# Soybeans Go to School Kit

## Lesson Plans

# Teacher Introduction

**Michigan Soybean Committee's Commitment to Education**

Teachers face increasing pressures to include innovative instruction into their classrooms, which simultaneously meet state standards. This has become increasingly difficult for teachers in today's learning environment, one where transitions between in-person and virtual learning are common. The Michigan Soybean Committee (MSC) has a history of supporting teachers in their desire to integrate programs that complement classroom learning while also meeting state benchmarks. As curriculum standards have changed, the MSC has updated its existing Soybean Go to School Kit curriculum to meet the current standards.

MSC is committed to introducing students and teachers to and deepening their understanding of soybeans and their impact in Michigan. MSC believes that soybeans help connect agriculture, food, and the environment to real world science instruction. Furthermore, MSC recognizes that soybeans play a significant role in providing a renewable resource to help solve some of Michigan's environmental dilemmas. Anyone who comes in contact with this curriculum quickly discovers that soybeans are linked to our everyday lives through industrial products and the food on our tables.

This updated curriculum is designed to enhance usability for teachers and students. This year the curriculum has been totally redesigned to allow for easier use by students who might be in a virtual or hybrid learning setting. Additionally, all curriculum materials have been updated giving them a fresh modern look allowing students to stay engaged in their learning. With the updated school kit, you will find new and exciting lessons along with our old favorites. We hope that you and your students truly enjoy learning about this miracle bean!

If you have any questions regarding the lesson plans or kit materials, please contact:

Katlin Fusilier
kfusilier@michgiansoybean.org
3055 W M-21
St. John's MI 48879

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MICHIGAN SOYBEAN COMMITTEE

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- Pre-Test Link (https://forms.gle/zeVkwAfZeUrQ6aGW7)

Lesson #2- What is a Seed?

Kit Supplies

- Lesson 2 Slides (https://docs.google.com/presentation/d/1P45W3V_JqaLxulWx--WcUGiLoztVjoMi0UDEy0xAlhM/edit?usp=sharing)
- Paper Towel
- Soybean Workbook
- Soybean Seeds

Optional Classroom Supplies

- Magnifying Glasses
- Tweezers
- Rulers

Lesson #3- Parts of a Plant

Kit Supplies

- Lesson 3 Slides (https://docs.google.com/presentation/d/1dHwTeONv_ZjBojo_vELCeV2quOGEPaPr_DpRD1gjxJs/edit?usp=sharing)
- Soybean Plant Parts Poster
- Soybean Workbook
- Crayons

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Kit Supplies

- Lesson 4 Slides (https://docs.google.com/presentation/d/18fRU1H4U2vWCncDxFlYrg6MNKVqwmfAjOFAMAHnDYTQ/edit?usp=sharing)
- Life Cycle Cards (https://www.michigansoybean.org/uploads/1/3/7/2/137244386/lesson_4_life_cycle_cards.pdf)
- Life Cycle Poster

Optional Classroom Supplies

- Tape
- Paper

Lesson #5- What do Plants Need to Grow?

Kit Supplies

- Lesson 5 Slides (https://docs.google.com/presentation/d/1zqu0sZf3rADhO3lkTE7WZc9AK11p_TjBckERTdQHrvM/edit?usp=sharing)
- Plant Needs Cards (https://www.michigansoybean.org/uploads/1/3/7/2/137244386/lesson_5_plant_needs_cards.pdf)
- Soybean Seeds (24)
- 24 Plastic Cups
- 3 Gallon Ziplock Baggies
- 21 Peat Pellets
- Crayons
- Paper Towels
- Soybean Workbook

Optional Classroom Supplies

- Measuring Cups
- Scissors

Required Classroom Supplies

- Water
- Markers
- Rulers
- Paper

- Tape

Lesson #6- Why Soybeans? Humans and Animals

Kit Supplies

- Lesson 6 Slides (https://docs.google.com/presentation/d/1q4BoiLlWTPL911UYkchb1MJwuL2wHRiZnitmxGJzgO8/edit?usp=sharing)
- Nutrition Labels (https://www.michigansoybean.org/uploads/1/3/7/2/137244386/lesson_6_nutrition_labels.pdf)
- Soybean Workbook
- Food Chain Cards (https://www.michigansoybean.org/uploads/1/3/7/2/137244386/lesson_6_food_chain_cards.pdf)

Optional Classroom Supplies

- Food Nutritional Labels

Lesson #7- Why Soybeans? Industrial Products

Kit Supplies

- Lesson 7 Slides (https://docs.google.com/presentation/d/1TzkYzdCmuBDAZT5sozhXfLCeUC2WFLnYQiY1UDz5Unc/edit?usp=sharing)
- Soybean Workbook
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Lesson #8- Renewable Resources Soybean Biodiesel

Kit Supplies

- Lesson 8 Slides (https://docs.google.com/presentation/d/1muMkxXV19tumh2BrrDDJaK2-KKly7ZKN0T_oYA_i7ws/edit?usp=sharing)
- Soybean Workbook
- Resource cards (https://www.michigansoybean.org/uploads/1/3/7/2/137244386/lesson_8_resource_cards.pdf)

Lesson #9- Where has the Soybean Been?

Kit Supplies

- Lesson 9 Slides (https://docs.google.com/presentation/d/1U9J9QrabSuLZxyrBiqtg_wzpCA9uV3gvHaBn3YoupDg/edit?usp=sharing)
- Soybean Workbook
- Production Maps found on the For Students Page (https://www.michigansoybean.org/for-students.html)

Lesson #10- Famous Soybean Scientists

Kit Supplies

- Lesson 10 Slides (https://docs.google.com/presentation/d/1vVbADBEaZSPhZaEuNAuOtGkzWV-zo3lrGbKnam3WcO0/edit?usp=sharing)
- Soybean Workbook

Lesson #11- Henry Ford

Kit Supplies

- Lesson 11 Slides (https://docs.google.com/presentation/d/1ZFdexegUPB4eeTUKY5UytxFKJ-TbSUvcp6K_7cdeDuY/edit?usp=sharing)
- Full of Beans Henry Ford Grows a Car Book
- Soybean Workbook

Lesson #12- Traits and Heredity

Kit Supplies

- Lesson 12 Slides (https://docs.google.com/presentation/d/1e7kDFl0mIyHtZQsNFooDx_xCRRgIPf__QRQIQI3zT_o/edit?usp=sharing)
- Soybean Workbook
- Crayons

Required Classroom Supplies

- Dice (1 per student)

Lesson #13- How Genetics Change Over Time

Kit Supplies

- Lesson 13 Slides (https://docs.google.com/presentation/d/1fZfvyTC64KaFXqoEBTL3RFna0V3C2mcuFu1g9jYamJI/edit?usp=sharing)
- Soybean Workbook
- 160 Red Pom Poms
- 160 Black Pom Poms
- Black Felt (2 pieces)
- Red Felt (2 pieces)
- Cups (1 per student)
- Spoons (1 per student)

Required Classroom Supplies

- Coins

Student Post-Test

https://docs.google.com/forms/d/1f6Jvdl6mYxEY__VASlIYMwJzG236l9P200YujqvVTww/edit?usp=sharing

Teacher Evaluation

Teachers who fill out the Teacher Evaluation Form will automatically be sent a prize for their classroom. In addition, teachers who's students fill out the pre-test and post-test will be entered into a drawing for a grant for their classroom along with a visit from a farmer to their school.

https://docs.google.com/forms/d/1YDVfXRcQLN9tyBC34TZV0YPN2I4u29nC4GNA3rPjf7g/edit?usp=sharing

# Pre/Post Test Answers

Where does our food come from?
Answer: Farms

Match up the following parts of a seed using the picture above.
Answer: A-Seed Coat, B- Cotyledon, C- Embryo

Match up the parts of the plant with their functions.
Answer: The underground part of a plant body that transports water and minerals, stores sugars produced by the plant and anchors the plant into the ground- Root, The major site of photosynthesis where oxygen is released and carbon dioxide is absorbed- Leaves, The bloom or blossoms of the plant, the seed producing structure of the plant- Flower

What is the correct order of the soybean life cycle in the picture above?
Answer: #2

What are the most important things for plant growth?
Answer: Water, Sun, Air

Chose how energy flows through the food chain.
Answer: Sun, Soybean, Pig, Human

Chose the following industrial products that are made with soybeans.
Answer: All of the above

What is biodiesel?
Answer: A fuel that is made from renewable resources that is vegetable oil- or animal fat- based

What country did the soybean come from?

Answer: China

What did Henry Ford build out of soybeans?

Answer: Soybean Car

What do recipes, blueprints, and DNA all have in common?

Answer: They are all sets of instructions.

Match up each of the types of genetic change with their definition.

Answer: Process by which humans breed plant and animals for particular traits- Artificial selection, Process by which organisms better suited to their environment survive and produce more offspring- Natural Selection, Process by which an organisms genes are manipulated by introducing, eliminating, or rearranging specific genes using methods of modern molecular technology- Genetic Engineering

# Lesson Number One: What is Agriculture?

**Estimated Time:** 35 minutes

**Objective:**

Students will be able to define what agriculture is and where their food comes from.

**Curriculum Standards:**

National Agriculture Literacy Outcomes

T5.3-5 Explain the value of agriculture and hot it is important in daily life

**Materials:**

Kit Supplies

- Lesson 1 Slide Deck (https://docs.google.com/presentation/d/1iKggvkCqd9XuyGY6xCN8WUp9GYwRWL9IX497otxWSxI/edit?usp=sharing)
- Pre-Test Link (https://forms.gle/zeVkwAfZeUrQ6aGW7)

**Background:**

Today, the average American is at least three generations removed from the farm, in fact, farmers and ranchers make up less than 2% of the population in the United States. Because of this, many students may not understand where their food comes from or what it takes to raise food to feed the world. Many students may have never been to a farm or met a farmer! This lesson is designed to give a short introduction to agriculture and where food comes from. In it, students will discuss agriculture and food along with watching two videos of Michigan farmers.

**Definitions:**

Agriculture

the science, art, or occupation of cultivating land, raising crops, and feeding, breeding, and raising livestock; farming.

**Lesson:**

Have students take the pre-test to test their knowledge about soybeans and agriculture. The pre-test is a Google Forms link. Inform the students that even if they do not know an answer to a question to use their best educated guess. Once students finish and submit, answers will be sent to MSC. Student names will not be connected with the forms, only teacher name and school. For teachers to be entered in the grand prize drawing students must take the pre and post-test.

Link: https://forms.gle/zeVkwAfZeUrQ6aGW7

Discuss with students the meaning of the word agriculture.
Has anyone heard the word agriculture before? What about the word farming?

Knowledge Question- Ask questions and solicit responses

- Do you know where your food comes from? - Students may or may not know where their food comes from. Some might answer farms, grocery stores, restaurants, refrigerator, etc. Collect and consider all student responses.

Watch Where does food come from? (1 min) video.

Discussion Questions- Ask questions and solicit responses

- Where do you think the plants, animals, and fungi we eat come from? - Students will have varying responses.

All of the food we eat comes from farms!

Discussion Questions- Ask questions and solicit responses

- Are you surprised to learn that your food comes from a farm? - Students will have varying responses.

Knowledge Questions- Ask questions and solicit responses

- Have you ever been to a farm or met a farmer? - Students may or may not have been to a farm or met a farmer. Encourage students to share stories if they have been to a farm.

Watch the Michigan Soybean Farmers in the Soybean Value Chain (7 min) and the Moore Seed Farm Growing Quality Seed (1.5 min) videos.

Discussion Questions- Ask questions and solicit responses

- What did you learn about life on a farm? – Some Michigan farms were started a long time ago, Michigan farms have families living on them with kids just like students in the classroom, Michigan farmers care about their land, Michigan farmers grow soybeans and many other crops, etc.
- Were you surprised by anything in the video? - Answers vary

**Summary:**

During this course we will learn about one very important crop in Michigan, soybeans! We will learn the science of the soybean, its history, why we use it and so much more! We are excited to join you on your journey to learn more about the miracle bean!

**Further Resources:**

Interactive timeline of the history of agriculture in the United States.
https://growinganation.org

# Lesson Number Two: What is a Seed?

**Estimated Time:** 1 hour

**Objective:**

Students will be able to determine the parts of a seed and their purpose.

**Curriculum Standards:**

Third Grade:

3-LS1-1 Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death

Fourth Grade:

4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction

**Materials:**

Kit Supplies

- Lesson Two Slides (https://docs.google.com/presentation/d/1P45W3V_JqaLxulWx--WcUGiLoztVjoMi0UDEy0xAlhM/edit?usp=sharing)
- Paper Towel
- Soybean Workbook
- Soybean Seeds

Optional Classroom Supplies

- Magnifying Glasses
- Tweezers
- Rulers

**Background:**

What is a seed? A soybean is a seed? Each spring, farmers plant soybean seeds in the ground, tend to them all summer, and then harvest the mature seeds in the fall. This cycle is how soybeans are grown and produced. Each seed grows up to be a plant with many more seeds on it! But how does a tiny seed contain all of the parts to grow a plant?

On a soybean seed there is an outer seed coat which protects the seeds, and every seed contains a tiny plant (embryo) that consists of leaves, stems, and root parts. The seed also contains a short-term food supply which is stored in the cotyledons. This is formed at fertilization; however, it is not part of the embryo. Instead, it is used by the embryo to help its growth until the soybean seedling is able to photosynthesis and produce its own food. Most of a seed is its fleshy interior called the cotyledon, which stores food for germination. Each part of the seed has a specific function and must be present for the healthy growth and germination of the seed.

**Definitions:**

Cotyledon
: The part of the seed that stores food for the seedling. Each bean has a pair of cotyledons forming a protective shield around the seedling

Embryo
: A tiny plant

Hilum
: The point of attachment of the seed to the seed pod

Hypocotyl
: The part of the embryo that forms the stem

Radicle
: The part of the embryo that forms the roots

Seed
: A fertilized and mature egg that contains a tiny plant that grows and develops when placed in an environment containing air, water, and warmth

Seed coat
: A thin covering that protects the seed's embryo from insects, disease, and damage

**Lesson Prep:**

The night before the lesson is to be presented, fill a cup with water and enough soybean seeds for each of the students to have one. Allow the seeds to soak for at least eight hours.

**Intro:**

Pass out one dry soybean seed per student

Knowledge Questions- ask questions and solicit responses from students

- What is a seed? - a fertilized and mature egg that contains a tiny plant that grows and develops when placed in an environment containing water, air, and warmth
- Where do we find seeds? - Students might have examples of seeds they have encountered in their everyday lives (ex. Sunflower seeds, planting a garden, etc.) or examples of where they might have found seeds (ex. On a plant, on the ground, etc.), seeds come from the flower or fruit of plants
- What is the purpose of a seed? - has an embryo (tiny plant) inside that can grow into the same plant it came from; it's the plant's way of ensuring its species lives on; the tiny plants inside can be carried other places to grow

Watch the Planting Season 2018 video (4.5 minutes) to see how soybean seeds are planted in the ground. The video shows soybeans being planted with various types of equipment common around the state of Michigan. Feel free to stop the video prior to the end to save time.

Knowledge Questions- ask questions and solicit responses from students

- Is a seed made up of different parts or is it one thing? – Seeds are made up of many different parts

- How can we find out? – The seed could be opened, we could use a microscope to see inside the cells, etc.

**Lesson:**

Explain

Today we are going to find out what parts make up a seed and what the parts of a seed do. To do that we will be dissecting soybean seeds!

Pass out the wet soybean seed, paper towel, and optionally tweezers, rulers, and magnifying glasses.

Instruct students to turn to Page 1 in the Soybean Workbook.

Discovery Questions- ask questions and solicit responses from students.

- Compare the two seeds, what are the similarities and differences? - One is wet and soggy and larger than the other
- How did this happen to the second soybean? - It was soaked in water for a period of time, it absorbed the water and swelled

Direct students to pry open their wet seed, using their thumbs, directly down the middle crack. This will give the student two halves, which show the inside of the seed and its parts.

Ask questions and solicit responses

- What do you see inside? - Answers vary, students may not have any idea what they are looking at.

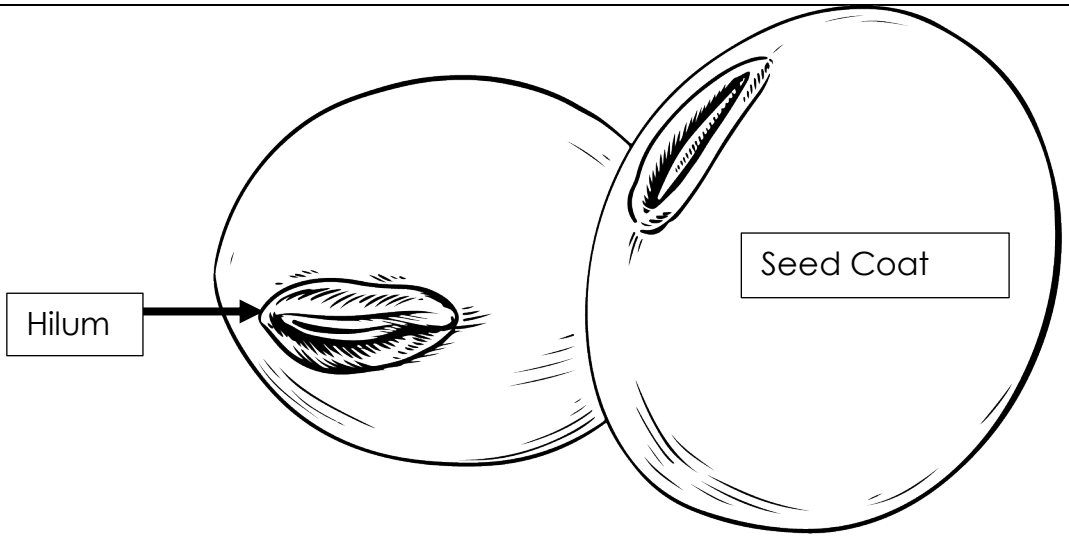
Direct students to observe both seeds. Have them use crayons, markers, etc. to draw what they see inside the one soybean seed and the outside of the other soybean seed. Have them write down their ideas to describe the parts inside the seed and the function of each part in their soybean lab notebook.

Have students share their pictures and guesses with one another.

Instruction about seed part identification and function

Instruct students on the parts of a seed and their function- outside of a seed

1. Seed Coat- A thin covering that protects the seed's embryo from insects, disease, and damage
2. Hilum- The point of attachment of the seed to the seed pod




Instruct students on the parts of a seed and their function- inside of a seed

1. Cotyledon- The part of the seed that stores food for the seedling. Each bean has a pair of cotyledons forming a protective shield around the seedling
2. Seed Coat- (same as above) A thin covering that protects the seed's embryo from insects, disease, and damage
3. Embryo- A tiny plant
4. Hypocotyl- The part of the embryo that forms the stem
5. Radicle- The part of the embryo that forms the roots


Connect and compare student generated ideas about part functions with real functions.

Discussion Questions- Ask questions and solicit feedback

- <u>Looking at what you wrote, did anyone think of functions of their seed parts that are similar to the functions we just learned about?</u> – Students will have different responses for this answer

| |
|---|
| Direct students to update the functions in their science notebook with the functions from the lesson. Answers are provided in the Soybean Workbook Teacher Guide (https://www.michigansoybean.org/lesson-plans--workbook-answer-key.html). |
| **Summary:**<br><br>Ask questions and solicit feedback<br>• What did we learn today that soybean seeds have inside of them? – Food for the tiny plant, a tiny plant<br>• If it didn't have that part what would happen? - The tiny plant wouldn't survive dormancy, the seed couldn't form a new plant<br>• What do these seeds need to grow? - Air, light, moisture, nutrients |

# Lesson Number Three: Parts of A Plant

**Estimated Time:** 30 minutes

**Objective:**

Students will be able to identify parts of a plant and describe the role that each part plays in survival of the plant

**Curriculum Standards:**

Third Grade:

3-LS1-1 Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death

Fourth Grade:

4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction

**Materials:**

Kit Supplies

- Lesson 3 Slides (https://docs.google.com/presentation/d/1dHwTeONv_ZjBojo_vELCeV2quOGEPaPr_DpRD1gjxJs/edit?usp=sharing)
- Soybean Plant Parts Poster
- Soybean Workbook
- Crayons

**Background:**

Just like other plants, soybean plants have basic plant structures. Soybeans grow roots that provide functions including (a) anchoring the plant into the ground for support, and (b) absorbing water and nutrients that are vital for growth and repair. They can even store sugars and carbohydrates to help carry out other plant functions. Stems carry water and nutrients from the roots to the leaves. Stems also act as a support for the plant to allow it to reach necessary sunlight for food production. Leaves catch light and have the important task of photosynthesis; the process of creating the plant's own energy by converting carbon dioxide, water, and light energy into glucose. They release oxygen in the process. Flowers are necessary to produce seeds. Soybeans are self-pollinating, meaning they poses both male and female parts to pollinate themselves. Different varieties of soybeans produce white, purple, and pink flowers. Seed pods are the seed holding structure of the soybean. They form from a fertilized flower. All of the parts of the plant work together to help the plant grow, mature, and reproduce. Each of the structures is important to the function of the plant, if one or more of the structures were missing the plant would not be able to carry out normal functions.

**Definitions:**

Cotyledon
While still in the seed it stores food for the seedling, it becomes the first leaf or leaves that are developed by the seed

Epicotyl
The part of the plant that grows, the stem forms and grows from this point

Flower
The bloom or blossoms of the plant, the seed producing structure of the plant

Fruit
A swollen mature flower. Fruits normally contain stored energy and nutrients that helps seeds grow during germination

Hypocotyl
The part of the embryo that forms the stem

Leaves
The major site of photosynthesis where oxygen is released, and carbon dioxide is absorbed

Plant
A eukaryotic organism that photosynthesizes and has rigid cell walls

Roots
The underground part of a plant body that transports water and minerals, stores sugars produced by the plant and anchors the plant into the ground

Seed pod
The fruit of the plants like legumes containing many seeds

Stem
Stalk; a slender or elongated structure that supports a plant through which water, minerals, and food are transported between the roots and the rest of the plant

**Intro:**

Knowledge Questions- ask questions and solicit responses

- What is a plant? – The scientific definition of a plant is a eukaryotic organism (organism that has nucleus enclosed within a nuclear membrane, plants, animals, fungi, and protozoa are all eukaryotic) that photosynthesizes and has rigid cell walls.
- Where do soybean plants grow? – Soybean plants grow in farmers fields. They are mostly grown in temperate regions though some are able to grow in tropical regions.
- Can anyone name a part of a plant? – Parts that could be named are the flower, petals, stem, leaves, roots, etc.

**Lesson:**

Show students the Parts of a Plant for Kids video (4 minutes).

Have students open their Soybean Workbooks to Page 2. Working with students on an overhead projector or similar, go through each of the plant parts with students. Answers are provided in the Soybean Workbook Teacher Guide (https://www.michigansoybean.org/lesson-plans--workbook-answer-key.html).

Starting at the soil line, instruct students to draw roots underneath the soil.

Ask students what their purpose is. Solicit responses from students.

Show students the roots slide. Explain to students the purpose of roots to a plant:

- Absorb water and nutrients
- Anchor the plant
- Stores sugars

Have students fill in the roots box on their worksheet with the purpose of the roots

Next, instruct students to draw a soybean plant stem.

Ask students what the purpose of a stem is, solicit responses from students.

Show students the stem slide. Explain to students the purpose of the stem to a plant:

- Transport water and nutrients from the roots to the leaves (like a straw)
- Support the plant
- Transport food from the leaves to the roots

Have students fill in the stem box on their worksheet with the purpose of the stem

Next, instruct students to draw the leaves of the plant.

Ask students what their purpose is. Solicit responses from students.

Show students the leaves slide. Explain to students the purpose of leaves to a plant:

- Major site of photosynthesis (the process by which the plant uses energy from the sun to make food)

Have students fill in the leaves box on their worksheet with the purpose of the roots.

Next, instruct students to draw the flowers of the plant.

Ask students what their purpose is. Solicit responses from students.

Show students the flowers slide. Explain to students the purpose of flowers to a plant:

- Seed producing structure of the plant
- Attract pollinators such as bees (soybeans are self-pollinating so they do not need pollinators but many other plants require pollinator species)

Have students fill in the flower box on their worksheet with the purpose of the flowers.

Next, instruct students to draw the seed pods of the plant.

Ask students what their purpose is. Solicit responses from students.

Show students the seed pods slide. Explain to students the purpose of seed pods to a plant:

- The fruit of the plant
- This is where the seeds are found

Have students fill in the seed pod box on their worksheet with the purpose of the seed pods.

**Summarize:**

Summary Questions- ask questions and solicit responses

What are the parts of the plant that we learned today? – Roots, Stem, Leaves, Flowers, Seed Pod

If it didn't have that part, what do you think would happen? – If a plant did not have certain parts, it would not be able to grow and survive.

Roots- without roots the plant would not be able to get water or nutrients from the ground

Stem- without the stem the plant would not be able to transport water or food throughout the plant

Leaves- without leaves the plant would not be able to produce energy

Flower- without flowers the seeds would not form

Seed Pod- without the seed pod the plant would not be able to produce seeds

What do you think these plants need to grow? – these answers will vary; students will investigate this further in a future lesson

**Further Resources**

Parts of a Plant Game- this game quizzes students on the parts of a plant and their functions. Students can advance through the game with the white arrow in the lower right-hand corner.

https://www.tinytap.com/activities/g3bj6/play/parts-of-the-plant

# Lesson Number Four: Soybean Life Cycle

**Estimated Time:**

**Objective:**

Students will be able to describe the steps of the soybean life cycle and understand how different lifecycles compare.

**Curriculum Standards:**

Third Grade:

3-LS1-1 Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death

**Materials:**

Kit Supplies

- Lesson 4 Slides (https://docs.google.com/presentation/d/18fRU1H4U2vWCncDxFlYrg6MNKVqwmfAjOFAMAHnDYTQ/edit?usp=sharing)
- Life Cycle Cards (https://www.michigansoybean.org/uploads/1/3/7/2/137244386/lesson_4_life_cycle_cards.pdf)
- Life Cycle Poster

Optional Classroom Supplies

- Tape
- Paper

**Background:**

Soybeans are an annual plant, completing their lifecycle in less than one year. They are planted in the spring (May-June) and harvested in the fall (September-November). When a soybean seed is planted, it absorbs water and begins growing. Throughout the summer the plant grows adding more trifoliates. Around 6 to 8 weeks after planting, soybeans generally begin flowering. From there, pods form with seeds inside. In the fall, the leaves and stalks turn brown, and the plants are harvested. The bean itself is the most important part of the plant and is the part most sought by producers and consumers. Some of the harvested seeds get saved to be planted next spring. Thus continues the circle of life!

**Definitions:**

Birth

The process of bearing offspring in mammals and some other animals

Death

The ending of vital processes in tissue or cells

Germination

The process of an embryo emerging from its seed

Growth

When a living thing undergoes natural development by increasing in size and changing physically, progressing to maturity

**Intro:**

Knowledge Questions- ask questions and solicit responses

- Has anyone ever planted seeds in a garden? – Answers vary
- What kind of seeds? – Answers vary

**Lesson:**

Show students the Soybeans Germination and Growth Timelapse video (5 minutes). Feel free to stop video early to save time.

Discussion Questions- ask questions and solicit responses

- What do you think has to happen before a seed can germinate? – Before they germinate, soybeans are planted in the ground. They must imbibe water before they germinate.
- What do you think happens next in the lifecycle? – Once they germinate the plants begin to photosynthesize and grow larger in size. They then flower and produce seeds.

Sort the Life Cycle Activity

Pass out one sheet of life cycle cards to each student, students can work in groups on the project. Optionally pass out paper and tape along with the cards so that students can tape their cards in order on the sheet of paper.

Have students carefully cut out the cards or have the cards pre-cut depending on time limits.

Have groups talk through the life cycle and place the cards in order on their desks.

As students work through the activity circulate the room and ask probing questions to each group. "Why do you think that stage belongs there?"

Once students have finished working through their life cycles, ask students to present their life cycles to the class. Students can tell the class what order they placed the cards in.

Finally, go through the order of the life cycles stages as a class. While going through the life cycle, students can fill in Page 3 of the Soybean Workbook.

Seed- This is the part of the plant that starts the next generation. The seed is planted into the ground where it is allowed to start growing.

Radicle Emerges- After absorbing adequate moisture the primary root or radicle emerges from the soybean seed and pulls the cotyledons to the soil surface. The cotyledons supply the plants nutrients for after emergence.
Seedling- the first set of unifoliate leaves emerge and start to photosynthesize
One Trifoliate- The first of the trifoliate leaves are established on the plant
Vegetative Growth- The plant continues to add trifoliate leaves
Flowering- The plant begins to flower on the main stem. The open flowers move up and down the main stem and eventually move to the branches
Pod Set- Pods begin to develop on the plant. The pods grow rapidly, and seeds begin to develop. Stress to the plant can reduce the number of pods and the number of seeds in the pod which can reduce yield.
Dry Down- First the leaves of the plants start to yellow. Then the seeds and pods begin to lose their green color. The plant eventually turns brown and dries out.
Dried Mature Plant- When at least 95% of the pods on the plant have reached their mature color (brown) the plant is fully mature. The plant has completed its life cycle.

Next, students will have the opportunity to compare two different lifecycles- a soybean and a chicken.

Show students the slide with the soybean life cycle next to the chicken life cycle.

Have students open their workbooks to the Compare and Contrast Life Cycles on Page 4 of the Soybean Workbook.

Students can work in groups or individually to come up with similarities and differences between the two life cycles.

Once all students have time to complete their Venn Diagrams. Allow students to share their observations with the class.

Answers are provided in the Soybean Workbook Teacher Guide (https://www.michigansoybean.org/lesson-plans--workbook-answer-key.html).

**Summarize:**

Discussion Questions- ask questions and solicit responses

- Which of the life cycles is more complicated in your opinion? – Answers vary
- What would happen if one of the steps of the life cycle was messed up or didn't happen? – If one of the steps of the life cycle was messed up or didn't happen the organism would have different consequences depending on what step it was. For example, if the soybean did not germinate, then the plant would not form. If the plant did not flower, then seed pods and seeds would not form. If the plant did not dry down, then the seeds would not be viable.

**Further Resources:**

The Life Cycle of a Chicken Video- This 2:30 video explains the life cycle of a chicken.
https://www.youtube.com/watch?v=NVq4lgHmATA

# Lesson Number Five: What do Plants Need to Grow?

**Estimated Time:** Part 1- 1 hour, Measurement Days- 15 minutes, Part 2- 45 minutes

**Objective:**

Students will be able to identify parts of a plant and describe the role that each part plays in survival of the plant

Students will be able to utilize the scientific method and analyze data with the use of line graphs.

**Curriculum Standards:**

Third Grade:

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved

Fourth Grade:

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved

Fifth Grade:

5-LS1-1 Support an argument that plants get the materials they need for growth chiefly from air and water

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved

**Materials:**

Kit Supplies

- Lesson 5 Slides (https://docs.google.com/presentation/d/1zqu0sZf3rADhO3lkTE7WZc9AK11p_TjBckERTdQHrvM/edit?usp=sharing)
- Plant Needs Cards (https://www.michigansoybean.org/uploads/1/3/7/2/137244386/lesson_5_plant_needs_cards.pdf)
- Soybean Seeds (24)
- 24 Plastic Cups
- 3 Gallon Ziplock Baggies
- 21 Peat Pellets
- Crayons
- Paper Towels
- Soybean Workbook

Optional Classroom Supplies

- Measuring Cups
- Scissors

Required Classroom Supplies

- Water
- Markers
- Rulers
- Paper
- Tape
- Dirt from outside

**Background:**

Plants use air, water, the energy from light, minerals, and nutrients to grow, reproduce, and repair themselves. Soybeans grown in a field get their nutrients and minerals from the soil. Soil also supports the plant and allows the plant to anchor its roots down. Plants need sunlight to produce energy. They use light energy to change carbon dioxide and water into food substances via the process of photosynthesis. Without light, a green plant can't produce food. Water is necessary for all life forms. In plants, water is a component required for photosynthesis, helps roots absorb nutrients in the soil, assists with the germination process and helps with the transpiration process. Transpiration is the loss of water and air directly from the leaves. Air is also a necessity; with it green plants take in carbon dioxide from air and use it during photosynthesis to make food.

**Definitions:**

Air
: The invisible gaseous substance surrounding the earth, a mixture of mainly oxygen and nitrogen

Control Variable
: A variable that is kept the same during a scientific experiment

Data
: Evidence or facts

Dependent Variable
: The variable being tested or measured during a scientific experiment

Hypothesis
: An educated guess based on observations and your knowledge of the topic that can be tested by further investigation

Independent Variable
: The variable that is altered during a scientific experiment

Line Graph
: A type of chart used to show information that changes over time

Scientific Method
: A process that is used to find answers to questions about the world around us

Soil
: The upper layer of earth in which plants grow, a natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface

Sun

The star around which the earth orbits, radiates energy mainly as visible light, ultraviolet light, and infrared radiation

Water

A colorless, transparent, odorless, and nearly colorless chemical substance, vital for all known forms of life, $H_2O$

**Lesson Prep:**

Print and cut out the growth experiment choice cards- one set for each of the four groups.

Divide out supplies for each of the four groups

Sun Group:

- 6 cups
- 6 peat pellets
- 6 soybean seeds
- Water
- Sunny Location
- Dark Location
- Marker

Air Group:

- 6 cups
- 6 peat pellets
- 6 soybean seeds
- Water
- Sunny Location
- 3 gallon Ziplock baggies
- Marker

Soil Group:

- 6 cups
- 3 peat pellets
- 6 soybean seeds
- 3 Paper Towels
- Water
- Sunny Location
- Marker
- Dirt from outside

Water Group:

- 6 cups
- 6 peat pellets
- 6 soybean seeds
- Water
- Sunny Location
- Marker

**Intro:**

Split the class into four groups. These will be the lab groups for the experiment.

Pass out a set of Plant Growth Experiment Choice Cards to each group along with a piece of paper and tape or glue stick. Have students cut cards apart or pre-cut cards depending on time constraints.

Explain to each group that we are going to learn what plants need to grow. Ask them to think about what they think the most important thing is for plants to grow. Ask the groups to discuss the answer to the question for a few minutes, circulate as they discuss and make sure that groups are including the "why" in their responses to one another.

After a few minutes of discussion, ask each group to create a poster with the item/items that they believe are the most important for plants to grow <u>and</u> their reason for choosing these items.

The poster helps to figure out background knowledge of the students and gives them something to refer to at the end of the experiments and compare their findings to their original ideas and explain if/how their reasoning has changed

**Lesson Part 1: Setting up the Experiment and Data Collection**

Instruct students that we will be conducting four experiments to see what the most important thing is for plants to grow (sun, air, water, soil- the same as the cards passed out earlier)

Go through the steps of the scientific method with students. For each step use the example below or your own to demonstrate how the scientific method works.

Example:

Observation: The ice in my glass of water melts quickly.
Question: Would ice melt faster sitting out in the air or in a glass of water?
Research: I know that pure water's freezing point is 32 degrees Fahrenheit
Hypothesis: If I put one ice cube in a glass of water and another ice cube on a plate, then the ice cube on the plate will melt faster.
Test Hypothesis: Conduct the experiment with one ice cube in a glass of water and other on a plate. Use a timer to see which melts faster.
Analyze your data: In the experiment the ice cube in the glass of water melted faster.
Report: I will tell my family that ice melts faster in water than in air.

Go over the definitions of independent variable, dependent variable, control variable, and hypothesis with students. Give examples if students are unfamiliar with the terms and how they are used.

Example:

Dependent Variable- time to melt ice
Independent Variable- water vs. air
Control Variable- we will use room temperature water, the same size ice cubes, we will set the plate and glass right next to each other on the counter, etc.
Hypothesis- Same as above. If I put one ice cube in a glass of water and another ice cube on a plate, then the ice cube on the plate will melt faster.

Pause to pass out the materials for the experiment and assign each of the group to one of the four needs- water, sun, air, or soil. Students should turn their workbook to their correct data sheet. This sheet contains instructions, hypothesis etc. The sheets can be found on pages 6, 8, 10, and 12 respectively.

Work with students to set up the experiment.

*Because this experiment involves a lot of set up, this portion will be done as a whole group instead of each group working individually. Groups will however, oversee collecting their data independently each day for each of the experiments.*

*Start with the water experiment by reading the question out loud "How does water affect plant growth?". Ask students what the independent variable is for the*

*experiment. The answer is the water. Students can record the independent variable in the Soybean Workbook.*

*After reading the hypothesis out loud allow students time to fill in what they think will happen. During this time circulate through the room to ensure that all students have the hypothesis filled in and to get an idea of what the majority of the class believes will happen.*

*Next, go through the materials and procedures for the experiment. Show students the materials as you go through them. Then read through the procedures. Allow students to ask questions if they do not understand the directions. As you go through the procedures be sure to stress the control variables of the experiment (these are the things that you will be keeping the same). For example, in the water experiment, the step that says to place both plants in a sunny location, stress that this is because we are only testing how water affects growth in this experiment and we don't want sunlight to have any effect on it. After going through all the steps of the procedure, asks students to identify at least four control variables (pot, soil, sun, time of measurement, types of plant, etc.).*

*Lastly review the data charts in the center of the workbook page. As the charts are reviewed, point out that the data that will be collected is the height of the plant. Ask students what type of variable height is. Students should answer dependent variable.*

*Cover each of the four experiments in the same manner (Water, Sunlight, Air, and Soil).*

Students should be prepared to start the experiment. While students are working on setting up their experiments, circulate the room to ensure that students are following the directions in their Soy Workbooks. Peat pellets will expand when water is added. Peat pellets will be used to plant seeds into except for the soil experiment where peat pellets and dirt from outside will be used.

After students are finished setting up their experiments, go over how plant measurements will be taken each week. Measurements should be taken using a ruler with one end of the ruler resting on the soil surface. Students should measure from the soil surface to the tallest leaf of the plant.

Measurements should be taken one day per week for three weeks. <u>During this time, it is important to follow a regular watering schedule for plants that receive water.</u>

**Lesson Part 2: Analyzing the experiment.**

Pass out crayons to each student.

Explain to students that today is the final day of the What do Plants Need Experiment. Students will be analyzing the data that they have been collecting over the last 3 weeks and presenting it to the class.

Have open their Soy Workbooks to the pages where they collected data for each of the experiments (pages 6-12). Each student should have data for the water, sun, air, and soil experiments.

Instruct students that they will be doing step number 5 of the scientific method, analyzing the data using line graphs. If students need a review this is a good time to go over the steps of the scientific method with them.

Work through the steps of creating a line graph.

1. Draw the X and Y axis
2. Title the graph
3. Label the Y axis with increments for measurements taken
4. Label the X axis with increments for measurements taken
5. Plot the data with points, then connect the points to form a line

Note: If there is more than one thing being graphed (like in our experiment control vs. dependent), use different color lines and a key

Have students turn to the Line Graph page in their Soy Workbooks (Pages 7, 9, 11, and 13). Have students work individually or in groups to create line graphs for each of their experiments. Circulate throughout the room during this time checking students' progress and that graphs are being created correctly.

After all graphs are complete, have students discuss within their groups what they think is the most important for plant growth.

**Wrap Up:**

Pass out the posters that groups created at the beginning of the experiment with what they thought was the most important for plant growth.

One at a time have groups present their findings to the class, explaining the data that they recorded in each experiment, and showing the class the graphs they created.

After sharing their graphs, have each group hold up their poster and share whether their data agrees with their original thoughts or led them to a new conclusion.

Did your thoughts on what a plant needs to survive change from Day #1?

Once all the groups have presented compare the thoughts of each of the groups. Was there one thing that stood out to the class as most important? Least important?

Ask the groups what they considered when deciding what affected growth the most. How did you decide what affects plant growth the most? Allow students to question each other and explain their reasoning when questioned.

**Further Resources:**

https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/edu/kthru6/

USDA Natural Resources Conservation Service Soils webpage designed for students grades K to 6 with information about soil.

https://www.youtube.com/watch?v=J3C6xiAbkPQ

Short 3:20 video about growing plants without using soil.

# Lesson Number Six: Why Soybeans? Humans and Animals

**Estimated Time:**

**Objective:**

Students will be able to describe how energy is transferred from the sun to plants and animals.

**Curriculum Standards:**

Fifth Grade:

5-PS3-1 Use models to describe the energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun

5-LS2-1 Develop a model to show the movement of matter among plants, animals, decomposers, and the environment

**Materials:**

Kit Supplies

- Lesson 6 Slides (https://docs.google.com/presentation/d/1q4BoiLlWTPL911UYkchb1MJwuL2wHRiZnitmxGJzgO8/edit?usp=sharing)
- Nutrition Labels (https://www.michigansoybean.org/uploads/1/3/7/2/137244386/lesson_6_nutrition_labels.pdf)
- Soybean Workbook
- Food Chain Cards (https://www.michigansoybean.org/uploads/1/3/7/2/137244386/lesson_6_food_chain_cards.pdf)

Optional Classroom Supplies

- Food Nutritional Labels

**Background:**

Soybeans are made up of two main components, oil and meal which is high in protein. Soybeans are an important source of protein and oil that are used in food, animal feed, paint, ink, and industrial applications all over the world. A 60-pound bushel of soybeans makes about 11 pounds of oil and 48 pounds of soybean meal (the ground up pulp). The oil and meal are both important and go into many foods and other products we use every day.

There are hundreds, perhaps thousands, of food products in which soybeans are an ingredient. In some food products, such as tofu and tempeh, soybeans are the main ingredient. Not only can soybeans be the star of the show, it is also found as an ingredient

in many food products we eat every day. Soybean oil is used in margarine, mayonnaise, salad dressing, cooking oil, and pharmaceuticals. Often soy cooking oil is sold at the grocery store labeled as "vegetable oil" or "vegetable shortening". Lecithin, extracted from soybean oil can be used in pharmaceuticals and as a natural emulsifier in chocolate candy.

Soybean meal is a protein-rich food that can be refined and made into soy flour, soy concentrate, or soy isolates. Soy flour can be used in baked goods, isolates can be used in high-protein drinks.

Besides being used in many of the food products that humans eat soybeans are an important part of many animals diets.

**Definitions:**

Energy
: The capacity for doing work, energy cannot be created or destroyed, only transferred

Food Chain
: A hierarchical series of organisms each dependent on the next as a source of food

Growth
: When a living thing undergoes natural development by increasing in size and changing physically, progressing to maturity

**Intro:**

Knowledge Questions- ask questions and solicit responses.

<u>What do you think that soybeans are used for?</u> – Responses will vary. Examples of responses could include human, animal, or industrial products. Humans eat soybeans in tofu, edamame, or in other processed products. Many different animals eat soybeans in their diet including livestock and wild animals. Many different industrial products are made from soybeans including hand sanitizer, road sealant, biodiesel, paint, etc.

**Lesson:**

Soybeans are a truly miracle bean because they are used for so many things! Today we will learn about how humans and animals use soybeans for energy.

Show the students the slide with the different food products on it. Ask students what they think these things have in common. Answers may vary but it is soybeans!

Have students think about what foods they like that might have soybeans in them. Students can bring in food labels from home, use food found in their classroom or cafeteria, find food labels online, or provided food labels. Have students take some time to see if their favorite snacks contain soybeans. When looking for soybeans on an ingredient label it could be listed as soybeans, soy fiber, soy flour, soy protein, soy lecithin, textured soy protein, and others.

Discussion questions- ask questions and solicit responses

What kinds of foods have you eaten with soybeans? - Answers will vary to this question.

Not only do humans eat soybeans as part of their diet, but many animals also love soybeans too! Pigs and chickens are one of the top soybean consumers in Michigan. Other animals such as cattle and fish are often fed soybeans too.

Show students the Feeding Soybean Hulls to Beef Cattle video (2 minutes) from the University of Kentucky.

Discussion questions- ask questions and solicit responses

Why do humans need to eat food? - Students might have different answers to this question such as because they are hungry. Allow students to speculate, then, explain to students that humans eat these food products to get the energy needed to grow and survive.

Have students get into groups for discussion and activity.

Ask each group to define energy, growth, and food chain. Allow time for groups to come up with definitions for each of the words.

Share group definitions with the class and come up with a class definition of the three words.

Knowledge Questions- ask questions and solicit resonses

- What do plants need to survive? – Students should know the answer to this question from Lessson 5 "What do Plants Need to Grow?" unless the measurement collection phase has not yet been completed. If not talk about how plants need water, sunlight, and air.

Plants get energy from the sun.

Go over how plants get their energy through the sun. The sun releases energy in the form of solar radiation.

Energy from the sun is formed by nuclear fusion that takes place inside the sun. The energy from the sun comes to earth in the form of electromagnetic radiation. Most of the electromagnetic waves emitted by the sun are high frequency and invisible to us (gamma rays, X-rays, ultraviolet radiation). The sun also emits infrared radiation, these waves are much lower in energy and felt in the form of heat. Between these high and low frequency waves is the visible light spectrum, or all of the colors that we see here on Earth!

Ask students if they have ever felt the warmth from the sun- this is energy!

Photosynthesis

Plants make their own food using the energy from the sun during a process called photosynthesis. Plants use the energy from the sun to change water and carbon dioxide into a sugar called glucose. Glucose is used by plants for energy and to make other substances like cellulose and starch.

Talk about what the students' plants looked like that didn't get sun in the "What do Plants Need to Grow?" experiment

Humans and animals get energy from plants

Explain to students that humans and animals need food to survive. Humans and animals get their energy from food.

Ask students if they know what type of food different animals eat

Respiration

Animals and humans have mitochondria in their cells which use sugars to generate chemical energy to power their cells through a process called respiration.

Animal Food Chain Activity

Pass out the Animal Food Chain cards to students in their groups.

Explain to students that the cards should be put in order of how energy flows through the food chain, thinking back to the earlier discussion of how plants get their energy from the sun and humans and animals get their energy from food.

Allow students time to work through the activity with their groups.

Once the activity is finished groups can present their food chain to the class.

**Summarize:**

Discuss how the sun provides energy to the plant and the plant provides energy to the rabbit. The energy in the rabbit's food comes from the sun. Students should understand that the models represent the transfer of energy.

# Lesson Number Seven: Why Soybeans? Industrial Products

**Objective:**

Students will be able to identify products made with soybeans and how they impact their everyday lives.

**Materials:**

Kit Supplies

- Lesson 7 Slides (https://docs.google.com/presentation/d/1TzkYzdCmuBDAZT5sozhXfLCeUC2WFLnYQiY1UDz5Unc/edit?usp=sharing)
- Soybean Workbook
- Soybean Uses Poster

**Background:**

Soybeans are made up of two main components, oil and meal which is high in protein. Soybeans are an important source of protein and oil that are used in food, animal feed, paint, ink, and industrial applications all over the world. A 60-pound bushel of soybeans makes about 11 pounds of oil and 48 pounds of soybean meal (the ground up pulp). The oil and meal are both important and go into many foods and other products we use every day.

There is just as much diversity in the types of inedible products that soybeans are found in. Soybean oil can be found in products such as cosmetics, herbicides, disinfectants, and more. Soybean meal is used in everything from adhesive to antibiotics to plywood. Soybean meal is also commonly fed to livestock animals as a good source of protein. Pigs and chickens love having soybeans as part of their daily diet!

**Definitions:**

Invention
: A unique or novel device, method, composition, or process

Inventor
: A person who invented a particular process or device or who invents things as an occupation

**Intro:**

As homework or a pre-reading assignment have students read the Soybean Uses article on Page 23 of the Soybean Workbook.

**Lesson:**

Knowledge Questions- ask questions and solicit responses

- Have you ever used a product that is made out of soybeans? – Answers vary.

Show students the Michigan Soybean- Oh the Places They Will Go! Video (3:56).
Ask students if they have ever used any of the products shown in the video.

Have students visit soynewuses.org and take a look at all of the products that are made with soybeans. The Common Uses tab gives a general overview of soybean uses. The Soybean Products tab gives an in depth look at products with soybeans in them.

Discussion Questions- ask questions and solicit responses

- Why do you think that soybeans are used in so many different products? – Soybeans are a renewable resource. Its oil and meal can be used to replace petroleum and other volatile ingredients in many industrial and consumer products.

Show students the Goodyear: Better and Better video (1:06).

Go over the definitions of invention and inventor with students.
Invention- A unique or novel device, method, composition, or process
Inventor- A person who invented a particular process or device or who invents things as an occupation

Discussion Questions- ask questions and solicit responses

- Can you think of any problems in your everyday life that could be solved with a soy-based product? – answers vary
- Can you invent a new product with soybeans in it? – answers vary

Have students turn their Soybean Workbooks to Page 15. Give students time to come up with a soybean invention to solve a problem in their everyday life.

**Summarize:**

Have students share their invention with the rest of the class. As they share their invention have them answer the questions: What problem does this solve in your life?

# Lesson Number Eight: Renewable Resources: Soybean Biodiesel

**Estimated Time:**

**Objective:**

Students will be able to differentiate between renewable and non-renewable resources by providing examples of each and advantages and disadvantages of using each.

**Curriculum Standards:**

Third Grade:
- 3-G5.0.2 Locate natural resources in Michigan and explain the consequences of their use

Fourth Grade:
- 4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment

Fifth Grade:
- 5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment

National Agriculture Literacy Outcomes
- T2.3-5 Distinguish between renewable and non-renewable resources used in the production of food, feed, fuel, fiber (fabric or clothing) and shelter

**Materials:**

Kit Supplies
- Lesson 8 Slide Deck (https://docs.google.com/presentation/d/1muMkxXV19tumh2BrrDDJaK2-KKly7ZKN0T_oYA_i7ws/edit?usp=sharing)
- Soybean Workbook
- Resource cards (https://www.michigansoybean.org/uploads/1/3/7/2/137244386/lesson_8_resource_cards.pdf)

**Background:**

Most trucks, buses, and tractors burn diesel fuel, a petroleum based, non-renewable resource. Using a petroleum-based fuel means tapping into a limited supply of fossil fuels that took millions of years to develop. Other consequences of using diesel fuel include: it is toxic, it adds pollutants to the air, it can be dangerous to the environment if spilled and it can be costly to import the necessary oil to make the fuel.

Many commercial producers are offering biodiesel as an alternative to diesel. Biodiesel is a fuel made from animal fats and vegetable oils, the most common of which is soy biodiesel. Soy biodiesel produces less air pollution that diesel, is non-toxic, is a renewable resource,

and is biodegradable. In Michigan, soybeans are the second most produced commodity, therefore, supporting soy biodiesel helps these producers and Michigan's economy. Vehicles that have diesel engines can use soy biodiesel without modifications. There are variants as to the extent that biodiesel can be used; one can use a blend with regular diesel or 100% soy biodiesel (B100). Some school districts are using B20 (soy biodiesel that consists of 20% soy biodiesel and 80% diesel) to fuel their bus fleets.

**Definitions:**

Biodiesel
: A fuel that is made from renewable resources that is vegetable oil- or animal fat-based

Diesel
: A fuel made from petroleum

Fossil Fuel
: A material that is the underground remains of a once living plant or animal that can be extracted and burned for energy

Fuel
: A material that produces heat or power by burning

Natural Resource
: Available raw material in the earth that can be drawn on by need

Non-Renewable Resource
: Raw material that cannot be replaced

Petroleum
: An oil found underground; it is a fossil fuel

Renewable Resource
: Raw material that can be replaced

**Intro:**

Knowledge Questions- ask questions and solicit responses

- <u>What are natural resources?</u> – Available raw material in the earth that can be drawn on by need.
- <u>What are renewable and non-renewable resources?</u> – Renewable resources are raw materials that can be replaced. Non-renewable resources are raw materials that cannot be replaced.

Present the definition of a natural resource to students.

Work with the class on breaking down the words renewable and non-renewable.

Point out the word renew that students should be familiar with (ex. Renewing library books)

Point out the suffix -able and have students discuss what this means

Point out the prefix non- and have students discuss what this means

Ask students what they think a renewable natural resource is versus a non-renewable natural resource. Allow students to discuss.

**Lesson:**

Show students the Difference Between Renewable and Non-Renewable Resources video (3:25).

Next, pass out the resource cards. Students can work alone or in groups to sort the resource cards out into renewable and non-renewable resources. Once students are finished sorting have them explain why they sorted the resources the way that they did.

Discussion Questions- ask questions and solicit responses

- What do you think would be some advantages of renewable energy sources? – Energy will never run out, lower carbon emissions, cleaner air and water,
- What do you think are disadvantages of renewable energy sources? - Higher costs for new infrastructure, unreliable energy production, must be able to store energy

Diesel vs. Biodiesel Comparison

Knowledge Questions- ask questions and solicit responses

- What is a fossil fuel? – a material that is the underground remains of a once living plant or animal that can be extracted and burned for energy
- Can you name three different fossil fuels? – coal, crude oil, natural gas

Explain to students that now we are going to compare two fuels, one made from a renewable resource, and one made from a non- renewable resource: Biodiesel and diesel. Biodiesel is an alternative to diesel fuel that can be made from soybeans!

Show students the Making Biodiesel: How U.S. Soybeans Became America's Advanced Biofuel video (1:40).

Next, have students complete the investigative reading of the article titled "Beans Give Gas" found on Page 16 of the Soybean Workbook.

Show students the B100 Brings Better, Cleaner Now to Nation's Capital Fleets video (3:05).

After watching the video and doing the investigative reading about biodiesel and diesel have students fill in the Compare and Contrast Diesel and Biodiesel Venn diagram found on Page 17 in their Soybean Workbooks. The Venn diagram should include similarities and differences between biodiesel and diesel along with advantages and disadvantages of each. Answers are provided in the Soybean Workbook Teacher Guide (https://www.michigansoybean.org/lesson-plans--workbook-answer-key.html).

Biodiesel and Diesel Discussion Questions- ask questions and solicit responses from students

**Summarize:**

Ask students- Do you think that vehicles should be required to use biodiesel instead of diesel? Students will have different opinions on this question. There is no right or wrong answer. Many states across the U.S. have biodiesel requirements or are working on

| |
|---|
| implementing biodiesel requirements through legislation. Currently, Michigan does not have any biodiesel regulations. |
| **Further Resources:**<br><br>https://kids.frontiersin.org/articles/10.3389/frym.2015.00010<br>In depth look into how biodiesel is produced. Goes into the scientific processes used to create biodiesel.<br><br>https://www.biodiesel.org/using-biodiesel/finding-biodiesel/retail-locations/retail-map<br>This map shows the registered biodiesel retailers across the United States. Sometimes the map takes a second to load. Red dots will indicate locations of retailers. From there students can zoom in and out to see retailers near them. Students can use this map to see if there are any biodiesel retailers near their hometown. How close is the nearest retailer to your hometown? How does Michigan's number of biodiesel retailers compare with other states? Why do you think this is the case? What states do you think have the most biodiesel retailers? Are there any states that don't have any biodiesel retailers? How do you think that we could increase the number of biodiesel retailers in states where there aren't very many? |

# Lesson Number Nine: Where has the Soybean Been?

**Objective:**

Students should be able to describe where soybeans are grown and used and how this impacts trade across regions.

**Curriculum Standards:**

Third Grade:

3-G2.0.1 Use a variety of visual materials and data sources and describe ways in which Michigan can be divided into regions

3-G2.0.2 Describe different regions to which Michigan belongs

3-E3.0.1 Identify products produced in other countries and consumed by people in Michigan

Fourth Grade:

4-G2.0.1 Describe ways in which the United States can be divided into different regions

**Materials:**

Kit Supplies

- Lesson 9 Slides (https://docs.google.com/presentation/d/1U9J9QrabSuLZxyrBiqtg_wzpCA9uV3gvHaBn3YoupDg/edit?usp=sharing)
- Soybean Workbook
- Production Maps found on the For Students Page (https://www.michigansoybean.org/for-students.html)

**Background:**

Soybeans originated in Asia and farmers in China have been producing soybeans for over 5,000 years. Aside from food, the Chinese also used soybeans for fertilizer, animal feed, medicines, and oils. The soybean first entered America between the late 1700s and the early 1800s and was produced for feeding both people and animals. For example, during the Civil War, a coffee substitute made from roasted soybeans was used in place of the scarce coffee beans (called coffee berries).

Today the leading producers of soybeans are America, Brazil, and Argentina. The top countries that import soybeans from Michigan are China, Canada, Mexico, South Korea, and Japan. Trade is an important global concept and is important to soybean growers in the state of Michigan. The U.S. exports over 2 billion of the 4 billion bushels of soybeans grown each year. Because of this, trade plays an important role in the soybean industry.

**Definitions:**

Export
Send goods or services to another country for sale
Import
Bring goods or services into a country from abroad for sale

**Intro:**

Have students read "Where has the Bean Been?" article for homework the night before or as a pre-reading assignment found on Page 19 of the Soybean Workbook.

Discussion Questions- ask questions and solicit responses

- What were some key points in the history of the soybean? - Answers will vary, students could answer any of the facts listed in the article.
- How did historical events influence the use of soybeans? – During the Civil War soybeans were used to brew a coffee like drink due to coffee bean shortages. This led to an increased use of soybeans in the United States during the war. After the Civil War the use of soybeans increased as farmers began planting soybeans for their livestock. World War II caused soybean production to take off in the United States. China halted production due to the war and revolution in their country. When the U.S. joined the war the increased demand for oils, lubricants, plastics, and other products led to an increase in demand for soybeans. After World War II the U.S. experienced a time of prosperity which led to an increase in meat consumption. This led to an increase in soybean demand.

**Lesson:**

We now know a little bit about how the soybean came be grown all around the world, so let's learn where the soybean is grown and used today.

Show students the slide with the world map.

Ask students what countries they think might produce soybeans today.

The next slide shows the 11 countries that produce the most soybeans. They are (in order of production 2017-2018)- United States, Brazil, Argentina, China, India, Paraguay, Canada, Ukraine, Russia, Uruguay, and Bolivia. Besides these, other countries produce soybeans in smaller amounts.

Which of those countries mentioned is the furthest away from Michigan? Or the closest to Michigan? (This is the distance from Lansing, MI to each country's capital city)

Brazil- 4,663 miles
Argentina- 5,590 miles
China- 6,574 miles
India- 7,368 miles (India is the furthest away from Michigan)
Paraguay- 4,999 miles
Canada- 550 miles (Canada is the closest to Michigan)

Ukraine- 4,905 miles
Russia- 4,838 miles
Uruguay- 5,652 miles
Bolivia- 4,221 miles

The next slide shows which countries produce 82% of the world's soybeans. These three countries are the United States, Brazil, and Argentina. Although soybeans are produced in many countries all over the world most of the production occurs in only three countries.

Why do you think that most of the production occurs in these three countries?

The story of Brazil and Argentina's growth is complex, and students do not need to understand its entirety. Students should understand that there are many different factors making these countries the top soybean producers in the world including the amount of arable land, political climate, infrastructure availability, economy, etc.

Since the 19070s the soybean industry has changed dramatically. China and the United States had dominated the market for years while Brazil and Argentina were essentially startups in the industry. By the end of the 1980s Brazil and Argentina had both seen an explosion of growth of soybeans in their countries. Brazil and Argentina have seen explosive growth in soybean production due to; political reforms that have helped create a more stable business environment when dealing with other countries, more efficient transportation of soybeans and a stronger infrastructure than in the past, high international soybean prices during a time of economic and political reforms that favored production, improved farm practices that helped expansion of farmland, lower cost of production than the United States, and finally due to the large amount of arable land and favorable climates.

Show students the slide with the map of the United States.

Ask students which states they think produce soybeans in the United States.

The next slide shows the 29 states that produced soybeans during the 2021 crop year.

Ask students why they think that these states produce soybeans compared to other states which do not produce soybeans. These states produce soybeans because of climactic conditions, proximity to ports or other processing facilities, arable land availability, infrastructure, etc.

The next slide shows the top three soybean producing states and where Michigan ranked in terms of acres planted during the 2021 crop year. The top three states for soybean production are Illinois (10.6 million acres), Iowa (10.1 million acres), and Minnesota (7.7 million acres). Michigan came in #13 with 2.15 million acres planted in 2021.

Show students the state of Michigan slide.

Ask students to locate their county on the map. Do they think that their county grows soybeans?

The next slide shows the soybean acreage by county across the state of Michigan for the 2020 cop year. Darker colors indicate more acres of soybeans in the county. Counties that are white did not publish their data for the 2020 crop year. The Upper Peninsula of Michigan has historically had low soybean acreage but has been increasing in recent years. The northern lower peninsula has also had expanding acreage in recent years.

The next slide shows the top three soybean producing counties in Michigan in 2020. They were Lenawee, Sanilac, and Saginaw counties.

Next, we will look at where Michigan's soybeans go.

Ask students where they think that Michigan sends many of their soybeans to.

The next slide shows where the majority of the soybeans in the state of Michigan are exported to. The top countries for exports of Michigan soybeans are China, Canada, Mexico, South Korea, and Japan.

What does it mean to export and import? Go over the definitions of exports and imports with students.

Discussion Questions- ask questions and solicit responses

Do you thing soybeans are the only product that we eat and use here that didn't originally come from our country? – No, there are many other products that Michiganders consume that are originally from other places in the world.

If not, what other types of products do we consume that are originally from other places in the world? – There are many answers to this question, spices, technology, tea, fuels, plastics, etc.

While Michigan exports many of their beans to countries around the world. The United States also imports many goods from these same countries.

The next slide shows the top import overall along with the top agricultural import from each of the top countries that Michigan exports soybeans to. Below is a list of all the top imports from each of the countries.

China

Top Imports: Electrical Machinery, Machinery, Furniture and Bedding, Toys and Sports Equipment, Plastics

Top Agricultural Imports: Processed Fruits and Vegetables, Snack Foods, Spices, Fresh Vegetables, Tea

Top Exports: Electrical Machinery, Machinery, Aircraft, Optical and Medical Instruments, Vehicles

Top Agricultural Exports: Soybeans, Pork and Pork Products, Cottom, Tree Nuts, Hides and Skins

Canada

Top Imports: Mineral fuels, Vehicles, Machinery, Plastics

Top Agricultural Imports: Snack Foods, Red Meats, Vegetable Oils, Processed Fruit and Vegetables, and Fresh Vegetables
Top Exports: Vehicles, Machinery, Electrical Machinery, Mineral Fuels, Plastics
Top Agricultural Exports: Prepared Food, Fresh Vegetables, Fresh Fruit, Snack Foods, Non-alcoholic Beverages

Mexico

Top Imports: Vehicles, Machinery, Electrical Machinery, Optical and Medical Instruments, Mineral Fuels
Top Agricultural Imports: Fresh Fruit, Fresh Vegetables, Wine, Beer, Snack Foods, and Processed Fruit and Vegetables
Top Exports: Machinery, Electrical Machinery, Mineral Fuels, Vehicles, and Plastics
Top Agricultural Exports: Corn, Soybeans, Dairy Products, Pork and Pork Products, Beef and Beef Products

South Korea

Top Imports: Vehicles, Machinery, Electrical Machinery, Plastics, Mineral Fuels
Top Agricultural Imports: Baked Goods, Cereals, Pasta, Processed Fruits and Vegetables, Manufactured Tobacco, Non-alcoholic Beverages, Food Preparations
Top Exports: Mineral Fuels, Machinery, Electrical Machinery, Optical and Medical Instruments, Vehicles
Top Agricultural Exports: Beef and Beef Products, Corn, Fresh Fruit, Pork and Pork Products, Food Preparations

Japan

Top Imports: Vehicles, Machinery, Electrical Machinery, Optical and Medical Instruments, Pharmaceuticals
Top Agricultural Imports: Baked Goods, Cereals, Pasta, Distilled Spirits, Condiments and Sauces, Tea, Food Preparations
Top Exports: Mineral Fuels, Machinery, Optical and Medical Instruments, Aircraft, Electrical Machinery
Top Agricultural Exports: Beef and Beef Products, Corn, Pork and Pork Products, Soybeans, Wheat

The U.S. is the 2nd largest goods exporter in the world. Canada was the largest purchaser of U.S. goods exports in 2019. The top five purchasers of U.S. goods in 2019 were: Canada, Mexico, China, Japan, and the United Kingdom. The U.S. is the largest goods importer in the world. China was the top supplier of goods to the U.S. The top five suppliers of U.S. goods imports in 2019 were: China, Mexico, Canada, Japan, and Germany.

If students are interested in other countries, information can be found on this website: https://ustr.gov/countries-regions.

Discussion Questions- ask questions and solicit responses

Why is it important for countries to trade with one another? – There are many benefits of trading with other countries. With trade, individuals are able to focus on doing the things they do best and then exchange the products of their labor with others who are concentrating on their own areas of expertise. This leads to higher levels of production and efficient use of labor and resources. Trade allows for competition, innovation, and economies of scale which allows for increased choice

in the marketplace. This means that consumers are able to buy a wider variety of goods at a lower price.

Instruct students to complete the map pages in their Soybean Workbook, found on Pages 20 and 21, using the maps found on the Student Page (https://www.michigansoybean.org/for-students.html) along with any other maps or resources in the classroom or online.

Answers are provided in the Soybean Workbook Teacher Guide (https://www.michigansoybean.org/lesson-plans--workbook-answer-key.html).

Discussion Questions- ask questions and solicit responses

- How do the regions of Michigan affect the transfer of goods within the state? – Production of good varies widely across the state of Michigan. For example, apples grow along the coast of Lake Michigan due to the lake effect. The lake effect causes a delay of warm up in the spring, creates a cool wet summer, and brings lots of snow in the winter. The perfect conditions for growing apples. Sugar beets are grown in the thumb area of Michigan. This area of Michigan has the right soil for growing sugar beets. It is also close to processing facilities. Sugar beets are large and heavy making them hard to move very far. Each of these areas specializes in their own crops. This allow for greater efficiencies; very different equipment is used to harvest the two crops. Because these crops are grown on opposite sides of the state, they must be transported. Apples will be shipped to Meijer stores in the thumb region while sugar from the Pioneer Sugar factory will be shipped to stores along Lake Michigan.
- How do the regions of the U.S. affect the transfer of goods within the country? – Similar to the state of Michigan, production of goods varies widely across the United States. The same sort of specialization occurs but on a much larger scale. For example, cotton is only grown in the south. Here in Michigan, we are not able to produce cotton because of our climate. But we are still able to buy cotton t-shirts at the store.

# Lesson Number Ten: Famous Soybean Scientists

**Objective:**

Develop an awareness of the contributions made to science by people of diverse backgrounds around the world.

**Materials:**

Kit Supplies

- Lesson 10 Slides (https://docs.google.com/presentation/d/1vVbADBEaZSPhZaEuNAuOtGkzWV-zo3lrGbKnam3WcO0/edit?usp=sharing)
- Soybean Workbook

**Background:**

George Washington Carver and Percy Lavan Julian were both Black scientists who contributed significantly towards soybean advancements despite facing great diversity. Washington Carver (born in 1864) and his mother were kidnapped by Confederates when he was an infant. Fortunately, Carver was later rescued and raised by a Black farmer and his wife. George Washington Carver became an agriscientist. In addition to discovering that soybeans are a significant source of protein and oil, he used soybean in creating soymeal, a coffee substitute and breakfast foods. He also saw the soybean and other agricultural crops as being useful for industry, such as the automobile industry.

Percy Lavon Julian (born in 1899) also faced hardship. He had little formal schooling due to the limited educational access for Black Americans. However, due to his parents' strong belief in education, Julian received sufficient informal educational experiences to be accepted as a student to DePauw University. He became a researcher and physician who used soybeans for medical-related inventions like a synthetic version of cortisone. Which was incredibly beneficial for relieving the pain of rheumatoid arthritis and was drastically cheaper than real cortisone, making it accessible to the public. Later, Julian invented aerofoam, a flame retardant that was used considerably by the Navy in World War II.

**Definitions:**

Agriscientist
: A scientist researching the science of agriculture

Physician
: A person trained in the art of healing, such as a Doctor of Medicine

Researcher
: A person who carries out academic or scientific research

**Intro:**

Ask students to look at the pictures of the two men on the screen. The man on the left is George Washington Carver. The man on the right is Percy Lavon Julian. Ask the students- Based on these photographs can you make inferences about these two men? What are their jobs? When were they alive? Where are they from?

**Lesson:**

Have students open their Soybean Workbook to the Soybean Scientists article on Page 22. Allow students time to read the article which covers the lives of George Washington Carver and Percy Lavon Julian. Alternatively, the article could be read aloud as a class.

Discussion questions- ask questions and solicit responses

- What are some key similarities between the two men that you learned from the article? – Both men were born in the 1800s during a time of racial discrimination, both men experienced difficulties obtaining an education because of the color of their skin, both men researched soybeans as part of their life work, both men left behind significant contributions to the agriculture industry.
- Percy Lavon Julian was a researcher and a physician. Describe the duties of a researcher and a physician. – A physician is a person trained in the art of healing such as a Doctor of Medicine. When most people think of a physician their duties include taking medical histories, prescribing medicine, ordering or performing tests, etc. A researcher is a person who carries out academic or scientific research. Duties of a researcher include determining areas to study, identifying sources of project funding, planning and performing experiments and surveys, collecting, recording and analyzing data, etc.
- George Washington Carver was an agriscientist. What do you think that an agriscientist studies? – An agriscientist studies the science of agriculture.

Show students the George Washington Carver video (1:01).

Discussion questions- ask questions and solicit responses

- What challenges did Carver face in seeking an education? – Starting when he was young, Carver moved many times before he graduated high school. He was rejected from college when they found out he was Black.
- How did Carver overcome these challenges? – Though he moved many times, Carver was able to graduate high school. When he was rejected from schools he kept applying before finding a school that would accept him. Carver persevered through adversity to go on to become a renowned agriscientist.

Show students the Black History Month- Percy Lavon Julian video (1:47).

Discussion questions- ask questions and solicit responses

- What challenges did Julian face in seeking an education? – Julian was accepted to his university as a sub-freshmen meaning he had to take high school classes while also taking his college classes. He was not allowed to sleep in a dorm room on campus. He was turned down from graduate school because he was Black,.
- How did Julian overcome these challenges? – Julian managed his extra classes while working in a fraternity for a place to live. Later when he was rejected form

graduate school he applied to more schools before finding one that would allow him to come study. Julian persevered through adversity to go on to become a great researcher.

Historical Interviews

In this activity students will pair up and perform a mock interview of one of the scientists. One student will pretend to be the interviewer while the other student will pretend to be the scientist. Students will come up with 3-4 questions and answers for the interview. Once students have prepared their questions and answers they can perform their skit for the class. If students would like to further research the two scientists beyond the article and videos provided see the below resources.

George Washington Carver
https://www.usda.gov/media/blog/2014/02/25/more-peanut-man

https://www.thehenryford.org/collections-and-research/digital-collections/sets/6074/

Percy Lavon Julian
https://www.depauw.edu/julian/biography/

**Summarize:**

What contributions did these two men make to the history of soybeans?

How did the era that these two men were alive, affect their work?

# Lesson Number Eleven: Henry Ford

**Objective:**

Students will develop an awareness of Henry Ford's contribution to the soybean industry in Michigan and its economy and how this shaped Michigan as a whole.

**Curriculum Standards:**

Third Grade:

3-H3.0.1 Identify questions historians ask in examining the past in Michigan

3-G4.0.1 Describe major kinds of economic activity in Michigan today, such as agriculture, forestry, manufacturing, services and tourism, and research and development, and explain the factors influencing the location of these economic activities

3-G5.0.1 Describe how people are a part of, adapt to, use, and modify the physical environment of Michigan

3-G5.0.2 Locate natural resources in Michigan and explain the consequences of their use

3-E1.0.3 Analyze how Michigan's location and natural resources influenced its economic development

3-E2.0.1 Using a Michigan example, explain how specialization leads to increased interdependence

3-E3.0.1 Identify products produced in other countries and consumed by people in Michigan

Fourth Grade:

4-H3.0.1 Use historical inquiry questions to investigate the development of Michigan's major economic activities from statehood to present

4-H3.0.4 Describe how the relationship between the location of natural resources and the location of industries (after 1837)affected and continue to affect the location and growth of Michigan cities

4-H3.0.6 Use a variety of primary and secondary sources to construct a historical narrative about the beginnings of the automobile industry and the labor movement in Michigan

**Materials:**

Kit Supplies

- Lesson 11 Slides (https://docs.google.com/presentation/d/1ZFdexegUPB4eeTUKY5UytxFKJ-TbSUvcp6K_7cdeDuY/edit?usp=sharing)
- Full of Beans Henry Ford Grows a Car Book
- Soybean Workbook

**Background:**

Henry Ford was one of America's pioneers in the automobile industry, leading the way for production-line assembly to be replicated in many of today's modern marvels. Ford hoped to see a time when industry would conserve the non-renewable resources (ex. Coal, oil, natural gas) by using renewable farm products (timber, corn, soybeans). In trying to bridge farm crops and industry, he coined the term "chemurgy" (KEM-ur-jee). He had scientists experiment with various crops to discover crop viability in the industrial market. Ford wanted to assist farmers by discovering ways in which their crops could be used as renewable resources to support the industrial boom, thereby making farming more profitable.

**Definitions:**

Capital Resource
: A good produced for and used to make other goods or services (such as buildings, equipment, tools, or cash)

Chemurgy
: The development of new industrial chemical products from raw materials, especially agricultural products

Human Resource
: The amount of labor/work people put into making a product

Natural resource
: Available raw material in the Earth that can be drawn on when needed

Non-renewable Resource
: Raw material from the Earth that cannot be replaced

Renewable Resource
: Raw material from the Earth that can be replaced

**Intro:**

Review- ask questions and solicit responses

- <u>What are examples of natural resources that we use in everyday life?</u> – Answers will vary but could include coal, oil, water, soybeans, gold, etc.
- <u>What is the difference between renewable and non-renewable resources?</u> – Non-renewable resources can't be replaced or at least it would take a long time, since there is a limited supply of non-renewable resources, if the demand is too high, we will soon deplete these sources and they will no longer be available

Knowledge Questions- ask questions and solicit responses

- <u>What do you know about Henry Ford?</u> – Answers will vary, made an affordable automobile (Model T), most successful early car manufacturer, created the Ford Motor Company, didn't invest the assembly line but responsible for making the assembly line concept in production a key component in American industry
- <u>Why was his work such an important contribution to the industrialization of America?</u> – Similar answers to previous question

**Lesson:**

Read out loud to the class "Full of Beans Henry Ford Grows a Car" a copy of this book is included with each of the school kits.

Discussion Questions- Ask questions and solicit responses from students

- What do you think Henry Ford though about preserving the environment? How do you know? What types of things did he do to show this? –Ford was passionate about using renewable resources in his automobile industry.
- What do you think Henry Ford thought about the growth of the agriculture industry in Michigan? How do you know? What types of things did he do to show this? – Ford envisioned agriculture and industry having a special relationship to support each other's business. Ford had numerous things created out of soybeans for his industry ("a bushel of soybeans went into every Ford").

Investigative Reading: Instruct the class to read the article titled Henry Ford's Vision in the Soy Workbook on Page 26 and 27.

Discussion Questions- ask questions and solicit responses

- What did you learn about Henry Ford and his vision? – Henry Ford was passionate about conserving resources. He wanted to find a way for industry and agriculture to work together.
- Why do you think that Henry Ford was so far ahead of his time in paying his workers a living wage? – Working on the assembly line was hard work and Henry Ford had high worker turnover. Ford decided to double his workers' pay to $5 and decreased work from 9 hours to 8 in hopes that they would be willing to continue working under the harsh conditions. Also, by paying higher wages, Ford hoped to create a new class of buyers for his product. The $5 a day wage come with other requirements including a company school to learn English and certain character requirements that must be followed. Raising the wage of his workers helped Ford stabilize his workforce.
- How did the Great Depression affect Henry Ford and soybeans? – Henry Ford hated waste. He wanted to recycle and reuse everything. Henry discovered that soybeans were very versatile and could create a new market for farmers.

Next, have students open their Soy Workbook to the Henry Ford's Life on Page 24 and 25. Instruct students to fill in the blank spots on the timeline.

While students are filling in the timeline sheet circle the room asking probing questions such as: Who was involved in this event? Why did this event happen?

Answers are provided in the Soybean Workbook Teacher Guide (https://www.michigansoybean.org/lesson-plans--workbook-answer-key.html).

Timeline Answers:

Foam seats in the Ford Mustang- 2008

One bushel of soybeans used in every car- 1935

Introduction of the Model T- 1908

End of the Civil War- 1865

U.S. enters World War II- 1941
Formation of the Ford Motor Company- 1903
Henry Ford starts to research soybeans- 1931
Goodyear Tire announces soy oil in their tires- 2021

**Summarize and Connect:**

Discussion Questions- Ask questions and solicit responses from students

- What does Michigan's automobile industry look like right now? Is it thriving? – In 2017 the automotive industry in Michigan produced 2 million vehicles off of 11 assembly lines. This was 18.5% of the total automobiles produced in the United States. There are 1,6000 automobile related manufacturing establishments in Michigan. From 2012 to 2017, automobile related jobs increased by 11.3% in Michigan.
- What about Michigan's agriculture industry, like soybean production, how is that doing? – In 2020 Michigan planted 2.2 million acres of soybeans with an average yield of 47 bushels per acre which was slightly lower than the national average of 50.2 bushels per acre. Currently as of Fall 2021, the agriculture of economy in Michigan is experiencing a strong market and is in a good economic position.
- Thinking about Henry Ford and his vision, do you have any ideas about how soybean production in Michigan could help our economy? – answers vary

**Further Resources:**

https://www.thehenryford.org/collections-and-research/digital-collections/
The Henry Ford Museum digital collections. Students can search "soybean" in the search bar to explore museum artifacts related to soybeans. Also, on the right-hand side students can click either "Henry Ford" or "Agriculture and the Environment" to see artifacts from Henry Ford's life and work along with artifacts from early agriculture in America.

https://www.youtube.com/watch?v=hu3B4t0to6A
Six minute video from Michigan Farm Bureau about Henry Ford and the transition to modern day uses of soybeans at Ford Motor Company with the introduction of SoyFoam Seating Technology which Michigan Soybean Committee helped to fund research on.

https://www.youtube.com/watch?v=kS6e797W4iA
Three minute video put out by the Henry Ford Museum about Henry Ford and his love of soybeans. Includes examples of soy foods that Ford ate and information about the soy based car.

https://www.thehenryford.org/collections-and-research/digital-collections/expert-sets/7149/
Curated collection of 15 artifacts from The Henry Ford Museum compiled in 2013 on the 150th anniversary of Henry Ford's birth.

https://www.youtube.com/watch?v=jOiADikymkE
Quick 1:06 video about the Model T

# Lesson Number Twelve: Traits and Heredity

**Objective:**

Students will be able to explain that DNA is the set of instructions for an organism and that offspring inherit traits from their parents.

**Curriculum Standards:**

Third Grade:

3-LS3-1 Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms

**Materials:**

Kit Supplies

- Lesson 12 Slides (https://docs.google.com/presentation/d/1e7kDFl0mlyHtZQsNFooDx_xCRRgIPf__QRQIQI3zT_o/edit?usp=sharing)
- Soybean Workbook
- Crayons

Required Classroom Supplies

- Dice (1 per student)

**Background:**

All living organisms contain DNA within their cells. The DNA is a set up instructions that makes up the "recipe" of an organism's traits. Information in a DNA strand is grouped into small segments called genes. Each of these segments is made up of even smaller units called nucleotides. This is like how a book is made of words and each word is made up of letters. Differences in the way that nucleotides are arranged results in different traits (just like different letters make up different words!). Every cell contains a complete set of instructions for all the organisms' processes. However, besides providing the instructions for the organism DNA also is the primary hereditary unit of organisms.

**Definitions:**

DNA (deoxyribonucleic acid)
: Molecule that stores the genetic code of an organism

Gene
: Parts of DNA that carry trait information

Genotype
: The genetic makeup of a particular organism

Inherited Trait
: A characteristic passed down from parent to offspring

Natural Variation

A process in which some individuals are better adapted to survive and reproduce

Nucleotide

Building blocks of DNA

Species

A group of organisms that can reproduce and have offspring under natural conditions

Trait

A characteristic that can be inherited

**Intro:**

Show students the video titled What are Traits? This video is not on YouTube so the slide contains an external link. Click the red button to be taken to the website.

**Lesson:**

Show students the slide titled "What do these things have in common?"

Ask students what they might use each of these for and what they might have in common. Allow students to discuss their answers.

Explain to students that just like a recipe is instructions to bake a dessert or a blueprint is instructions to build a house, DNA contains instructions for the traits of an organism.

Go through the definitions of DNA, gene, and nucleotide for students. It is likely that students are unfamiliar with these definitions and a thorough understanding will help during the following activity.

DNA- Molecule that stores the genetic code of an organism
Gene- Parts of the DNA that carry trait information
Nucleotide- Building blocks of DNA
Trait- A characteristic that can be inherited

Traits Activity

In this activity students will create and decode a DNA "recipe" to observe how variations in DNA lead to the inheritance of different traits. The roll of a die is used to randomly select combinations of nucleotides to create a DNA sequence. Students then read the DNA sequence and compare it with others in the class to note similarities and difference.

Pass out dice (one per student)

Read together the top paragraph in the Soybean Workbook.

A set of instructions called DNA makes up the "recipe" for an organism's traits. Information in a DNA strand is grouped into small segments called genes. Each of these segments is made up of even smaller units called nucleotides. This is similar to how a book is made of words and each word is made of different letters. Differences in the way the nucleotides are arranged results in different traits (just like different letters make up different words!

Explain to students how the activity works.

- Students will start by rolling their die for their first trait (Head). The number which the student rolls will determine the sequence of nucleotides for that specific trait.
- Students will match the number that they rolled with the nucleotide sequence according to the dice on the top portion of the page.
- This sequence of four letters is then written in the Head portion of the DNA sequence.
- This continues until each of the five traits (Head, Ears, Tail, Fur, Color) is filled in.
- Once the DNA sequence is complete, students can than match their sequence up to each trait in the charts below. For example, a student with the Head sequence A T C G would have a dog with a square head. Students can circle the correct trait on their chart that matches their DNA sequence.
- Once students match their DNA sequence up the correct trait, have each student draw their dog, either in their Soybean Workbook or on a separate sheet of paper for display in the classroom.

Allow students to work either alone or in pairs to complete the activity.

Discussion Questions- ask questions and solicit responses from students.

- <u>Are any of our two dogs alike? Why or why not?</u> - Students will have varying responses to this question. Point out that all the dogs share some traits in common with others but that each dog has an overall combination of traits that is unique.
- <u>How do you think that DNA affects a soybean plant? What sort of traits might a soybean plant inherit?</u> – Students will have varying responses to this question, but DNA works the same way in soybeans as it does in dogs. DNA codes for various traits in the soybean such as color, height, number of leaves, number of branches, stem thickness, root length, protein content, oil content, etc.

**Summarize and Connect:**

Just like a recipe or house blueprints, DNA is the instructions for an organism. DNA allows an organism to pass its traits to its offspring.

# Lesson Number Thirteen: Changing Genetics

**Objective:**

Students will be able to describe how genetics can change over time and distinguish between natural selection, artificial selection, and genetic engineering.

**Curriculum Standards:**

Third Grade:

3-LS3-1 Use evidence to support the explanation that traits can be influenced by the environment

3-LS4-1 Use evidence to construct an explanation for how the variations in characteristic among individuals of the same species may provide advantages in surviving, finding mates, and reproducing

**Materials:**

Kit Supplies

- Lesson 13 Slides (https://docs.google.com/presentation/d/1fZfvyTC64KaFXqoEBTL3RFna0V3C2mcuFu1g9jYamJI/edit?usp=sharing)
- Soybean Workbook
- 160 Red Pom Poms
- 160 Black Pom Poms
- Black Felt (2 pieces)
- Red Felt (2 pieces)
- Cups (1 per student)
- Spoons (1 per student)

Required Classroom Supplies

- Coins

**Background:**

Throughout time, the genetic code of all plants and animals has been changing and evolving. This has allowed humans to domesticate and grow many of the plants and animals that we use for food. Without the evolution of genetic traits, we would not have corn, broccoli, kale, or many other crops.

Genetic change happens through various means. One example is natural selection. Natural selection is the process by which organisms better suited to their environment survive and produce more offspring. Natural selection has allowed plants and animals populations to change as their environment changes, whether through climate change, natural disasters, or other means. Artificial selection is the process by which humans breed plants and animals for particular traits. Artificial selection has been occurring for thousands of years, ever since humans began to grow food. In fact, cabbage, brussel sprouts,

kohlrabi, kale, broccoli, and cauliflower were all artificially selected from the same plant. A more modern form of genetic change is genetic engineering. This is the process by which an organism's genes are manipulated by introducing, eliminating, or rearranging specific genes using methods of modern molecular biology. Genetic engineering has allowed scientists to create crops that produce more food which will help to feed our growing population.

**Definitions:**

Artificial Selection
: Process by which humans breed plants and animals for particular traits

Genetic Drift
: Change in allele frequency due to random chance

Genetic Engineering
: Process by which an organism's genes are manipulated by introducing, eliminating, or rearranging specific genes using methods of modern molecular biology

Gene Flow
: Migration of genes, if individuals from a different population flood into an existing population, they can change the ration of alleles in a population

Inherited Trait
: A characteristic passed down from parent to offspring

Mutation
: Changes in genes that can create new alleles

Natural Selection
: Process by which organisms better suited to their environment survive and produce more offspring

Natural Variation
: A process in which some individuals are better adapted to survive and reproduce

Non-Random Mating
: Mating of individuals that is not random, individuals choose mates that display certain characteristics over others

Species
: A group of organisms that can reproduce and have offspring under natural conditions

Trait
: A characteristic that can be inherited

**Intro:**

Knowledge Questions- ask questions and solicit responses from students

- <u>Do you think that genes and traits change over time?</u> – Yes, population traits change over time. Evolution describes changes in inherited traits of a population over successive generations. The genes and traits of an individual do not change through evolution, those of the population change.
- <u>How do you think that genes and traits can change?</u> – Many different types of genetic change can occur. These include: genetic drift, non-random mating, mutations, gene flow, natural selection, artificial selection, and genetic engineering.

**Lesson:**

Although genetic change can occur through various means (genetic drift, non-random mating, mutations, natural selection, artificial selection, and genetic engineering), today we will learn about three ways that genes and traits can change over time. They are known as natural selection, artificial selection, and genetic engineering.

Natural Selection

Explain to students what natural selection is- process by which organisms better suited to their environment survive and reproduce more offspring.

Go through the natural selection infographic and explain how the grey mice are better suited to their environment (grey rock). This means that the grey mice are less likely to be eaten by the bird. Because fewer grey mice are eaten by the bird, they have a better chance of surviving and reproducing. This means that the next generation will have a greater proportion of grey mice.

There are three requirements for natural selection to occur. They are:

1. There is variation in traits within the population. This means that members of the population cannot be genetically identical.
2. There must be a difference in survivability of individuals with different alleles.
3. The trait must be heritable.

Next, the class will participate in an activity modeling natural selection.

Natural Selection Activity

- Split students into four groups. Each group should get the following supplies:
    - One piece of felt (two groups should have red felt and two groups should have black felt)
    - 50 red pom poms
    - 50 black pom poms
    - One cup and one spoon per student
- Have students make predictions about which color natural selection will select for
- When students are set up with their materials tell them that they each have 5 seconds to pick up as many pom-poms as possible and place them in their cup using only their spoon.
- Time the students for five seconds.
- When the round is complete have students count and record the number of red and black pom-poms in their soy workbook
- Repeat this two more times

Once students complete the runs of the experiment. Discuss with them how natural selection acted on these two populations.

How did natural selection differ between populations on the red felt vs. the black felt?

How many generations do you think it would take for the population to be all the same color?

Discussion Questions- ask questions and solicit responses

- What do you think would happen if after round #2 the black forest went through a drought and turned into a red grassland? – As long as the three criteria for natural selection are met natural selection would result in a population of red pom poms after continued generations.
- Next, suppose that natural selection resulted in only black pom poms surviving in the black forest and then a drought turned this population into a red grassland. Would natural selection for pom pom color occur? – No, natural selection for pom pom color would not occur. For natural selection to occur three things must be present: variation of traits within a population, difference in survivability, and traits must be heritable. This population would not have a variation of traits if they are all the same color when the forest turns into a grassland.

Natural Selection and Soybeans

Give students a few moments to look at the map of China's rainfall patterns (Red= lower rainfall, Blue= higher rainfall).

Ask students how rainfall might have affected natural selection of wild type soybeans in China.

Artificial Selection

Explain to students what artificial selection is- process by which humans breed plants and animals for particular traits.

Go through the artificial selection infographic with the students. Dog breeding is a very relatable example of how artificial selection works. All dogs are descendants of the wolf, but the use of artificial selection has allowed humans to drastically alter the appearance of dogs. For many centuries, dogs have been bred for various desired characteristic leading to a wide range of dog breeds. For example, Great Danes were bred to hunt wild boar, Basset Hounds were bred to hunt rabbits and badgers, Collies were bred to corral animals like sheep, St. Bernard's were bred to lead search and rescue missions, Golden Retrievers were bred to retrieve waterfowl, and so many more!

Not only has artificial selection been used to breed dogs but it is used in agriculture all the time! For example, broccoli, cauliflower, cabbage, Brussel sprouts, kohlrabi, and kale all were artificially selected from the same plant *Brassica oleracea*! Artificial selection appeals to humans since it is much faster than natural selection and allows humans to mold organisms to their needs.

Next the class will participate in an activity modeling artificial selection.

Artificial Selection Activity

- Divide students into teams

- Have students turn their soybean workbooks to the Artificial Selection page (Page 31).
- Explain that each group will be trying to artificially select a dog with certain traits by crossing two breeds.
- Go through the existing dog breeds and what their traits are
- Give students time to select two dog breeds with the features most likely to produce a breed with the features needed. Students will have to prioritize the features since no two breeds will likely have the exact combination they desire
- Have each group share with the class which parents they chose and why
- Explain that each breeding pair will produce three puppies, but that each puppy may inherit traits from the mother or the father. We will determine this by the flip of a coin (heads= mother's trait, tails= father's trait)
- Students will flip a coin for each trait and each puppy and keep track of the results in the table in their Soybean Workbook
- After students have completed the traits for their puppies, discuss as a class the following questions
    - Was anyone able to breed a puppy that is perfect for the task?
    - Which of the resulting dogs do you think will best serve the assigned task?
    - If you were to conduct the dog breeding for another generation, which pups would you select to be the parents of the next generation?

<u>Genetic Engineering</u>

Explain to students what genetic engineering is - process by which an organism's genes are manipulated by introducing, eliminating, or rearranging specific genes using methods of modern molecular biology

Go through the genetic engineering infographic with the students. Genetically engineered crops have been grown in the United States since 1996. It involves the use of science to change the genetics of an organism. The genetically modified crops available in the United States are; Sugar Beets, Canola, Corn, Potatoes, Summer Squash, Soybeans, Cotton, Papaya, Apples, and Alfalfa.

Show students the Agricultural Biotechnology- How are GMO plants made? (0:31) and Agricultural Biotechnology- What GMO crops are grown and sold in the US? (0:31) videos.

**Summarize and Connect:**

Did you know that Michigan has a very successful soybean breeding program? Dr. Dechun Wang and his crew at Michigan State University are working to create soybean varieties to feed the world!

Show students the Michigan State University Soybean Breeding Program Video (2:26).

Can you think of ways that natural selection, artificial selection, or genetic engineering has influenced your life?

**Further Resources:**

https://games.legendsoflearning.com/game/dog-breeding-center/724?partner=no-referrer&media=game

Online game that allows students to experience artificial selection in dogs. Students are assigned to make produce a puppy with certain offspring. They must research the parents traits to make a decision on which dogs to breed to produce the correct offspring.

https://www.fda.gov/media/135274/download

Infographic from the FDA with information about each of the GMO crops grown in the United States.

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

Great six and a half minute video demonstrating the steps of soybean genetic modification.