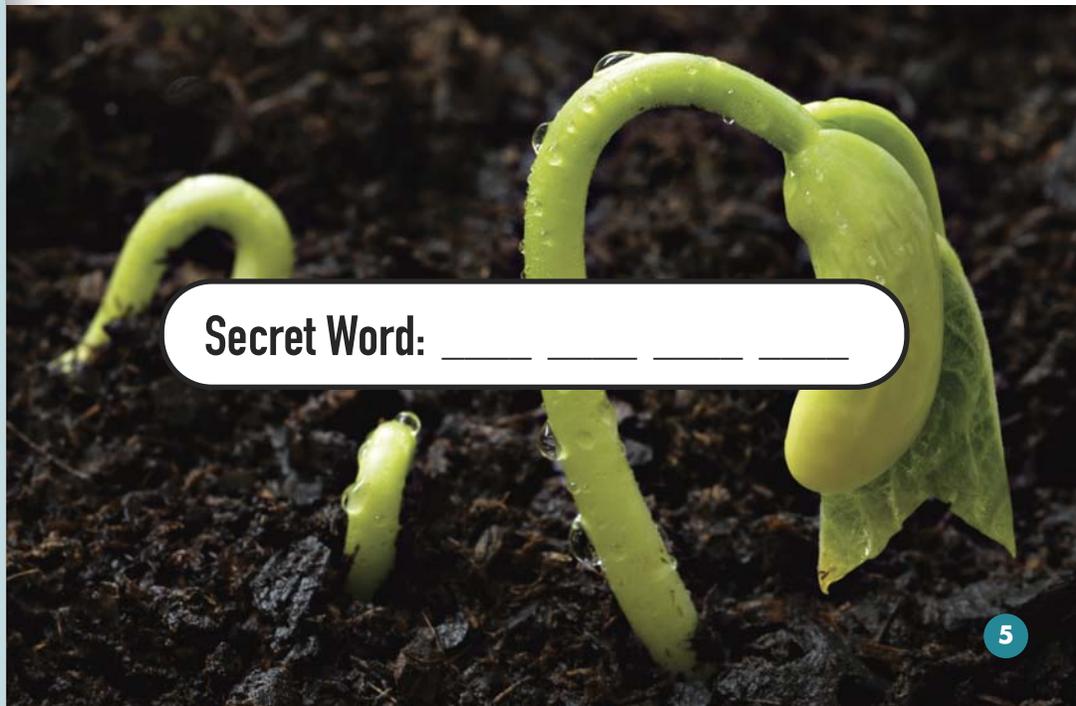
3. _____

4. _____

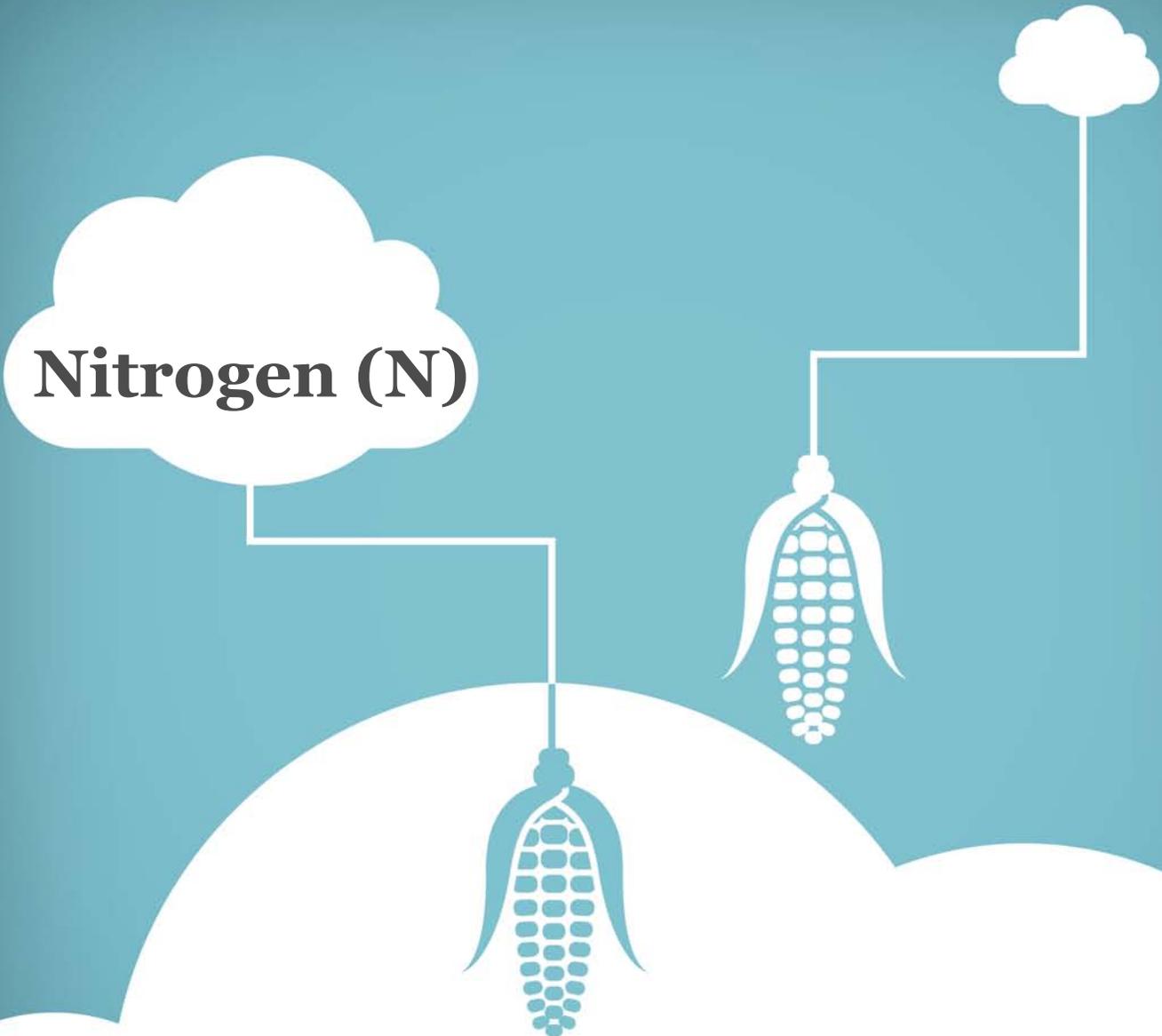
1

5. _____

4



Secret Word: _____



Nitrogen (N)

Take a Deeeep Breath

About 78 percent of the air we breathe is made up of nitrogen which, among other things, is a vital nutrient for growing corn and other crops. The trouble is, corn plants can't "digest" nitrogen and use it directly from the air. Fertilizers help them out by converting nitrogen from the air into nitrogen for the ground. Farmers apply the fertilizer. Corn takes up the nutrients, grows tall and provides food for us all. So next time someone asks where nitrogen fertilizer comes from, have them take a deep breath . . . then say: **"Guess what?"**

Nutrients for Plants

People and plants are very different organisms. For example, people have blood, while plants have sap. People are **consumers**, while plants are **producers**. Despite their many differences, both people and plants are made up of cells. In order for cells to be healthy, they must contain certain nutrients. If a person is lacking a necessary vitamin, mineral, or essential element, then they have a **deficiency**. If a person lacks iron, he or she becomes anemic. If a person lacks calcium, his or her bones become brittle. Plants require 17 elements for healthy growth. Soil serves as a nutrient bank for plants; it contains most of the nutrients plants need. A nutrient **deficiency** results if not enough of a nutrient is available to keep the plant healthy. Interestingly, plants and humans require similar essential elements, like iron, calcium, phosphorus, potassium and more.

When a plant needs more of a nutrient, it shows specific symptoms related to the **deficiency**. For example, if a plant is deficient in nitrogen then the plant will often have large yellow sections on its leaves. A farmer concerned for the health of his or her crops must use scientific tools to prevent **deficiencies** and, if necessary, to examine these symptoms and diagnose problems, much like a doctor does when they have a human patient with a **deficiency**. Soil and plant tissue tests are used to detect nutrient **imbalances**. Once the problem has been identified, steps are taken to correct the **imbalance**. Plants get their essential elements from air, water, and soil. Farmers prescribe fertilizers for their soil and crops, similar to doctors prescribing vitamins for their patients.

The three main nutrients plants need to be healthy are nitrogen, phosphorus, and potassium. These nutrients are needed in the highest quantity in most plants.

In your own words: Explain why nutrients are essential for humans. How is this similar to plants' need for nutrients?



Words to Know

Consumer:

An organism that generally gets food by feeding on other organisms or organic matter.

Deficiency:

A lack or defect.

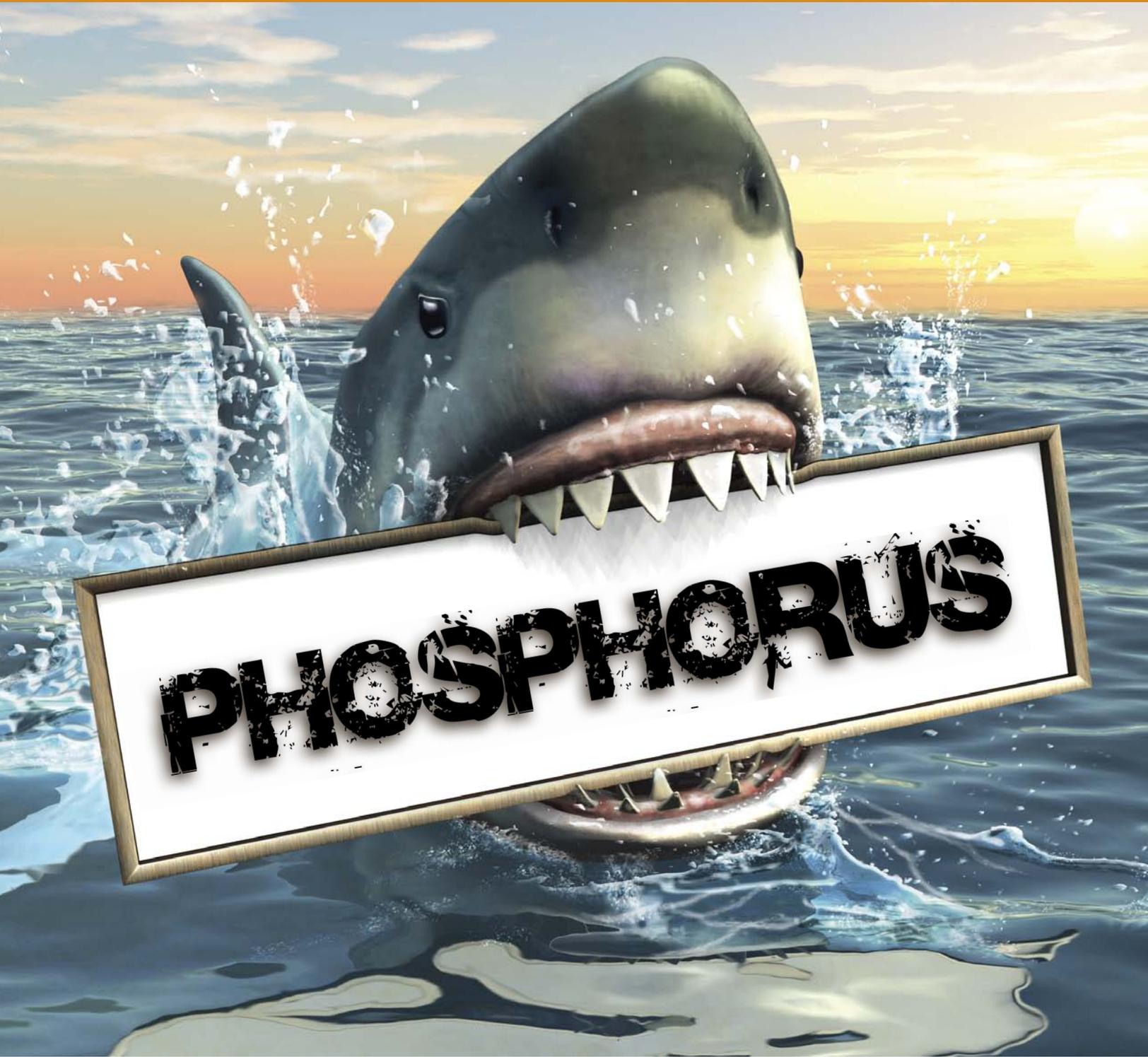
Imbalance:

Lack of equality or balance.

Producer:

In science, organisms capable of producing their own food, such as through photosynthesis.

Phosphorus (P) helps plants catch the sun's energy.



It's the ultimate form of recycling: much of the world's fertilizers come from remnants of ancient sea life. Phosphate, for example, is mined from ore deposits that are rich in fossilized sea remains, like this shark's tooth. Phosphate is mined from the ground and converted into a form that plants, including apple trees, can use. Phosphorus is essential to plants because it is the backbone of DNA, the genetic blueprint contained in every living cell. Who would have thought that apples, which are high in phosphate, have a connection to sea creatures from more than 20 million years ago?



Meet David Still

Environmental Supervisor and Agriculture Engineer, PotashCorp

Growing up, David Still was always fascinated with water. From water sports to drinking water, David grew to understand how important clean water is to everything around us. “Water is key. Without clean water, humans, plants, and animals are in trouble.”

Today, David works with both water and agriculture as the manager of a certified laboratory at a phosphate mine. “At different locations, the company I work for produces the three main elements of fertilizer: nitrogen, phosphorus, and potassium.” These are the three nutrients in soil that are necessary for plants to be healthy. When crops are planted in the same spot every year, it can eventually deplete those three essential nutrients. Fertilizer is one way of putting those nutrients back in the soil. David added, “Without the fertilizer that my company produces, farmers would not be able to produce enough food to feed the world.”





Phosphate fertilizers come from one of our nation’s largest natural resources. David’s job is to make sure that any materials or chemicals from the mining operation do not affect the quality of the surrounding water or air. David shared, “we have rules from the government that the mining operation follows.” These are important rules, called permits, which help companies take care of the environment while creating their important product: fertilizer. David said, “The way we make sure we are taking care of the water and air is by testing it for any unwanted chemicals. When water leaves the mining



operation, we sample it and run an analysis to make sure that the water flowing to another body of water, like lakes, streams, or rivers, is below the chemical limits stated on the permits.”

On an average day, David gets to enjoy the outdoors by taking water samples and scheduling air quality samples for the facility. He also educates other employees about safety procedures, like wearing the proper equipment or what to do in an emergency. Once the mining of phosphate is finished in an area, the company restores and

reclaims the land back to its beautiful and high-quality ecosystems. “This morning, while I was working near some reclaimed land, I saw three turkeys and some deer. I like not being in an office all day.”

David advised, “It’s important to have an environmental science or agriculture background if you are considering becoming an agriculture engineer. Because of what it takes to grow plants and take care of the environment, biology, math, and chemistry are really great classes to take in high school.” His advice to students considering a career in agriculture engineering is, “don’t be afraid of math and science! It is so important, and you can do it if you set your mind to it.”

Q: What part of David’s job would you enjoy?

Want to learn more about phosphate mining? Watch the video at www.nutrientsforlife.org/for-teachers



Testing 1-2-3!

Soil Testing Your Yard



Imagine the flower garden at your school has not been blooming this school year. A few years ago, colorful flowers added beauty to your school. Now, the plants are barely blooming and have not not grown very much this season. The answer is probably in the soil. Gardeners and farmers often test their soil to see which nutrients are absent. A quality soil sample is so important for plants to grow well in gardens and lawns. Whether on a large farm or a backyard garden, these tests can give a gardener or farmer important information about the land, help keep plants healthy, and harvests bountiful. Soil tests provide information on a spectrum of nutrients in your soil, from Aluminum to Zinc. The tests also tell you other important details about your soil, like the amount of organic matter and the soil's acidity. Why are these tests so important? Master Gardner's Professor-in-Charge at Iowa State University, Cindy Haynes states, "It is important to do a soil test before starting a garden, because it tells you what you need, and just as important: what you don't need. Taking soil samples are always recommended."

FUN FACT

Nitrogen is also found in the air!
Trouble is: plants cannot use the nitrogen straight from the air.
Farmers apply fertilizer with nitrogen to help with this.

Many plants are capable of growing in different areas of the country; however, they thrive in areas where their basic growth requirements are met. Soil and climate weather are the two basic requirements to a plant's success. Although we cannot control the weather, we can improve our soil. A plant will show signs of stress when they are deficient in nutrients. Some plants will have yellow leaves, or produce few blooms and fruit. It is a good idea to have soil tests done before starting a new garden, but it is also a great way to get answers to existing problems. The results not only let you know what nutrients are missing from the soil, but give advice on what you should do to fix any issues. Sometimes the report will advise a certain type of fertilizer to best fits the needs of the garden and lawn.



Let's Get Digital

Do you know what the soil at your school is called? Is it "Bluepoint Loamy Fine Sand?" Or maybe "Ernest Silt Loam?" Go to <http://websoilsurvey.sc.egov.usda.gov> to find out. Follow the "Four Basic Steps" instructions to help you get started!



Smaller gardens only require a sample of soil from one area. Larger gardens or lawn should have multiple samples from different points of the area. Depending on the size of the area, use a shovel to dig a 6" deep hole. If taking multiple samples, put each sample into a paper sack and mix with the previous samples from that area. It is a good idea to perform a soil test on a yearly basis. Next, send the sample to a testing lab. Many local universities, state commissions, local extension agronomist, farmers' co-ops, and possibly a local feed store can provide a helpful analysis.

At first glance, the results from a soil test can look overwhelming. Luckily, most soil test results arrive with specific recommendations and general directions for which fertilizer to apply to bring the soil to optimal standards.

Oftentimes, to fix or "amend" the soil, the lab will recommend adding fertilizer to the soil. Iowa State University Regional Field Agronomist Mark Carlton adds, "No fertilizer decision should be made without a good current soil test." The results from the soil test allow farmers and gardeners to make these decisions easily and accurately.

How to Take a Soil Test



Use a shovel to dig a 6" deep hole.



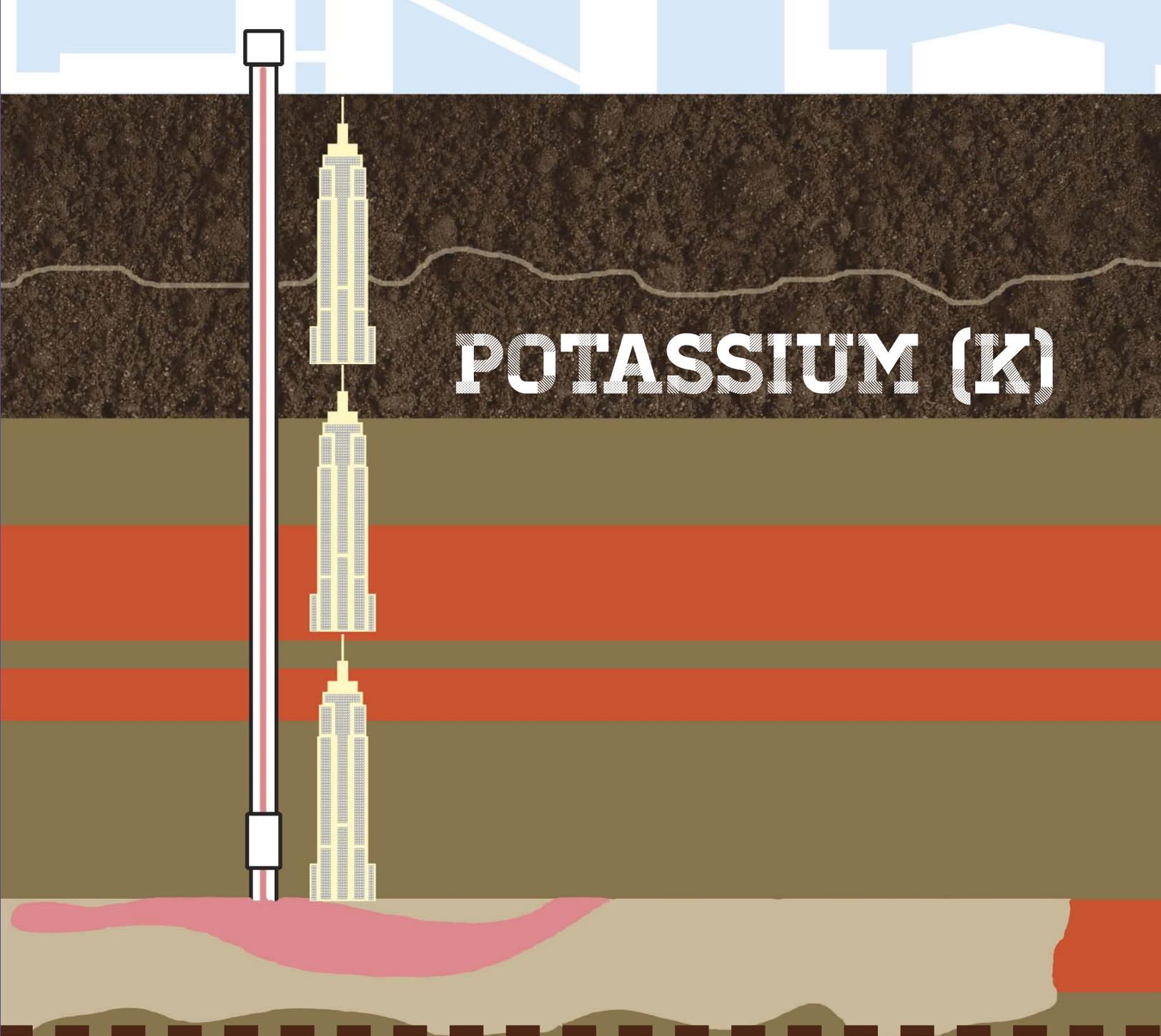
Send the soil sample to your local cooperative extension agent. Every state has one!



Your soil analysis will tell you which nutrients are high or low in your soil. It will also have solutions to any issues that the agent detects.



Following the extension agent's recommendations will bring your garden or lawn back to life!

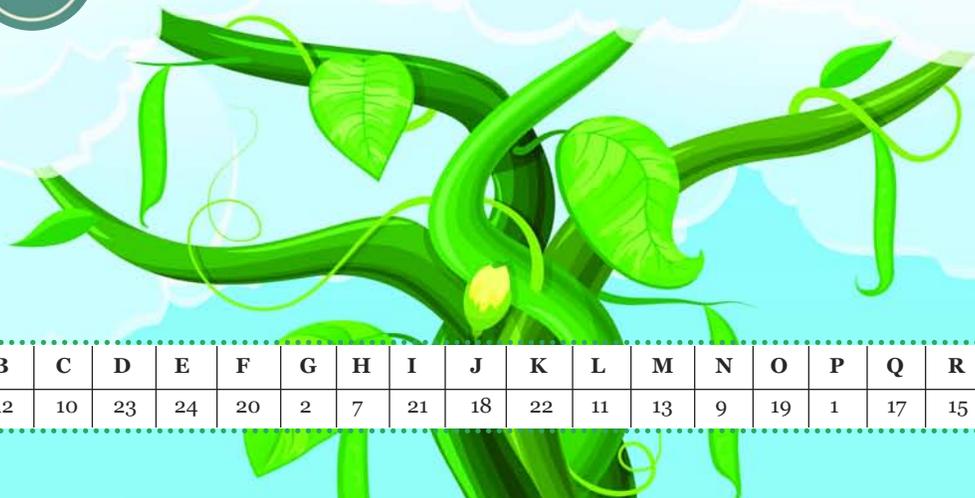


POTASSIUM (K)



When soil is lacking Potassium, plants simply can't grow as they should. Luckily, science has taught us how to reintroduce these important elements to the soil. Replacing nutrients in the soil is really important because by 2050 the world's population will likely reach 9.6 billion people. That's why farmers turn to fertilizers.

Reserves of potassium were deposited in prehistoric inland oceans. When they evaporated, the potassium salts crystallized into beds of potash ore. Most potash mines today are deep shaft mines as much as 4,400 feet underground. That's roughly the height of three Empire State Buildings stacked one atop the other!



A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
16	12	10	23	24	20	2	7	21	18	22	11	13	9	19	1	17	15	5	3	27	8	6	28	14	4

Potassium – Funny Word, Fun Game

Potassium is important to humans and plants. In humans, potassium is important for healthy circulation, which is why we are often encouraged to eat potassium-rich foods. What are some potassium rich foods? Solve this cryptogram to find out!

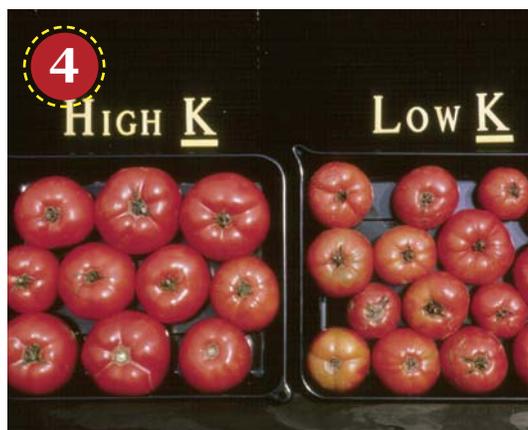
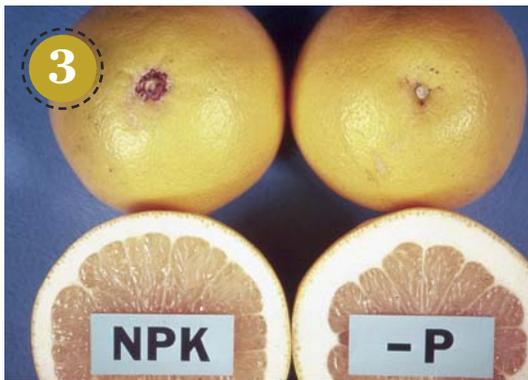
6 7 21 3 24 12 24 16 9 5

5 1 21 9 16 10 7

12 16 22 24 23 1 19 3 16 3 19 24 5

12 16 9 16 9 16 5

20 21 5 7



What's Missing in Each Photo?

What happens if crops don't get the correct balance of needed nutrients at the right time? Various negative effects can include poor growth, yield losses, inferior quality harvests, and diminished storage and shelf life.

Components of crop products that may suffer include contents of protein, carbohydrates, vitamins and other nutritive factors.

1 What nutrient is deficient in the corn and cornstalk at left? Potassium is a key nutrient for corn and other crops where a strong root system is important. The consequence of low potassium fertility is shown at right above.

2 What nutrient is deficient in the ear of corn above? The ear of corn at left is deficient in phosphorus, which is essential during early growth. Deficiency interferes with pollination, grain fill and maturity.

3 What nutrient is deficient in the grapefruit? The lack of phosphorus resulted in a thicker rind. Poor phosphorus nutrition can cause pale color and spongy citrus fruit.

4 What nutrient is deficient in the tomatoes? Tomatoes on the right suffered from low potassium fertility. In some vegetables, potassium fertilization can increase the vitamin C content.

Energy

Oxygen is released

PHOTOSYNTHESIS

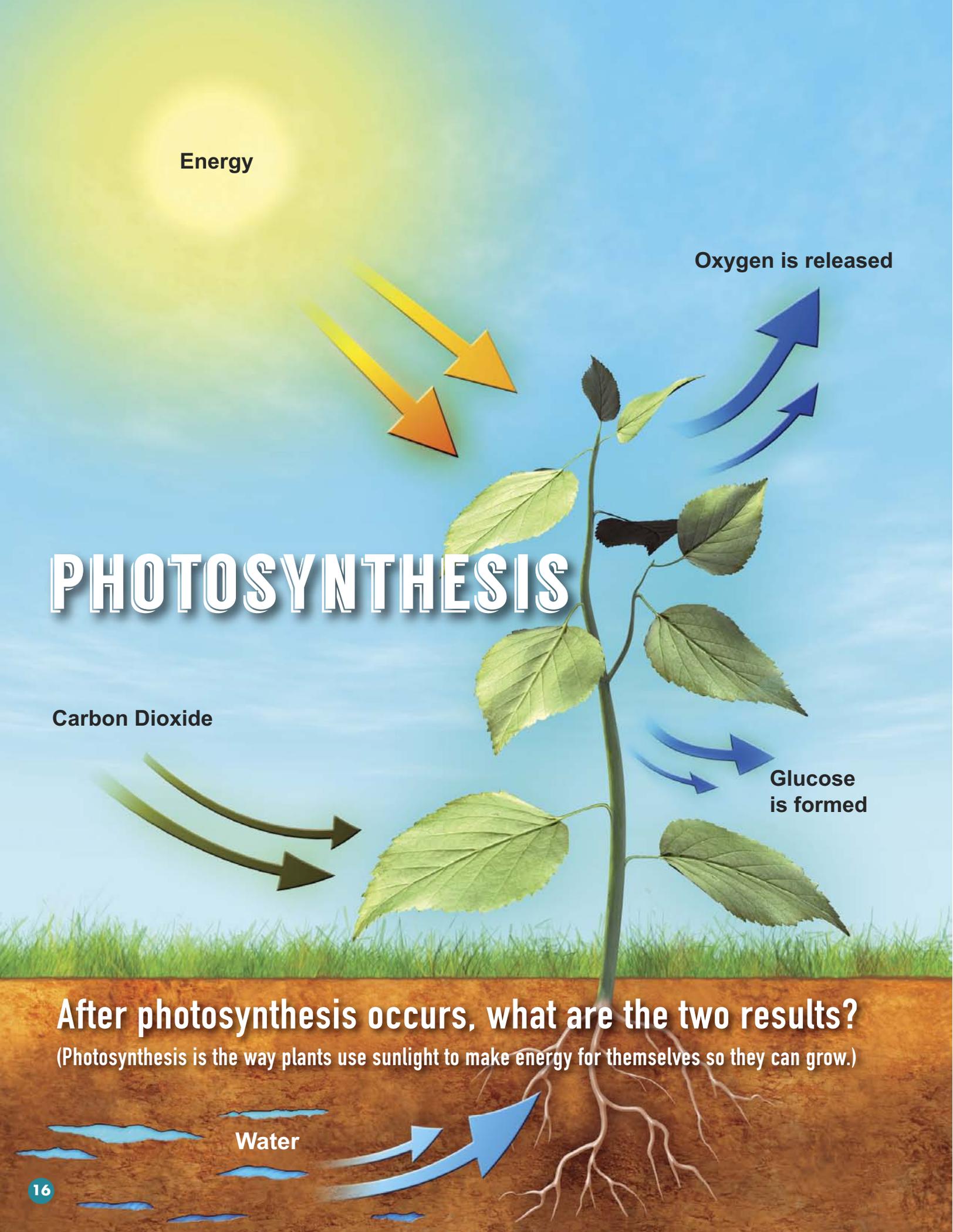
Carbon Dioxide

Glucose is formed

After photosynthesis occurs, what are the two results?

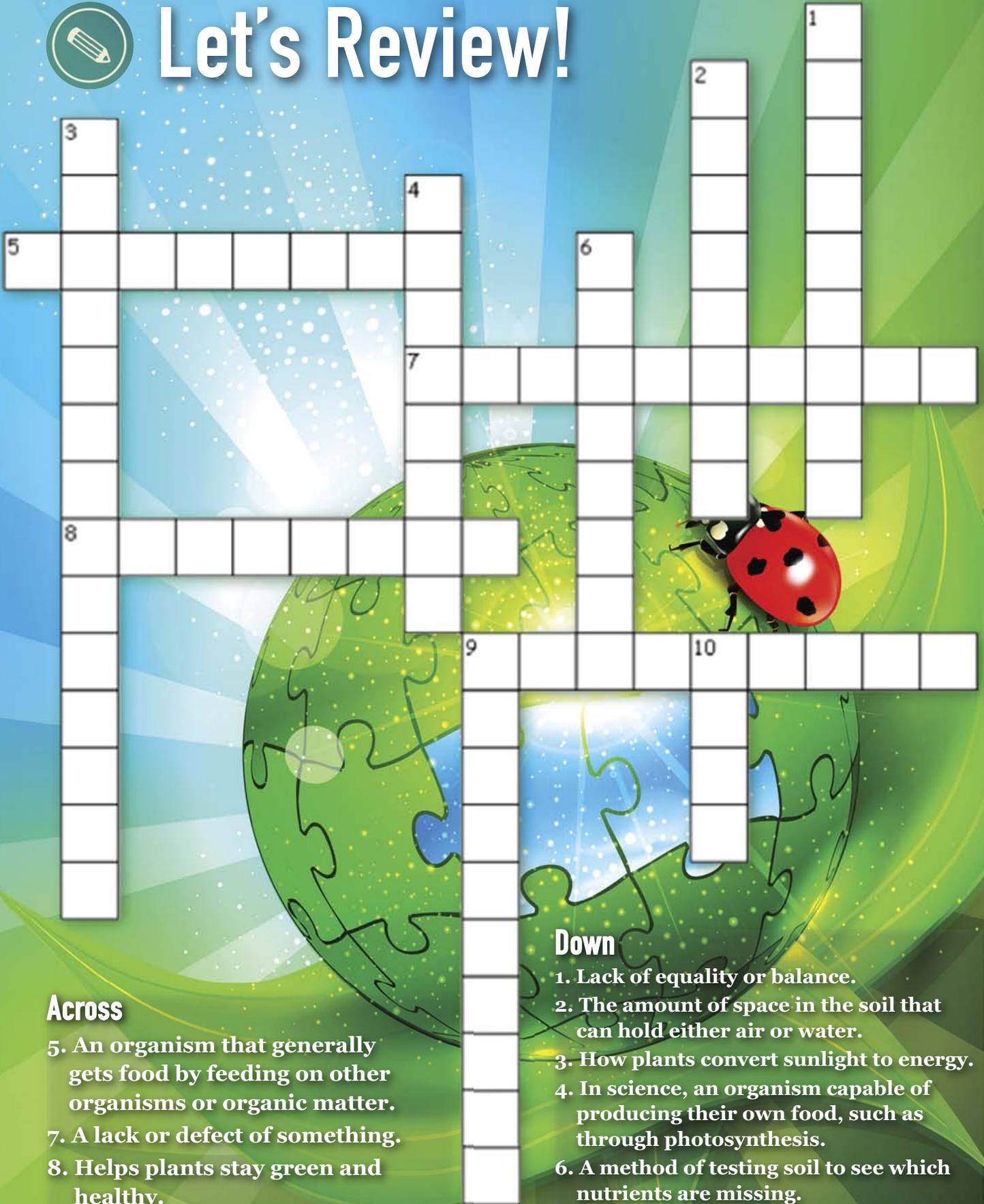
(Photosynthesis is the way plants use sunlight to make energy for themselves so they can grow.)

Water





Let's Review!



Across

- 5. An organism that generally gets food by feeding on other organisms or organic matter.
- 7. A lack or defect of something.
- 8. Helps plants stay green and healthy.
- 9. Helps protect plants from diseases, plus cold and dry weather.

Down

- 1. Lack of equality or balance.
- 2. The amount of space in the soil that can hold either air or water.
- 3. How plants convert sunlight to energy.
- 4. In science, an organism capable of producing their own food, such as through photosynthesis.
- 6. A method of testing soil to see which nutrients are missing.
- 9. A nutrient that helps plants absorb the sun's energy.
- 10. The largest soil particles category.



Test Your Brain



We give you the answers.
You give us the questions.

Earn points for each question you answer correctly; all answers can be found in this issue of SOIL. Some answers may be used more than once.

How many points can you earn?

Points	Nutrients for Plants	Soil Test	Properties of Soil
50-60 points	<i>Clue:</i> The result from a calcium deficiency in humans. <u>Answer:</u> What is _____ ?	<i>Clue:</i> Provides information and analysis about a soil sample. <u>Answer:</u> What is _____ ?	<i>Clue:</i> The upper, thin layer of soil. <u>Answer:</u> What is _____ ?
40-50 points	<i>Clue:</i> A nutrient bank for plants; it contains most of the essential plant nutrients. <u>Answer:</u> What is _____ ?	<i>Clue:</i> The depth of a hole when gathering a soil sample. <u>Answer:</u> What is _____ ?	<i>Clue:</i> Constant exposure to wind and rain which causes rock to break down. <u>Answer:</u> How is _____ made?
30-40 points	<i>Clue:</i> Occurs when not enough of a nutrient is available to keep a plant healthy. <u>Answer:</u> What is _____ ?	<i>Clue:</i> Your county's extension agent, farmers' co-ops, and possible a local feed store. <u>Answer:</u> What are places that _____ ?	<i>Clue:</i> Composed of organic material, materials from rock and inorganic material. <u>Answer:</u> What is _____ ?
20-30 points	<i>Clue:</i> A plant that is nutrient deficient and has large yellow sections on its leaves. <u>Answer:</u> What is _____ ?	<i>Clue:</i> Contains general directions for amending the soil and specific instructions for the soil sample. <u>Answer:</u> What is _____ ?	<i>Clue:</i> Small soil particles that measure less than 0.002 millimeters. <u>Answer:</u> What is _____ ?
10-20 points	<i>Clue:</i> The three main nutrients for plants. <u>Answer:</u> What are _____, _____, and _____ ?	<i>Clue:</i> To "fix" the soil <u>Answer:</u> What is _____ ?	<i>Clue:</i> The amount of space in the soil that can hold either water or air. <u>Answer:</u> What is _____ ?



**For more soil science and
crop nutrient resources:**



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