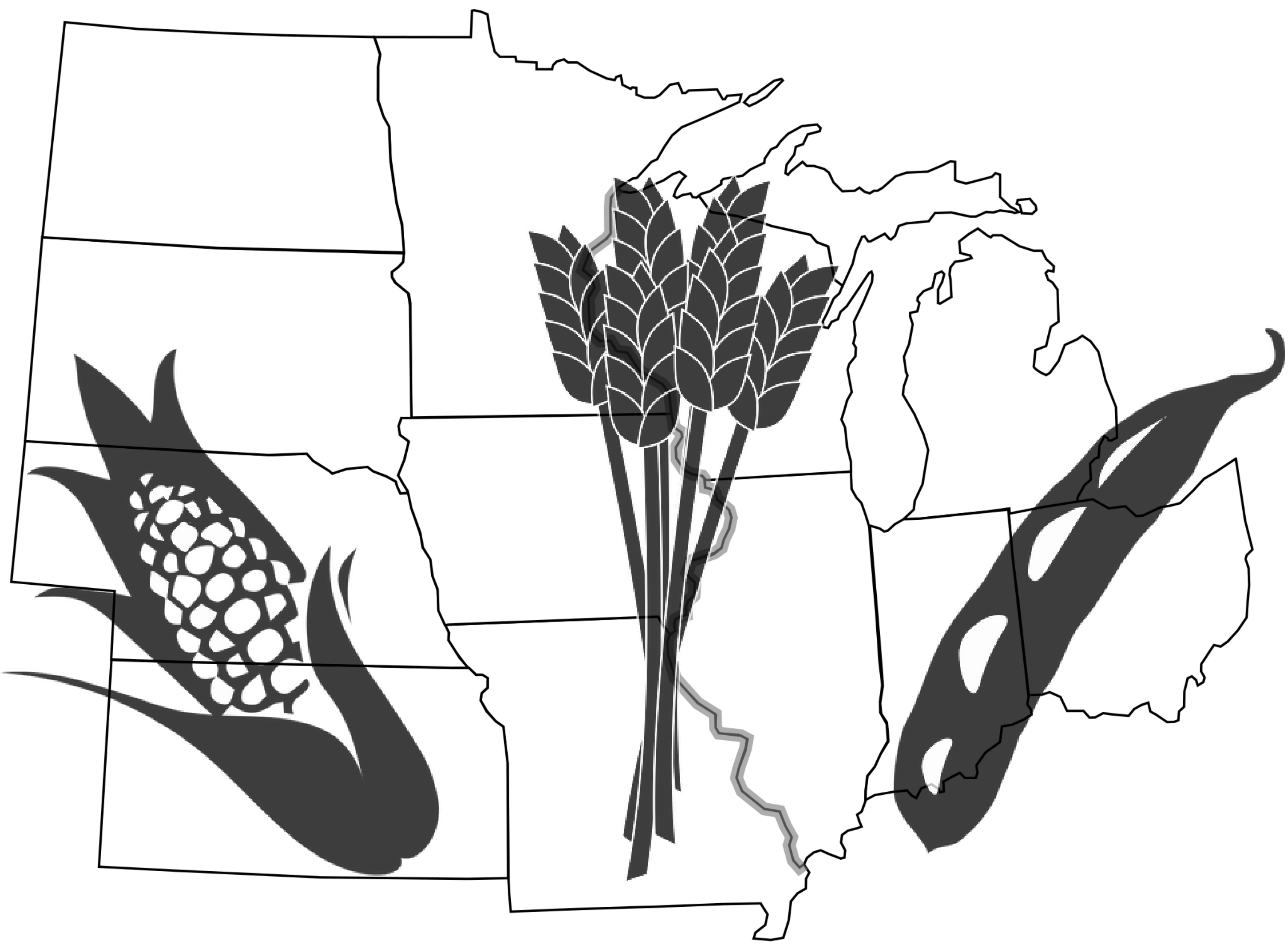
How the Midwest Shapes the World

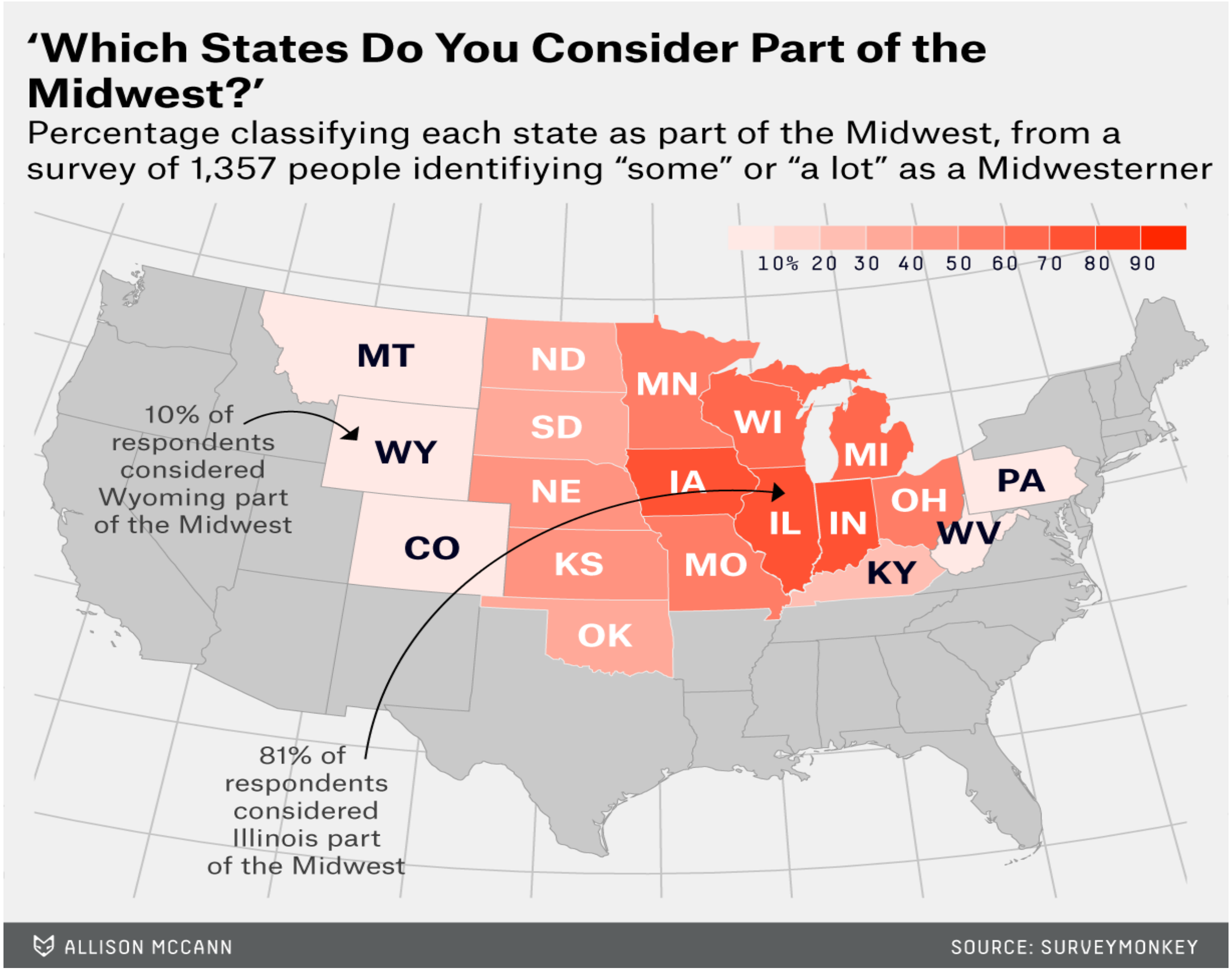


Illinois AGRICULTURE in the Classroom℠

Table of Contents

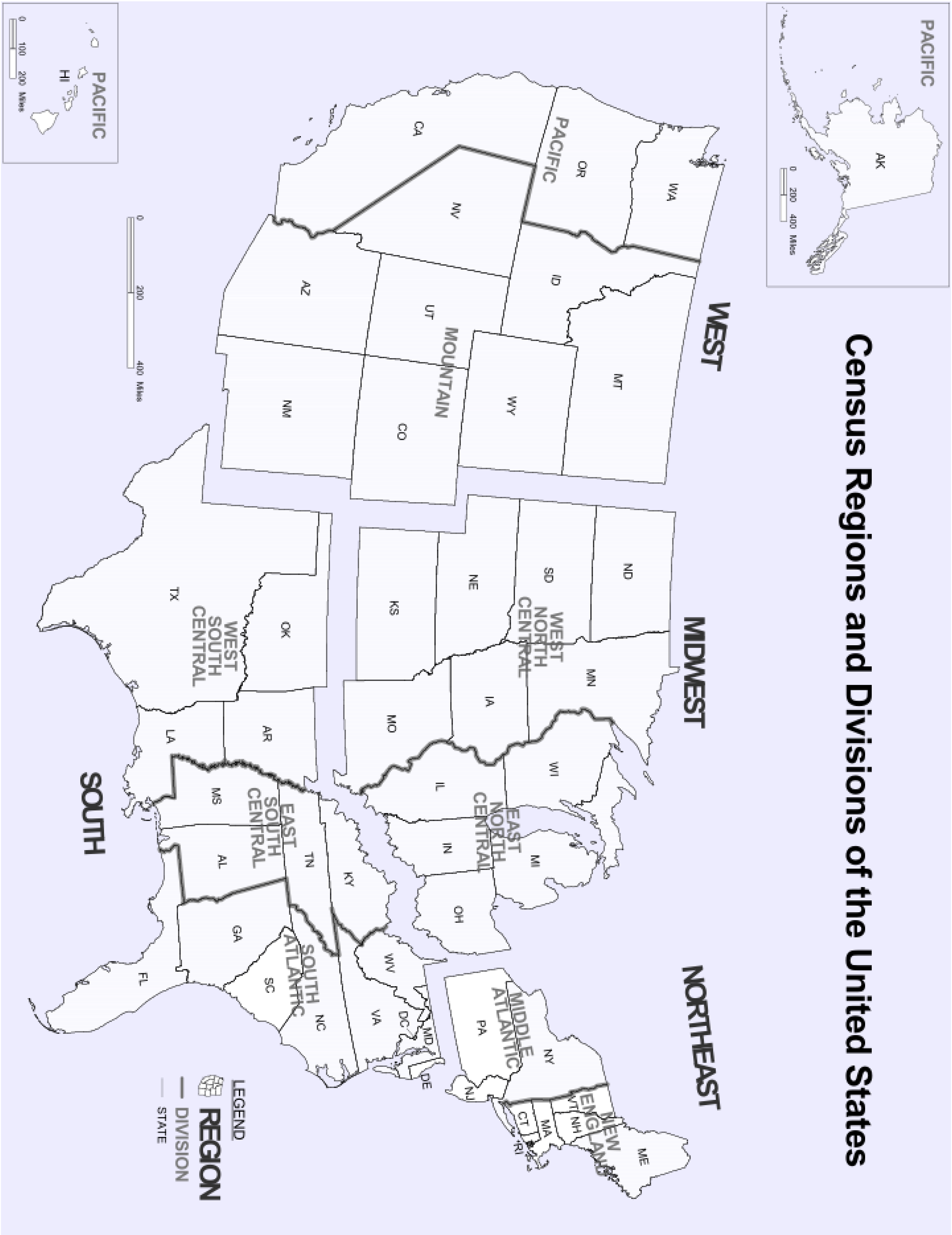
My home state is ___________________________? *Draw a star in your state.*

My state is in a region called ________________________? *Color this region on the map.*



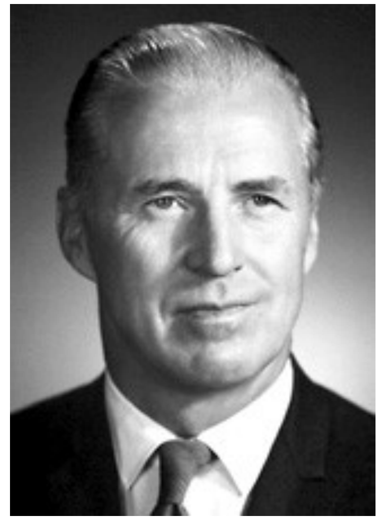
Fivethirtyeight.com

Source: US Census Bureau



Source: US Census Bureau

The Man Who Fed the World



Grade Levels: 4-6

Purpose: Students will learn evaluate important quotes from Norman Borlaug and learn about the importance of his work in plant pathology

Common Core State Standards: CCSS.ELA-Literacy.RI.4.3; RI.4.4; RI.4.5; RF.4.3a; SL.4.1; W.4.2; W.4.6; W.4.7; W.4.8

Next Generation Science Standards: Interdependent Relationships in Ecosystems: 3-LS4-4; Life Cycles & Traits: 3-LS3-2; Earth's Systems: 5-ESS3-1

Suggested Reading Materials:

IAITC's Wheat Ag Mag

The Man Who Fed the World by Leon Hesser ISBN: 1930754906

The Kid Who Changed the World by Andy Andrews ISBN: 1400324335

Materials Needed:

- Norman Borlaug quotes on the following page

Background:

1. Using the provided quotes, cut quotes into strips and distribute to students.
2. Students will read the quote and write a paragraph about the quote. Some/all of the following questions should be addressed:
   What does the quote mean to me?
   What does this quote tell me about Borlaug's work?
   What does this quote tell me about Borlaug's character?
   What questions does this quote raise?
   Is this quote still relevant?
3. Students can share their writing with the entire class.

Complementary Activities:

- Slice of Soil—Complete this demonstration using an apple to show how little soil we have to grow food and then discuss the importance of science in feeding the world.

Find this activity on our website under Interest Approaches: http://www.agintheclassroom.org/TeacherResources/InterestApproaches/slice%20of%20soil.pdf

The Man Who Fed the World (cont.)

Norman Borlaug Quotes

Food is the Moral right of all who are born into this world.

Almost certainly, however, the first essential component of social justice is adequate food for all mankind.

Civilization as it is know today could not have evolved, nor can it survive without adequate food supply.

Man seems to insist on ignoring the lessons available from history.

Man's survival, from the time of Adam and Eve until the invention of agriculture, must have been precarious because of his inability to ensure his food supply.

Without food, man can live at most but a few weeks; without it, all other components of social justice are meaningless.

The destiny of world civilization depends upon providing decent standard of living for all mankind.

Unless progress with agricultural yields remains very strong, the next century will experience sheer human misery that, on a numerical scale, will exceed the worst of everything that has come before.

Solving Today's Problems with Corn

https://www.youtube.com/watch?v=XMDnaQ6hFtU

360° Farm Tour: Harvesting the Corn | #360Corn

http://web.extension.illinois.edu/ethanol/

University of Illinois Extension

Ethanol

What Is It?

Ethanol Use in Motor Vehicles

Biofuels and the Consumer

Food and Fuel Issues

Water Use For Ethanol Production

The Future of Ethanol: Cellulosic

Ethanol: What Is It?

Ethanol is a grain alcohol that can be blended with gasoline and used in motor vehicles. Many gasoline stations provide a blended fuel, which typically is 10 percent ethanol and 90 percent gasoline. Vehicles do not need any modifications to use this blend of fuel. Flex fuel vehicles, which have modifications to the fuel systems, can use E85, which is a blend of up to 85 percent ethanol and 15 percent gasoline. With the modifications, these vehicles can use straight gasoline or any blend of ethanol up to 85 percent.

Where Does It Come From?

2008 U.S. Ethanol

The Disappearing Packing Peanut

Grade Levels: 3-5

Purpose: Students will learn about renewable and non-renewable resources.

Common Core State Standards: CCSS.ELA-Literacy.W.3.1; W.3.7

Next Generation Science Standards: Structures and Properties of Matter: 2-PS1-1; 2-PS1-3

Engineering Design: K-2.ETS1-1; K-2-ETS1-2

Suggested Reading Materials:

IAITC's Corn Terra Nova

IAITC's Corn Ag Mag

<u>11 Experiments That Failed</u> by Jenny Offill ISBN: 978-0375847622

Materials Needed:

- Cornstarch Packing Peanuts and Styrofoam Peanuts
- Clear Plastic Cups
- Water

Background:

Corn and other crops are renewable resources because we can regrow a new supply every season. Using renewable resources to produce everyday products, like packing peanuts, is an environmentally responsible practice. Additionally, cornstarch packing peanuts are biodegradable, unlike traditional Styrofoam packing peanuts and decompose in water, leaving no toxic waste.

The Scientific Method:

The Scientific Method is a system for investigating the unknown. It involves a series of six steps used to reach a clear conclusion. The six steps are:

Question - What is it you are trying to find out?

Research - Discover what you can about your topic by exploring what has already been discovered and by making initial observations.

Hypothesis - State what you expect to find.

Experiment - Develop a way to test if your hypothesis is true or not.

Analyze - Record new observations and collect new data.

Conclusion - Interpret your data and compare the results to your hypothesis.

Procedure

Observation/Research

- Place one small cup of each type of packing peanut into a larger cup.
- List the characteristic of each type of packing peanut in the boxes below. Describe each type of peanut in detail.
- List how you think these peanuts are different.
- In today's world, many are often very interested in products being biodegradable. In this experiment, we will want to determine which of these peanuts are made from a biodegradable product.

Hypothesis

- Form a TOPIC sentence and a HYPOTHESIS for this Packing Peanut Project

____

____

Packing Peanut A	Packing Peanut B

Experiment

- Get two cups of water with the same amount of water in each cup.
- Slowly pour the water into each cup of packing peanuts.
- For faster results, gently stir each of the cups with a spoon or the end of a pen.

Analyze

- What happened to each sample of packing peanuts? Record your new observations in the boxes below.

Conclusion

- At the conclusion of the experiment can you reject or accept your hypothesis?
- Pick up the Corn Ag Mag, and read page 3, CORN BASED PRODUCTS, FIELD CORN and add what you think the dissolved peanuts are made from to your Lab Notes.

Packing Peanut A	Packing Peanut B

Lick and Stick Sculptures

Grade Levels: K-4

Purpose: Students will visually represent what they learned about agriculture with a sculpture. Students will apply the concepts of biodegradable materials by producing a structure.

Next Generation Science Standards:

Structures and Properties of Matter: 2-PS1-1; 2-PS1-3

Engineering Design: K-2.ETS1-1; K-2-ETS1-2

Suggested Reading Materials:

IAITC's Corn Terra Nova

IAITC's Corn Ag Mag

Materials Needed:

- Cornstarch Packing Peanuts
- Clear Plastic Cups (optional)
- Water (optional)

Background:

Corn and other crops are renewable resources because we can regrow a new supply every season. Using renewable resources to produce everyday products, like packing peanuts, is an environmentally responsible practice. Additionally, cornstarch packing peanuts are biodegradable, unlike traditional Styrofoam packing peanuts and decompose in water, leaving no toxic waste.

Procedure:

1. Review the Corn Ag Mag or Terra Nova.
2. Pass out a few handfuls of the Cornstarch packing peanuts to each student.
3. Demonstrate the biodegradable qualities of the cornstarch packing peanut by licking two (or lightly dipping them in a cup of water) and sticking them together.
4. Have the students use the peanuts to construct sculptures representing one fact they learned from the Ag Mag or Terra Nova reading.

Fermentation In A Bag

Overview

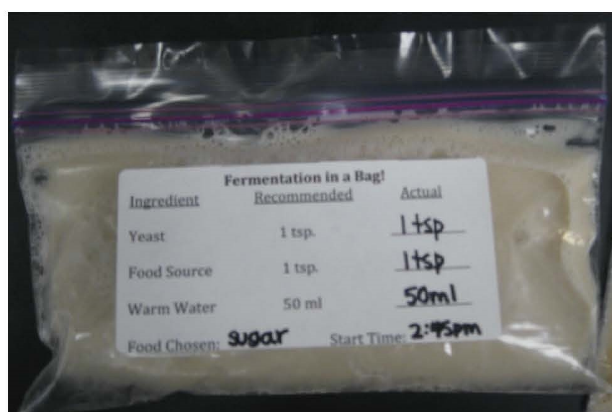
This classroom activity is a basic experiment that allows students to observe the process of fermentation and the challenge of producing ethanol from cellulosic sources. Students combine yeast and warm water with a feedstock in a "snack" size resealable zipper bag and observe as the yeast "eats" the feedstock such as sugar, cornmeal, or sawdust, and produces carbon dioxide and ethanol. Younger students can observe fermentation in a single bag, while older students can create multiple set-ups to compare how yeast reacts with different feedstocks. This can also be done at family-style outreach events and science fairs.

Fermentation in a bag – Recommended Recipe:

- In a snack-size resealable zipper bag, combine 1 tsp. of sugar (or another feedstock) and 1 tsp. of yeast.
- Add 50mL (1/4 cup) of warm tap water and zip the bag closed, removing as much air as possible.
- Mix gently. Lay bag on a flat surface and watch for results – fastest results should be achieved in 15 minutes.
- Warning: As the yeast produce carbon dioxide, the bag will expand – it may even pop! Be sure to monitor the bag and release the gas if becomes too inflated.

Basic Experiment

Using table sugar (sucrose) as a feedstock will yield the most rapid results. Some alternate feedstocks include corn meal (students could even grind their own corn), corn stover powder, sawdust, finely ground grass clippings, dead leaves, composting materials, etc. Feedstocks with a starchy or fibrous composition will not ferment as well.



Labels:

Bag labels formatted for Avery Template 5163 are included in this package. Below is the sample label:

Fermentation in a Bag!		
<u>Ingredient</u>	<u>Recommended</u>	<u>Actual</u>
Yeast	1 tsp.	______________
Food Source	1 tsp.	______________
Warm Water	50 ml	______________
Food Chosen: _________________		Start Time: ______________

Questions to discuss about the bags:

1. If the bag is inflating, what is filling it up?
2. Are you observing fermentation? How do you know?
3. How did the yeast respond to different kinds of "food"? Why do you think there is a difference? (Use the *Grassoline* poster included in this package to help).
4. If sugar is yeast's favorite "food", why might we want to use cellulosic plant materials instead of sugar for making ethanol?

Master Materials List:

- Dry Active Yeast (one 4 oz. jar contains approximately 36 teaspoons of yeast, which will make 36 bags)
- Hot water source
- 2-4 Liter Thermos (with spout) for hot tap water
- 2 Small Graduated Cylinders (100mL)
- Measuring Spoons (one teaspoon for each feedstock source and the yeast to avoid cross-contamination)
- Sugar
- Cornmeal, Corn Stover Powder, Sawdust, and any other sample feedstocks to use in experiments
- Resealable zipper bags ("snack" size) with fill-in labels (found in this package)
- Paper towels

Video Resources:

- Measuring Ethanol in the Classroom: Tips & Tricks - A 2-minute video on how to calibrate, operate, and troubleshoot Vernier and Pasco ethanol sensors to allow for qualitative comparisons between ethanol samples. https://youtu.be/8iNAWPy7xS8

Extensions

Science Fair Extension:

Prep time: 30-60 minutes, depending on event/group size
Activity time: 10 minute set-up, observe for 15 minutes or up to 1.5 hours

Students ran this experiment at a table at a family-oriented "science fair" event. The table was set up so that the experiment had two main options: completing of a *Fermentation In A Bag* comparison experiment at the event or picking up pre-filled dry materials bags (containing yeast and sugar) for take home completion. The option of providing pre-filled bags with direction labels allowed many families who were in a rush to take the activity home and complete it later by just adding warm water and noting any observations. Empty bags had labels with fill-in-the-blank style directions for students to design their own comparison experiment. Also on the table were several materials on display to help explain the creation process of cellulosic ethanol, from feedstock to the final fuel.

Other Possible Extensions:

1. Add bromothymol blue (BTB) pH indicator to water for color indicator of CO2 production.
2. Try other methods of quantifying fermentation rates, such as "time to bag inflation" or bag volume after 15 min. (i.e. displacement of water in beaker).
3. In the inquiry version, have students choose their own feedstock and explain results. See example "Classroom Variation" described below.
4. Use an ethanol probe, such as one made by Vernier, to measure the amount of ethanol produced in the bag. A blank data sheet is included in the package for this activity.
5. Refer to the Fermentation Challenge or CB2E: Cellulosic Biomass to Ethanol lab on the GLBRC website for more sophisticated versions of this experiment.
6. Compile, graph and interpret class data.

Sample Ethanol Probe Data: (measured in % ethanol with a Vernier ethanol probe)

	SUGAR	CORNMEAL	CORN STOVER
	0.77	0.40	0.16
	3.18	0.35	0.11
	2.61	0.29	0.14
	2.95	0.27	0.20
	2.72	0.29	0.16
	2.91	0.32	0.21
	2.98	0.25	0.17
	1.72	0.29	0.18
	2.66	0.21	0.24
	3.21	0.24	0.18
	2.86	0.26	0.25
	2.52	0.22	0.19
Average:	2.59	0.28	0.18

Interpreting results: Yeast only has the ability to consume simple sugars, such as glucose, fructose and sucrose. This explains why table sugar (sucrose) produced the highest ethanol yields. Cornmeal is primarily starch, a polymer (long chain) of glucose, which yeast cannot break down. Even so, there is a small amount of sugar in the cornmeal which is why average ethanol levels are slightly higher than corn stover. Corn stover - essentially ground up corn stalks - is primarily made up of cellulose. Cellulose is also a polymer of glucose molecules, but it is wrapped up inside the plant cell wall and very difficult to break down. There are virtually no sugars available for yeast in corn stover. Yeast are able to produce small amount of ethanol in corn stover because there is a little bit of sugar in the dry yeast mixture. This similar to the amount of ethanol that would be produced from combining yeast and water.

Example Classroom Variation

Fermentation in a Bag is a simple, yet educationally rich activity that can be adapted to target a variety of learning objectives and different grade levels. Desribed below is an inquiry version of the activity similar to our Fermentation Challenge lab, in which students can choose their research question, data collection methods and experimental set-up. You can find additional details and classroom resources to run version of the activity in the "Supporting Materials" folder in this activity package.

An Inquiry into Fermentation (with Bag, Bottle and Balloon!):

Students work in small groups ("research teams") to investigate two guiding questions: 1.) "Which feedstock will produce the largest volume of CO_2 gas?" and 2.) "What methods could be used to collect data to measure volume of CO_2 produced?" Student teams can be given flexibility to choose reseach questions, feedstock options and data collection methods. Example feedstocks could include ripe versus unripe bananas, breakfast cereals, sugar, corn starch, sawdust, etc. Example data collection could include measuring bag volume, time to bag inflation, baloon inflation circumference, or Vernier CO_2 gas pressure sensors.

Pictured left: Students use the Fermentation in a Bag protocol to investigate a range of feedstocks, including breakfast cereals. They also develop creative methods to measure volume of CO_2 produced by different feedstocks. Here students measure the circumference of baloons as an indicator of CO_2 production during fermentation of breakfast cereals.

Dr. Ken Newberry, Science Methods Instructor at Bowling Green State University and alum of the GLBRC Bioenergy Institute for Educators, shared this variation on *Fermentation in a Bag* with pre-service middle school science teachers. He found that fermenting common foods such as breakfast cereals can harness students' natural curiosity about the foods they eat. For example, students were surprised to observe that Cheerios produced more CO_2 than Corn Pops. This led them to compare the sugar content of cereals by both mass and volume on the product nutritional labels.

See the "Supporting Materials" folder in this activity package for more details on how to run this version of Fermentation in a Bag.

Standards

Next Generation Science Standards (2013)

Performance Expectations

Elementary School:

- **K-LS1-1**. Use observations to describe patterns of what plants and animals (including humans) need to survive.

High School:

- **HS-LS2-3.** Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

Scientific and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and carrying out investigations Analyzing and interpreting data Engaging in argument from evidence	**LS1**: From Molecules to Organisms: Structures and processes **LS2**: Ecosystems: Interactions, energy, and dynamics	Patterns Cause and effect: Mechanism and explanation Energy and matter: Flows, cycles and conservation

Corn Plastic

Grade Levels: K-4

Purpose: Students will use a corn-based material to experiment with traits of liquids and solids.

Next Generation Science Standards:

Structures and Properties of Matter: 2-PS1-1; 2-PS1-3

Engineering Design: K-2.ETS1-1; K-2-ETS1-2

Suggested Reading Materials:

IAITC's Corn Terra Nova

IAITC's Corn Ag Mag

Materials Needed:

- Cornstarch
- Clear Plastic Cups or plates
- Water (optional)

Background:

Corn, like soybeans, other crops, and animal products are beneficial for more than just the food they supply. These resources can often be used to create secondary products we call "by-products." The plastic-like material created in this activity is one by-product of corn.

Procedure:

1. Place 1 cup of cornstarch in a bowl.
2. Add 1/4 cup + 1 tablespoon of water to the cornstarch
3. Add a few drops of food coloring to the bowl.
4. Blend the mixture with a fork. It should flow when the bowl is tipped but feel solid to the touch.
   If the substance is too thick, add a little water.
   If the substance is too runny, add more corn starch.
5. Play with the new corn plastic. Is it a solid or a liquid?

Solving Today's Problems with Soybeans

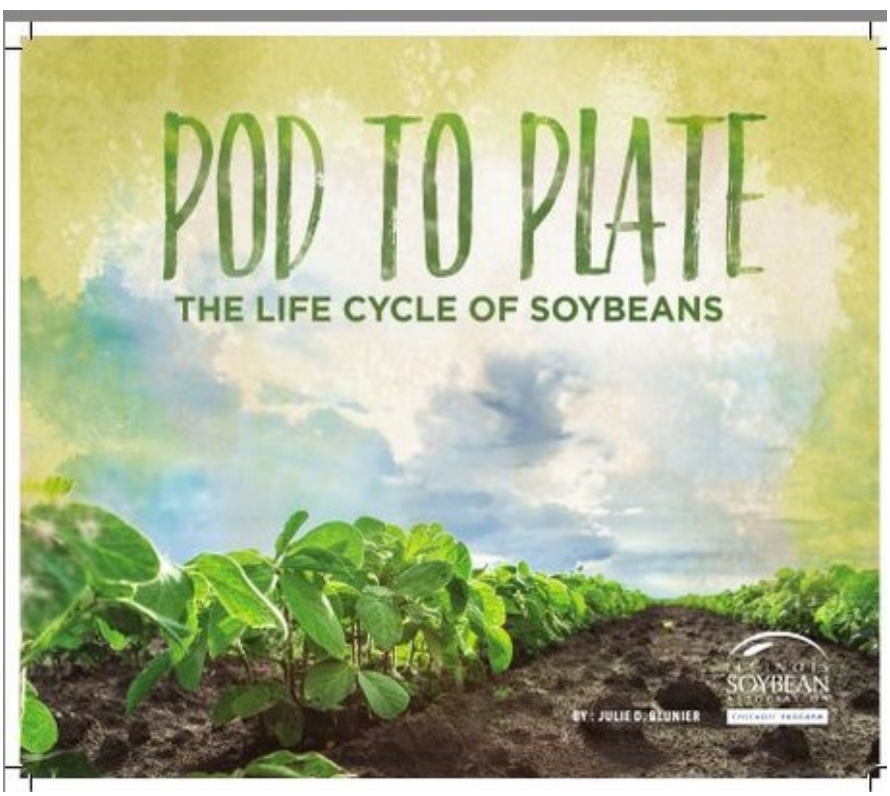
Sitting on Soybeans: Building the Bio-Based Automobile | Debbie Mielewski | TEDxDetroit

https://www.youtube.com/watch?v=mNOCWTAp3xA

Published on Mar 16, 2015

In 2001, Ford scientist Debbie Mielewski had an idea: use biomaterials to create car parts. In the past 15 years, she's proven how persistence can turn ideas into realities. Debbie has incorporated soy foam into all of the company's North American vehicles, saving an estimated 25 million pounds of carbon dioxide annually. She's also explored wheat-straw, hemp, algae, recycled plastic bottles and post-consumer blue jeans – redefining the automobile as we know it.

Dr. Deborah Mielewski is Technical Leader of Plastics Research at Ford Motor Company. Since launching the biomaterials program in 2001, she has incorporated soy-based foam into every vehicle in Ford's North American lineup.



Illinois Soybean Association

Flipbook available online or as a pdf.

Visit www.podtoplate.org

Soybean Lip Balm

Grade Levels: K-4

Common Core State Standards:

Mathematics: CCSS.Math.Practice.MP.4; MP.5; 5.MD.A.1; 5.MD.C.3

Next Generation Science Standards:

Structures and Properties of Matter: 2-PS1-1; 2-PS1-3

Engineering Design: K-2.ETS1-1; K-2-ETS1-2

Materials Needed:

- For each student:
- lip balm container
- For class:
- 3.5 ounces (l00g) beeswax
- stir stick
- beaker
- 1 bottle (3.7ml) of cooking flavoring oil (optional)
- 1-1/2 cups (360 ml) soybean oil
- hot plate
- hot pad

Directions:

1. Place the block of beeswax in a large Ziploc bag before breaking the block into smaller pieces.
2. Weigh 100g of the small pieces in a 600 ml beaker.
3. Place the beaker on the hotplate, and turn the hotplate on low.
4. As soon as the wax begins to melt, add the soybean oil, stirring occasionally until the entire mixture is melted.
5. Turn off the hotplate.
6. Add the flavoring oil and continue to stir until the mixture is nicely blended.
7. Pour the mixture into the lip balm containers, reheating when necessary to keep the mixture viscous. Allow the lip balm to cool in the containers before distributing them.

Lesson Extender:

Your class is a lip balm manufacturing company. Conduct flavoring and cost analysis to find out how to make and sell their product. By listing ingredients such as soybean oil, beeswax, and other information identified on flavoring oils, students can generate labels for their jars or twist-up tubes.

Illinois AGRICULTURE in the Classroom℠

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