



Spread It.
Grow It.
Know It.

This breakout is made possible with the support and content contributions of the Nutrients for Life Foundation and the Kansas Corn Commission.



Spread It. Grow It. Know It.

Grade Level: Middle School

Overview

There are many things that impact growing healthy plants, like corn. Essential elements are vital to sustaining life on our planet. Plants require 17 essential elements. These essential elements can be found in air, water, and soil. Soil is continuously being formed by geological and biological processes. The organisms that live in the soil create a unique ecosystem in which its inhabitants depend upon and interact with one another. Missing essential elements and poor soil can both cause plant health to be affected.

Objectives

- Students will understand elements essential for plant growth.
- Students will assess different nutrient deficiencies in corn plants.
- Students will explore different soil types.

Next Generation Science Standards (NGSS)

Middle School Science

- **MS-PS1-1.** Develop models to describe the atomic composition of simple molecules and extended structures.
- **MS-LS1-6.** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
- **MS-LS2-4.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Breakout Edu Tips

If this is your first time using a Breakout Edu box, you are in for a treat. Once you've done one breakout box, your students will be ready for the next time.

- You can use breakout boxes as a whole class in addition to small groups.
- You can give students hints. Every box comes with at least two hint cards. If you have a higher performing group, you may want to challenge them with fewer hints while a different hour may need more.
- Having a visual timer for students while they are working is helpful. It allows them to budget their time and decide when they may want to use their hints.
- As the teacher, you have the discretion to hide things wherever they best fit in your room. Feel free to make adjustments. Just make sure the clues for the locks don't change. Otherwise, students may not be able to get in.
- Do note, when programming the locks, there is a starter ring that has mini teeth. This ring needs to come first.

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Background

We are fortunate to live in a society with abundant food, but the challenge for the future is simple. We must feed a population that grows by 80 million people each year, using the same amount of farmland and depleting natural resources. Clearly, the farming practices of the past are not going to be able to sustain us in the future. Our response to this challenge involves making difficult decisions about land use, fertilizers, pesticides, and genetic engineering, among others. As a society, we will have to decide how agriculture can economically feed our growing population, while at the same time help us protect our environment.

Plants and Their Essential Elements

All organisms must take in matter from their environment in order to survive. There are 92 naturally occurring elements on Earth. Only a minor number of them are needed by living things.

Plants must carry out thousands of different chemical reactions, many of which are like those of humans. Scientists have identified 17 elements that are described as essential elements. An element is defined as being important to the plant if the following conditions are met.

- The element must be required by the plant to complete its life cycle.
- The element cannot be replaced by another element.
- The element must be required for a specific biological function.
- The element must be required by a substantial number of different plant species.

Nutrient Deficiencies of Plants

Plants require a variety of elements to be present in different amounts in order to support healthy growth. A nutrient deficiency results from a nutrient not being available in a sufficient quantity to meet the needs of the growing plant. Nutrient toxicity occurs when a nutrient is present in such an excess that it harms the plant. When a plant is out of nutrient balance, it displays symptoms that are characteristic for that nutrient. 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. Soil and plant tissue tests are used to detect nutrient imbalances. Once the problem has been identified, steps are taken to correct the imbalance. Farmers prescribe fertilizers for their crops based on nutrient needs determined by soil testing.

Free Educational Resources

Science and proper soil nutrition will be critical to helping with not only feeding our world but doing so sustainably. This background information serves as a basic understanding of this complex subject. Free Nourishing the Planet in the 21st Century high school curriculum is available for teachers to use. Teaching the curriculum prior to teaching the breakout box will provide the background information needed for the students to be successful at the lesson. To view other free educational resources, visit www.nutrientsforlife.org and www.kansascornstem.com.

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Materials

- Diffusion Question Card
- Diffusion Comic
- Number 15 and Decoy Cards
- Nutrient Deficiency Strips
- Plant Essential Nutrient Periodic Table
- Human Essential Nutrient Periodic Table
- Periodic Table of Elements
- Most Common Essential Elements Hint Card
- Nutrient Deficiency Cards
- Soil Strips and Soil Characteristic Cards
- Certificate (Optional)

Breakout Activity

Game Name

Spread It. Grow It. Know It.

Game Designer

Kansas Corn Commission, Nutrients for Life Foundation, and Jessica Sadler

Content Areas

STEM, Agriculture, Nutrients, Corn, Science

Recommended Ages

K-Adult

Ideal Group Size

Can be used in small groups or whole class

Suggested Time

30-40 minutes

Story

A nearby neighbor is traveling out of town for the next month. They have an incredible amount of plants, and even a greenhouse, they're nervous to leave unattended. They have asked you to take care of their plants and plan to pay you. Extra money is something you could really use right now to buy new earbuds and a video game. Yet, if you can't take care of their plants successfully, you'll have to pay them back for damaged plants. Solve the

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clues below to prove you have the knowledge to keep their plants healthy and make a few bucks!

Lock Combinations

The following codes will open the locks on the box.

3-Digit Lock - 3 numbers

1, 4, 6

4-Digit Lock - 4 numbers

4, 8, 9, 3

Color Lock- 5 colors

Red, Green, Blue, Yellow, Orange

5-Character Lock- 5 different symbols

↑, X, ↓, L, 1

Key Lock

Teacher's Choice

Setup Instructions

Steps

1. Students will need the soils strips and soil characteristics cards to solve the 4-digit lock on the main box. These pieces should be hidden in the small lock box with the key lock on it. Students will need to match the cards under the correct soil type. In the end, there will be three cards under each soil type. When the cards are ordered, students will put the numbers into the lock. The other shapes and color dots are there to add an additional challenge.
2. To solve the 5-character lock, students will need to use the diffusion comic. Before laying it out for students, you will need to cut off the top right corner that says, "use me last: 1." This piece can be hidden where you like. If you have students that need more of a challenge, you can make the piece more difficult to find. Students will also need the Diffusion Question card that says, "Water and nutrients move _____ through the _____ ylem. Sugars are moved _____ through the ph_____oem." Supplying the answers for these blanks and using the last piece of the comic will help them remove the 5-character lock on the main box.
3. Students will need to use the most common essential elements hint card and periodic table of elements to help solve the 3-digit lock that is on the main box. Students will need to add the atomic numbers for the five most common and abundant essential elements (carbon, hydrogen, sulfur, phosphorus, and oxygen). When they are finished adding these numbers, they will have an answer of 46. They will need to combine this answer with the bolded and squared "1" from the hint card.

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4. Students will need to use the four different corn nutrient deficiencies cards and nutrient deficiency strips to solve the color lock. There are also small information cards. They will need to match the definition to the correct picture. They will then enter the font color on the information card into the number space listed on the corn nutrient deficiency card. This will take off the color lock from the large main box.
5. To remove the key lock, students will need to compare the periodic table of essential nutrients for plants and the periodic table of essential nutrients for humans. Students will want to circle, highlight, or color all the elements essential for both plants and animals. When finished, they should have identified 15 essential nutrients. Somewhere in the room you should have the number 15 represented. You may use the provided card, write it on a board, build it out of materials, or hide the key in or near something that already has a 15 labeled on it. There are other number cards included if you would like to leave them out as a decoy.
6. It is also possible to include materials or information in the large black box to lead into other Nutrients for Life Foundation or Kansas Corn STEM lessons.

Additional Requirements

To access the full labs visit nutrientsforlife.org and kansascornstem.com.

Reflection and Conclusion

At the completion of this breakout, your students should have a better understanding of essential nutrients (including which are most common), diffusion, plant nutrient deficiencies, and soil types. Feel free to give students the following questions as an exit ticket or knowledge check at the end of the breakout. If you have groups that do not breakout, it is always nice to go over the information or clues that would have led to the last locks coming off.

Questions:

1. How many essential elements are shared among plants and humans? **Answer: 15**
2. What are the three categories of soil? **Answer: Clay, silt, and loam**
3. What part of the plant pulls up water and nutrients from the roots of the plant? **Xylem**
4. What is the name of the process causing nutrients to concentrate in root hairs? **Answer: Diffusion**

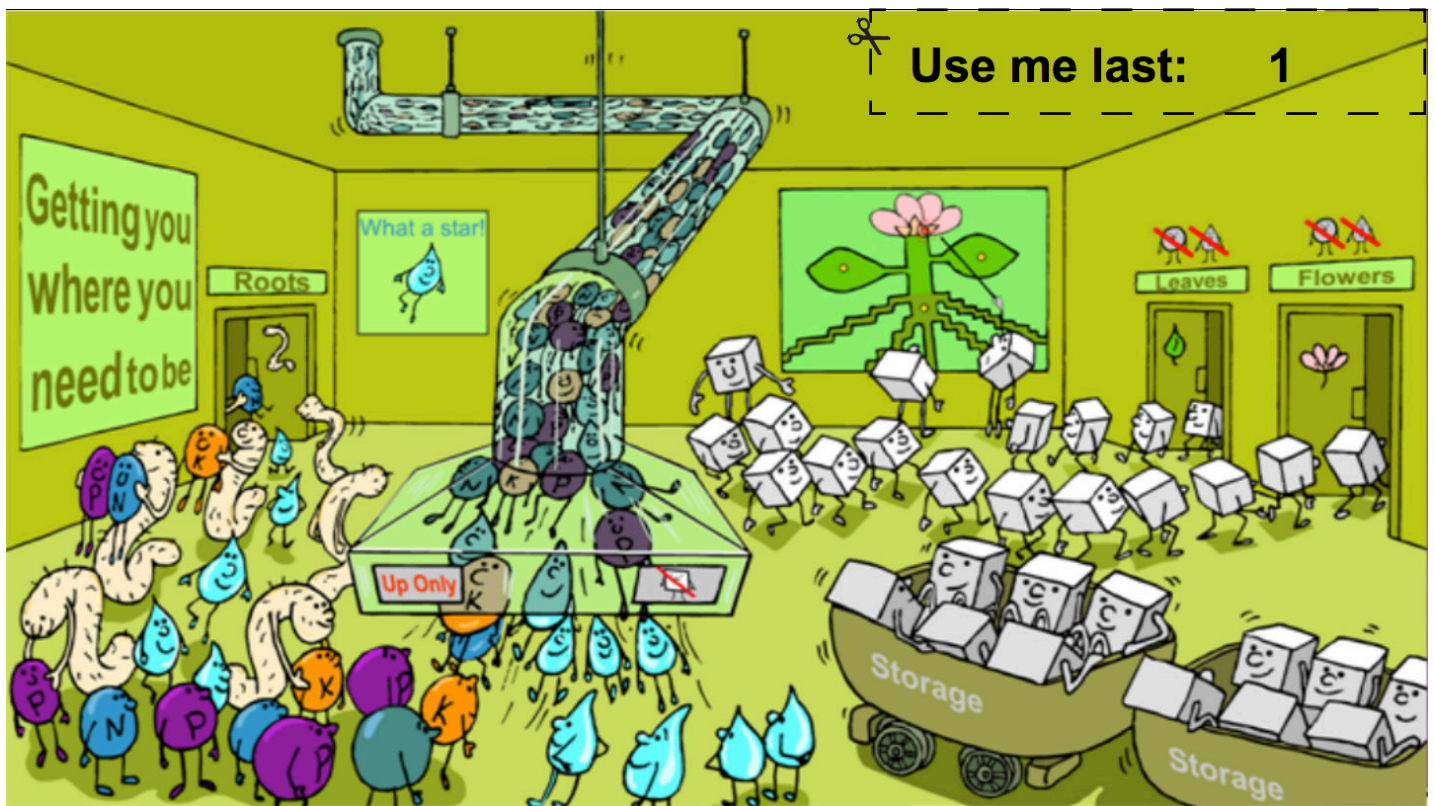
Any educator electing to perform demonstrations is expected to follow *NSTA Minimum Safety Practices and Regulations for Demonstrations, Experiments, and Workshops*, which are available at <http://static.nsta.org/pdfs/MinimumSafetyPracticesAndRegulations.pdf>, as well as all school policies and rules and all state and federal laws, regulations, codes and professional standards. Educators are under a duty of care to make laboratories and demonstrations in and out of the classroom as safe as possible. If in doubt, do not perform the demonstrations.

Your Task

A nearby neighbor is traveling out of town for the next month. They have an incredible amount of plants, and even a greenhouse, they're nervous to leave unattended. They have asked you to take care of their plants and plan to pay you. Extra money is something you could really use right now to buy new earbuds and a video game. Yet, if you can't take care of their plants successfully, you'll have to pay them back for damaged plants. Solve the clues below to prove you have the knowledge to keep their plants healthy and make a few bucks!

Water and nutrients move _____ through the xylem.

Sugars are moved _____ through the phloem.



Number 15 and Decoy Cards

15



7



11



30



10



24



3



118



Most Common Essential Elements Hint Card

Essential Elements are number **1** . Add the atomic numbers of the five most common to get the three digit lock undone!

The major symptom of this nutrient deficiency is a general yellowing of the plant. The yellowing begins at the top and gradually works its way down to the base of the leaf. Older leaves can show a V-Shape of yellowing on the inner parts of the leaves.



Plants lacking this essential nutrient show stunted growth and mature later than plants that are healthy. This can make plants more susceptible to frost, harvest damage, disease infection, and summer drought. Leaves often take on a darkened look and can seem purple.



Plants lacking this essential nutrient show stunted growth and mature later than plants that are healthy. Missing this essential nutrient can cause yellowing and drying of leaf edges, particularly on older leaves.



Plants lacking this essential nutrient show stunted growth and mature later than plants that are healthy. Missing this essential nutrient can cause cell death on leaves and may appear as dark spots.



Plants lacking this essential nutrient show pale- to whitish-colored bands located between the veins of the leaves. Plant growth can be stunted. This can be caused by soils that have a high pH making them more alkaline.



Essential Plant Nutrients

1 IA 1A																				18 VIII 8A									
1 H Hydrogen 1.008																		2 He Helium 4.003											
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180												
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948												
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798												
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55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018												
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Essential Human Nutrients

1 IA 1A										2 IIA 2A										13 IIIA 3A										14 IVA 4A										15 VA 5A										16 VIA 6A										17 VIIA 7A										18 VIIIA 8A									
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Periodic Table of the Elements

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LeBlanc

1 Nitrogen

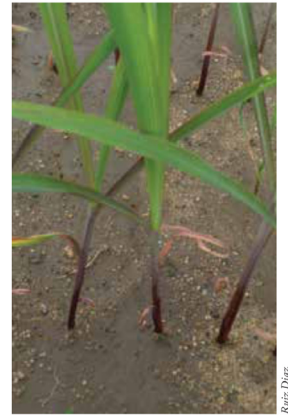


Ruiz Diaz



Ruiz Diaz

5 Phosphorus



Ruiz Diaz



Roeschboom

2 Potassium



Ruiz Diaz

3 Zinc



Roeschboom

4 Potassium



Sandy Soils

Silty Soils

Clay Soils

Loamy Soils

Soil Characteristic Cards

**Do not
hold water
well**



**Somewhat
hard to drain.
Keeps water
longer than
sand**



**Very water
tight and hard
to drain
9**



**Best
soil for
drainage**



**Low in
nutrients**

4



**Tend to
be
fertile**



**Tend to
be rich
in nutrients**



**Tend to
be rich in
nutrients**



**Warm
quickly in
heat**



**Warm slower
than sand but
faster than
clay
8**



**Warm
slowly
in
heat**



**Consist of
sand, silt
and clay
3**



Sandy Soils	Silty Soils	Clay Soils	Loamy Soils
<p>Do not hold water well</p>  	<p>Somewhat hard to drain. Keeps water longer than sand</p>  	<p>Very water tight and hard to drain</p> <p>9</p>  	<p>Best soil for drainage</p>  
<p>Low in nutrients</p> <p>4</p>  	<p>Tend to be fertile</p>  	<p>Tend to be rich in nutrients</p>  	<p>Tend to be rich in nutrients</p>  
<p>Warm quickly in heat</p>  	<p>Warm slower than sand but faster than clay</p> <p>8</p>  	<p>Warm slowly in heat</p>  	<p>Consist of sand, silt and clay</p> <p>3</p>  

Congratulations!



NUTRIENTS  **FOR LIFE**
FOUNDATION

KANSAS CORN  **STEM** 