August Working Calendar

Key: S= Start indoors, DS= Direct sow, T= Transplant, H= Harvest, TC = Transplant cuttings/bulbs, P=Prune

	Week 1	Week 2	Week 3	Week 4
Baby Lettuce	H6/DS8		H7/DS9	
Head Lettuce	H5	S8	T7	H6
Basil		H2		
Cabbage/Cauliflower			H2	
Collards	T2			
Kale/Kohlrabi			T1	
Mustard			H2	
Radishes/Turnips	DS5	H3		DS6
Spinach	S7			T7
Melons				H1
Summer Squash/Cucs			H3	
Peppers	H1			
Tomatoes/Eggplant			H1	
Corn	H1		H2	
Green Beans	H4	DS7	H5	DS8

Plant Family Key

Asteraceae	Brassicaceae	Amaranthaceae	Cucurbitaceae
Fabaceae	Lamiaceae	Poaceae	Solanaceae

AUGUST

Focus: Sustainability & Earth Stewardship

Key Concepts: Nutrition, ecology, the living kingdoms, seed saving

Think Ahead

- If you are planning on winter farming, pay attention to seed start dates around this time.
- Any berries harvested this month could be frozen or dehydrated for the February jam making lesson.
- In week 4's *Introduction to Seed Saving*, the activity will require a 3 day waiting period OR an example prepared ahead of time.

August Lesson Outline

- *Week 1 Sustainability Topic*
    - Introduction to Sustainability
- *Week 2 Theri's Summer Kitchen*
    - August Kitchen Project: Mixed Melon Salad
- *Week 3 Science Lessons*
    - Introduction to the Five Living Kingdoms
- *Week 4 On the Farm*
    - Introduction to Seed Saving

Introduction

Teachers of this curriculum will take on many roles: teacher, farmer, nutritionist, ecologist, and earth steward, to name a few. Each lesson has a host of cross curricular opportunities that beautifully intercept As you know, repetition is a key element in the lifelong learning process. These lessons in and about nature present a recurring theme of interconnectedness between all life cycles and allow for review and referencing throughout the year. Interconnectedness is about relationships. You and your students will notice these relationships as your engagement with nature grows and your observation skills improve. Understanding this concept of interconnectedness might be the greatest lesson the farm offers. These building blocks should inspire our students as future environmentalists, creative thinkers, and responsible problem solvers. Use every opportunity you have to acknowledge nature's relationships wherever you notice them: in the lunchroom, in the garden, under the microscope, at your school, on the farm, in the grocery store, or at the market. You are embarking on a truly cross- curriculum experience. Each month is packed with possibilities.

August is a short but busy month for most schools. It is equally busy on the farm as summer harvests are abundant. Take advantage of this abundance by exposing your students to the many colors and flavors of summer. Harvest and taste test whenever and however possible. These are the times when students can expand their palates and connect with fresh flavors. If your gardens are limited or just getting started, remember homegrown includes fresh and local produce from the farmers market. Sharing a platter of summer produce can be low budget and include bite-sized tastes of a variety of in-season fruits and vegetables. Every taste is an opportunity to review what they are learning and to encourage a love for whole foods. Spend as much time as you can with the farm curriculum in the early weeks of the new school year and use the work of the lessons to build community among your new family of learners. Adopt lessons to suit your environment and age group.

Suggested August Field Trip

Visit a local farmers' market to purchase fresh produce for cooking and tasting projects this month. Students can use their journals to list the fruits and vegetables they see for sale. Are these locally grown? How would they know? Equip students with respectful ways to ask farmers questions about their produce (i.e. Did you grow this?). I have them put a check mark next to the things that are grown close to home. Explore the concepts of seasonal and local foods.
Joel Salatin, a well known ecology farmer, suggests the best way to stay healthy *and* be a better earth steward is to buy directly from farmers. He suggests that eliminating grocery store shopping altogether is a move toward better health and that greater health for us is also greater health for the environment. While this is out of the control of young students and not yet a practical solution for most, adding trips to the local farmers market might be doable. Close this lesson by discussing ideas why shopping at the farmers market, fresh and local, could be healthier and more sustainable.

Week 1: Sustainability Topic

Introduction to Sustainability

Goal(s): To understand sustainability using the three pillar approach including; environmental, social and economic; to be able to apply this thinking to personal actions.

Learning objectives:

1. Students can depict the concept of sustainability using the three pillars visual
2. Students can define natural resources and give five examples.
3. Students can identify three personal choices that support living sustainably.

Next Generation Science Standard connections (grades 3-12):

- *MS. Ecosystems: Interactions, Energy, and Dynamics (MS-LS2-3)* Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *MS. Earth and Human Activity (MS-ESS3-3)* Students who demonstrate understanding can apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- *MS. Earth and Human Activity (MS-ESS3-4)* Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- *HS. Earth and Human Activity (HS-ESS3-4)* Evaluate or refine a technological solution that reduces impacts of human activities on natural systems

Time: 45 min

Lesson supplies:

- Farm journal
- Pens or pencils
- Reading assignment: Duplicate or read out loud- Chapter 7 of *Nature's Allies: Eight Conservationists Who Changed Our World*, by Larry Nielsen, *The Green Crusader,* on Wangari Maathai.

Background review for the instructor:

- *The 3 pillars of sustainability: environmental, social and economic (https://www.enel.com/company/stories/articles/2023/06/three-pillars-sustainability)*
- *Journaling:* All my lessons include journaling. I use the term farm journal and journal interchangeably. I have students use journals for all notes, assignments and evaluations. I like the simplicity of having everything in one place. I check these weekly and comment as needed. I start each lesson with vocabulary on the left side of the board, adding definitions as the lesson progresses. My expectation is that students will record these in their journals before the lesson is complete along with any other directed use of their journals.

Vocabulary:

Natural Resources: Material found in nature, made by nature, that is valuable; energy producing resources: air, soil, water, sun, fossil fuels, Biology:plants, animals, people,
Sustainability: Derived from the Latin "sustinere" (tenere, to hold; sus, up).
From the Oxford Dictionary: noun, the ability to be maintained at a certain rate or level. avoidance of the depletion of natural resources in order to maintain an ecological balance.
Earth stewardship: The responsible use and protection of nature through conservation and sustainable practices. This definition was crafted by Aldo Leopold, the father of modern conservation.
The Three Pillars of Sustainability: Environmental, economic and social.
Environmenta*l*: To protect and conserve natural resources for future generations
Economic: To ensure that economic growth (business and profit) does not compromise the environment or people.
Social: To protect the well being of people and communities - meeting basic needs

Overview:

The modern sustainability movement is not new. Some call it the revolution in response to industrialization, having started back in the 1970's. While this may be true, sustainability education is fairly new in our schools and has never been more necessary. As teachers we must include sustainability education whenever we can and review these principles wherever they apply so that this ideology is a natural part of all decision making along the way. The farm provides a perfect classroom for a deeper understanding of sustainability in action, or ***earth stewardship***. If our students take this thinking to heart and with them into the world we will have accomplished great work. It's fitting that our first lesson will introduce students to the word and concept of sustainability.

This introductory lesson will serve as a building block for the rest of the year. If we can reflect on the question, "Is this a sustainable practice?", as often as possible in the decisions we make as a class, our students will begin to feel empowered as environmentalists and earth stewards.

Procedure:

1. Prepare yourself: Use the overview, background review and vocabulary for this discussion.
2. Ask: What do you know about sustainability? Have students reflect and make notes in their journals before sharing and listing on the board. Look at the root word sustain to guide a definition; present a dictionary definition.

3. Discuss: Sustainability definitions refer to conserving natural resources: What are natural resources?
4. View: What Is Sustainability? (10 mins) (https://www.youtube.com/watch?v=rmQby7adocM), from Christian Wiesser (6th grade up)

Pause at 3:05 and let students record the definition of sustainability given by the United Nations in 1987- still the most commonly used.
Pause at 5:38 to have students record the three pillars of sustainability.
Review the three pillars and discuss examples of each after completing the view.

Or view https://www.youtube.com/watch?v=_5r4loXPyx8 (3-6th).
5. Read silently or out loud by guide: Let's end this lesson with an inspiring story of one woman's life work as an earth steward, protecting natural resources and contributing to a more sustainable future. Chapter 7 of *Nature's Allies: Eight Conservationists Who Changed Our World*, by Larry Nielsen, *The Green Crusader,* by Wangari Maathai.
6. Summarize and discuss reading: Give students 5-7 minutes to prepare 3-5 sentences on reflection summarizing how Wangari demonstrated earth stewardship and where/how that fits into the three pillars of sustainability.
7. Evaluation:

1. Have students depict the three pillars of sustainability in their journals, labeling each pillar.
2. Have students list five examples of natural resources, circling those resources that are considered renewable/sustainable, and place them next to the most relevant pillar.
3. Next to each pillar, have students list three personal choices that support each area of sustainability.

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 2: Theri's Summer Kitchen

August Kitchen Project: Mixed Melon Salad

Goal(s): To introduce melons, a local summer produce, and their nutritional value; to learn important knife safety techniques when preparing a melon salad.

Learning objectives:

1. Students can give two examples of melon's nutrition.
2. Students can describe the growth pattern of melon plants.
3. Students can safely demonstrate basic knife handling skills.

Next Generation Science Standard connections (grades 3-12):

- *5. From Molecules to Organisms: Structures and Processes (5-LS1-1)* Support an argument that plants get the materials they need for growth chiefly from air and water.
- *MS. From Molecules to Organisms: Structures and Processes (MS-LS1-6)* Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

Time: 45 min

Lesson supplies:

- Assorted fresh melons (as much color variety as you can find and enough for all students to have a serving). Cantaloupe, watermelon, etc.
- Knives
- Bowl
- Compost bucket

Background review for the instructor:

- Cooking For Kids - Knife Techniques (5 mins) (https://www.youtube.com/watch?v=fw4Fm7E7juU) from Jason Spafford

Vocabulary:

(Definitions from Healthline.com)

Vitamin A: Nutrient important for eye health including vision, and supports healthy cell growth.

Vitamin C: Nutrient that helps to boost our bodies immunity, helping to protect from disease.

Antioxidants: Substances that protect the body from harmful free radicals.

Free radicals: Unstable atoms in the body that can damage our cells and cause illness and premature aging.

Overview:

Melons belong to the gourd family (cucurbitae) and are known as cucurbits. Included in this plant family are squash, pumpkin, cucumber, gourds, watermelon, and cantaloupe. Melons are a good source of vitamin A, vitamin C, and antioxidants. ***Vitamin A*** supports healthy body functions including eye health, ***vitamin C*** helps boost our bodies protection from disease, and ***antioxidants*** are substances that remove ***free radicals***, unstable atoms that can damage our cells and cause illness and premature aging. Common local melons include honeydew, cantaloupe, watermelon, and cucumbers.

This is our first food preparation class together and should include a knife skills lesson (which should be reviewed each time you use sharp knives) and a handwashing presentation. These are valuable lessons for all ages. Make sure you are comfortable with presenting good knife skills; review the knife skills video listed in the background review. If there is a nearby green space currently growing melons, take a walk so that students can observe, smell, touch, and harvest melons. A discussion about melon plants, classifications, and nutrition are that much more meaningful in the garden.

Procedure:

1. Before each kitchen demonstration, lead the class in a short discussion. Start each recipe by reviewing the fruits and vegetables that are fresh and local, asking “what do you know about these fruits/vegetables?” Give students a few minutes to reflect in their journals and then do a group share while listing these on the board.
2. **Discuss:** Ask students what they know about hand washing: Why do we wash our hands? How do we wash them correctly? In farming, we are careful to wash our hands between

jobs, especially when moving from animals to plants. We do this to eliminate any cross contamination of microbes that could be harmful to humans.

3. **Demonstrate:** Hand washing is mandatory before preparing food in all public kitchens. Demonstrate the proper technique for washing hands: Cleaning between fingers and rinsing last. Use an easy time measurement for approximating appropriate hand washing time such as singing the "happy birthday song" while washing with warm soapy water. The water can be shut off after sudsing up and turned back on for rinsing to conserve water usage.
4. Have students wash their hands as demonstrated.
5. **Recipe: Mixed Melon Salad**

   Supplies
   - Assorted fresh melons (as much color variety as you can find and enough for all students to have a serving). Cantaloupe, watermelon, etc.
   - Knives
   - Bowl
   - Compost bucket

   Directions
   1. Practice knife holding and posture while cutting whole melons into manageable sections before removing the edible parts of the melon.
   2. Remove the edible part from the rind using the appropriate knife hold. Safety tip: Cut away from self and use claw hold. Chop fruit into uniform bite size pieces.
   3. In a large bowl, mix melon varieties before serving.
   4. Compost melon rinds or feed them to farm animals.

5. **Evaluation:**
   1. Ask students to identify two key nutrients found in melons.
   2. Ask students to draw and label the different stages of a melon plant's development demonstrating the unique growth pattern of melons..
   3. Ask students to list three safety practices when using a knife.

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 3: Science Enrichment

Week 3 of each month features three different science focus areas: botany, zoology, and microbiology. Instructors can choose to use lessons based on their science requirements.

In August we introduce the three areas of science as a foundational lesson.

Introduction to the Five Living Kingdoms

Goal(s): Students will understand the plant and animal kingdoms are made up of seven classifications that group plants and animals by like characteristics; classifications include, from

largest grouping to individuals species: kingdom, division (phylum for animals), class, order, family, genus, and species.

Learning objectives:

1. Students can identify five living kingdoms in the biological world.
2. Students can distinguish plant and animal kingdoms, and can compare the different ways plants and animals interact with their environments to survive.
3. Students can name the seven categories of plant and animal taxonomic classifications.
4. Students understand how scientific names are created from classification names, (the use of binomial nomenclature) for plants and animals.

Next Generation Science Standard connections (grades 3-12):

- *3. Biological Evolution: Unity and Diversity (3-LS4-3)* Construct an argument with evidence that in a particular habitat, some organisms can survive well, some survive less well, and some cannot survive at all.
- *3. Hereditary: Inheritance and Variation of Traits (3-LS3-2)* Use evidence to support the explanation that traits can be influenced by the environment.
- *HS. Biological Evolution: Unity and Diversity (HS-LS4-1)* Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- *(HS-LS4-4)* Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Time: ~ Can be broken into two 45 min periods (Animal or plant kingdom) .

Lesson supplies:

- Farm journals
- Pens or pencils
- Poster or overhead of Plant Kingdom Classification Pyramid
- Several potted plants including- vascular/non vascular, angiosperm/gymnosperm
- Research resources (encyclopedias, computers)

Background review for the instructor:

- Plant kingdom vocabulary from Classification and Naming of Plants (https://alec.unl.edu/documents/cde/2017/natural-resources/classification-and-naming-of-plants.pdf)
- Animal kingdom vocabulary from Classification of Animals: The Complete Guide (https://a-z-animals.com/reference/animal-classification/)
- The Classification of Living Things 🦠 🐰 5 ANIMAL KINGDOMS 🌱 Science for Kids (8 mins) (https://youtu.be/SIbFuiCfkr8?si=rQlTuZbcTUCD_5k6)

Vocabulary:

Angiosperms: Flowering plants (largest grouping of plants) that include most plants we get food from.
Binomial nomenclature: The two-part naming system that includes genus and species name. Ex. Phaseolus vulgaris (common bean).
Biology: The study of anything living. Those who study biology are called biologists.
Botany: The study of plants. Those who study botany are called botanists.
Class: The category following division and preceding order. There are seven animal classes. One example is the class mammalia (mammals).
Division/phylum: The first category within a kingdom. An example within the animal kingdom is Arthropoda (the largest division).
Entomology: The study of insects, studied by entomologists.

Family: The category following order and preceding genus. An example is the Suidae family (containing pigs). Animal family names always end in "ae".
Genus: The category following family and preceding species. Ovis is the genus that contains sheep. In binomial nomenclature, genus comes first and is always capitalized.
Gymnosperms: Non-flowering plants.
Heterotrophs: A living thing that does not produce its own food.
Immotile: Not mobile or moving.
Kingdom: Largest category of living organism. There are currently five known kingdoms.
Microorganisms: Microorganisms are part of the animal family, small particles that replicate, have genetic information, and synthesize proteins in some way. They all reproduce by dividing their particles to create more particles.
Multicellular: Having more than a single cell.
Non-vascular plants: Category of plants that do not contain water conducting tissues, true roots, leaves, or stems;includes mosses and liverworts.
Order: The category following class and preceding family. 'Primates' is an example.
Species: The category following genus. Genus plus species is the scientific name for organisms. Species can be further divided into varieties.
Taxonomy: A system of classification, the study of organism classification
Vascular plants: Category of plants that contain water and nutrient conducting tissues, along with true roots, stems, and leaves.
Zoology: The study of animals. People who study zoology are called zoologists.

Overview:

Scientists who study living nature are called biologists. Biologists classify living organisms into groups called ***kingdoms*** according to similar characteristics. Scientists currently acknowledge five living kingdoms in the world. The plant and animal kingdoms are the two largest. The remaining kingdoms include fungi, protista, and monera (includes bacteria).
The study of plants is called ***botany***, and scientists who study plants are called botanists. The study of animals is called ***zoology*****,** and scientists who study zoology are called zoologists. Entomologists are those who study insects specifically, or ***entomology***. Microbiologists study ***microorganisms*****.** Farming requires knowledge in each of these areas because of the interactions with plants, animals, and the soil.

The world of living organisms is enormous. In 1735, a man named Carl Linnaeus created a classification system to organize and name living creatures. He is known as the father of ***taxonomy-*** the classification of living organisms. Modern classification continues to use Linnaeus' hierarchy of classifications (kingdom, phylum/division, class, order, family, genus, species) based on similar characteristics and his two part naming system called ***binomial nomenclature*****.** Binomial nomenclature gives each species a scientific, two-part name, starting with the genus name (capitalized) followed by its species name (lower case). Linnaeus's classification and scientific names are in Latin and are meant to eliminate confusion among different common names that may have been given to the same organism.

Today's lesson introduces the five known kingdoms and looks closer at the hierarchy of classifications that organize the plant and animal kingdoms. Scientists agree that there are probably millions of unknown/unnamed additional living organisms.

<u>The Five (known) Kingdoms</u>

KINGDOM	# of species (*Identified*)
Animals (vertebrate and invertebrate)	1-2 million (https://www.wonderopolis.org/wonder/how-many-animals-are-there-in-the-world)
Plants	~350,000 (https://bionumbers.hms.harvard.edu/bionumber.aspx?s=n&v=0&id=113395)
Protists (algae, protozoa)	60,000-200,000 (https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_Introductory_Biology_(CK-12)/08%3A_Protists_and_Fungi/8.01%3A_Protist_Kingdom#:~:text=There%20are%20thought%20to%20be,vital%20primary%20producers%20in%20ecosystems)
Fungi	~150,000 (https://link.springer.com/article/10.1007/s13225-022-00507-y)
Monera (includes bacteria and microorganisms)	~1.8 million (https://www.nagwa.com/en/explainers/720102326325/)

The estimated number of total organism species is around 8.7 million. However, only around 1.2 million animal species have been identified and described so far, most of which are insects. This means that millions of other organisms remain a mystery. (Source: https://education.nationalgeographic.org/resource/biodiversity/)

Plant Kingdom

Distinguished from animals. Plants are multicellular, have complex cell walls, are primarily immotile, and make their own food(autotrophs). There are approximately 350,000 identified plant species. Within the plant kingdom are two smaller categories: vascular and nonvascular. Non-vascular plants include mosses and liverworts; these do not contain water-conducting tissues or true roots, leaves, or stems. Vascular plants contain water and nutrient conducting tissues, along with true roots, stems, and leaves.

Hierarchy of Plant Classifications

Division/phylum: Vascular plants are further divided based on whether they reproduce by spores or seeds. Spore-bearing plants include ferns, club mosses, and horsetails. Seed-bearing plants are divided into two categories; gymnosperms (nonflowering plants) and angiosperms (flowering plants). Angiosperms are the largest classification of plants and include most food producing plants.

Class: Angiosperm plants are placed into one of two classes- Monocots (monocotyledon) with a single cotyledon, and dicots (dicotyledon) with two cotyledons.

Order: Plant order is not commonly used as a way to distinguish plants for gardeners, but is used to group similar families when learning or teaching about plants. Most plant order names end in "-ales", such as Rosales which contains 24 families.

Family: Plants in the same family have similar flower, fruit, and seed structures. Most families in the plant kingdom are angiosperms. Family is often the first level of plant classification discussed when talking about specific plants, as pest problems and management practices within a family may be similar. Family names end in "-ae".

Genus: Plants within a family that have more characteristics in common with one another than other plants of the same family are placed in a genus. The genus name is the first part of the scientific or Latin name for a specific plant. The first letter of the genus name is always capitalized and the word is always italicized or underlined, as in Quercus or *Quercus*. *Quercus* is the oak genus.

Species: Species is the name of a specific plant. It is noted by the genus name first and a second further distinguishing characteristic name second. Species can reproduce among themselves. The name of the species should always be lower case and underlined or placed in italics.

Varieties: Variety subdivides a species and is the third name in a species designation. Varieties are naturally occurring variations of the species.

Animal Kingdom

Distinguished from plants as multi-celled organisms that do not produce their own food (heterotrophs).

Hierarchy of Animal Classifications

Division or phylum: This category distinguishes vertebrate (with a spinal column) and invertebrate (without spinal column) species into 6 categories: Porifera, Cnidaria, Platyhelminthes, Annelida, Mollusca, Arthropoda (largest phylum, includes butterflies and shrimps), and Chordata (vertebrates, most animals we are most familiar with).

Class: The phylum Chordata (vertebrae) splits into these seven animal classes: Agnatha (jawless fish), Chondrichthyes (cartilaginous fish), Osteichthyes (bony fish), Amphibia (amphibians), Reptilia (reptiles), Aves (birds), and Mammalia (mammals).

Order: A breakdown of the class categories by similar characteristics. For example, the mammalia class includes 26 orders, of which here are 6:

- Artiodactyla (even-toed hoofed animals) – Examples include moose, camels, and giraffes.
- Carnivora – Animals that specialize in mostly eating meat, but also contain some omnivores and herbivores. Characterized as having non retractable claws and long snouts. Examples include bears.
- Rodentia (gnawing mammals) – Examples include beavers, mice, and squirrels.
- Chiroptera (bats) – The only mammals that can fly. Examples include free-tailed and vampire bats.
- Cetacea (porpoises and whales) – Examples include killer whales, dolphins, and hump-backed whales.
- Primates – have prehensile hands and feet, commonly with opposable thumbs. Examples include gorillas, chimpanzees, and humans.

Family: Orders are further divided into similar characteristics, creating over 5,000 family classifications in the animalia kingdom. Here are families within the order Artiodactyla (even-toed hoofed animals):

- Suidae – Pigs
- Tayassuidae – Peccaries
- Hippopotamidae – Hippopotamuses

- Camelidae – Camels, llamas
- Cervidae – Deer
- Giraffidae – Giraffe
- Antilocapridae – Pronghorn
- Bovidae – Cattle, antelope, sheep, goats

Genus: Each genus includes very similar animals that are related. The Bovidae family is further divided into 52 genera (categories of genus) of which a few examples are Arabitragus, Capra, Hemitragus, Nilgiritragus, Ovis, and Pseudois.

Species: The genus Ovis contains 146 living and 300 extinct species. Further divided by like characteristics, these should sound more familiar to you; Sheep, Cattle, Goats, Water buffalo, Gazelles.

Farmers work most closely with the family, genus, and species classifications in the plant and animal kingdoms, but it is good to know why plants and animals are grouped and how they get their scientific names.

Procedure:

1. **Ask:** What are living kingdoms? Can you name all 5?
2. **Optional View**: The Classification of Living Things 🦠 🐰 5 ANIMAL KINGDOMS 🌱 Science for Kids (8 mins) (https://www.youtube.com/watch?si=rQlTuZbcTUCD_5k6&v=SIbFuiCfkr8&feature=youtu.be)
3. **Discuss:** Our work today will focus on the largest of the five kingdoms, plants and animals. Discuss the major differences between plants and animals; How do they get their energy? What is different about their habitats? Compare a squirrel to a tree. Use the vocabulary and the background review to introduce these kingdoms and classifications in age appropriate detail.
4. **Display:** Use a visual chart (see **Background Review for the instructor**) or overhead to help students through this classification lesson. Walk students through each layer of the pyramid and point out what unique features distinguish each classification. Simplify and generalize as needed. The Latin words can be confusing.
5. **Research Project: Plant and Animal Kingdom Classifications**

   Supplies
   - Farm journals
   - Pens or pencils
   - Poster or overhead of Plant Kingdom Classification Pyramid
   - Several potted plants including- vascular/non vascular, angiosperm/gymnosperm
   - Research resources (encyclopedias, computers)

   Directions
   1. Have students use two open sheets in their journals to create two upside down pyramids, as large as they can, dividing each pyramid into six sections. Demonstrate on the board with an overhead image or a poster depiction. Title the pyramids on the largest top, flat side: kingdom Plantae and kingdom Animalia. As you move through the classifications, have students add each category to their pyramid, including the distinguishing characteristics of that classification. Use live plants or animals (or pictures) you collected to demonstrate some of the classification distinctions. These kingdoms are large and can seem overwhelming but a general understanding is the key takeaway, along with knowing how scientific names are derived. Notice family classifications end in the same letters

"ae". This will be reviewed throughout the curriculum, especially as we introduce many plants.

2. Ask students to brainstorm why knowing this information is important (can they generalize the needs of plants and animals by their family names)?
3. Use the following examples to demonstrate the general to the specific and how the scientific name is derived:

Kingdom: Plantae	**Kingdom:** Animalia
Division/Phylum: Angiosperm	**Division/Phylum:** Chordata
Class: Dicotyledon	**Class:** Mammalia
Order: Fabales	**Order:** Artiodactyla
Family: Fabaceae	**Family:** Bovidae
Genus: Phaseolus	**Genus:** Ovis
Species: vulgaris var. Provider Common name: bush beans	**Species:** O. aries Common name:sheep

4. When students have completed their inverted pyramids, have them work in groups of two to choose a familiar farmed plant and animal, then to use research resources to find classification and scientific names for each. (Hint: They may need to work backwards)

5. Evaluation:

1. Have students list the five living kingdoms in the biological world.
2. Ask students what the first distinction is that sets apart plants and animals.
3. Have students give two reasons why classifying living creatures is helpful, to farmers especially.
4. Ask students to depict the formula for binomial nomenclature (Genus (capitalized) + species name) and describe why this naming system is useful.
5. Ask students why having scientific names for living organisms is important.

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 4: On the Farm

Farmer Spotlight- Meadowlark Hearth Organic Farm

Introduction to Seed Saving

Goal(s): To understand the value of seed saving in relation to sustainability on the farm; to learn how to save seeds for best efficiency.

Learning objectives:

1. Students can give two examples of why seed saving is a sustainability practice.
2. Students can describe two methods of seed saving: wet and dry.
3. Students can give an example of when to use wet seed saving practices versus dry and explain why.

Next Generation Science Standards connections (grades 3-12):

- *3. Biological Evolution: Unity and Diversity (3-LS4-4)* Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
- *4. From Molecules to Organisms: Structures and Processes (4-LS1-1)* Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *5. Earth and Human Activity (5-ESS3-1)* Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- *HS. Ecosystems: Interactions, Energy, and Dynamics (HS-LS2-7)* Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Time: 90 min

Lesson supplies:

- Paper or journal
- Pencils or pen
- Ripe tomatoes, separate by variety (making sure they are heirloom or open pollinated).
- Canning jars or containers with lids
- Knife or other pairing utensil
- Sieve/strainer/colander
- Bucket

Vocabulary:

Seed saving: Harvesting seeds from a parent plant when they are mature and storing the seed to be used in subsequent years (vs buying seed each year).
Annual: Plants that complete their life cycle in one growing season (seed to seed).
Dry seed saving: Seed saving done by air drying seeds.
Wet seed saving: Seed saving process done with wet seeds in which seeds are soaked in water before drying to increase seed germination rate.
Biennials: Plants that complete their life cycle in two seasons, producing seed in the second year.
Perennial: Plants that live for more than one growing season. These plants will die back in the winter months, become dormant, and then sprout again the following spring/summer from the same roots. It usually takes two or more seasons for perennials to produce seed but once they produce seeds they will continue to seed each year after.
Hybrid plants: A natural process in which two plants that are different varieties are cross-pollinated to produce a seed with the best characteristics from two parents.
GMO: GMO stands for genetically modified organism; a plant, animal, microorganism or other organism whose genetic makeup has been modified in a laboratory using genetic engineering or transgenic technology. This creates combinations of plant, animal,

bacterial and virus genes that do not occur in nature or through traditional crossbreeding methods (https://www.nongmoproject.org/gmo-facts/what-is-gmo/).

Heirloom: Any seeds that have been kept true (not crossed) for at least 50 years. An heirloom seed can start as a hybrid.

Open pollinated seeds: Seeds that have not been previously cross pollinated. These seeds you can collect each year and they will grow into plants with the same characteristics of the parent plant.

Overview:

Seeds are the mature ovule of a flower. Each seed contains the genetic makeup to create a "child" plant. Farmers can save seeds to eliminate the need for purchasing seed each year and also to conserve the energy that is used to process and transport seeds. ***Seed saving*** is an important part of being sustainable on a farm and is done throughout the season as different plants mature. In order to save seeds it is important to know a plant's life cycle.

The life cycle of a plant begins when a seed is planted and ends when the plant has produced seed for the next generation. Some plant life cycles are only one season long, called ***annuals*** (tomatoes, green beans, squash, ect.). ***Biennials*** are plants that produce seed in their second growing season after having a dormant winter (broccoli, cabbage, carrots, kale, beets). ***Perennial*** plants come back year after year from the same root system but can take multiple years to mature and produce seeds. Once a perennial matures it usually produces seeds every year after (asparagus, rhubarb, strawberries). Knowing a plant's life cycle will guide you in best seed saving practices.

There are two primary ways for saving seeds, dry and wet. In the ***dry seed saving*** method seeds are saved by simply letting the seeds dry on the plant and then collecting them (such as green beans, marigolds, gourds) and storing them in airtight packaging in a cool dark cabinet. The ***wet seed saving*** method requires harvesting seeds when they are mature but still wet inside the fruit and soaking them in water for a few days to rot any non viable seeds (tomato, cucumbers, peppers and eggplant). This lesson will review the process and benefits for each. How does seed saving fit into our discussion of sustainability?

Seed saving is something that can be done throughout the season as different plantings mature and make seed. We introduce it here, in the beginning, so you keep it in mind throughout the season but we will talk more about seeds and things to consider later in our curriculum. If you find seed saving is an exciting part of your student farm, think about dedicating a whole garden to the collection of seed. Selling seed is a great micro-economy project. There are farms that grow seed as their primary business. NOTE: Do not save seeds from ***hybrid*** or ***GMO*** plants. Only save seeds from ***heirloom*** or ***open pollinated plants***.

Procedure:

1. **Discuss:** All fruits start as a flower and have seeds inside at maturity. Tomatoes, peppers, cucumbers: we think of these as vegetables but using this scientific definition to classify fruits we know they are really fruits, even if they are not sweet. Seeds are an important part of both fruits and vegetables because they contain the genetic material and the stored energy (starches) to grow more plants that are like themselves. Everything a seedling needs until it can grow leaves is inside a seed. Farmers save seeds as a way of saving money, conserving energy on processing and transportation (of purchased seed) and creating stronger plants for their farm (always saving the seeds from the best plants).
2. **Watch:** Seed Saving (20 mins) (https://www.youtube.com/watch?v=ZVb9JIAXJxU), from Charles Dowding

3. **<u>Activity: Tomato Seed Saving</u>** *(15 minutes, wait 3 days or have a 3 day example prepared prior to lesson).* This hands-on activity provides a look at how we preserve and save seeds for future years on the farm. Tomato seeds are saved best using a wet seed process, which means we harvest seed when the fruit is still wet. The wet seed process will insure the highest percentage of viable seed. Harvesting dry seeds is easiest as in the case of green beans: we wait for the bean to dry out on the vine before picking and shelling the beans. Both processing methods require storing seeds in a labeled protective container and keeping them cool and dry.

   Supplies
   - Ripe tomatoes, separate by variety (making sure they are heirloom or open pollinated).
   - Canning jars or containers with lids
   - Knife or other pairing utensil
   - Sieve/strainer/colander
   - Bucket

   Directions
   1. Fill a quart size jar ¼ full with spring water.
   2. Cut open the ripe tomato, squeeze the pulp, juice and seeds into a glass jar/ container. Set the skins aside for compost.
   3. Label the containers and set aside for three days at a temperature of approximately 70 degrees F. Stir the juices once a day. This prevents mold build up (but is not harmful to the seeds).
   4. After three days, pour seed mixture into a larger container that is big enough to house a seed pulp to water ratio of 1:3. Allow the seeds to sink to the bottom (1 hour) and pour off the floating pulp and seeds. Usable seeds will sink to the bottom. Repeat this process two or more times until the seeds are clean.
   5. Pour the seeds into a sieve or onto a clean pan without excess water where they can dry for 5-6 days at room temperature.
   6. Allow seeds to dry on an absorbent surface like paper.
   7. Label & store seeds in an airtight container in a cool dark cabinet.
   8. Seeds can be tested in the spring for germination rates and used accordingly.
4. **Evaluation**
   1. Ask students to give two examples of why seed saving is a sustainability practice.
   2. Have students explain the basic procedures of wet and dry seed saving.
   3. Ask students to explain when to use wet seed saving versus dry.

   Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Additional August Resources

Compiled by Jennifer Eburuoh

Grades 3-5

- **Book-** *On the Farm, At the Table*, G. Brian Karas
  - A picture book about where food comes from and farmer's markets.
  - Amazon link- On the Farm, At the Market

- **Book**- *What Does It Mean to Be Green? Eco-Pig Explains,* Lisa S. French
    - Amazon link- What Does It Mean to Be Green?: Eco-pig Explains Living Green: Lisa S. French, Barry Gott: 9781602706651: Amazon.com: Books
- **Book**- *I Am Farmer: Growing an Environmental Movement in Cameroon*, Miranda Paul, Baptiste Paul, and Elizabeth Zunon
    - Amazon link- I Am Farmer: Growing an Environmental Movement in Cameroon
- **Book**- *The Farm That Feeds Us: A year in the life of an organic farm*, Nancy Castaldo
    - An illustrated book which explores life on a local, organic farm.
    - Amazon link- The Farm That Feeds Us: A year in the life of an organic farm

Grades 6-8

- **Poem**- From Blossoms, Li-Young Lee. (https://www.poetryfoundation.org/poems/43012/from-blossoms)
    - Also appropriate for 9-12 graders.
- **Book**- *Nature's Allies: Eight Conservationists Who Changed Our World*, by Larry Nielsen
- **Article**- Sustainable Agriculture
    - **(**https://www.nationalgeographic.com/environment/article/sustainable-agriculture)
- **Article**- A Kids Guide to Understanding Sustainability
    - This article provides a general introduction to the concept of sustainability. It covers the different causes and industries involved in the world's problems with energy, waste, overpopulation, and biodiversity. (https://www.reusethisbag.com/articles/a-kids-guide-to-understanding-sustainability/)
- **Short Video**- What is Sustainability? (3 minutes)
    - This video offers a definition of sustainability suitable for middle schoolers from Mocomi Kids. (https://www.youtube.com/watch?v=gTamnlXbgqc)
- **Short Video**- Nigel Walker: Saving Seed (1 minute) (https://www.youtube.com/watch?v=bn8D7YaE9KY#action=share**)**
    - Quick overview that defines seed saving.
- **Short Video**- PBS Parents | Adventures in Learning Episode 2: Farmers Market Math (4.5 minutes) From PBS Parents. (https://vimeo.com/74988783)
    - This video offers ideas for the Farmers' Market Field trip. It can be shown to students before so that students who have never been can visualize what to expect. The video follows two middle school aged students as they spend money buying goods at a local farmers' market alongside a teacher (or parent). They spend money given to them by the adult, and they must budget their money and answer math problems along the way.
- **Documentary**- Food for Thought, Food for Life (22 minutes) (https://vimeo.com/113311433)
    - This documentary gives students a visual, fast paced overview of different aspects of the sustainable food movement throughout the US.
- **Documentary**- *Sustainable* (1 hour 30 minutes) (https://sustainablefoodfilm.com/)
    - The documentary is an investigation into the modern food system and agricultural issues. It follows the narrative of a seventh-generation farmer who pioneers the sustainable food movement in Chicago.

Grades 9-12

- **Book**- *The Planter of Modern Life: Louis Bloomfield and the Seeds of a Food Revolution*, Stephen Heyman.
    - About Louis Bloomfield and the origins of organic food movement

    - Amazon- The Planter of Modern Life: Louis Bromfield and the Seeds of a Food Revolution
- **Article-** Gardening Is Important, But Seed Saving Is Crucial | Civil Eats
    - This reading goes well with the video, "Saving Seeds with Kristyn Leach." https://civileats.com/2020/04/21/gardening-is-important-but-seed-saving-is-crucial/
- **Short video-** What is sustainability? (2 mins) From ACCIONA. (https://www.activesustainability.com/sustainable-development/what-is-sustainability/)
    - Introductory video focuses on the history of the term "Sustainability" originating in the 1987 text, "Our Common Future." The video focuses on the three subjects core to this definition: environmental protection, social development, and economic growth.
- **Short video-** Saving Seeds with Kristyn Leach (5 minutes) From Civil Eats TV. (https://youtu.be/jVKtmrrdW3U)
    - A video that talks about seed saving in relation to the COVID-19 pandemic
    - Can be paired with the Civil Eats article "Gardening is Important, But Seed Saving is Crucial".
- **Short video-** Michael Pollan: Why Eat Local? (2 minutes)
    - This video explains why it is important to eat local and how it fits into the bigger picture of mitigating climate change and stopping suburban sprawl. From NourishLife. (https://youtu.be/DhaG_Zi6izU)
- **Video-** The Truth About GMOs (15 minutes)
    - This video explains what GMOs are and explores the widespread controversy around them about whether or not they are good. From Real Science (https://youtu.be/DK5kRGs0HX0)
- **Videos-** Charles Dowding video collection
    - A man who has pioneered the no till/no dig movement (https://charlesdowding.co.uk/)

More Teacher Resources

- *Growing Food*, Pamela A. Koch
    - First book of the Linking Food and the Environment (LiFE) curriculum series by the Teacher's College at Columbia University
    - Contains a teacher's curriculum guide and activity guide for helping students to learn about the source of their food
- *Farm to Table and Beyond*, Pamela A. Koch
    - Second book of the Linking Food and the Environment (LiFE) curriculum series by the Teacher's College at Columbia University
    - Contains a teacher's curriculum guide and activity guide for helping students to learn about the source and production of their food
- *Choice, Control, and Change: Using Science to Make Food*, Pamela A. Koch
    - Third book of the Linking Food and the Environment (LiFE) curriculum series by the Teacher's College at Columbia University
    - Contains a teacher's curriculum guide and activity guide for helping students to analyze their food choices
- *Restoration Agriculture*, Mark Shepard
    - Overview of restoration agriculture
- *Poetry and Food | Poetry Foundation*
    - Poems about our relationships with food
    - https://www.poetryfoundation.org/collections/145091/poetry-and-food

September Working Calendar

Key: S= Start indoors, DS= Direct sow, T= Transplant, H= Harvest, TC = Transplant cuttings/bulbs, P=Prune

	Week 1	Week 2	Week 3	Week 4
Baby Lettuce	H8/DS10		H9/DS11	
Head Lettuce	T8		H7	
Collards				H2
Mustard			H3	
Radishes/Turnips	H4		DS7	H5
Green Beans	H6		H7	
Corn	H3		H4	
Peppers	H2			
Tomatoes/Eggplant			H2	

Plant Family Key

Asteraceae	Brassicaceae	Fabaceae	Poaceae	Solanaceae

SEPTEMBER

Focus: Farming Methods

Key Concepts: *Regenerative agriculture, soil health, the nitrogen cycle*

Think Ahead

- Any berries harvested this month could be frozen or dehydrated for the February jam making lesson.

September Lesson Outline

- *Week 1 Sustainability Topic*
    - Farming for Earth Stewardship
- *Week 2 Theri's Summer Kitchen*
    - September Kitchen Project: Tomatoes & Salsa
    - September Kitchen Project: Green Beans
    - September Kitchen Project: Sun Pickles
    - September Kitchen Project: Zucchini Bread
- *Week 3 Science Enrichment*
    - Botany: Native Plants
    - Zoology: Birds as environmental indicators
    - Microbiology: The Microbiome
- *Week 4 On the Farm*
    - Soil Health

Introduction

September often marks the end of summer's oppressive heat. The abundant harvest includes the last of summer crops and the beginnings of fall favorites. Cooking can be a great joy with the diversity of bounty that September brings. Our recipes this month continue to focus on the summer harvests.

A great pre-read for this month is Michael Pollan's *Omnivore's Dilemma*. *The Young Adult* version is a fast and informative introduction for teachers and students (6th grade +) to this month's focus on farming methods. We introduce two basic farm model concepts: Industrial farming, which includes conventional industrial and organic industrial (highest fossil fuel energy use and environmental side effects); and restorative/regenerative farming (focused on nutrition and environmental stewardship). While a farm can be a combination of multiple growing styles I have found these three, 1) conventional/ industrial, 2) organic industrial, and 3) regenerative, to

be distinguished within most farm operations. Using these models we address some distinguishing characteristics and the reality that the organic label does not always mean environmentally better.

While most people have heard the term “organic”, many are unclear of its meaning in the context of agriculture and environmental health. The term has been compromised over the last 30 years by relaxed guidelines and the creation of industrial organic food production. I do believe the best produce/food is organic, for taste and nutrition, but I also believe the “organic” label no longer gives us the highest confidence in our food. For beginners, organic is simply thought of as farming that does not use chemicals. While industrial organic farming does not use chemical pesticides, it does usually focus on feeding the plant(vs empowering the soil) with a large energy input like any conventional farming and soil loss is still a major side effect.

Regenerative farming takes organic practices a step further and asks - how can we leave the soil in place, and in better quality than we found it? To better understand this you will need an understanding of nature's relationships, including what is in the soil and how plants and soil interact. Healthy soil contains living organisms and nutrients, like carbon and minerals. These provide fertility for healthy plant growth; that in turn produces edible parts that feed and provide the nutrients that keep us healthy (relationships). The following soil lessons will explore these relationships further and begin to instill a greater understanding of what earth stewardship means.

Suggested September Field Trip

Take a field trip to a local farm. Be sure to pre-tour the farm to know if it is appropriate for your lesson. Choose a local farm, urban or rural, ideally with a diverse production of fruits, vegetables and livestock. A farm that offers a tour with tasting and harvesting where you can purchase produce for this month’s kitchen projects would be perfect. Make sure to keep groups at a manageable size for the guides and the hosts. For larger groups, consider touring half the group at a time and having an assistant lead a supporting activity opposite the tour. Better yet, get a chore assignment from the farmer. Students of all ages love to help.

Trip Tips: Excitement is contagious and actions speak louder than words. Don’t let your own phobias color the students' experience. If you are afraid of bugs, spiders or bees, this curriculum will help you overcome your fears so that you can share their importance to the garden ecosystem with your students! Respect for all nature is part of the farm curriculum. Remember when eating your lunch with students, you are role modeling for them and any meal serves as an interactive lesson. Never pack or stop for fast food with students; it undoes everything you will be teaching. Have containers ready at the lunch area for: food scraps that can be given to animals or composted, recyclable items, and trash.

Week 1: Sustainability Topic

Farming for Earth Stewardship

Goal(s): Students will understand characteristics of industrial and regenerative agricultural methods and their impact on the environment.

Learning objectives:

1. Students can define organic and natural when applied to farming.
2. Students can compare and contrast farming styles and methods: Industrial and regenerative farming, giving examples for each.
3. Students can describe farming styles with regard to their required energy inputs.

Next Generation Science Standards connections (grades 3-12):

- *3. Biological Evolution: Unity and Diversity (3-LS4-4)* Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
- *MS. From Molecules to Organisms: Structures and Processes (MS-LS1-5)* Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- *MS. Ecosystems: Interactions, Energy, and Dynamics (MS-LS2-3)* Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *MS. Ecosystems: Interactions, Energy, and Dynamics (MS-LS2-5)* Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- *HS. Ecosystems: Interactions, Energy, and Dynamics (HS-LS2-6)* Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

Time: 45 min

Lesson supplies:

- Journal or paper
- Pens or pencils

Background review for the instructor:

- *Rachel Carson and the Book that Changed the World* by Laurie Lawlor.
    - Rachel Carson is famous for her book *Silent Spring (1962)*, which exposed the pesticide DDT and led to new laws protecting our air, wind and water. *Silent Spring* is a great book for older students, in part or in its entirety, but can sometimes leave a feeling of dread. I prefer to use an appropriate chapter versus the whole book.
- Chapter 4 of *Nature's Allies: Eight Conservationists Who Changed Our World*.
    - Short read and good for older students

Vocabulary:

Organic: Anything living or previously living. In agriculture, organic refers to production that does not use synthetically or chemically derived products (usually produced with fossil fuels) such as pesticides and fertilizers.

Soil organic matter: The top layer of the soil that contains living organisms feeding on organic material that was previously alive.

Natural: Free of human intervention. As a substance, free of synthetic or artificial ingredients, i.e. come from nature. Some of these substances can be harmful in concentrated forms, i.e. hemlock is poisonous to humans. Natural products and practices in agriculture are also often referred to as “organic”.

Synthetic: Made by humans, typically in a factory.

Pesticide: A substance that kills unwanted plants (weeds) or insects that feed on plant tissues. A pesticide can be natural or synthetic. Chemical pesticides are synthetically produced or derived, and have a large fossil fuel footprint involved in their production and transport. They also linger longer in the environment and can damage ecosystems and harm plants, animals, and humans. Natural/organic pesticides are not derived from fossil fuels, and do not remain in the environment. They typically have a lower fossil fuel footprint involved in their production and often can be locally sourced to avoid fossil fuel heavy transportation.The two main categories are herbicides and insecticides.
Herbicide: Type of pesticide, natural or chemical, that kills or suppresses weeds that might lower production of the intended crop by competing for light, water, and nutrients.
Insecticide: Type of pesticide, natural or chemical, that kills/repels insects to protect plants from damage. These in particular, whether synthetically or naturally derived, can be harmful to humans in concentrated forms.
Fertilizer: A substance, organic or chemical, that is added to soil/plants to supply nutrients that help with growth. Chemical fertilizers contain fewer types of nutrients than organic ones, have a larger fossil fuel footprint, and can cause damage to the environment. Natural fertilizers contain most if not all of the nutrients needed for plant growth and have fewer environmental side effects.
Industrial farming: Also called factory farming, a farming method characterized by its ability to produce large amounts of food or commodities e.g., corn, soy beans, wheat, cotton. It is characterized by large machinery, significant product inputs, and fewer farmers. This agricultural style requires the greatest amount of energy in the form of fossil fuels, e.g. diesel fuel to run the tractors, processing and production of soil inputs, and transportation costs. The labor costs are minimized. Industrial farming can be organic or conventional (non-organic). Both have a carbon loss from the soil with this type of farming
Monoculture farming: The farming of only one type of crop within a given area and time period.
Polyculture: Farming that involves growing two or more crops in combination, within a given area and time period.
Organic farming: A farming method that does not use unapproved soil inputs, chemically synthesized herbicides, or hormones in farming practices. A farm may be certified as organic by the USDA (United States Department of Agriculture) or uncertified.The USDA certifies a farm to be organic or not based on specific requirements. Certification must be renewed yearly. Organic does not necessarily mean environmentally friendly, as other factors like transportation methods and fossil fuel energy reliance are not considered.
Regenerative farming: A farming method that protects land by using practices that improve soil quality and quantity. Regenerative farming uses planting and livestock grazing designs such as polyculture that maximize photosynthesis and seek to foster the relationships of plants and animals with the soil, water, and air. Regenerative farming is usually organic and takes into account the farm's total impact on the environment; it is also referred to as restorative or restoration agriculture. Human or animal labor is often substituted for machine labor. Carbon is added to the soil rather than lost.
***The soil food web*:** A community of living organisms in the soil that represent three different levels of consumers. Each level of consumer depends on the level below it to get

food energy and is the energy source for the level above it. These levels of consumers are often depicted in concentric circles or layers showing who eats who, with a carbon food source at the center (organic matter). The smallest microorganisms are fed by the organic matter layer and go on to be the food or produce the food that will be eaten by the next level of life and so on. No level of consumer can exist apart from the others.

Microorganisms: A microscopic organism. The five main groups include: bacteria, archaea, fungi (yeasts and molds), algae, protozoa and viruses. (https://www.britannica.com/browse/Fungi-Protists-Viruses/1)

Conservation practices (in farming): Methods/activity that work to protect our natural resources. In farming that includes decreasing soil erosion and improving water & air quality

Overview:

This lesson focuses on farming styles and their related energy requirements and methods. This is a general introduction to concepts that will be further explored in the coming year. It is rich in vocabulary. For an easy visual print a picture poster for each farming style and list the defining methods/practices on the back of the poster. Keep these visible/accessible throughout the year to refer back to as students begin to analyze, discern, and develop their own opinions about the connection between agriculture and environment and personal health.

To understand farming methods,you will need some basic knowledge of pesticides (herbicides and insecticides) and fertilizers. These are tools for plant growth that can be naturally or chemically derived. ***Pesticides*** is an umbrella term that includes ***herbicides***, made to kill plant life, and ***insecticides***, made to kill insects. Each of these can be chemically derived or naturally sourced. Chemically-derived pesticides are usually systemic, meaning they travel throughout the plant and into the soil; they degrade slowly and can stay in the soil for extended periods of time. An oversupply of chemically produced pesticides combined with rainwater runoff from fields can lead to water contamination and death of plant or animal life. Chemical pesticides are absorbed through plant root systems and when eaten can accumulate in animal's bodies, and become concentrated in our foods, plant and animal. Studies have linked the common household herbicide Roundup (glyphosate) to cancer in farmers and backyard users.

Fertilizers are chemically/synthetically or organically/naturally derived substances that are added to soil or sprayed on plants to add vigor and increase crop yields. Chemical fertilizers are made to mimic natural minerals, but do not act the same in the soil or in our bodies. Chemical fertilizers have created a "feed the plant" approach to agriculture. These fertilizers supply synthetic minerals, mainly nitrogen, phosphorus, and potassium (NPK). While these minerals are necessary, natural soil amendments (think compost) include these minerals and contain a larger diversity of ingredients, which support biological activity in the soil, that naturally digest minerals and make them available to the plant and then to us. This is a "feed the soil" approach that allows nature to work as it is intended to.

Industrial farming is large scale growing of one crop in a given area during a given time ***(monoculture)*** and relies on a large amount of fossil fuel use. It is characterized by few workers and large machinery. Conventional industrial agriculture uses chemically-derived pesticides to kill weeds and insects and chemical fertilizers to manage plant growth. These chemicals are synthesized and require large amounts of fossil fuels to produce, package and transport. ***Organic industrial farming*** is a hybrid of industrial and organic practices. It has many of the same characteristics as conventional industrial farming but is limited to organic inputs; seeds and

pesticides that are certified as organic by the USDA. Natural fertilizers and pesticides are more environmentally friendly i.e. have fewer side effects on the soil, water, and air.

Regenerative or restorative farming is a method that implies actively repairing the land through restoring the functions and health of the soil in addition to producing food. Regenerative agriculture is characterized by smaller scale farming models that work directly with nature. Inputs can include soil amending which is typically done by using compost and a diverse planting schedule; that creates a natural balancing system whereby pesticides are conserved or eliminated.

The biology in living soil is known as ***the soil food web*** (the relationship of life forms in the soil that range in size from microscopic, ***microorganisms*****,** to easily viewed by the naked eye such as earthworms or, macro organisms). The soil food web is constantly in motion and in relationship with organic matter and plant roots, naturally digesting and sharing minerals and nutrients. These cycling processes are the soil's great work. These are called the carbon and nitrogen cycles and will be introduced in the coming months.

Living soil is essential to support nature's ability to cycle carbon and nitrogen, the building blocks of nutrition. Authentic organic food production is regenerative and relies on these processes, which are energized by the sun, or photosynthesis. Regenerative farming focuses on maximizing photosynthesis by keeping the ground covered with diverse plantings (polyculture) and building soil quality (adding carbon) as the answer to repairing our environment while producing abundant nutrition. Regenerative agriculture prioritizes conservation practices to protect our natural resources and prioritizes decreasing the use of fossil fuel use in food production. Regenerative farming designs have a long term focus on environmental health

Procedure:

1. **Discuss:** How does food grow? Ask students to think about where food comes from and how it gets to their plate. Does anyone know what organic means? What is the difference between organic and conventional/industrial farming? What is a pesticide? Why does it matter?
2. **Watch:** Organic Sustainable Farming is the Future of Agriculture (6 minutes) from Happens Films.(https://www.youtube.com/watch?v=hWkYtZxpQUo)
3. **Watch:** How regenerative agriculture can help farmlands thrive and improve ecosystems (5 minutes) from WWF International and Gabe Brown. (https://www.youtube.com/watch?v=N_NtNyvOyRM)
4. **Read:** *Rachel Carson and the Book that Changed the World* by Laurie Lawlor. This is a quick, light read, elementary grade focus but informative, that introduces Rachel Carson and her life's work as an environmentalist and earth steward. A short, but good read for older students about Rachel Carson is Chapter 4 of *Nature's Allies: Eight Conservationists Who Changed Our World*.
5. **Evaluation:**
    1. Define the word organic; how does it apply to organic farming?
    2. On a clean page of your journal create two parallel columns, title one regenerative farming and the other industrial farming. Under each heading list the common characteristics of each, comparing and contrasting. Include at least five Defining characteristics including sources of energy input and effects on the environment.

Modification- Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 2: Theri's Summer Kitchen

September Kitchen Project: Tomatoes & Salsa

Goal(s): To learn about the nutritional benefits of tomatoes, practice knife skills and make salsa.

Learning objectives:

1. Students can describe tomato plant structure by labeling.
2. Students can list two nutritional benefits of tomatoes.

Next Generation Science Standards connections (grades 3-12):

- *5. From Molecules to Organisms: Structures and Processes* (5-LS1-1) Support an argument that plants get the materials they need for growth chiefly from air and water.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-6) Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

Time: 45 min

Lesson supplies:

- Knives
- Cutting boards
- Large bowl
- Ingredients
    - 4 chopped tomatoes
    - Tortilla chips
    - ½ cup chopped green bell pepper
    - ¼ cup of a sweet onion, diced
    - ½ cup minced fresh cilantro(optional)
    - 1 fresh lime (juiced)
    - ½ tsp salt
    - ½ tsp black pepper

Overview:

The tomato, one of summer's most famous crops, can be tasted right off the vine. There is so much variety in size, shape, color and flavor. I grow a number of favorites in my garden including cherry tomatoes, which are fun for kids. It's hard to match the robust fresh flavor of a midwest tomato. Tomatoes can be easily preserved because of their acidic base and are found in all kinds of kid friendly products including tomato sauce, ketchup, tomato soup, and salsa. Making any of these fresh is an eye opener for kids.

Scientifically, tomatoes are a fruit; they start with a flower and have the seeds in the middle. Tomatoes are part of the family Solanaceae (common name nightshade), along with

potatoes, eggplants, peppers and tomatillos. Tomatoes are rich in lycopene, an antioxidant, as well as vitamins K and C. Like most antioxidants and vitamin-rich foods, the tomato offers many anti-cancer and anti-inflammatory properties. In this lesson, we'll make a delicious salsa. Students can sample and practice knife skills while they learn about the benefits of tomatoes.

Before the kitchen demonstrations, the instructor should lead the class in discussion by listing what students know about the plant. If there is an outdoor green space currently growing tomatoes, take a walk so that students may touch, feel, and taste growing tomatoes. If possible, try some different varieties, harvest for your recipe, or do a cherry tomato taste for each student. Be sure to demonstrate how the tomato is properly removed from the vine, with a bit of stem intact, to keep it fresh longer (stems on fruits are like lids to your tupperware bowl, they keep the food fresh longer). Don't refrigerate tomatoes if you want the flavor to stay robust. Refrigerating will keep the fruit longer but diminishes the flavor.

Procedure:

1. **Ask:** What do the students know about tomatoes?
2. **Watch:** Health Benefits of Tomatoes (4.5 mins) from Karen Roth. (https://www.youtube.com/watch?v=euoK2gb1Jxs)
3. **Recipe: Easy Salsa**

   Supplies
   - Knives
   - Cutting boards
   - Large bowl
   - 4 chopped tomatoes
   - Tortilla chips
   - ½ cup chopped green bell pepper
   - ¼ cup of a sweet onion, diced
   - ½ cup minced fresh cilantro(optional)
   - 1 fresh lime (juiced)
   - ½ tsp salt
   - ½ tsp black pepper

   Directions
   1. Review knife safety (see *August Kitchen Project: Melons*).
   2. Chop all the ingredients. Consider letting each group of students chop one of the ingredients.
   3. Mix the ingredients together.
   4. Serve with tortilla chips.
4. **Evaluation:**
   - **a.** Name two important nutrients that we get from tomatos; how do these nutrients contribute to our health?

   Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

September Kitchen Project: Green Beans

Goal(s): Students will learn about the nutritional value of green beans and the biology and function of legumes.

Learning objectives:

1. Students can describe a green bean plant structure.
2. Students can classify green beans in the legume family and give 2 examples of their unique features.
3. Students can list two nutritional benefits of green beans.

Next Generation Science Standards connections (grades 3-12):

- *5. From Molecules to Organisms: Structures and Processes (5-LS1-1)* Support an argument that plants get the materials they need for growth chiefly from air and water.
- *MS. From Molecules to Organisms: Structures and Processes (MS-LS1-6)* Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

Time: 45 min

Lesson supplies:

- Water for boiling
- Green beans
- Steam basket (optional)

Background review for the instructor:

- What Is the Nitrogen Cycle and Why Is It Key to Life? Miriam R. Aczel (https://kids.frontiersin.org/articles/10.3389/frym.2019.00041)

Vocabulary:

Legumes: A family of plants that have a special ability to digest and use nitrogen, an essential element for nutrition and plant growth. Legumes are notable in that most of them have symbiotic nitrogen-fixing bacteria in structures called root nodules.
Nitrogen: An element that occurs in the tissue of all living things and is a major component of chlorophyll, the compound plants use to produce sugars. Nitrogen is also an essential part of amino acids. From Nitrogen - Nutrient Management | Mosaic Crop Nutrition.
The nitrogen cycle: The series of processes by which nitrogen is converted from one compound into another continuously in the environment and in living organisms, including nitrogen fixation and decomposition (Oxford Dictionary).

Overview:

Green beans belong to a family of plants known as ***legumes***. Legumes have a special role in the garden because of their associated bacterium companions' ability to digest and use (we call it fix) nitrogen. These companions live in visible nodules on the legumes root system. Plants and people need nitrogen to live but can not use it directly. We rely on legumes to make nitrogen available to us and to other plants around them (relationships/interconnection). During photosynthesis, legumes take in atmospheric nitrogen and digest it in special bacteria laden nodules located on their roots, using some to grow, and the surplus to share with surrounding plant roots and microscopic organisms. Introducing ***the nitrogen cycle***, in age appropriate depth and language, can include a look at these nitrogen fixing nodules of the green bean plant roots.

Green beans are direct-seeded into the soil after the danger of frost is over. Before planting, check your area's average frost free date. There are about 200 different varieties of

beans. Pole beans require a trellis; they will grow straight up on a string or wire. Most people agree pole beans are the most flavorful varieties of bean and they are easier to pick too.

There are several parts to a green bean plant: the roots, laden with bacteria nodules, that hold the plant in the ground and communicate with the soil and other plants around them, the stem which supports the leaves and pods, the leaves which house the food factory, where photosynthesis occurs, and shields the developing flowers from too much sun, the flowers where pollination/reproduction occurs, and the seed pods known as green beans. To have continual green beans all summer, plant at two or three week intervals. We can harvest green beans at multiple stages in their life cycle: when the bean is green and tender and when it has completely dried out on the vine.

Green beans are a highly nutritious crop that students can appreciate with simple preparation. The vitamins (K, A, and C) and minerals (phytochemicals) contained in green beans are shown to lower the risk of some cancers (breast, prostate, lymph), to promote eye health, boost immunity, and promote strong bones and teeth. Green beans help keep our immune system strong. By lightly cooking the beans, we can actually make these nutrients easier to digest. Make sure not to overcook though, as this diminishes nutrients. The bright green color of lightly steamed green beans indicates the best nutritional choice stage for eating. For demonstration purposes, you can overcook some beans and show the bright green to dull green transition and the resulting green water. ***Nitrogen*** is in the chlorophyll molecule of plants; chlorophyll gives plants their green color.

All recipes should allow for taste testing at some level. Demonstrate if students can't cook on their own. Steaming produce is always preferred nutritionally to boiling. If you do so, make sure to explain to your students how steaming maintains more nutrition, as opposed to boiling in water, where some of the nutrients will be lost. Before the kitchen demonstrations, the instructor should lead the class in discussion by listing what they know about the plant. If there is an outdoor green space currently growing green beans, take a walk so that students may touch, feel, and taste the fresh green beans. If you are growing pole beans and bush beans take a minute to compare and contrast growth patterns and flavor. The garden is a perfect place to review plant parts and their functions. I always remind students that it is fine to blow off the dust and eat fresh any fruit or vegetable that is raised organically.

Procedure:

1. **Discuss:** Explain to the class about legumes and the nitrogen cycle. If available, observe green beans growing.
2. Harvest or have ready pre-purchased fresh green beans for the class recipe.
3. **<u>Recipe: Easy Green Beans</u>**

   Supplies
   - Water for boiling
   - Green beans
   - Steam basket (optional)

   Directions
   1. Explore what the class knows about green beans throughout the demonstration.
   2. Snap the stem end of the green beans off (great compost). These are harder to digest. Set aside some of the raw beans to compare to the ones you will cook.
   3. Bring a large pot of water to a boil or if steaming bring two inches of water to boil and place the steam basket in the pot.
   4. Carefully lower the green beans into the water or basket.

5. Steam beans just until the color is a vibrant green. Be careful not to overcook. When you lose the vibrant color you lose the nutrition too.
6. Remove beans and cool by running under cold water to stop them from overcooking. This also cools them for taste testing.
7. Optional - toss beans with a bit of butter and a pinch of salt.
8. Enjoy!

4. **Evaluation:**
   - **a.** Draw and label a green bean plant, including the roots, stems, leaves, and flowers.
   - b. Which plant family do beans belong to and what are two important features of this family?
   - c. What are two nutrients we get from green beans?

   Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

September Kitchen Project: Sun Pickles

Goal: Students will learn about the nutrition of cucumbers and the process of making pickles as a preserving practice.

Learning objectives:

1. Students can list two nutritional benefits of cucumbers.
2. Students can classify pickles as preserved cucumbers.

Next Generation Science Standards connections (grades 3-12):

- *5. From Molecules to Organisms: Structures and Processes (5-LS1-1)* Support an argument that plants get the materials they need for growth chiefly from air and water.
- *MS. From Molecules to Organisms: Structures and Processes (MS-LS1-6)* Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

Time: 45 min

Lesson supplies:

- Mason jars - (pint sized, one per student)
- Black permanent marker for labeling
- Cucumbers, 6" pickling , 4- per quart of finished pickles
- Garlic, 2 cloves per quart
- Med. onion, per quart (optional)
- Dill-2 large flowers per quart
- Brine (for 4 quarts of pickles, multiply as needed)
  - 3 ¼ cups vinegar,
  - 6 ½ cups water
  - ⅔ cups canning salt

Background review for the instructor:

- Review knife safety techniques for kids, especially handle hold and produce hold (see *August Kitchen Project: Melons*).
- For the Sun Pickles recipe, you will want to start the brine beforehand because it will take a while to boil.

Vocabulary:

Fermenting: The process by which a substance breaks down into a simpler substance. Microorganisms like yeast and bacteria play a role in the fermenting process and make vegetables more nutritious by adding healthy microbes to the product, making raw vegetables more easily digested; sauerkraut and kimchi are examples of this process.
Probiotics: Microscopic organisms that live in our gut and aid in digestion and overall health.

Overview:

Cucumbers are members of the Cucurbitae family, common name cucurbits, and contain a good portion of your recommended daily intake of vitamin K, as well as some vitamins C and B. As with most green vegetables, cucumbers have antioxidant and anti-inflammatory properties. Cucumbers are extremely low in calories, as they are mostly water. Fresh cucumbers are crunchy and delicious. Pickling cucumbers is a common way of preserving them. Preserving allows us to eat cucumbers all year, long after their growing season is over. There are a number of ways to make pickles from cucumbers. They can be brined with a vinegar solution or fermented. Vinegar is an acidic liquid that slows down food decay**.** ***Fermenting*** is the oldest and healthiest way to preserve cucumbers (pickles) and most produce, as the process adds healthy ***probiotics*** to our diet. We will learn more about fermenting later.

Today we are going to make refrigerator pickles because they are fast and easy for the classroom and they extend the cucumber's edible life up to one year.This recipe will use a hot brine that will create a soft seal and raise acidity keeping cucumbers, pickles, fresh up to one year in the refrigerator. <u>This product must be refrigerated,</u> as the seal does not have much pressure.

No matter the recipe, pickles are best made with varieties of cucumber that are small and extra crisp. I like to harvest pickling cucumbers the morning of the day I am going to use them. If I need to collect them for several days to get enough for a recipe, I keep the cucumbers crisp by storing them in ice and salt in the refrigerator until I have enough. In this lesson, we use an easy sun pickle recipe that I find just about everyone loves.

Cucumbers are sun loving plants. They are planted outside about two weeks after your last frost date but can be seed started inside three weeks before transplanting outside. Cucumbers benefit from a manure compost soil amendment. They are fast growing vines and can be a great ground cover if you have wide open spaces. Conversely, they can be trellised and grown vertically if space is limited. For best growing results choose a pickling cucumber variety and consult your seed package for specific planting instructions and timeline. I plant a new variety of cucumbers every three weeks throughout the growing season, always making sure to include one large planting of pickling cucumbers for preservation so I can eat my favorite pickles all year long.

Before the kitchen demonstrations, the instructor should lead the class in discussion by listing what they know about the plant. If there is an outdoor green space growing cucumbers, take a walk so that students can see how cucumbers grow and touch, feel, and taste a freshly harvested cucumber. Cucumbers make a refreshing summer treat as they are 96% water.

Procedure:

1. **Discuss:** Review and demonstrate the process of preparing a jar of sun pickles
2. **<u>Recipe: Sun Pickles</u>**

   Supplies

   - Bucket (for compost)

- Mason jars - (pint sized, one per student)
- Black permanent marker for labeling
- Cucumbers, 6” pickling , 4- per quart of finished pickles
- Garlic, 2 cloves per quart
- Med. onion, per quart (optional)
- Dill-2 large flowers per quart
- Brine (for 4 quarts of pickles, multiply as needed)
    - 3 ¼ cups vinegar,
    - 6 ½ cups water
    - ⅔ cups canning salt

Directions

1. Place a bucket close to the work area for compost collection.
2. Brine- If the recipe is multiplied, consider using more than one stock pot to hasten boiling time.
3. Combine all brine ingredients in a stock pot and bring to a boil. Stir until salt is dissolved. Set aside.
4. Preparing produce: After harvesting or purchasing fresh cucumbers, onions, garlic and dill prepare by:
    - Garlic- Peel 3-4 cloves of garlic per quart, peeling the papery outer coating, and chop them in half.
    - Onions- Peel the papery layers off, cut in half and lay on a flat side to make thin slices.
    - Cucumbers- Using a vegetable brush, clean each cucumber under cold water. Be sure to get all dirt out of crevices. Slice cucumbers into ¼ in circles, compost ends or feed to animals
    - Dill- Remove flowers from stem, leaving heads whole with or without seed
5. Place into the bottom of each jar: Two heads of dill (one in a pint size jar) and two cloves of chopped garlic.
6. Pack down alternating layers of cucumbers and onion until the jar is full to the bottom of the rim.
7. Use a canning funnel to pour very warm brine into jars, just enough to cover produce.
8. Remove trapped air bubbles by inserting a plastic knife (metal knives can sometimes crack jars) down the edge of the jar then push the knife toward the center of the jar. Bubbles will rise to the top and release. Repeat this four times around the jar.
9. Wipe off the rim of the jar and use a solid or two piece lid system. Secure lid.
10. Record the date on the seal/lid of the jar in black permanent marker.
11. Set in the direct sun for 3 days, then refrigerate.
12. If possible, send a jar of sun pickles home with each student.
13. Refrigerate one week before eating for the best flavor. The seals will be tight when opening. Pickles are good for a few months after opening. Keep refrigerated until opening. Eat from oldest to youngest dated jars. Delicious!

3. **Evaluation:**
    - **a.** Name at least two nutrients we get from eating cucumbers?

b. What is the process of food preservation that changes cucumbers into pickles : how does that happen?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

September Kitchen Project: Zucchini Bread

Goal(s): To learn about the fruit zucchini, its nutrients and native origin, and how to make zucchini bread.

Learning objectives:

1. Students can list two nutritional benefits of zucchini.
2. Students can categorize zucchinis as native to America.

Next Generation Science Standards connections (grades 3-12):

- *5. From Molecules to Organisms: Structures and Processes (5-LS1-1)* Support an argument that plants get the materials they need for growth chiefly from air and water.
- *MS. From Molecules to Organisms: Structures and Processes (MS-LS1-6)* Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

Time: 45 min

Lesson supplies:

- 1 egg
- ¼ cup vegetable oil
- 1/3 cup sugar
- 1 cup all purpose flour
- 1 tsp. salt
- 1 tsp. baking soda
- 1 tsp. baking powder
- 1 tbsp. cinnamon
- ½ tsp. nutmeg
- 1 cup zucchini (grated)

Overview:

Zucchini belongs to the Cucurbitae family. They are related to cucumbers, also cucurbits. Though often thought to be a vegetable, zucchinis are a fruit. It is a summer squash, originating in North America (native), distinguished from winter squash like pumpkins and butternut squash by their soft skin. Though the plant originated in America, it is said to have been bred by the Italians, which is why you will sometimes see it called the "Italian squash". Zucchinis have nutritional benefits including a high amount of vitamin C, an antioxidant, which may help lower blood pressure and protect against clogged arteries. Zucchini is also high in potassium. Potassium helps our nerves and muscles work, keeps our heartbeat healthy and helps our bodies' cells intake nutrients and eliminate waste.

Zucchinis can be directly seeded into your garden after the fear of frost or transplanted as a three week old seedling. If directly seeded, plant in hills, or plant multiple seeds together. This helps with pollination. Pollinators, like bees, butterflies and birds are very important to this summer squash. Zucchinis benefit from a manure compost soil amendment.

Due to its abundant production, there are so many zucchini recipes out there to try. Raw zucchini can be cubed in salads or sliced in rounds for dipping. Try zucchini lightly steamed or stir fried with onions and peppers. If these don't win you over, zucchini bread surely will. I am sharing an easy to make zucchini bread recipe that has been a favorite in my classroom for over 25 years; no other recipe has been requested more (makes a loved addition to the farm journal). I try to keep the sugar to a minimum in baking with students and sometimes will use honey as a substitute.

Always try recipes first when making substitutes to make sure your students will experience success. This is an easy recipe that can be made with the youngest bakers with a minimum of help. This bread will make a zucchini lover out of everyone!

If you don't have access to an oven, consider making zucchini waffles on a waffle iron or zucchini pancakes on an electric grill. Use the same batter and follow instructions for your cooking surface. Before the kitchen demonstrations, the instructor should lead the class in a discussion by listing what they know about the plant. If there is an outdoor green space currently growing it, take a walk so that students may touch, feel, and taste the freshly picked zucchini.

Procedure:

1. **Discuss:** Talk with the class about zucchini's, if available observe them growing and harvest a few for this recipe.
2. **<u>Recipe: Easy Zucchini Bread</u>***

   *One of my students' all time favorites!

   Supplies

   - 1 egg
   - ¼ cup vegetable oil
   - 1/3 cup sugar
   - 1 cup all purpose flour
   - 1 tsp. salt
   - 1 tsp. baking soda
   - 1 tsp. baking powder
   - 1 tbsp. cinnamon
   - ½ tsp. nutmeg
   - 1 cup zucchini (grated)

   Directions:

   1. Grate 1 cup of zucchini (packed), set aside
   2. Beat 1 egg in a medium sized bowl
   3. Add oil and sugar mixing together after each addition.
   4. Add in the grated zucchini, mix.
   5. Fold in flour, salt, baking powder, baking soda, nutmeg and cinnamon slowly.
   6. Fill 2 small bread pans or tins ½ - ¾ full (this batter can be used for a waffle or pancake alternative)
   7. Cook at 350 for approximately 20 mins.
   8. Cool and enjoy.
3. **Evaluation:**
   a. What are two nutrients we get from eating zucchini?
   b. Where did the zucchini originate?

   Modification: Students unable to journal can share what they've learned orally,

pictorially, or in another medium of their choosing.

Week 3: Science Enrichment

Week 3 of each month features three different science focus areas: botany, zoology, and microbiology. Instructors can choose to use lessons based on their science requirements.

Botany: Native Plants

Goal(s): Students will learn the concepts: native plants, non-native plants, and invasive species.

Learning objectives:

1. Students can compare and contrast native and invasive species.
2. Students can identify at least 2 native plants in their region.
3. Students can identify at least 2 invasive species and explain how they are able to thrive.

Next Generation Science Standards connections (grades 3-12):

- *3. Biological Evolution: Unity and Diversity (3-LS4-3)* Construct an argument with evidence that in a particular habitat, some organisms can survive well, some survive less well, and some cannot survive at all.
- *MS. Earth and Human Activity (MS-ESS3-3)* Students who demonstrate understanding can apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- *HS. Ecosystems: Interactions, Energy, and Dynamics (HS-LS2-6)* Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- *HS. Biological Evolution: Unity and Diversity (HS-LS4-5)* Evaluate the evidence of supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

Time: 90 Min

Lesson supplies:

- Access to resource books/the internet
- Index cards
- Journal
- Pen or pencil

Background review for the instructor:

- This week's research project exploring native plants can be a multi-week project, so plan accordingly. Try going to the school library or computer lab for fact finding first; have one period to synthesize their information into a presentation, and one period to present.

Vocabulary:

Native plants/species: Plants and animals indigenous to a given area that occur naturally in the environment.

Non-native species: Plants and animals present in a given area that are not originally from there.

Invasive species: Usually a non-native species that has entered a foreign ecosystem and is likely to cause economic or environmental harm.
Biodiversity: The degree to which many different life forms inhabit a place. Biodiversity is a key element in creating balanced systems that take care of themselves without human or chemical intervention.

Overview:

Plants originating from a given area are known as ***native plants***. Present on the landscape for thousands of years, they adapted to the soil and climate of an area and thus became incredibly hardy through developed relationships. Many native plants originally provided nutrition for local humans and animals but have disappeared from the farm and natural landscape and are now unfamiliar due to their scarcity or extinction. For instance, not many people are familiar with gooseberries, a native berry bush from the midwest area. Over the last hundred years or so they have become scarce on the farming landscape because they are considered inefficient for large scale production. Gooseberry bushes have large thorns and small fruits. They are sweet and make delicious jams but the inconvenience of harvesting them has mostly eliminated them from farming and even backyard production.

Native plants are well adapted to weather extremes and will grow hardiest in their native environment requiring very little attention on the part of the farmer. Native plants conserve energy and contribute to environmental healing (regenerative farming). The hundreds and thousands of years these plants have spent adapting to the soil type, precipitation levels, and sunlight in their native lands is what makes them so well suited to their environments. Native plants have deep roots and contribute to water conservation. They create diverse habitats that attract and feed more bees, birds, butterflies and bats, increasing ***biodiversity*** on the landscape naturally. On the other hand, ***non-native species*** are those that are not naturally occurring in a given area. These plants (and animals) are brought to new areas by humans on purpose or accidentally. Many fruits and vegetables on farms today are non-native plants including: tomatoes, spinach, apples, oranges, carrots, peaches, peanuts, and more. These were brought to America as plants and/or seeds from other countries.

Invasive species are those plants that grow fast, multiply quickly and often choke out other species (animals and plants) or cause human harm. Invasive species are usually, but not always, non-native. This classification is unique because of the harm they cause. The effects of invasive species can be severe both economically and environmentally. When invasive plants smother native plantings they limit biodiversity. The Natural Resource and Conservation Service (NRCS) in your area can give you a listing of invasive (and native) species you might find. Removing invasive species can require non-organic measures.

Procedure:

1. **Introduce native and invasive plants.** Does anyone know what a native plant is? How about an invasive species? What are they? Use pictures or plants from your area to illustrate your discussion.
2. **Watch:** Why Native Plants? (4 minutes) from Catherine Zimmerman (https://www.youtube.com/watch?v=trJKZDEfvrc)
3. **Research Project: Native Plants** (two 40 minute sessions work for me)
   As a class, plug in the school's zip code to determine what plants are native to your unique region at https://www.nwf.org/NativePlantFinder/About
   Supplies
   - Access to resource books/the internet

- Index cards
- Journal
- Pen or pencil

Directions

1. This lesson can be a multi-week project. Try going to the school library or computer lab for fact finding first; have one period to synthesize their information into a presentation, and one period to present.
2. Divide the students into pairs, assigning each a native plant or two.
   Have the students explore:
   a. What the native plant looks like.
   b. What kind of pollinators and animals it attracts.
   c. What other functions it serves or
   d. Why we should consider planting this in a school meadow.
3. To stimulate interpersonal learning, have each group give a brief presentation on what they have learned. Allow appropriate presentation media; powerpoint, drawings, posters, ect. Give the students 5-10 minutes to present, based on how much research and information they had time to collect.

4. **Native plant walk:** If you have natives and invasives on your property take students on a walk to identify them or prepare a treasure hunt handout using pictures for students to find these plants. I pair students up for this hunt and have them note the locations the plants are found.
5. **Evaluation:**
   a. Give a definition for each: native, non-native, and invasive species?
   b. Can a native plant also be invasive: how does that work?
   c. Can you name any plants that are invasive in this region, and how they are able to spread so easily?

   Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Zoology: Birds as environmental indicators

Goal(s): Students will learn distinguishing characteristics of animals in the following categories: native, domestic, wild, farm and indicator species.

Learning objectives:

1. Students can define the importance/role of birds in nature and on the farm.
2. Students can explain the pattern of interaction between the pollution of the ecosystem and native birds behavior.
3. Students can explain why birds are an indicator species.

Next Generation Science Standards connections (grades 3-12):

- *MS. Ecosystems: Interactions, Energy, and Dynamics (MS-LS2-1)* Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- *MS. Ecosystems: Interactions, Energy, and Dynamics (MS-LS2-2)* Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

- *HS. Ecosystems: Interactions, Energy, and Dynamics (HS-LS2-1)* Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- *HS. Biological Evolution: Unity and Diversity (HS-LS4-2)* Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

Time: 1 hour

Lesson supplies:

- Printed copies of the Audubon article "Why do birds matter?" (http://www.audubon.org/news/why-do-birds-matter)
- Technology/access to the internet or library

Vocabulary:

Native: Animals originating in a particular region or land having evolved there for thousands of years.
Domestic: Animals that have been bred to live alongside humans. Can be on a farm or in a home, as companions, e.g. dog or cat. can be native and non-native.
Farm: Domestic animals that are raised for edible or usable products; including meat, fibers, eggs, medicine.
Wild: Animals not tamed; live on their own without human intervention. Can be native and non-native.
Indicator species: A species whose presence, absence, or relative well-being in a given environment is a sign of the overall health of its ecosystem
Ecosystem: An ecosystem is a community of living organisms interacting with the nonliving components of their environment,

Overview:

In recent years, studies have shown that birds are useful in identifying ecosystem health. We refer to birds as ***indicator species***. A diverse showing of healthy ***native*** birds can indicate a healthy environment. Insect eating birds offer pest control for farmers and scavenger birds clean up a lot of roadkill which can aid in disease control. Birds are particularly sensitive to chemicals and other human impacts on their natural environments, hence the title of Rachel Carson's book, *Silents Springs,* which exposed the damaging effects of pesticide use in industrial farming.

This lesson looks at grouping well known animals with a focus on native birds as environmental indicators.

Procedure:

1. **Discuss:** Introduce animal categories. Go through the four groups from the vocabulary (native, **domestic**, **farm**, and **wild**), asking students to pick an animal and place it in the proper grouping. Notice how some animals belong in more than one group. What is the difference between groups? What distinguishes farm animals? What (how) do you think animals can tell us about their surroundings?
2. **Discuss:** Why are birds important to the environment? Why should we be concerned with bird populations?
3. **Read:** Why Do Birds Matter? | Audubon (http://www.audubon.org/news/why-do-birds-matter)

This article is not meant to be scientific, but introduces students to a wide variety of ideas as to why birds are important. Ask the students what quotes they identify with. How does the definition of earth stewardship apply to this article?

4. **Explore:** Project FeederWatch (https://feederwatch.org/learn/common-feeder-birds/) with your students (10 mins). Allow their interest to guide the online work. What birds look interesting? Has anyone seen any of these birds before?
5. **Activity: Bird Walk**
    1. Print the list of common feeder birds (if possible, print a few copies to share among the class).
    2. Take the class outside on a nature walk to identify local birds, identify them from the list given. Time permitting, upon entering the classroom, go back to Project FeederWatch and look up the birds you found in more detail with the class.
    3. Another activity to consider for this unit is making a bird feeder (found in December week 1).
6. **Evaluation**
    a. Name at least three important functions that birds serve on a farm ?
    b. How does the behavior of native birds indicate the health and well being of an ecosystem?
    c. Why is it important that we are looking at native birds when we use them as environmental indicators?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Microbiology: The Microbiome

Goal(s): To introduce the human microbiome to students, including classifications of microorganisms and pathogens.

Learning objectives:

1. Students can explain what a microbiome is in its relation to microorganisms and germs.
2. Students understand that most microorganisms are non pathogenic and are part of a healthy support system.
3. Students can explain why washing hands is important.
4. Students can define the terms pathogen and virus.
5. Students can explain why over-sanitizing hands can be harmful.

Next Generation Science Standards connections (grades 3-12):

- *HS. Engineering Design (HS-ETS1-1)* Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- *HS. Engineering Design (HS-ETS1-2)* Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Time: 1 hour 40 mins

Lesson supplies:

Before class

- Filter paper (coffee filters work)
- Scissors

- Paperclips or small envelopes
- Baking soda
- Water
- Measuring cup
- Red cabbage
- Stock pot
- Kitchen knife
- Jar, test tubes or paper cups

During class

- Prepared Strips of paper
- Pen or pencil
- Indicator solution (cabbage juice)

Background review for the instructor:

- The HIDDEN World of Microbiomes (3 minutes) (https://youtu.be/MjhDRG-mQ7w)
- What Is Coronavirus? | Johns Hopkins Medicine (https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus)

Vocabulary:

Microorganisms: A microscopic organism. The five main groups include: Bacteria, Archaea, Fungi (yeasts and molds), algae, protozoa and viruses.
Microbiome: Microorganisms in a particular environment (such as in the stomach or on the hands).
Pathogen: Bacteria or other microorganisms that can cause disease, sometimes referred to as germs.
Epidemiology: The study of health and diseases.
Antibacterial: Anything that destroys bacteria or inhibits its growth.

Overview:

This lesson introduces young students to ***microorganisms***; microscopic life forms that live on and around us. Our bodies are teeming with trillions of these — and that's a good thing! This amazing universe makes up the human ***microbiome***. Students should understand that microbial life is a necessary element for healthy systems. ***Pathogens*** are a small percentage of microorganisms that can cause disease. The study of health and diseases is called ***epidemiology***. Something that is ***antibacterial*** destroys bacteria or inhibits its growth, a feature of many hand soaps and hand sanitizers. In this lesson, students will consider the merits of hand washing, watch a video from the news, and participate in an outbreak exercise to see how pathogens spread.

Procedure:

1. **Discuss:** Ask students what they remember from the hand washing lesson last month. Why is hand washing so important? What actions do people use to remove germs from their hands? Remember most bacteria are good: our gut is filled with millions of bacteria that help us break down our food and are even shown to help our brains function. Microbiomes are found in the soil and without them the minerals our bodies need for health would not be in our food (produce). We should wash our hands well, especially after certain activities, but be careful not to be obsessive. We need a good variety of microorganisms (microbiome) on our hands, and everywhere, to support health. Be cautious of harsh chemicals when hand washing.

2. **Watch:** CBS: Soap & #38; Water vs. Hand Sanitizer (8 minutes) (https://www.youtube.com/watch?v=f9TV61e8gTI)
3. **Activity: Outbreak! Investigating Epidemics** (1 hour teacher prep, 40 mins activity)
   Adapted from the American Society for Microbiology

   Supplies:

   Before class
   - Filter paper (coffee filters work)
   - Scissors
   - Paperclips or small envelopes
   - Baking soda
   - Water
   - Measuring cup
   - Red cabbage
   - Stock pot
   - Kitchen knife
   - Jar, test tubes or paper cups

   During class
   - Prepared Strips of paper
   - Pen or pencil
   - Indicator solution (cabbage juice)

   Teacher Prep (1 hr)

   Paper Strips:
   1. Count the number of students in the class. Cut up filter paper into strips approximately 1 inch by 3 inches so that each student gets five strips of paper. Coffee filters purchased at the grocery store work fine as the filter paper.
   2. Group five strips together using a paper clip, small envelope, or some other method to keep the five strips together.
   3. Randomly select one group of five strips and dip them into the saturated baking soda solution (directions below) for a few seconds. (The students who get these strips will be "infected" with the agent of transmission.) For a large class (over 25), you may want to have more than one student receive "infected strips."
   4. Allow the wet strips to dry on a clean surface. This should take about an hour.
   5. Regroup the five "infected" strips and assemble in the same way as you did the other packets of five strips so that all the groups of five look alike.
   6. If you want to know ahead of time which student picks the infected group of strips, then you can personally pass out the strips, taking note of who gets the "infected" packet(s).

   Saturated baking soda solution for "infected" strips:
   1. Add a couple of tablespoons of baking soda to one cup of water.
   2. Stir the baking soda so that it dissolves.
   3. Keep adding baking soda until it does not fully dissolve, collecting at the bottom. Now the solution is saturated. Dip five strips into the solution for a few seconds each.

   Red Cabbage pH indicator:
   1. Cut a head of red cabbage in half. Cut the halves into small pieces with a kitchen knife.
   2. Place cabbage in a large pot and add enough water to cover the shredded cabbage.

3. Bring the water to a boil and boil for 30 minutes.
4. Drain off the cabbage pieces and allow the cabbage juice to cool. (You can store this solution in the refrigerator for a number of weeks.)
5. On the day of the simulation, place the cabbage juice in a jar in a central location to serve as the "microbe testing station." Alternatively, you can pour small amounts of the cabbage juice into plastic test tubes or paper cups, so that student groups have their own testing station.

Directions

1. Discuss the concept of epidemiology and how epidemiologists track the spread of disease. Be clear that most bacterias are good for us, so it is good to have some on our hands. Discuss the Covid19 epidemic.
2. Invite the students to think of questions they need to answer in order to identify the source of an unknown infectious disease.
3. Explain the purpose of the Center for Disease Control and Prevention and local public health agencies and their efforts to determine how diseases spread.
4. Give each student 5 strips, with 2 students receiving the "infected" strips.
5. Have students write their initials or names on each of their five strips.
6. Begin the simulation by telling students to trade one strip with another student. In their notebook, they can write down who they traded with, the name on the strip they gave away and the name of the strip they received.
7. On the first trade, they have to give away one of their own strips.
8. On the following trades, they can trade any of the strips they have (their own or that of someone who has traded with them), but trade only ONE strip per trade.
9. You may decide how many trades or how long you want the trading to continue (between 5 and 8 are good).
10. Once all trading has stopped, ask them to use the indicator solution to see who is holding the "infected" strips. They should dip each strip one at a time because the color may bleed onto another strip. If the strip turns green, it is one of the infected strips (ie. it has been soaked in the baking soda solution).
11. Ask the students to journal or answer in groups the following questions (make sure to reaffirm that germs strengthen our immune system, so even if the students got infected, their hypothetical immune system will grow stronger because of it):
    1) Did you get the infectious disease?
    2) What do you think epidemiologists want to know about diseases in order to track them?
    3) How many people in the class were exposed to the disease? What is the fraction of infected people? Can you state this in a percentage?
    4) What is the role of vaccines in strengthening our immune systems?

4. **Evaluation:**
    a. Explain what a human microbiome is?
    b. How do we get a healthy microbiome and how do we keep it healthy?
    c. Why is washing hands important?
    d. Define "pathogen" and "virus".
    e. Can over-sanitizing hands be more harmful than good, explain?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 4: On the Farm

Farmer Spotlight- Wild Coyote Farm

Soil Health

Goal(s): Introduce soil erosion and look at common causes and solutions.

Learning objectives:

1. Students can define soil erosion
1. Students can list at least two conditions that contribute to building soil health.
2. Students can define three conditions that contribute to soil erosion.
3. Students can define living soil.

Next Generation Science Standards connections (grades 3-12):

- *MS. Ecosystems: Interactions, Energy, and Dynamics (MS-LS2-3)* Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *MS. Earth's Systems (MS-ESS2-1)* Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

Time: 45 min

Lesson supplies:

- Loose Soil
- A Soil clump (shovel full) covered with living grass

Vocabulary:

Cover crops: Crops that are planted to prevent soil erosion and build soil fertility, not typically a cash crop.
Topsoil: The top soil layers.
Erosion: The process that wears away at rock and soil particles by wind, water, or other agents (tillage).
Living soil: Topsoil that maintains a healthy biome of living organisms; micro -macro. T
Percolate: Filter through a porous surface.
Mulch: Organic materials such as wood chips, leaves, grass clippings or living ground covers such as cover crops that are used to cover and protect topsoil around plants.

Overview:

This lesson explores the farming practices of ***cover cropping*** and ***mulching*** used to build and hold soil in place after harvesting annual crops. We will look at two soil samples to compare and contrast.

Topsoil is invaluable to the health and wellness of all living things. The soil food web lives in topsoil making it ***living soil***; alive with micro to macro living organisms. Organisms that are responsible for breaking down minerals and making them soluble to plants. Minerals are a building block of human nutrition and are found in plants(fruits and vegetables) that grow in living soil. Research suggests the more diverse and abundant living soil organisms are the greater the soil health, and plant health, will be. We get our needed minerals by eating fruits and vegetables that contain these minerals. Topsoil depth is one indicator of good soil. Without

topsoil there is no source of nutrition for plants or people. Topsoil is essential for all life. ***Erosion*** refers to a loss of topsoil.

In September our summer gardens are dying back. It is time to remove finished plant matter and add it to your compost pile as a source of carbon and/or nitrogen (C=brown organic matter, N=green). While we still have time we can protect these garden beds and enrich the soil over the winter by planting cover crops. Most cover crops are not grown for a food harvest or cash crop but are grown to "cover" and enrich the soil while protecting it from weather conditions that cause erosion. Cover crops also help water ***percolate*** in the soil. Another way to care for soil health is by ***mulching*****,** which enriches the soil by holding in moisture, feeding soil microbiomes, suppressing weeds, and insulating the soil from erosion activity.

Procedure:

1. **Discuss:** Introduce topsoil. Topsoil is the home of plant roots and many living creatures. What is the role of the soil food web? Ask why the condition of soil is important when it comes to growing food.
2. **Demonstrate:** Hold an open handful of loose soil and blow across it. What happens to the parts of the soil that get into the air? Where do they go? Demonstrate a heavy rain by lightly pouring water over the soil; where does this soil go? What makes this soil so weak? (tilling, lack of roots to hold it together)
3. **Discuss:** Lead discussion to address one of agriculture's greatest challenges, the loss of topsoil. Tons of topsoil is lost every year as it is dumped into the ocean after running off land and traveling through water ways. This is a huge problem for farmers and consumers alike, as it leads to nutrition loss in our foods and dead zones in coastal waters. How can we address this?
4. **Demonstrate:** Try the same experiment using a clump of soil with grass or clover growing on the surface. Why isn't the soil moving? Where is the water going? How does the soil hold together?
5. **Discuss:** Crop roots anchor soil and help water percolate (soak in), and feed microorganisms that live in the soil. The soil microbiome is full of living organisms including viruses, bacteria, archaea, fungi, and protists (the same microorganisms that live in our human microbiome). Microorganisms live in the topsoil in a symbiotic relationship with plant roots, feeding and being fed. How can we protect these? I use oats as a ground cover in early fall, September and early October, especially where early spring crops will grow next season. Oats will have time to grow lush and strong through the fall and shouldn't go to seed before winter. Oats protect soil from erosion and feed the microorganisms that live among its roots all winter long. The microbiome is very busy under the snow especially. In the winter, the green biomass of the oat plant will die and create a thick bed of dead grass that will continue to cover and protect the soil while feeding the microorganisms. In the spring, the areas covered will be left with a thick layer of dead oat plant matter - mulch. You can plant your early spring crop right into it, no garden prep needed. This technique works great for a spring planting of onions and broccoli.
6. **Watch:** Winter-kill Cover Crop Update: Early Spring (2 minutes) (https://www.youtube.com/watch?v=7Rrv05SxKSo) on using oats as a fall cover crop and spring mulch.
7. **Watch:** Winter Soil Preparation for Vegetable Gardening (3 minutes) (https://www.youtube.com/watch?v=IseUtL9knak) on mulching for the winter. I use this kind of

mulching when there is no time for a living cover crop to grow. Oats in September are perfect!

8. Watch the clip from Spotlighted Farmers Series on cover cropping on this month's introduction page.
9. **Evaluation:**
    a. What are two important factors that help build healthy soil?
    b. List at least three factors that contribute to soil erosion.
    c. What does "living soil" mean?

    Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Additional September Resources

Compiled by Jennifer Eburuoh and Ragan Sernel

Grades 3-5

- **Book-** *The Good Garden: How One Family Went from Hunger to Having Enough*, Katie Milway.
- **Book-** *The Green Mother Goose: Saving the World One Rhyme at a Time*, David Davis.
- **Book-** *Wangari's Trees of Peace: A True Story from Africa*, Jeanette Winter.

Grades 6-8

- **Poem-** "For All" by Gary Snyder (https://www.poetrysoup.com/famous/poem/for_all_23509(
    - The poem evokes imagery of life on a farm in September and the beauty of a diverse ecosystem.
- **Book-** *The Green Foodprint: Food Choices For Healthy People and a Healthy Planet*, Linda Riebel
    - A straightforward overview of the impact of industrial agriculture and a practical guide to living a more sustainable life through our food choices.
- **Book-** *Young Readers Edition :Omnivore's Dilemma,* Michael Pollan.
- **Article-** Introducing the Soil Food Web (https://www.finegardening.com/project-guides/gardening-basics/introducing-the-soil-food-web)
    - Explains the critical parts of soil such as minerals, bateria, fungi, worms, etc.
- **Website-** Home - Native Plants Finder (https://www.nwf.org/NativePlantFinder/)
    - This is an interactive resource for students to discover what plants and butterflies are native to their area.
- **Website-** Center for Biological Diversity (https://www.biologicaldiversity.org/)
    - This website may serve as a reference for information about topics regarding biodiversity and sustainability.
- **Short video-** What is the Soil Food Web? (6 minutes) Dr. Elaine Ingham
    - Overview of the definition and benefits of the soil food web in organic food production.
    - (https://www.youtube.com/watch?v=uAMniWJm2vo)
- **Short video-** What is Organic Farming? (3 minutes)
    - A short overview of organic farming from FuseSchool

    - (https://www.youtube.com/watch?v=WhOrIUlrnPo)
- **Short video-** Why Organic, Sustainable Farming Matters | Portrait of a Farmer (6 minutes)
    - A personal story of a farmer's commitment to local, organic farming (https://www.youtube.com/watch?v=mD5jnxhne7o&t=277s)
- **Short video-** What is biodiversity? | Natural History Museum (3 minutes)
    - This video gives a great definition of the term "biodiversity." It uses the example of a coastline to show how kelp, fish, humans, etc. all interact as part of the biodiverse landscape. It also explains how modern human decisions can lead to the destruction of biodiversity. From the Natural History Museum. (https://www.youtube.com/watch?v=XTC4qiXd36Q&list=TLGGqLHDkKYWmQcwMTA5MjAyMg&t=3s)
- **Documentary-** From Farm to Table (20 minutes)
    - An overview of the transformation of agriculture of 5000 years in images; highlights the significance of agriculture in social studies from National Geographic (https://www.nationalgeographic.com/environment/article/sustainable-agriculture)
    - Same link as article Sustainable Agriculture (https://www.nationalgeographic.com/environment/habitats/sustainable-agriculture/)

Grades 9-12

- **Poem-** "September Tomatoes" Karina Borowicz (https://www.poetryfoundation.org/poems/56583/september-tomatoes)
    - This poem enables the reader to appreciate the sights and smells of the end of the tomato growing season and the end of summer.
    - Relates well with Week 2 *Summer Kitchen Projects: Tomatoes & Salsa.*
- **Book-** *The Humane Gardener: Nurturing a Backyard Habitat for Wildlife*, Nancy Lawson
    - Lawson discusses the importance of working with nature instead of against it when gardening. She explores the importance of allowing the planting of native species and providing safe zones for local wildlife in the garden.
- **Book-** *Food: The New Gold*, Kathlyn Day
    - This short research-based exploration of the global problems with the modern food system helps readers to understand how local efforts to engage in sustainable food practices relate to the global hunger crisis and climate change.
- **Book-** The Living Soil, SARE
    - Introduces the different aspects of soil and the interactions between different organisms
- **Article-** Soil Food Web, USDA
    - Explores the different parts of the soil food when and each component's purpose
- **Article-** What is Organic Farming? Sustainable Agriculture Research and Education
    - Overview of organic farming (https://www.sare.org/publications/transitioning-to-organic-production/What-is-Organic-Farming/)
- **Article-** Industrial Agriculture 101, National Resource Defense Council
    - Explains the characteristics and impact of industrial agriculture. Includes descriptions of CAFO's (concentrated animal feeding operation) and monoculture. (https://www.nrdc.org/stories/industrial-agriculture-101#alternatives)
- **Article-** "Silent Spring—I | The New Yorker" Rachel Carson

    - High schoolers might be assigned this article written by Rachel Carson in 1962 as a precursor to the release of *Silent Spring*.
    - The whole article might be difficult for some students, but the f*irst three paragraphs* offer prose that avoids the scientific specifics of insecticides which arise throughout the rest of the article. Likewise, the last paragraph could accompany the reading of the first three (with a teacher filling in the blanks of the article's body). (https://www.newyorker.com/magazine/1962/06/16/silent-spring-part-1)
- **Article-**"Time capsule found on the dead planet" Margaret Atwood
    - This short fictional letter is written from the perspective of the extinct human race. It explains how the world fell apart following the deification of money and the growth of deserts. This is a short, thought-provoking read for students that could spark dialogue. (https://www.theguardian.com/books/2009/sep/26/margaret-atwood-mini-science-fiction)
- **Article-** "What is biodiversity? | Natural History Museum", Katie Pavid
    - This article contains a short video that gives a great definition of the term "biodiversity." It uses the example of a coastline and shows how kelp, fish, humans, etc. all interact as part of the biodiverse landscape. It offers explanations as to how modern, human decisions can lead to the destruction of biodiversity. (https://www.nhm.ac.uk/discover/what-is-biodiversity.html**)**
- **Short Video-** Industrial Agriculture (12 mins) From Khan Academy
    - An overview of industrial farming; provides a historical context for the rise of industrial agriculture in the US, its benefits, and environmental concerns. (https://www.youtube.com/watch?v=cajeNeQ5p64)
- **Short Video-** How the Soil Food Web Works in the Organic Garden (6 mins) From The Living Farm
    - Visual explanation of the soil food web and how it contributes to human nutrition (https://www.youtube.com/watch?v=4wO5WwOaPKE)
- **Short Video-** Farming Sustainably with Regenerative Agriculture | Restoring Paradise (8 mins) From Happen Film
    - A visual description of the methods and philosophy of restorative agriculture. (https://www.youtube.com/watch?v=ob_asuZ6OtE&t=92s)
- **Short Video-** America Revealed | Factory Farming | PBS (6 mins)
    - This video looks at a family-owned farm in Kansas which evolved from a subsistence farm to a large-scale industrial farm over generations. The video directs a positive connotation towards the industrialization of farming, so could serve as a critiquing assignment. (https://www.pbs.org/video/america-revealed-factory-farming/)
- **Short Video-** "Organic Regenerative Farming is the Future of Agriculture | The Future of Food" (6 mins)
    - This video addresses the importance of biodiversity and clean farming. The farmers interviewed also offer comparisons between their CSA-styled farm and the supermarket system. This could be shown alongside the "America Revealed" video. It features similar aerial images and interviews with the farmers at a sustainable farm in New Zealand. From Happen Films. (https://www.youtube.com/watch?v=hWkYtZxpQUo**)**
- **Short Video-** Why Poor Places Are More Diverse (3 ½ mins)
    - This video explains a thought-provoking connection between resource scarcity and biodiversity in the soil and economic disparities and human diversity in societies. From MinuteEarth. (https://www.youtube.com/watch?v=mWVATekt4ZA&list=PLElB7nLNHZvi0c6GatyBT-DpwX2AN_Sz5&index=2**)**
- **Documentary-** Transgenic Wars | Kanopy (1 hour)

    - Documentary about the controversy over GMOs (https://www.kanopy.com/en/product/186997)
- **Documentary-** Farm to Table (20 minutes)
    - An overview of the transformation of agriculture of 5000 years in through images; highlights the significance of agriculture in social studies from National Geographic (https://www.nationalgeographic.com/environment/article/sustainable-agriculture)
- **Documentary-** Food for Thought, Food for Life
    - Explores the impact of industrial farming on the planet and our lives (https://vimeo.com/113311433)
- **Documentary-** *Inhabit: A Permaculture Perspective* (1.5 hours)
    - This documentary introduces permaculture as a design method that tackles some of the issues related to biodiversity and industrial agriculture. (https://www.filmsforaction.org/watch/inhabit/)

Extra Teacher Resources

- Home - Native Plants Finder
    - This is an interactive resource for students to discover what plants and butterflies are native to their area. (https://www.nwf.org/NativePlantFinder/)
- Silent Spring Quotes by Rachel Carson from *Goodreads*
    - Goodreads offers this page of important quotes from Rachel Carson's *Silent Spring*. Teachers might write one of these on the board or assign different groups to discuss a certain quote from the book and its implications today. (https://www.goodreads.com/work/quotes/880193-silent-spring)

October Working Calendar

Key: S= Start indoors, DS= Direct sow, T= Transplant, H= Harvest, TC = Transplant cuttings/bulbs, P=Prune, PE= Perennial

	First Frost			
	Week 1	**Week 2**	**Week 3**	**Week 4**
Daffodils **(PE)**			TC	
Baby Lettuce		H10		
Head Lettuce		H8		
Brussel Sprouts				H1
Cabbage/Cauliflower		H3		
Kale/Kohlrabi		H2		
Radishes/Turnips			H6	
Spinach	H7			
Winter Squash		H1		
Green Beans	H8			
Corn	H5			

Plant Family Key

Amaryllidaceae	Asteraceae	Brassicaceae	Amaranthaceae
Cucurbitaceae	Fabaceae	Poaceae	

OCTOBER

Focus: Harvesting & Preserving

Key concepts: *Local food, composting, and the carbon cycle*

Think Ahead

- If you harvest pumpkins this month, save some of the "meat" and freeze it so that it can be thawed and used in November's Pumpkin Pie recipe.
- This can be a time to start researching options for small livestock you might want to add to your farming operation come springtime.
- Towards the end of this month, consider growing green beans in pots to be used in December's Week 3 Plant Anatomy lesson. If you can, grow one for each student to dissect. They grow well in a large pot with a pole for support, 6 weeks will give you a plant with fruit and flowers. Beans are legumes so will add the ability to see the nitrogen digesting bacteria in the root nodules.

October Lesson Outline

- *Week 1 Sustainability Topic*
    - The Carbon Cycle part 1: A visit to the forest
    - The Carbon Cycle part 2: The Carbon Footprint
- *Week 2 Theri's Fall Kitchen*
    - October Kitchen Project: Applesauce (Canning in a water bath)
    - October Kitchen Project: Carrot & Cabbage (or kale) Coleslaw
    - October Kitchen Project: Raspberry smoothie
    - October Kitchen Project: Kale Chips
- *Week 3 Science Enrichment*
    - Botany: Preserving the Harvest (Plants)
    - Zoology: Livestock (animals)
    - Microbiology: Composting with Microorganisms
- *Week 4 On the Farm*
    - Sheet Mulching and Lasagna Gardening (Compost)

Introduction

October is one of the busiest months on the farm. The cooling temperatures give us added energy to push through to the end of the season. Typically we expect the first frost around mid month and use that as a gauge for getting the summer crops in and preserved. The last plantings of cool crops should be fully grown in the field by now and ready to harvest after the sweetening of the first frost. Try to make some time this month to celebrate the cooling temperatures, the bountiful harvests, and the explosion of fall colors. October brings the end of many life cycles.

Seed saving continues throughout the fall season- be sure to dry seed thoroughly, use airtight packaging, label and store in a dry, cool, and dark place. Consider making your own seed bank. Seed saving can be done for all open pollinated plants. Do as much food and seed preserving as you can. Seed saving will build highly resistant plants for your landscape over time and reduce costs.

Deciduous trees start to lose their leaves. The days are getting shorter and the trees can no longer make enough chlorophyll to keep the leaves green. When the green falls away the true color of the leaf is exposed progressing from yellows to oranges to reds before falling to the ground and browning. Frost will hasten this process and mild temperatures will prolong it. Observing this leaf cycle in a nearby wooded area or forest provides a perfect visual and environment to introduce the carbon life cycle, so important to our understanding of living soil. Take advantage of the fallen leaves and include them in your work this month. We compost them, use them for mulch around perennial plants or layer them in sheet mulching to prepare garden beds for next year. The hard but simple work of raking leaves can teach us all a much needed positive work ethic and provide a venue for service.

The tastes of fall are plentiful and preserving is at its peak. There are so many flavors to choose from; Try some fresh apples, grapes, winter squash, berries, brassicas, greens and roots. Watch your projected temperatures closely for early frost or freezes; be aware of which plants will need protection and have your supplies ready for the unexpected. Get your pumpkins picked before the first freeze; if you can't store them, cook them down, roast the seeds and scrape out and freeze the meat for November's pumpkin pie project (compost the skins or feed to livestock). Make your last plantings of spinach, kale, and any hardy baby greens in the hoop house to ensure fresh salads throughout the fall and into winter. Get your spring bulbs, including garlic, planted.

During this month of October spend a significant amount of time observing the seasonal changes in nature and the farm life cycle. I am not sure any other month will provide a more vast scenery change than October. In Michiana, the month starts green and lush and the ground is still covered with life and harvest; 30 days later the trees and bushes are mostly bare and many of the farm fields are harvested or mowed down, some exposing the bare ground. Farmers go from their busiest to the promise of rest. It is a perfect time to celebrate your local farmers.

Suggested October Field Trip

Consider visiting an orchard with a pumpkin patch; support a small farmer with a diverse offering; apples, raspberries, grapes and pumpkins if possible. These fruits all have similar harvest times so it shouldn't be hard to find. Ideally, find a location where students can pick produce or at least buy it. Hayrides or cider mills are great too. Bring some produce back to taste fresh and use in cooking and preserving this month.

Week 1: Sustainability Topic

The Carbon Cycle

This month we look at the element carbon (C) and how it exists in solid and gas forms in our environment. There are two lessons to introduce this important building block of nature.

Carbon part 1: A visit to the forest

Goal(s): Students understand that the element carbon can be a gas or a solid and natures ability to recycle both through decomposition and photosynthesis.

Learning objectives:

1. Students can define two states of carbon and give examples of each.
2. Students can describe the element carbon including 4 facts.
3. Students can describe the carbon cycle in words and/or visual display.

Next Generation Science Standards connections (grades 3-12):

- *MS. Matter and its Interactions (MS-PS1-4)* Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Time: 45 mins

Lesson supplies:

- Farm journals and writing utensils
- Clean glass jars for collecting soil samples
- A permanent marker to label jars
- Magnifying glasses to use on site in the forest
- A white piece of heavy paper per student for observations
- A microscope for viewing different life forms (400X to see microbiology/oil slides) (To be used in the classroom after trip)

Background review for the instructor:

- Photosynthesis review (article) | Khan Academy. (https://www.khanacademy.org/science/ap-biology/cellular-energetics/photosynthesis/a/hs-photosynthesis-review#:~:text=There%20are%20two%20main%20stages,reactions%20and%20the%20Calvin%20cycle)
- How Forests Store Carbon (article). (https://extension.psu.edu/how-forests-store-carbon)

Vocabulary:

Carbon: An abundant chemical element that can be found in all known forms of life.
Carbon dioxide (CO2): A colorless odorless gas made up of one carbon and two oxygen elements prevalent in the atmosphere.
The Carbon Cycle: The circulation of carbon atoms as a result of photosynthetic conversion of carbon dioxide into complex organic compounds by plants, which are consumed by other organisms: the carbon returns to the atmosphere in the form of CO2 as a result of respiration, decay by fungi, bacteria, etc., and combustion of fossil fuels.
Biology: The living organisms of a region; the science of life in all its forms.
Biosphere*:* The part of the earth where life exists - the soil food web is part of the biosphere.
Soil food web: A community of living organisms in the soil that represent three different levels of consumers. Each level of consumer depends on the level below it to get food energy and is the energy source for the level above it. These levels of consumers are often depicted in concentric circles or layers showing who eats who, with a carbon food source at the center (organic matter). The smallest microorganisms are fed by the organic matter layer and go on to be the food or produce the food that will be eaten by the next level of life and so on. No level of consumer can exist apart from the others.
Decompose: To disintegrate, to rot, to separate into parts.

Humus: The dark organic material in soils.
Lithosphere: The solid part of the earth, the upper crust.
Atmosphere: The gas/air surrounding the earth.
Photosynthesis: The process by which plants, algae and some bacteria convert light energy into chemical energy in the form of sugars.
***Hydrosphere*:** The part of the earth where water exists.

Overview:

Carbon is an organic element that can be found in nature in a solid or gas form. Pure carbon is rare and only exists in two solid forms; diamonds and graphite (coal is close at 99% pure C). For this lesson, have a copy of the periodic table of the elements for review. All other sources of carbon are combinations of elements, like the gas ***carbon dioxide*** (abbreviated **CO2**, which is one carbon atom and two oxygen atoms). Carbon is present in the air, in the soil and in all bodies of water like lakes and oceans. Carbon is present in all organic matter. Physics tells us that carbon is never lost; rather nature is constantly recycling carbon in both solid and gas forms. The following lesson looks at this process, known as ***the carbon cycle***. The forest is a perfect environment for your lesson and discussion on the carbon cycle.

Did you know that there are more living organisms in a cup of fertile soil than people in the world? ***Microorganisms*** are the smallest living creatures on earth. They are part of all living systems. They are especially happy to live on the forest floor because their needs are so nicely met; moisture, fresh air and lots of food in the form of dead organic matter, known for its carbon content and sometimes simply called carbon. The forest is full of carbon sources; fallen leaves and tree limbs, dead plants and animals and animal manures to name a few. This carbon rich organic matter feeds the soil ***biology***, the living creatures in the soil on the forest floor that are part of the earth's ***biosphere,*** the part of the earth where life exists. This biology is referred to as the ***soil food web*** and includes everything from microorganisms to earthworms. These organisms live in the top inches of the soil, and are in constant motion feeding on carbon and each other while growing and reproducing. Over time, more organic carbon material is added to the forest feast: dead animals and insects, forest fruits and nuts, wild animal manures and fallen tree limbs. The eating and excretion (pooping) of all these carbons by the life forms in the soil food web continue and is a digestion system; referred to as ***decomposing***. The excretion is a rich fertile soil called ***humus***. This rich humus is full of carbon and mineral nutrients that will support new plant life in the coming spring. In addition to the carbon solids that are humus, living organisms also release carbon in a gas form known as carbon dioxide (CO2) during this digestive process. CO2 is a carbon gas that can be stored in the ground, also called the ***lithosphere***, if there is room, or can be released into the air, also called the ***atmosphere***. CO2 that is released from the ground/lithosphere can be recycled by plants through ***photosynthesis.***

Trees have the greatest potential for recycling CO2 because of their many leaves and deep roots. The leaf is where CO2 is inhaled, known as respiration, and where photosynthesis occurs (use a poster example to review photosynthesis, at the appropriate depth for your students; see "Background review" above). The deep roots of older trees will carry CO2 deep into the ground where it can be stored. When there are no trees or leafy plants to catch the released CO2 it rises and collects in the atmosphere. Old trees are so important to the carbon cycle because of their large respiration system and their deep storage ability. Deforestation is one of the most damaging practices to our environment.

The forest floor is a natural composting system and is known for having the most fertile soil on earth. Dig some of the soil up and count the life forms you can see. Take some soil back

to the classroom to get a better look under a microscope. Before you head into the lab, also collect a couple soil samples from different areas on your landscape. Mark each sample so you remember its unique characteristics. It will be interesting to compare your results.
Regenerative farming (see September's week 1) aims to mimic the forest and nature's ability to cycle carbon as a natural practice of building soil fertility (no fossil fuel needed).
Consider hosting this conversation in a woods or forest, or under a big tree prior to the coming composting lessons.

Procedure:

1. **Discuss:** Review the Periodic Table of elements with regards to carbon (and nitrogen too). Ask students what they know about this chart?
2. **<u>Activity: Soil under a microscope</u>** (45 mins)
   Supplies
   - Farm journals and writing utensils
   - Clean glass jars for collecting soil samples
   - A permanent marker to label jars
   - Magnifying glasses to use on site in the forest
   - A white piece of heavy paper per student for observations
   - A microscope for viewing different life forms (400X to see microbiology/oil slides) (To be used in the classroom after trip)

   Directions
   1. Present the carbon cycle discussion while sitting in a circle in a wooded area; hopefully an old forest that will provide lots of carbon and decomposing organic matter to observe.
   2. Have students create a chart in their journals that will make it easier for them to compare and contrast their findings when they are finished - soil conditions could be across the top and include life forms; diversity and counts. A left column could include environmental factors, in the woods, in dry soil, garden soil etc. This could also be a premade handout if you chose.
   3. Have students work in pairs, sharing a magnifying glass, to observe and record their observations and findings. Observe and record:
      a. How many kinds of carbon(organic matter) can you observe present in this forest?
      b. Dig up one cup of soil from under dead leaves and spread it out on your white piece of paper; how many life forms can you observe without aids, use a magnifying glass and repeat the exercise. If you can not name the life forms, draw them to identify later.
   4. Have students use their charts to move around the forest and repeat this exercise using some diverse variables; heavily mulched and moist soils, bare and dry soils, shaded areas, a sunny spot. Work with the variables you have pre chosen or what you have available.
   5. Gather for a closing discussion; what conclusions can your observations support? What environments are most attractive to living organisms? Can we mimic these conditions on our farm and how?
   6. Before you leave the forest collect soil samples to take back to class (from the top 4 inches of the forest floor) using some of the same diverse locations. Label each jar as to where it came from.

7. When class time allows set up slides for students to view the diversity and counts of the microorganisms in the soil samples as well. Have a column on their journal chart to record these findings.

3. **Evaluation:**
    a. What is the scientific notation for carbon?
    b. Does carbon exist in pure form in nature, example(s)?
    c. List four facts about the element carbon?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Carbon part 2: The Carbon Footprint

Goal(s): Students can evaluate food choice purchases with regards to environmental and personal sustainability; to be able to apply their comprehension of carbon footprints to their own lifestyle practices.

Learning objectives:

1. Students can define the concept of carbon footprinting in processed foods; giving three examples of carbon producing practices involved in processing food.
2. Students can explain the direct relationship between lowering carbon footprinting and increasing sustainability; both nutritionally and environmentally.
3. Students can give examples of environmentally expensive foods (i.e. avocado) and inexpensive foods and explain.
4. Students can describe a sustainable diet giving 4 examples.

Next Generation Science Standards connections (grades 3-12):

- *MS. From Molecules to Organisms: Structures and Processes (MS-LS1-7)* Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.
- *MS. Ecosystems: Interactions, Energy, and Dynamics (MS-LS2-3)* Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *HS. Ecosystems: Interactions, Energy, and Dynamics (HS-LS2-5)* Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

Lesson supplies:

- Farm journals and writing utensils
- 10 food items including highly processed boxed and fresh whole food (sugary cereal box, ice cream container, banana, oatmeal box, peanut butter etc.).

Vocabulary:

Food miles: How far food travels from harvest to your plate.
Carbon footprint: The amount of carbon dioxide emitted during specific activities.
Environmental cost: The negative effects an activity has on the environment.
Local food: Food that is grown close to home. There is no universal definition for miles. I have seen a range of 30-300 miles used for "local". In general, the closer to home, the more local (set your own definition using some research).

Energy: Power derived from physical or other natural or chemical resources, often associated with heat and light.
Whole foods: Foods that come direct from nature, including: raw milk, fruits, vegetables, eggs, and whole grains. They are foods with no added ingredients or necessary packaging (see November's week 1 lesson).

Overview:

Carbon dioxide, CO2, is an essential part of our environment. Plants need CO2 to do the important work of photosynthesis; feeding the soil that creates our food's nutrition and gives us fresh air. We need CO2! Unfortunately CO2 is a greenhouse gas that can be dangerous when it is over abundant in the atmosphere; when the carbon cycle can not keep up with the production of CO2. One main cause of the overproduction of CO2 in the atmosphere comes from the burning of fossil fuels. In our current food system and lifestyles, our consumer choices support fossil fuel driven products. ***Food miles*** refers to how long your food travels from harvest to plate. We all bear a responsibility for the damaging effects of too much CO2 in the atmosphere which is now linked to global warming and climate change. The concept that our consumer and production practices affect the amounts of CO2 released into the atmosphere is measured and called ***carbon footprinting***.

This lesson explores the concept of carbon footprinting in relation to consumer food production and choices. Students will learn about ***environmental costs*** that are associated with processed food purchases versus ***local food*** purchases in order to evaluate what I call *true costs of food choices,* which take into consideration total ***energy*** input in order to obtain the food and the effects on environmental health (which can not be separated from personal health). Students will understand the link between ***whole foods*** and environmental health versus the costs of processed foods. This lesson focuses on food purchases but this concept encompasses all consumer purchases. Be sure to include this conversation whenever you are making purchases together.

Procedure:

1. **Discuss**: What do we remember about carbon footprints? Ask students how their eating habits affect their carbon footprint, how can you lessen your individual carbon footprint at meals? Ideas they may come up with, but are not limited to, include: growing your own food, shopping at a local farmers market, eating less meat or less processed meat, eating and cooking with fresh whole foods, and buying organically.
2. **Explain:** The difference between environmental cost and the dollar and cents cost of food purchases.
3. **Watch:** Michael Pollan: Why Eat Local? (2 mins) (https://www.youtube.com/watch?v=DhaG_Zi6izU), from NourishLife.
4. **Activity: The Cost of It All** (45 mins)
   Supplies
   - Farm journals and writing utensils
   - 10 food items including highly processed boxed and fresh whole food (sugary cereal box, ice cream container, banana, oatmeal box, peanut butter etc.).

   Teacher Preparation
   1. Collect a diverse set of foods from highly processed with multiple layers of packaging to lose fruits and vegetables.
   2. Display in bold print (heavy marker) the dollar and cents price of each food on the box or make a tent sign(fold paper to stand up).

Directions

1. Create a handout that lists all food products. Have two columns down the right side of the handout; one titled actual cost and the other titled environmental cost.
2. Children will move around the room with this handout using simple math skills to determine the environmental cost of each product (based on #3)and record the actual and environmental cost for each on the sheet.
3. In a highly visible place, present the following theorem for determining environmental costs on a large poster board or a chalkboard:
    - For every ingredient on the label, add $1.
    - For every layer of packaging, add $1.
    - If the layers of packaging are recyclable, subtract .50 cents (look for the recycle sign)
    - If sugars are in the ingredients, for each additional sugar after one, add $1. If the product was purchased from a local farmer, subtract .50 cents. Sugar names include: Anhydrous dextrose, brown sugar, confectioners powdered sugar, corn syrup, corn syrup solids, dextrose, fructose, high-fructose corn syrup (HFCS), honey, invert sugar, lactose, malt syrup, maltose, maple syrup, molasses, nectars (e.g. peach nectar, pear nectar), raw sugar, sucrose, sugar, white granulated sugar
4. Have students calculate the environmental cost for each product.
5. Compare the dollar and cents cost to the environmental cost as a class.
6. **Discuss:** After the activity, discuss the following questions as a group.
    a. Why do you think there are so many different names for sugar?
    b. What do you notice about foods with low actual costs and high environmental costs, is there a recurring relationship pattern??
    c. Which foods do you think are better for us and why?
    d. What causes high environmental costs?
    e. Discuss terms: whole foods, local foods, food miles, carbon footprint as they relate to these foods.
    f. List any conclusions the class can make from the data collected.

5. **Evaluation:**
    1. How is carbon related to the burning of fossil fuels?
    2. In the timeline of processing food , what steps are releasing carbon pollution?
    3. What is a carbon footprint and how does it relate to sustainability?
    4. List two examples of a sustainable product and a unsustainable product and tell why.

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 2: Theri's Fall Kitchen

October Kitchen Project: Applesauce (Canning in a Water Bath)

Goal(s): To encourage students to enjoy cooking and eating new things while also better understanding the seasonal foods that are local and available to them in October; to learn about the nutrition and life cycle of apples and applesauce canning.

Learning objectives:

1. Students can illustrate the lifecycle of an apple, from seed to fruit.
2. Students can explain why we preserve food as a function of sustainability.

Next Generation Science Standards connections (grades 3-12):

- *MS. Ecosystems: Interactions, Energy, and Dynamics (MS-LS2-3)* Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *HS. From Molecules to Organisms: Structures and Processes (HS-LS1-5)* Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
- *HS. From Molecules to Organisms: Structures and Processes (HS-LS1-6)* Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

Time: 1 hour

Lesson supplies:

- Farm journals and writing utensils
- The book *How Do Apples Grow?* Betsy Maestro.
- 8 apples (use a sweet eating apple to eliminate the need for sweeteners)
- ¾ cup water
- ¼ cup local honey (optional- if you cannot get sweet apples)
- ½ tsp. cinnamon
- Canning pot
- A clean spatula
- Tongs
- Two 1 quart canning jars with two-piece lids.

Background review for the instructor:

- Poster that shows the lifecycle of an apple, example https://www.teacherspayteachers.com/Product/Apple-Life-Cycle-Mini-Poster-Sequencing-activity-and-student-assessment-5910800
- *How Do Apples Grow?* by Betsy Maestro (to be read as a class)

Overview:

Apples are a popular and delicious fall fruit. Naturally sweet, they can be paired with a fresh bite of kale to get even the pickiest of eaters to expand their palette.
This lesson reviews the nutrition of apples and their lifecycle. They are a perennial crop, rich in carbohydrates and simple sugars, making them a great energy boost on an empty stomach. One large apple can provide over 20% of our daily-recommended fiber, which helps us stay full longer. Apples are also a good source of vitamin C. Most of the apple's vitamins are in the skin. One of my favorite ways to eat apples is sliced and dipped into fresh ground peanut butter.

A single apple tree can yield 40- 400 pounds of fruit each year depending on its size. I grow semi dwarf apple trees that average 150 lbs of apples each season. It can take three to five years for apple trees to fruit. Apples can be grown in almost every climate. Most apples are harvested from August thru October in the midwest depending on the variety. Washington state, New York, and Michigan are the biggest growers of apples (in that order). Apples are a great storage crop that can be enjoyed all winter long if stored just above freezing.

Before the kitchen demonstrations, the instructor should lead the class in a discussion by listing what they know about apple trees. If there is an outdoor green space currently growing apples, take a walk so that students may be able to touch, smell, and harvest. Always have

enough for students to have a taste of fresh apples before cooking. I like to review nutrition facts while taste testing whenever possible.

Procedure:

1. **Discuss:** Ask the students what they know about apples. Discuss apple nutrition and lifecycle information.
2. **Watch:** Meet Some Apple Farmers!- Dinner Starts Here (11 mins) (https://www.youtube.com/watch?v=pSMRKH_h48w) from Fresh Air Farmer.
3. **Read:** *How Do Apples Grow?* by Betsy Maestro.
4. **Recipe: Applesauce (Canning in a Water Bath)**

   Canning adapted from *The Spruce*

   Supplies (multiply as needed)
   - 8 apples (use a sweet eating apple to eliminate the need for sweeteners)
   - ¾ cup water
   - ¼ cup local honey (optional- if you cannot get sweet apples)
   - ½ tsp. cinnamon
   - Canning pot
   - A clean spatula
   - Tongs
   - Two 1 quart canning jars with two-piece lids.

   Directions
   1. Dice apples and combine all the ingredients in a large pan. Allow this to be a time to practice knife skills.
   2. Cover and let cook down for 20 minutes on medium heat/until the apples are soft.
   3. Allow time to cool, then mash with a potato masher.
   4. Fill the deep pot with water and bring to a boil. It should be deep enough that the jars can be submerged with at least 2 inches of water.
   5. Make sure all your jars are clean. Consider washing them in the dishwasher ahead of time. Do not use damaged or imperfect jars.
   6. Fill jats to rim, leaving a 1 inch air space, with finished sauce. Tap out any air bubbles
   7. Wipe the top of the jar to remove any product that will keep the jar from sealing.
   8. Screw the seal on tightly with the two-piece seal/rim system.
   9. Using the tongs, lower the jars into the boiling water. Process them for ten minutes.
   10. Turn off the heat, and let the jars settle for another five minutes.
   11. Using tongs, pull the jars out of the water and space at least 1 inch apart, making sure not to tilt them, as that can interfere with the sealing. Let them cool for at least 12 hours. Do not disturb the jars.
   12. After cooling, test the jars by pressing down on the lid. If everything goes well the seal won't move. If it does move, refrigerate and use soon or use for taste testing.
   13. Remove the rims after cooling and test the seal by lifting the jar up by just the seal. It should demonstrate a tight suction.
   14. Wash and dry the jars to remove any stickiness. When completely dry return the rim.
   15. Bring this canned sauce out in the middle of winter for a refreshing treat. Canned applesauce has an 18-24 month shelf life.

5. **Evaluation**
    1. Use a drawing to represent the apple lifecycle, include as many stages of development as you can?
    2. How does preserving apples relate to sustainability?

    Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

October Kitchen Project: Carrot & Cabbage (or Kale) Coleslaw

Goal(s): To learn about the nutrition and life cycles of cabbage and carrots; to learn about root crops.

Learning objectives:

1. Students can give two examples for each of carrot and cabbage nutrition.
2. Students can identify two distinguishing characteristics of root crops.

Next Generation Science Standards connections (grades 3-12):

- *MS. Ecosystems: Interactions, Energy, and Dynamics (MS-LS2-3)* Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *HS. From Molecules to Organisms: Structures and Processes (HS-LS1-5)* Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
- *HS. From Molecules to Organisms: Structures and Processes (HS-LS1-6)* Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

Time: 45 min

Lesson supplies:

- Farm journals and writing utensils
- 4 large carrots
- 4 green onions
- 1 head of red cabbage (kale can be used in place of cabbage)
- *Dressing:*
    - 1 tbsp. dijon mustard
    - 1 garlic clove
    - ½ cup extra virgin olive oil
    - ¼ cup apple cider vinegar
    - 2 tsp. fresh lemon juice
    - ¼ tbsp. honey
    - ¼ tsp. chili powder
    - Salt and pepper to taste

Vocabulary:

Root crop: Plants whose tubers (parts that grow underground) can be eaten by humans. Usually longer lasting than above ground vegetables.

Tap root: Tap roots are distinguished from fibrous roots as they typically have one large root that grows vertically down into the soil. Thin and fibrous roots sprout out from the main tap root.

Overview:

This kitchen project features two star vegetables. The bright orange carrot is a naturally sweet root vegetable. The bright color indicates beta-carotene, an antioxidant that turns into vitamin A in our bodies, essential for eye health. Carrots also contain vitamin K, which promotes blood clotting. The first planting of carrots can be done before the last frost. They are a cold weather root crop. ***Root crops*** are vegetables grown underground. Root crops are distinguished by a tap root system. ***Tap roots*** are a large single root, edible in this family. Carrots can take 2-3 months to mature, and can be orange, purple, yellow, and even white. I plant carrots several times throughout the season to make sure I have them all year long. It's important to let them mature to get their full flavor. For the best storage remove the tops, as the greens will pull moisture from the roots and make the carrots rubbery. Store in a refrigerator, tightly sealed, with a dry cloth or paper towel in the container for the longest life.

The cabbage (cruciferous family) is full of nutrition. One serving of red cabbage has almost a full day's requirements of vitamins K and C. Cabbage is anti-inflammatory and an anti-cancer agent. My first planting of cabbage seed starts indoors around the first day of spring, March 20, six weeks before the last frost, and gets transplanted outdoors in early May. Some cabbages are planted two times each season, some only once. Early cabbage can produce a second harvest of small heads after the initial larger head is harvested. Late cabbage is an excellent storage crop for winter bounty. Store just above freezing to maintain freshness for several months.

Before the kitchen demonstrations, the instructor should lead the class in a discussion by listing what they know about the plant. If there is an outdoor green space currently growing these, take a walk so that students will be able to touch, feel, harvest and taste fresh carrots and/or cabbage (kale can be used in place of cabbage in this recipe).

Procedure:

1. **Discuss:** Ask students what they know about root crops. Have an example illustration of a tap root growing in the ground if it's helpful.
2. **<u>Recipe: Carrot & Cabbage Coleslaw</u>**

   Supplies
   - 4 large carrots
   - 4 green onions
   - 1 head of red cabbage (kale can be used in place of cabbage)
   - *Dressing:*
     - 1 tbsp. dijon mustard
     - 1 garlic clove
     - ½ cup extra virgin olive oil
     - ¼ cup apple cider vinegar
     - 2 tsp. fresh lemon juice
     - ¼ tbsp. honey
     - ¼ tsp. chili powder
     - Salt and pepper to taste

   Directions
   1. Shred the head of cabbage, finely grate the carrots and onion and set aside.
   2. Mix the dressing ingredients together.
   3. Pour dressing over the cabbage mixture, gently tossing it to combine.
   4. Serve with lunch or as a snack.

3. **Evaluation:**
    a. List two health benefits of eating carrots and cabbage(each).
    b. What are two defining characteristics of root crops?

    Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

October Kitchen Project: Raspberry Smoothie

Goal(s): To become familiar with the taste and nutrition of raspberries and to learn how to make a delicious raspberry treat.

Learning objectives:

1. Students can explain why we eat raspberries and identify two nutritional benefits of raspberries.
2. Students can list three characteristics of raspberry plants.

Next Generation Science Standards connections (grades 3-12):

- *MS. Ecosystems: Interactions, Energy, and Dynamics (MS-LS2-3)* Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *HS. From Molecules to Organisms: Structures and Processes (HS-LS1-5)* Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
- *HS. From Molecules to Organisms: Structures and Processes (HS-LS1-6)* Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

Time: 45 min

Lesson supplies:

- Farm journal and writing utensils
- 2 cup of spinach or a foraged edible weed like lambsquarter or purslane
- 1 cup fresh raspberries
- 1 cup apple cider
- 1 medium banana (cut and freeze ahead of time)
- Blender
- Small cups for serving

Vocabulary:

Cane fruit: A type of plant that produces fruit and has tall and stiff prickly stems from which the fruit grows.

Overview:

Raspberries are an easy fruit to grow. They are ***cane fruits,*** meaning they grow on canes versus bushes. Canes are a single branch growing straight out of the ground. Raspberry canes are covered in small thorns and produce in their second year and then die. They can have two harvest seasons each year, summer and fall, or just one depending on the variety and how they are pruned. I like to remove dead wood in the spring and lightly prune canes in early March for a full

fall harvest. I grow multiple varieties of raspberries but prefer the heritage variety for large red berries. Raspberries make a good hedge planting. You can find them on the edge of the forest, as they do best in full sun. I make my own garden hedge by planting a single row of canes centered in a double row, three wire trellis system, about two feet apart, one on each side of the planting.

Raspberries are great on the school farm because students can be involved in the spring work of pruning and be back for the fall work and pleasure of harvesting and preserving. Raspberries can easily be dehydrated, frozen and made into jam for preserving lessons. It's always a big deal at our farm when the red raspberries arrive as they are my husband's favorite fruit. There are so many ways to celebrate raspberries.

Raspberries are high in antioxidants and vitamin C if picked when fully ripe. If not fully ripe, the raspberries won't reach their full nutritional potential. I remind students to look for the bright red berries. Sometimes it's worth having them taste test the not so ripe berries so they understand the color taste relationship. Fruit color always gives us an opportunity to review nutrition content. My raspberry harvest starts in September and goes strong until late October.

This lesson showcases simple smoothie recipes, which can be demonstrated and shared with your class while discussing the benefits of the raspberry. Before the kitchen demonstrations, the instructor should lead the class in discussion by listing what students know about the plant. If there is an outdoor green space currently growing raspberries, take a walk so that students can see how raspberries grow on thorny canes and touch, feel, and taste raspberries.

Procedure:

1. **Discuss:** Ask the students what they know about raspberries.
2. **Watch:** Health Benefits Of Raspberries - Raspberry Nutrition (2 mins) (https://www.youtube.com/watch?v=fC8HSz4qYW8)
3. **Recipe: Raspberry Smoothie**

   Supplies
   - 2 cup of spinach or a foraged edible weed like lambsquarter or purslane
   - 1 cup fresh raspberries
   - 1 cup apple cider
   - 1 medium banana (cut and freeze ahead of time)
   - Blender
   - Small cups for serving

   Directions
   1. Combine the ingredients in blender in the order listed
   2. Blend until smooth.
   3. Serve.
4. **Evaluation:**
   - **a.** List three characteristics about raspberry plants.
   - **b.** What are two nutritional benefits raspberries provide?

   Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

October Kitchen Project: Kale Chips

Goal(s): To introduce kale chips as a low carbon footprint alternative to highly processed chips.

Learning objectives:

1. Students can list two examples of the nutritional benefits of kale.
2. Students can classify the vegetable family for kale.
3. Students can make the case that kale is a superfood.

Next Generation Science Standards connections (grades 3-12):

- *MS. Matter and Energy in Organisms and Ecosystems (MS-LS2-3)* Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *HS. Matter and Energy in Organisms and Ecosystems (HS-LS1-5)* Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
- *HS. Matter and Energy in Organisms and Ecosystems (HS-LS1-6)* Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

Time: 45 min

Lesson supplies:

- Farm journals and writing utensils
- Oven
- Bowl and large spoon
- 2 tbsp. olive oil
- 2 large bunches of kale
- Mineral salt (lots of different spices and herbs can be used, I love parmesan cheese or nutritional yeast too)

Vocabulary:

Brassica: A family of plants that includes broccoli, brussel sprouts, and kale.

Overview:

Known as a superfood, kale has grown in popularity across the country because of its dense nutrition and easy propagation. Kale is a leafy vegetable that is part of the ***brassica*** family. The leaves can be green or purple, smooth or curly. A single cup of uncooked kale has more than your daily value of vitamins A, K and C, and boasts benefits like antioxidants and magnesium while still coming in at a low calorie count. Vitamin K is an important nutrient needed for blood clotting. Antioxidants are great for our bodies, as they are anti-inflammatory (reduce swelling) and an antiviral agent. Properties found in kale have been linked to reductions in heart disease and cancer risk.

Kale can be eaten raw, but more easily digested when massaged with a bit of olive oil or lightly steamed. Review the dense nutrition of greens. Kale chips can be a nutritious substitute for potato chips. Kale chips retain the most nutritional value when dehydrated/crisped on a low temperature (below 120 degrees will maintain nutrition including enzymes).

Kale chips are an easy and fun way to introduce kale. Before the kitchen demonstrations, the instructor should lead the class in discussion by listing what students know about the plant. If there is an outdoor green space currently growing kale, take a walk so that students can observe, harvest, and taste fresh kale. Be sure to rinse kale before using it if picking it fresh.

Kale harvesting is unique. The central stem is quite hardy and is where the leaves will branch from. The leaves are snapped down from the stem with a quick strong pull downward. Leaves are harvested from the bottom up leaving the crown to continue growing new leaves. There are numerous YouTube video demonstrations on harvesting kale if you have never done so. Kale will continue to produce with very little cover through most winters in the midwest. Kale stored in airtight packaging has a long life in the refrigerator and can be dehydrated for year round use.

Procedure:

1. **Discuss:** Ask your students what they know about kale.
2. **Watch:** Health Benefits of Kale – 8 Reasons why Dr.Berg loves this superfood! (3 mins) from Dr. Eric Berg D (https://www.youtube.com/watch?v=FyX91jza5rE)
3. **Recipe: Kale Chips**

   Supplies
   - Oven
   - Bowl and large spoon
   - 2 tbsp. olive oil
   - 2 large bunches of kale
   - Mineral salt (lots of different spices and herbs can be used, I love parmesan cheese or nutritional yeast too)

   Directions
   1. Have the students wash their hands as you preheat the oven to 350 degrees.
   2. Tear off the leaves in chip size pieces from the stem (removing the rib)
   3. Place the pieces into a large bowl, sprinkling the olive oil over kale. Using hands or spoon toss until all kale is lightly coated with olive oil.
   4. Spread kale pieces on a cookie sheet in a single layer (I use parchment paper).
   5. Sprinkle any combination of salt and/or spices (fine ground parm if desired).
   6. Roast the kale in the oven until crisp. Check it periodically; the edges should brown but not burn. Time will depend on the amount of kale and coatings.
   7. Wait for the kale to cool before serving.
   8. Post-recip, ask students to comment/journal on the taste/texture of the kale. Some ideas: delicious, crunchy, and flavorful (*Theri's Tip:* I prefer positive language guidelines).
4. **Evaluation:**
   1. What plant family does kale belong to?
   2. Why is kale considered a superfood?

   Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 3: Science Enrichment

Week 3 of each month features three different science focus areas: botany, zoology, and microbiology. Instructors can choose to use lessons based on their science requirements.

Botany: Preserving the Harvest (Plants)

Goal(s): Understanding the benefits of preserving food and why it is a key factor in sustainability.

Learning objectives:

1. Students can describe food preservation as a sustainability practice, listing four common methods.
2. Students can define the four common methods of food preserving and their general effects on nutritional value of the raw material.

Next Generation Science Standards connections (grades 3-12):

- *5. Energy (5-PS3-1)* Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.
- *MS. From Molecules to Organisms: Structures and Processes (MS-LS1-6)* Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
- *HS. From Molecules to Organisms: Structures and Processes (HS-LS1-7)* Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

Time: 90 mins

Lesson supplies:

- Farm journal and writing utensils
- 10 lbs. (or whatever you need to insure taste testing for everyone) of concord grapes removed from stems - rinse with non chlorinated water and let dry
- Dehydrator or use a low oven temperature
- One large canning jar to observe fermenting(or a crock if you want to make a large batch of wine)
- 4 pint canning jars to demonstrate cold water bath canning/preserving (and or freezing for later use).

Background review for the instructor:

- If you haven't made grape juice before- HOW TO MAKE CONCORD GRAPE JUICE (6 mins) (https://www.youtube.com/watch?v=DwFVpacTgc8)
- For canning the juice- Making & Canning Homemade Welch's Grape Juice (7 mins) (https://www.youtube.com/watch?v=l9tu2H0icoo)
- Article on fermenting- Make Alcohol Without Yeast? (3 Natural Substitutes For Yeast) (https://homebrewadvice.com/alcohol-without-yeast)

Vocabulary:

Canning: A method of preserving the harvest that removes air(which is necessary for microorganisms to grow). This method starts by properly preparing produce and packing canning jars. The canning jars are then submerged into boiling water for a proven amount

of time (depending on their acidity level), removed to cool and complete the seal process. *During the canning process, air is driven from the jar and a vacuum is formed as the jar cools and seals, preventing microorganisms from entering and recontaminating the food. It does not take long at 212 degrees Fahrenheit, the temperature at which water boils, to force air out, create a vacuum and seal a jar.*
(see:https://www.extension.purdue.edu/extmedia/Store/Guide1.pdf)

Dehydrating: A method of preserving the harvest that removes moisture (necessary for microorganisms to grow). Dehydrating is done in fresh air or especially designed ovens that use low temps. Low temperatures preserve all the nutrients. *Dehydrated foods also maintain their nutrients for much longer than their fresh counterparts. Research shows that fresh produce loses its vitamin, mineral, and antioxidant content within a few days of refrigeration — with reductions as high as 50% for some nutrients* (https://learn.eartheasy.com/guides/a-beginners-guide-to-dehydrating-food/).

Freezing: A method of preserving the harvest that removes both moisture and air eliminating microorganism growth. Freezing foods extends longevity but does require a constant input of fossil fuel to do so. Make sure foods are prepared correctly and packaged well to give the greatest longevity and to protect from freezer burn (https://learn.eartheasy.com/guides/a-beginners-guide-to-dehydrating-food/)

Fermenting: A form of preserving that grows probiotics, microorganisms, that protect and add nutrition to fresh produce. This is an age-old process and the most nutritious way to store foods though the shelf life is not the longest.This process is commonly used with cold crops, brassica and root crops. Review fermenting here: (https://news.extension.uconn.edu/2015/11/20/fermentation-preservation-with-benefits/)

Sterilized: Sanitizing of supplies; most commonly by heating in a dishwasher or submerging into boiling water.

Overview:

Just like seed saving is a season long process and vital to sustainability, preserving the harvest is essential to food sustainability practices. I introduce students to four common food preserving methods including ***canning***, ***dehydrating***, ***freezing*****,** and ***fermenting*****.** Preserving produce in peak season will capture the best flavor and texture of produce and will provide a diverse and nutritional stockpile of foods during the winter months. Preserving produce on the same day as it is harvested is always ideal for flavor. I preserve as many foods as I can with my class every fall. It is exciting to share these foods in the dead of winter and taste the "summer" in them. I have found these tastings to be the best way to help them understand the benefits of preserving.

Food preservation is not to be feared, though it is important to know what you are doing. These methods were once used in every household. For sustainability in the coming years it will be important to get these practices back in the mainstream. If you want to get a professional credential, Purdue University offers a certificate course in canning. I had been canning for twenty years before taking this course and I learned a number of new things. It is always best to preserve with someone who has ample experience until you feel confident (that someone might be YouTube these days). Invite an expert into the class for these projects if you need too. Maybe one of your friends, parents or contact a local land grant school extension (Purdue University is Indiana's land grant school and their local extension office has an extensive education department) for support. This lesson could segway nicely into or from a history lesson on the Victory Garden (US History) era; a time when growing food and preserving literally saved many families from starving during WWII.

Fermentation is the process in which a substance breaks down into a simpler substance, fermented grape juice becomes wine when sugars are transformed by yeast to create alcohol (ethanol) and carbon dioxide gas. Foods are fermented as a form of presserving; think kimchi, yogurt and sauerkraut. This lesson we demonstrate fermenting grapes to become familiar with the process (not for tasting). Next month we will practice fermenting cabbage. Making wine as a class or family project can be a special project for a religious ceremony.

Procedure:

1. **Discuss**: Fall is an abundant harvest season. It is a natural time to introduce preserving methods if you haven't already.
2. **<u>Activity: A Comparison Chart for Preserving</u>**
    a. Across the top of the chart add the title: Preserving the Harvest. Horizontally, across the 4 column chart, note the four practices we are reviewing and engaging in; canning, dehydrating, freezing and fermenting. If you have processed using all four by now; review those lessons/recipes and remind students what preserving method you used and the general steps you took. If you have not introduced each method yet you can leave that part of the chart to fill in later or you can verbally introduce the method and review it when you engage in the method later.
    b. On the vertical axis list some comparisons;
        1. Longevity of finished product(fill in with months),
        2. Cost of materials needed(estimate added costs per unit),
        3. Use of natural resources(list any natural resources used in process until eaten),
        4. Nutrition (on a scale from added nutrients(fermentation) to loss of nutrients(heated canning).
    c. Begin by looking at the Title- Preserve - how does this word/definition compare to Sustainability; are they synonyms? (Have two students look up these definitions and read aloud. Listeners could take notes of key words in their journal where they will be recording this chart also). If so, why or why not.
    d. Soon most of our production will be finished and our gardens will be preparing for winter. Today we want to look at several ways we can prepare for the winter ensuring our own sustainability. Food is a basic need and must be at the top of our list when planning our own sustainability in the short and long term. Reviewing this chart can guide us to best practices.
    e. Fill in the chart together and talk about the results; which is good, best and better? Is there room for all/ What might guide your choosing best practices for preserving(room in refrigerator, back up fuels, storage areas etc.)
    f. Consider adding as many preserving lessons as your program will allow during the growing/harvesting season preserving lessons found in Theri's kitchen for apples and herbs.
3. **Proceed to:** Consider one of the grape activities below. Grapes are great for demonstrating all the common preserving methods. Choose what will work best for your circumstances and age group.
4. **<u>Activity: Preserving Grapes</u>**
    Supplies
    - 10 lbs. (or whatever you need to insure taste testing for everyone)of concord grapes removed from stems - rinse with non chlorinated water and let dry

- Dehydrator or use a low oven temperature
- One large canning jar to observe fermenting(or a crock if you want to make a large batch of wine)
- 4 pint canning jars to demonstrate cold water bath canning/preserving (and or freezing for later use).

Directions

1. Grapes are usually abundant in October and can provide a look at all four preserving methods.
2. Demonstrate Dehydrating
    a. Rinse your grapes in cold water and let dry/drain in a colander.
    b. Review dehydrating before placing 2 lb of the rinsed and dried grapes on a screened tray.
    c. Place in a dehydrator (120) or on an oven rack (lowest temp or 120)). This can take a couple days on a low temperature for grapes to become raisins. Sometimes I will cut grapes in half, remove seeds, if necessary, and dry for quicker results. Watch for the right raisin consistency.
    d. Cool and taste; Store in an airtight container.
3. Demonstrate Freezing
    a. Review freezing as a preserving method. Place 2 lbs of rinsed and dried grapes on a cookie sheet, single layered and put in the freezer until frozen solid.
    b. Remove grapes after frozen and place in a freezer container for longer term storage. Always label and date your product packaging.
    c. Freezing this way allows the grapes(or any berries) to be measured more easily when used later. When juicy fruits or vegetables are frozen stacked they tend to freeze together and must be thawed and used all at once. These frozen grapes can be used to make jam at a later date, maybe a gift giving time.

5. Activity: Juicing Grapes for Canning and Fermenting

Canning Grapes

1. Separate rinsed grapes for fermenting and/or canning juice. I have found one pack of fresh concord grapes yields between 3 and 4 quarts of juice (concentrated, no additives). Plan accordingly for this project.
2. Have students mash the grapes in a flat bottom bowl or stockpot using a potato masher until juice is extracted from the grapes.
3. Using the mashed grape mixture place in a small stock pot- heat to boiling on a stove or hotplate.
4. Lower temperature to simmer for 8-10 minutes, mashing/mixing during the process.
5. Pour hot juice mixture, 2 cups at a time, through a fine mesh strainer, overlaid with cheesecloth, held over a second stockpot. Allow the mixture to drain and cool to touch, about 10 minutes.
6. Gather cheesecloth (or nut milk bag) together, keeping all the pulp inside. Twist the gathered opening to apply pressure to the pulp and watch the juice escape. Knead the pulp while holding the twisted end tightly closed so not to allow pulp

to escape. Wear protective gloves. This can take 10 minutes to get all the juice out but it's well worth the time and kids love to do it.
7. Pour strained juice into a clean canning jar (compost or feed pulp to animals).
8. Wipe tops of each canning jar, add seal and hand tightened rim.
9. Place in a cold bath canner (decrease wait time by heating water before project), submerge jars and bring water to a rolling boil
10. Boil jars submerged for 15 minutes.
11. Carefully remove jars from canner and let cool
12. Check jars for seals(notice bing sounds as vacuum seals). Label and date.
13. Canned and sealed jars can be stored in cabinets for drinking or cooking for up to 2 years (per USDA guidelines). This juice makes the best jelly ever.

Fermenting Grapes

1. This simple look at fermentation will not be tasted but observed to introduce the concept of microorganisms in our food- raw foods are truly alive and add to our well being. Fermentation adds life to our food but is a process that should be learned using specific recipes for safety.
2. Using some of the rinsed mashed grape mixture, strain through cheesecloth or a nut bag, separating all fresh raw juice from the pulp. Using unwashed grapes (rinsed and air dried is fine)we can capture the natural yeast that lives on the skins of the grapes rather than needing to add yeast.
3. Ferment this juice by placing it in a ***sterilized***, clear jar, covering the jar opening with a thin cloth to keep pests out and allowing the escape of carbon dioxide gassesgases.
4. Place the covered jar of juice in a safe place at room temperature.
5. Stir juice 4-5 times a day, replacing cover after stirring. Watch for bubbling to begin in the liquid. This bubbling indicates the presence of microbiology working/fermentation. Bubbling indicates yeast at work digesting carbohydrates, sugars, in the process of creating ethanol. You can cap the jar with a carboy to observe the release of carbon dioxide or you can simply finish the observation here (Teacher review: Make Alcohol Without Yeast? (3 Natural Substitutes For Yeast)**.**

6. **Evaluation:**
    a. List the four common methods of preserving foods discussed in this lesson. Organize the methods in most to least nutritionally beneficial and give a short description of the practice.

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Zoology: Livestock (Animals)

Goal(s): Students will learn about the needs and responsibilities of livestock farming. Writing and research skills will be practiced during the learning process.

Learning objectives:

1. Students can give two examples of why animals are important in the farming life cycle.
2. Students can give four examples of responsibilities of livestock ownership.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes (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.
- *5. Energy (5-PS3-1)* Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.
- *From Molecules to Organisms: Structures and Processes (MS-LS1-7)* Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

Time: 45 Min. (multiple work sessions needed after initial introduction)

Lesson supplies:

- Farm journals and writing utensils
- Research materials (internet, books, ect.)

Overview:

Animals are an important part of nature on the farm. Their digestion is the fastest composting systems we know of, breaking down plant matter into valuable nutrients in as fast as a couple hours. Grazing animals create a self fertilizing system for the pasture and adding manures to our garden composting systems increases carbon and nitrogen which are building blocks for soil fertility. Sometimes I have to remind myself how valuable these manures are when I am cleaning out the barns and litter boxes.

The key to deciding what livestock you can/want to include in your farm production should start with a careful assessment of the needs and responsibilities of that livestock. Once you have determined a plausible course of action, I suggest starting small. On an urban farm animal production is going to be limited by acarage and ordinances. As an exercise in starting this discernment process ask your students, what farm animal(s) can we raise responsibly? Involve your students in the research you need to review. This work will provide an exciting introduction to doing research as animal husbandry is an area most kids are interested in, and knowing their research is practical, and might result in adding an exciting element to your farm program is a big win for everyone.

Procedure:

1. **<u>Research Project: Raising Livestock</u>**

   Supplies
   - Farm journals and writing utensils
   - Research materials (books/internet)

   Directions (adjust for age appropriateness)
   1. I allow my students to choose any farm animal they want to learn more about for the coming research project. This can be an eye opening project - not all farms have cows for a reason. If you prefer, make a list of farm livestock for the students to choose from. This could serve an additional purpose of discerning an animal to add to your farm operation, or may dispel any ideas of such due to the resulting research findings that will clearly distinguish the needs and responsibilities of the farm environment.
   2. This lesson could include a trip to the school or public library or have books available to them in the classroom depending on age and time availability. Using the following questions, have students work alone or in pairs to write a research

paper discerning the possibility of adding this animal to a farm operation. What do you need to know to make this decision? Take this format to the depth your students are prepared for. I use index cards to record research facts, then organize facts into format, then rough drafts and final draft.

3. Information for researchers to include in their paper:
    a. Livestock variety and description.
    b. What family does this animal belong to?
    c. What is the history of the animal; where did it originate and how/why was it brought to America?
    d. What are your animals' food, shelter and space requirements?
    e. What is the lifecycle of this animal (birth to reproduction to life expectancy)?
    f. What is the cost of raising this animal/ all the costs involved; shelter, fencing, feed, ect.?
    g. What products will this animal provide the farmer? Is this animal sustainable; does it pay for itself and what are the products it will provide?
    h. Is this animal available locally? When is a good time to purchase?
4. Have students present their research while the audience takes notes in their journals.
5. When all research has been presented, a class discussion could include a process of elimination for considering raising an animal as part of your own farm. You might ask: Can our farm responsibly raise this livestock; why or why not for each presentation based on the facts presented?

2. Evaluation:

a. Why are animals important to life cycles on the farm? Give two examples.

b. List four responsibilities of livestock ownership.

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Microbiology: Composting with Microorganisms

Goal(s): To learn about composting and how to create a successful composting system.

Learning objectives:

1. Students can list the four ingredients of a working compost pile.
2. Students can define the appropriate C:N ratios for compost to work.
3. Students can describe three benefits of composting.
4. Students can argue that composting is a practice of earth stewardship.

Next Generation Science Standards connections (grades 3-12):

- *5. Ecosystems: Interactions, Energy, and Dynamics (5-LS2-1)* Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- *MS. Ecosystems: Interactions, Energy, and Dynamics (MS-LS2-3)* Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

- *HS. Ecosystems: Interactions, Energy, and Dynamics (HS-LS2-7)* Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Time: 45 min

Lesson supplies:

- Farm journals and writing utensils
- Poster of the Periodic Table of Elements

Background review for the instructor:

- The book *Composting: Nature's Recyclers* by Robin Koontz
- System I like- Designing a 3 bin pallet Compost System (6 mins) (https://www.youtube.com/watch?v=cNn7Q0yYR-I). This is a good video for ideas and inspiration.
- How to make Compost - The Simplest Easy Method To Compost Piles! (18 mins) (https://www.youtube.com/watch?v=nxTzuasQLFo)
- Perfect Compost Recipe - How to Get Your Compost Heap Cooking! (5 mins) (https://www.youtube.com/watch?v=M1kIpCBD3UI)

Vocabulary:

Composting: A natural process of rotting organic matter; requires carbon, nitrogen, moisture and oxygen.
Microorganism: Organisms that need magnification to view including: bacteria and fungi
Soil food web: A community of living organisms in the soil that represent three different levels of consumers. Each level of consumer depends on the level below it to get food energy and is the energy source for the level above it. These levels of consumers are often depicted in concentric circles or layers showing who eats who, with a carbon food source at the center (organic matter). The smallest microorganisms are fed by the organic matter layer and go on to be the food or produce the food that will be eaten by the next level of life and so on. No level of consumer can exist apart from the others.
Fertility: The ability to sustain agricultural growth.
Vermiculture: The cultivation of worms (see December's year 3).

Overview:

What do you know about composting? ***Composting*** is a natural rotting process of organic matter. This rotted material is valuable to gardeners and farmers because it is rich in nutrients for plants. Composting happens in nature all the time, all around us. Think about the forest floor and all the nature that falls to the ground there (leaves, limbs, dead animals). Over time these layers of dead nature are breaking down. We can mimic nature to create composting centers or piles when we understand this natural process and how it works. When we compost our own organic waste we lessen landfill pressure and create our own garden fertilizer.

Let's review, what is organic matter? *"All organic compounds have in common the presence of carbon atoms and hydrogen atoms. In addition, different organic compounds may contain oxygen, nitrogen, phosphorus, and other elements."* is the definition from www.britannica.com/science/organic-compound.

Review the Periodic Table of the Elements to find these elements in their simplest forms (atoms). Point out carbon, hydrogen and nitrogen and their scientific notations and atomic weight. Every element that comes from nature is listed on the periodic table of elements(have a copy hanging for review). Some of these elements are organic and some are not - do you know what distinguishes them? Scientists say that to be an organic compound(a combination of these

elements) it must have carbon and hydrogen atoms. Carbon alone does not distinguish organic from inorganic. I like to simplify the definition of organic matter for ease of understanding, to that which comes from nature and is alive or dead (which implies it was once alive); Carbon and nitrogen exists in the tissue of all living compounds. Carbon and nitrogen are the building blocks of our compost pile.

The Compost Recipe

To encourage the fastest breakdown of organic material, composting, use this recipe:

1. Carbon (browns)
2. Nitrogen (greens)
3. Moisture (H2O)
4. Oxygen (air)

These are the four vital ingredients to a successful compost pile.

Procedure: Layer organic matter; using carbons and nitrogens ideally at a ratio of 30:1, C:N, or as close as possible. Some use the equation of 3 parts carbon for every one part nitrogen(25:1). Add moisture when layering; when the pile is no larger than 6' high X 6'wide stop adding new material and allow for the breakdown period; add air and moisture, if needed, when you turn the pile regularly. Check success by measuring the internal temperature; turn before temperature exceeds 140. Turning can be done on whatever schedule works best for you, though note; the more you turn and keep materials moist, the faster the breakdown will occur.

What to know: All organic matter has an existing ratio of carbon to nitrogen; in general living organic matter has more nitrogen and dead organic matter has more carbon. I refer to dead things in nature as carbon because they are primarily made up of carbon atoms and usually, but not always, are brown(manures are an exception on color)i.e. dead leaves, wood chips, cardboard, straw and papers. All of these were once alive but are now dead. Living things are organic also and often have varying amounts of both carbon and nitrogen. I refer to the living things in nature as nitrogen because they are typically composed of more nitrogen than carbon atoms and often, but not always, are green (one exception is manure) i.e. green leaves, green grass, fresh weeds and plants, fruits and vegetables. Manures are an exception to the color rule; I call manures super nitrogens because they are typically much higher on the nitrogen side of the carbon to nitrogen ratio. Knowing the existing C:N ratio of living and dead organic matter is important to successful composting. Remember all organic materials break down over time, but by following this recipe as closely as possible you will expedite the natural process.

ESTIMATED CARBON - TO - NITROGEN (C:N) RATIO in common organic matter*

(*I base these ratios on an average of five resources)

Ashes, wood	25:1
Cardboard shredded	350:1
Cornstalks, brown	75:1
Fruit waste	35:1
Leaves	60:1
Pine needles	80:1
Newspaper shredded	175:1
Greens = Nitrogen	
Alfalfa	12:1
Cover	23:1
Food Waste	20:1
Garden Waste	30:1
Grass Clipping	20:1
Vegetable Scraps	25:1

Manures

Dairy Manure	20:1
Horse Manure	30:1
Chicken Manure	18:1

Try this C:N calculator created by Cornell University: Calculate the Carbon to Nitrogen Ratio - Cornell Composting (https://compost.css.cornell.edu/calc/2.html). To get a general average of the carbon to nitrogen ratio you have in your compost pile, add up the number of carbons in each item divided by the number of items you have. Example: Leaves 60 + Veggies 25 + Food Waste 20 = 105 Carbon. 105 divided by 3 = 35. This would be a good composting mixture because 35 is close to the 30:1 ratio.

In addition to the nitrogen and carbon ratio, water and oxygen need to be present. You can aerate your compost by mixing or turning the pile with a shovel, pitch fork or tractor. Ideal moisture can be measured by squeezing the ingredients; if the handful holds together or extracts a drop of moisture this is perfect. It is important to have air and moisture to invite all levels of decomposers, (the soil food web, starting with the very smallest microorganisms that eat and poop and invite the larger decomposers. It is said there are more microbes in a scoop of compost than there are people in the whole world. Try counting some of these. You will need a 400X or greater microscope.)

Moisture can be retained longer by situating the pile in indirect light and covering it with a tarp. Microscopic organisms, insects, worms, snails, and fungi all help decompose the organic material. We call this the ***soil food web***, which is responsible for eating and pooping and breaking down these carbons and nitrogens into usable ***fertility.*** As they move, eat and grow, while breaking down materials, they release some carbon dioxide and create heat (have students rub their hands together to feel the heat friction creates, much like the work of microorganisms in the working compost pile). The farming of worms for composting is called ***vermiculture***. You can measure this heat with a compost thermometer. This is important to the finished compost because heat kills weed seed and pathogens. Once a pile reaches ideal temperatures, 120-140°F, it is time to turn the pile, always moving unfinished ingredients to the center, where the heat will grow again, and hot ingredients to the outside, for cooling so as to maintain beneficial organisms.

Your compost will be mature and ready to use when all organic materials have passed through the heat process and look like rich soil. The individual ingredients are no longer distinguishable. Maturation can take 20 days to 2 years depending on how close to ideal your recipe and practices are. In general the closer to the ideal C:N ratio and the more the pile is turned and watered or kept moist the faster you will get a finished product. Never spread hot compost on a ready to plant garden as seeds or young roots could be burned.

Compost adds valuable characteristics to soil. It increases the vitality of the soil food web while creating a natural organic waste recycling system that decreases the pressure on landfills. Composting can replace the need for purchasing fertilizers for lawns and gardens. It is an important part of creating sustainability on the small farm.

Procedure:

1. **Discuss:** What is compost? Does anyone here compost or know someone who does? Why might we want to compost?
2. **Read:** *Composting: Nature's Recyclers* by Robin Koontz.
3. **Watch:** Compost (National Geographic Explorer) (3 mins) (https://www.youtube.com/watch?v=MPf5WNHhoJo).

4. **Create your own:** Consider starting your own compost pile using organic waste from the cafeteria/kitchen, office, bathroom, landscape etc including, grass clipping, leaves, shredded paper, food waste. If there's any landscape available consider a composting system; make a pile together, break into groups, where each group has a layer. Remember if installing a new system for composting you will need to have more than one pile or container as once you begin turning and finishing a pile you must stop adding to it. I like to have a three section bin system. Check out the first video in the background review section for ideas.
5. **Evaluation:**
    1. List the four essential ingredients for a working compost pile?
    2. How would you set up a working composting system for your home?
    3. Explain how composting contributes to earth stewardship and sustainable systems.

    Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 4: On the Farm

Farmer Spotlight- Farming the City: Good Shepherd Montessori School Farm

Sheet Mulching and Lasagna Gardening (Composting)

Goal(s): Learning how and why to prepare next year's garden beds in the fall for early spring plantings.

Learning objectives:

1. Students can describe sheet mulching and lasagna gardening techniques and give 4 examples of materials to use.

Next Generation Science Standards connections (grades 3-12):

- *5. Ecosystems: Interactions, Energy, and Dynamics (5-LS2-1)* Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- *MS. Ecosystems: Interactions, Energy, and Dynamics (MS-LS2-3)* Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *HS. Ecosystems: Interactions, Energy, and Dynamics (HS-LS2-7)* Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Time: 45 min

Lesson supplies:

- Farm journals and writing utensils
- Brown and green organic matter
    - Plant residue
    - Wood chips

- Grass clipping
- Leaves (brown & green)
- Animal manure

Background review for the instructor:

- Sheet mulching article- Sheet Mulching: How to Smother Weeds, Build Soil & Conserve Water the Easy Way - Modern Farmer (https://modernfarmer.com/2016/05/sheet-mulching/)
- Lasagna gardening article- How to Make a Lasagna Garden (https://www.thespruce.com/how-to-make-a-lasagna-garden-2539877)
- Lasagna gardening video- No-Dig Lasagna Gardening (How-to) (13 mins) (https://www.youtube.com/watch?v=lWV-XlwEI70)

Vocabulary:

Lasagna gardening: A system of no till garden preparation that uses layers of organic materials, alternating carbons and nitrogens, to create a fertile planting bed. Typically done in the fall for spring planting.

Sheet mulching: A system of no till garden preparation or protection by covering soil with a layer, sheet, of carbon, often wet cardboard, as a method of killing grass, suppressing weeds and holding moisture. Often the wet carbon is covered with a thick layer of finished compost for a ready to plant garden.

Overview:

Sheet mulching and lasagna gardening apply the same construction principles as any good composting recipe; layering greens and browns in a good C:N ratio, adding oxygen and moisture. As a no-dig gardening method, ***lasagna gardening*** is most effective if done in the fall. This method does not include stirring so it needs the valuable time of winter to accelerate decomposition. Microorganisms are said to be most active in the undisturbed times of winter, especially under the snow. Lasagna gardening is efficient and effective. It eliminates moving composting materials twice and it effortlessly removes any green growth on the landscape surface. It is a system of composting in place. I find it to be the most efficient way to increase my garden space. All that is required is thinking ahead. I use lasagna gardening techniques in the fall for creating any new spring gardens, as well as, winterizing any garden areas that will be early spring planted. This technique gives me a weed free surface as soon as the snow melts allowing for early planting with minimum disruption of the soil surface.

Sheet mulching, on the other hand, is more flexible and can be done anytime during the growing season if you can add a thick, finished compost layer over the wet cardboard mulch. This too is a great no dig practice that is highly efficient for quick garden bed preparation or repair. I use sheet mulching throughout the season whenever I find a garden bed to be consumed with plant residue or obnoxious weeds. I simply mow down the green growth (nitrogen), cover with saturated cardboard (carbon), add four inches or more of mature compost, thoroughly water and plant the next day- instant clean garden plot! Of course you have to have access to cardboard and mature compost. I collect cardboard all year in anticipation of these projects and if I haven't finished enough compost myself our city has an organic resource center where you can get free high carbon compost.

Procedure:

1. **Plan:** Determine a garden area to be established for spring planting.
2. **Activity: Planting a Lasagna Garden**

(*Theri's Tip:* I find a freshly made lasagna garden to be nearly weed free the entire first season of production.)

Supplies

- Brown and green organic matter
    - Plant residue
    - Wood chips
    - Grass clipping
    - Leaves (brown & green)
    - Animal manure

Directions

Include students in the gathering, layering and watering process of building the lasagna garden as follows:

1. Layer your entire garden area with a nitrogen source. If there is grass growing on the surface consider this a layer of nitrogen.
2. After the nitrogen source covers the entire area of the new garden, add a layer of carbon. I like to use wet cardboard on grass but any high carbon source will work.
3. Create your lasagna layers by adding layers of nitrogens then carbons.
4. Water heavily between each layer.
5. When layers total 18"-24"(inches) deep it is time to be done. I like to end with finished compost if I have a source or a carbon layer like straw.
6. Let your lasagna garden sit undisturbed until early spring when you can plant right into it. Just open a spot and stick your transplants in. Do not mix or till.

3. **Evaluation:**
    a. What does lasagna gardening method remind you of, explain why with examples.

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Additional October Resources

Compiled by Abigail Meyer

Grades 3-5

- **Short Video-** The Carbon Cycle | Carbon Cycle Process | Video for Kids (4 mins) (https://www.youtube.com/watch?v=p3R-dB9K4ss)

Grades 6-8

- **Poem-** "October" by Robert Frost
    - This is a poem about the month of October and the transition from fall to winter. (https://www.poetryfoundation.org/poems/53084/october-56d23212a5b72)
- **Poems-** Poems About Potatoes
    - This page features different poems about the root crop potatoes. (https://alanjwrightpoetrypizzazz.blogspot.com/2020/09/poetry-friday-poems-about-potatoes.html)
- **Book-** *Grow Your Soil!: Harness the Power of the Soil Food Web to Create Your Best Garden Ever*, Diane Miessler (https://www.amazon.com/Grow-Your-Soil-Harness-Microbes/dp/1635862078)
    - Teaches the inner workings of the soil food web and how each component can contribute to the flourishing of a backyard garden
    - Introduces topics such as cover crops, compost, and mulching
- **Book-** *Hungry Planet: What the World Eats*, Faith D'Aluisio and Peter Menzel (https://www.amazon.com/Hungry-Planet-What-World-Eats/dp/0984074422)
    - Illustrated book that gives a look at what families eat around the world; shows students different cultures' foods and the impact of the globalization of food, especially in European and Western countries. This book will help raise awareness about how environments and cultures raise the cost and calories of the world's meals and raises questions such as why doesn't abundance bring better health, instead of increased occurrences of diabetes and similar diseases?
- **Article-** Sustainable Agriculture: Perennial Plants Produce More; Landscape Diversity Creates Habitat For Pest Enemies -- ScienceDaily
    - This article explains the advantage perennial plants have over annuals and how this works into making farming more sustainable and durable. (https://www.sciencedaily.com/releases/2009/08/090804071358.htm)
- **Article-** What is "soil carbon"? (https://soilsmatter.wordpress.com/2021/10/01/what-is-soil-carbon/)
    - A well-written article that explains the relationship between carbon and the soil.
- **Website-** Local Harvest
    - Includes helpful resources such as where to find your local CSAs (Community Supported Agriculture), farmers markets, and farming and food related events going on near you, along with ways to support local food businesses. (https://www.localharvest.org/)
- **Short Video-** "The Hidden Costs of Hamburgers" (8 mins)

    - Overview of the environmental impact of animal agriculture. (https://www.youtube.com/watch?v=ut3URdEzlKQ)
- **Short Video-** Composting 101 -- Making Compost in Composting Bins and Compost Piles (4 mins)
    - Explains basic composting concepts in a way that can be applicable in schools. Also suits grades 3-5. (https://www.youtube.com/watch?v=AJuiNtXXB58)
- **Short Video-** "How to Start Your Own Compost" (4 mins)
    - Explains how to start a basic composting system at home and how to reduce the waste that we put into landfills. (https://youtu.be/3-uxdrMt4k0)
- **Documentary-** *Cowspiracy: The Sustainability Secret* (1 hour 31 mins)
    - This documentary explains why animal agriculture is the number one contributor to greenhouse gasses and a huge environmental problem. Specifically, it is about one person's discovery of the hidden truth behind the meat and dairy industry. It is unassuming and even goofy at times, but the overall message is very important.

Grades 9-12

- **Poem-** "This Compost" by Walt Whitman
    - Poem that examines nature's natural 'rebirth' process through composting. **(**https://poets.org/poem/compost**)**
    - An analysis of Whitman's poem: Ecocritical Analysis of Whitman's "This Compost" | AML 4453: Visions of the Land (https://aml4453uf.wordpress.com/2011/10/18/ecocritical-analysis-of-whitmans-this-compost/**)**
- **Book-** *Animal, Vegetable Miracle: A Year of Food Life*, Barbara Kingslover
    - This is a suitable book for high schoolers because it is entertaining to read while also bringing up bigger questions about eating locally and how to build a food culture in America. Part memoir, part journalistic investigation, this is a story of how a family went from living on the industrial-food chain to living on locally grown food. It also includes recipes for eating seasonal, locally grown food.
- **Book-** *How Bad Are Bananas? The Carbon Footprint of Everything*, Mike Berners-Lee
    - Good introduction book to our carbon footprint; will raise students' awareness about sustainability and help them to analyze their own lifestyles
    - Puts technical sustainability topics into layman's terms; very readable and often humorous; good for class discussion.
- **Website-** Local Harvest
    - Includes helpful resources such as where to find your local CSAs (Community Supported Agriculture), farmers markets, and farming and food related events going on near you, along with ways to support local food businesses. (https://www.localharvest.org/)
- **Article-** Gardening Is Important, But Seed Saving Is Crucial | Civil Eats
    - This article goes well with the video below, "Saving Seeds with Kristyn Leach." (https://civileats.com/2020/04/21/gardening-is-important-but-seed-saving-is-crucial/)
- **Short Video-** "Saving Seeds with Kristyn Leach" (5 mins)
    - Talks about seed saving in relation to the COVID-19 pandemic. Can be watched alongside the Civil Eats article "Gardening is Important, But Seed Saving is Crucial".

(https://youtu.be/jVKtmrrdW3U)

- **Short Video-** "Michael Pollan: Why Eat Local?" (2 mins)
  - Explains the importance of eating local and how it fits into the bigger picture of mitigating climate change and stopping suburban sprawl. (https://youtu.be/DhaG_Zi6izU)
- **Short Video-** "The Truth About GMOs" (15 mins)
  - Explains what GMOs are and explores the widespread controversy around them about whether or not they are good. (https://youtu.be/DK5kRGs0HX0)
- **Documentary-** *Transgenic Wars* (1 hour)
  - Documentary about the controversy over GMOs
  - Buy or rent: Transgenic Wars (https://www.youtube.com/watch?v=twSnNG_2x4k)
- **Documentary-** *Just Eat It: A Food Waste Story (FULL MOVIE)* (1 hour 13 mins)
  - This eye opening documentary delves into the issue of food waste that is not often talked about. It discusses in depth a part of the food economy that is usually hidden and brings up questions about food security and environmental sustainability. (https://www.youtube.com/watch?v=KUHdTDwdq8U)

Extra Teacher Resources

- **Carbon Footprint Calculator:** WWF Carbon Footprint Calculator:
  - simple carbon footprint calculator, appropriate for any age group, divides up carbon footprint into sections (food, stuff, travel, home) to see how small changes in your lifestyle affect your carbon footprint, includes information on the side about each topic
- Ecological Footprint Calculator:
  - will tell you how many earths you would use up if everyone lived like you, allows you to add details or to simply follow categories as is, works better than most other carbon footprints because it allows you to leave numbers on the "average" setting or to guesstimate if you're not sure of the answer, also has an option to see how you can improve
- Calculate the Carbon to Nitrogen Ratio - Cornell Composting
  - A calculator to figure out the carbon to nitrogen ratio of compost. (https://compost.css.cornell.edu/calc/2.html)
- Videos - All - Nourish: Food + Community
  - Collection of 1-3 minute videos from food activists about topics such as eating in season, seed saving, and how kids can take action. (https://www.nourishlife.org/videos-all/)
- *The Feast Nearby*, Robin Mather
  - This book includes recipes and personal anecdotes on how to eat locally on a limited budget and contains useful tips on eating by the seasons. (https://www.amazon.com/Feast-Nearby-marriage-preserving-bartering-ebook/dp/B004CFAWIO/ref=sr_1_1?dchild=1&keywords=the+feast+nearby&qid=1593122806&sr=8-1)
- *Locally Grown: Portraits of Artisanal Farms from America's Heartland*, Anna Blessing
  - Contains resources such as books, websites, and documentaries about locally grown food, recipes, and mini biographies of dozens of family and urban farms across the Midwest. (https://www.amazon.com/Locally-Grown-Portraits-Artisanal-Heartland/dp/157284129X)

- *Local Flavors: Cooking and Eating from America's Farmers' Markets [A Cookbook]*, Deborah Madison
    - Provides recipes for every week of the year from locally grown foods. (https://www.amazon.com/Local-Flavors-Cooking-Americas-Farmers/dp/0767929497)

NOVEMBER

Focus: Whole Foods

Key concepts: *Winterizing, microgreens, season extension, animal biology, soil structure, winter farming*

Think Ahead

- This can be a time to start researching options for small livestock you might want to add to your farming operation come springtime.
- If you want to include spinach in your winter farming, plant it this month for harvest in March.

November Lesson Outline

- *Week 1 Sustainability Topic*
    - Whole Foods
- *Week 2 Theri's Fall Kitchen*
    - November Kitchen Project: Cabbage Fermenting (Sauerkraut)
    - November Kitchen Project: Brussel Sprouts
    - November Kitchen Project: Pumpkin Pie
- *Week 3 Science Enrichment*
    - Botany: Microgreens for Winter Production
    - Zoology: Livestock for Meat Production
    - Microbiology: Soil Structure
- *Week 4 On the Farm*
    - Overwintering

Introduction

Freezing weather can arrive early in November. I make a list of the farm's winterizing needs, assess and plan to fit in these extra chores early in the month. You don't want to find yourself knee deep in snow trying to make outdoor repairs in mid-November, when weather can change overnight. My list includes: draining and storing hoses; blowing water out of any irrigation lines; sharpening, oiling and organizing tools; repairing and insulating animal shelters to ensure wind protection; and pulling out protective season extension covers for any hardy field plantings still producing. With these chores checked off my list, I can enjoy the days ahead and hope for an abundant fall full of fresh nutrition, holiday harvesting, and preserving.

The Persephone Period & Season Extension

The Persephone Period begins when daylight falls below ten hours. Persephone was a Greek goddess of the underworld, associated with living in darkness part of each year; likened to our shortened day lengths from mid-November to mid-January. During this time, field plantings show minimal to no growth. By mid-November our crop diversity is limited to cold loving, short day-length crops such as greens, roots and brassicas. We use the Persephone starting date to plan for late fall and winter plantings and harvests, all based on temperatures and day length. Heavy greens, roots and brassicas that were planted with this date in mind should be mature by the time the Persephone Period begins.

If you are lucky enough to have a hoop house, you can extend your growing season by as much as a couple months. In the midwest that means our short day crops can tolerate most of our winter weather. Minimal cloth coverings can provide extra degrees of protection in the fields and hoop houses to extend your winter harvesting. Trial and error will be necessary to get the winter planting/harvesting timeline right for your area and its unique environmental and soil conditions, but it is well worth the effort. Winter gardening offers a source of diversity and fresh nutrition in the winter, moving us closer to creating resilient local food systems. You will need to think ahead if you want to add winter harvesting to your production. Some winter plantings begin in late summer, others in late September. These dates should be part of your seasonal working calendar schedule. I have shared my crop work on the Working Farm Calendar provided in this curriculum. Personalize and edit this schedule annually as you continuously try new plant varieties.

The History of Thanksgiving

The Thanksgiving holiday provides a natural time to explore the Indigenous history of our country. The Three Sister Garden is a commemorative addition to any farm, big or small, and if planted in the spring will be fruitful for a memorable fall celebration. The Native Americans shared their store of squash, saving the lives of the few pilgrims who survived that first Plymouth winter. It was the sharing of their farming knowledge and food storage that we remember during this time of thanks and giving each year. The pumpkin pie making lesson can include this history with examples of shared bounty and nutrition. Current writings on the themes of native Americans and Thanksgiving are clear that this time of friendship and reciprocity did not last long. It is only fair and accurate to include this honesty when presenting a depiction of this time in history (read American Indian Perspectives on Thanksgiving (https://americanindian.si.edu/sites/1/files/pdf/education/thanksgiving_poster.pdf). Your history lesson this month could include research and acknowledgement of our Native American contribution to environmental stewardship. A great companion read for students this month is the new young readers edition of *Braiding Sweetgrass* by Robin Wall Kimmer. The entire month could be planned around this amazing book.

Suggested November Field Trip

Visit a year-round food production facility such as a greenhouse, hydroponic farm, aquaponic farm or CAFO (this could be sensitive). While there you can think about the environmental costs and benefits of this type of farming. Think about energy input (renewable and nonrenewable) vs. energy output (nutrition). How expensive are the calories? Can farmingthat is not in the soil be considered regenerative? A sustainable system should produce far more energy than it uses. Brainstorm improvements that might be made to make an operation more sustainable and/or note

what energy alternatives are being used (energy conservation practices, solar, wind). Of course, be sensitive where and when you have this discussion. Apply this thinking to your own production; what can we do better?

Week 1: Sustainability Topic

Whole Foods

Goal(s): To understand what whole foods are; how and why whole foods are processed; how processing changes the nutritional content; why whole foods are nutritionally and environmentally healthier choices than processed foods.

Learning objectives:

1. Students can define unprocessed and processed food giving three examples of each.
2. Students can classify foods into categories based on amount of processing; highly processed, mildly processed and unprocessed (whole foods) giving two examples of each.
3. Students can explain why highly processed foods are often less expensive than mildly processed or whole foods.

Next Generation Science Standards connections (grades 3-12):

- *5. Earth and Human Activity: Human Impacts on Earth Systems* (5-ESS3-1) Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- *MS. Earth and Human Activity: Human Impacts on Earth Systems* (MS-ESS3-3) Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- *MS. Earth and Human Activity: Human Impacts on Earth Systems* (MS-ESS3-4) Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- *HS. Earth and Human Activity: Human Impacts on Earth Systems* (HS-ESS3-3) Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
- *HS. Earth and Human Activity: Human Impacts on Earth Systems* (HS-ESS3-4) Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Time: 60 Min.

Lesson supplies

- Large sheet of paper, poster board, chalkboard, or dry-erase board
- Tape
- Scissors
- Pictures of common foods or flashcards with foods listed on them. If you make the list, include a variety of foods.
- Examples:
    - Unprocessed: Fresh green beans, grapes, corn, peas, oranges
    - Minimally processed: Canned or frozen green beans, cooked chicken, canned applesauce, eggs, milk, oats, maple syrup
    - Highly processed: Chips, sugary cereal, candy, canned soups, soda

Background review for the instructor:

- Obesity is about poverty and cheap food, not a lack of moral fibre | Zoe Williams | The Guardian (https://www.theguardian.com/commentisfree/2011/dec/14/obesity-diabetes-cheap-food-poverty)

Vocabulary:

Calorie: Unit of energy contained in food.
Whole foods: These foods come directly from nature, including: raw milk, fruits, vegetables, eggs, and whole grains. They are foods with no added ingredients or packaging, or unprocessed.
Processed foods: Foods that have been adapted, usually for convenience and usually have multiple ingredients. These foods often have "ingredients" lists.
Mildly processed foods: Packaged or preserved whole foods (e.g. packaged chopped carrots, canned tomatoes). These foods have minimal ingredients.
Highly processed foods: Food that is packaged and has been altered and added to. Often these foods have many ingredients (also highly processed) including preservatives.

Overview:

Nutrient content is key in deciding which foods to eat. The number of calories in the food is important, along with the amount of fat, protein, carbohydrates, and sugars. For healthy eating we should maximize our protein, good fat and carbohydrate intake, and try to minimize our bad fat and carbohydrate intake. Scientific research shows us which fats and carbohydrates are best used by our bodies, and which ones do not provide necessary nutrients. All **calories**, the amount of energy stored in food and drink, are not equal. The fats and carbohydrates that are unhealthy for us show up in junk foods as "empty calories". These calories occur rarely in nature, if at all, so they are foreign to our bodies, cannot be used, and end up stored as excess body fat. Healthy calories are used for bone & muscle growth, and provide energy for our work and play.

Whole foods are foods that have not been processed or changed from their original forms. Apples are an example, or raw vegetables. ***Mildly processed foods*** such as home baked goods are usually more expensive than ***highly processed foods.*** Small batch cooking usually requires more manual labor, includes healthier ingredients (using less filler and preservation ingredients), and uses less packaging. This makes a good conversation with regards to energy input and output.

Family food purchases can be a sensitive topic. Be informative, not judgmental. Include further discussion with older students as to the cost of these foods. Why are highly processed foods less expensive (subsidized ingredients, food fillers, longevity of product)? How does heavy processing show up in our health (disease, obesity)? Why are certain populations more susceptible to poor health (poverty and cheap food go together)?

Procedure:

1. **Discuss:** Ask students what they think is healthier: an apple or an apple pie.? Explain the term "whole foods" and processed vs minimally processed vs unprocessed foods(whole food).
2. **Watch:** Processed Food vs. Nutritional Needs (34 minutes) (https://www.youtube.com/watch?v=guxledYcXcE)
3. **Discuss:** How does processing food (adding sugar and other ingredients) lead to disease and obesity?
4. **Activity: Processed or Unprocessed?** (45 minutes)
   Supplies
   - Large sheet of paper, poster board, chalkboard, or dry-erase board

- Tape
- Scissors
- Pictures of common foods or flashcards with foods listed on them. If you make the list, include a variety of foods.
- Examples:
    - Unprocessed: Fresh green beans, grapes, corn, peas, oranges
    - Minimally processed: Canned or frozen green beans, cooked chicken, canned applesauce, eggs, milk, oats, maple syrup
    - Highly processed: Chips, sugary cereal, candy, canned soups, soda

Teacher preparation (20 mins)

1. Choose how you want to present different categories of foods to the students. You can print pictures of common foods, list food items on flashcards, or ask older students to make a list of all the foods they ate yesterday .
    a. Make sure to include whole foods, mildly processed foods and heavily processed food items.
2. Create a chart on the board(or a poster) for this activity. Draw two parallel, perpendicular and evenly spaced lines on the page to create three columns. Label the columns as “Unprocessed,” “Minimally processed,” and “Highly processed”. This can also be done by students in their journal.

Directions

1. Assign each student at least one food (older students can do this in their journal using their prepared list and can offer examples of each for discussion).
2. Go around the room and have each student put a food item on the chart, discussing the food and what to consider for appropriate classification .
3. After all the foods have been added, review the concept of unprocessed foods being called “whole foods.” Whole foods keep their nutrition in tack (and have little or no packaging) and are the best food choices for health.
4. Discuss: How does last month's lesson on carbon footprint apply to processed food? Is there a relationship between processing and carbon footprints?

5. **Ongoing discussion:** Continue this theme in Week 2. Consider purchasing a commercially processed pumpkin pie from the grocery store, and doing a comparison with the recipe listed in Week 2. Compare the packaging, ingredients and calories. Make a chart for comparison: the number of ingredients; the total calories for a serving; the calories from protein, fat, and carbohydrate. Have students share thoughts. This should create some good conversation on ingredients.
6. **Evaluation**:
    a. Compare and contrast whole foods and processed foods, giving examples of each.
    b. Give two examples of each - whole foods, minimally processed foods and highly processed foods.
    c. Why are highly processed foods lacking nutrition and what are some of the results from diets heavy in highly processed foods?

Modification: Students unable to journal can demonstrate what they’ve learned orally, pictorially, or another medium of their choosing.

Week 2: Theri's Fall Kitchen

November Kitchen Project: Cabbage Fermenting (Sauerkraut)

Goal(s): To understand how cabbage grows, the process of fermenting cabbage (into sauerkraut) and its benefits.

Learning objectives:

1. Students can reconize cabbage plant structure.
2. Students can list two benefits of fermentation preserving.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-2) Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-4) Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-3) Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Time: 45 min

Lesson supplies:

For each group

- 1 medium to large cabbage (preferably organic and locally grown)
- 1 tablespoon sea salt (no iodine)
- 1 large mixing bowl
- *Optional:* 1 teaspoon of spice of your choice. Traditional spices include caraway seed, mustard seed, dill seed or 2 cloves garlic.
- 1 mason jar per recipe with seal and rim. (I recommend Ball Jars' inexpensive fermentation kit, a spring and lid for any standard canning jar that makes keeping the cabbage submerged in its juices an easy job.)

Vocabulary:

Fermentation: The process in which a substance breaks down into a simpler substance. Microorganisms like yeast and bacteria usually play a role in the fermentation process. Fermenting some vegetables can make them more nutritious by adding this biology to our diet and can make the food product more easily digested; sauerkraut and kimchi is an example of this process.

Overview:

Cabbage belongs to the brassica family. The common name is the Mustard family. It has health benefits that offer nearly a full day's recommended dose of vitamins K and C in a single serving. There is growing evidence that cabbage can help to prevent inflammation, cancer, and even diabetes!

There are many varieties of cabbage. Some varieties take the entire growing season to mature and others are fast growing and can be planted twice in one season. My first planting of cabbage includes both varieties so I have early and late cabbage in one planting. I start cabbage seeds in March, before the first frost, and transplant to the fields the last week of April or the first of May. By early July I am harvesting early cabbage and the big late cabbage is ready starting in September. After harvesting the initial cabbage heads, the early plantings will produce a second smaller crop of heads if the plant is left to grow. While they won't grow as big as the first harvest, they are delicious and edible for both humans and animals. The best tasting cabbage is harvested after the first frost and lasts in the field until freezing, which could be as late as December. Leave a cabbage or two in the garden for next year's seed collection. Like most brassicas and roots, cabbage is a biennial producing seed in the second season of its lifecycle. A well planned working calendar should include both early and late cabbage varieties.
Before the kitchen demonstration, the instructor should lead the class in discussion by listing what students know about cabbage. If there is an outdoor green space currently growing cabbage, take a walk so that students may be able to touch, feel, and taste fresh cabbage. Harvesting is typically done with a sturdy harvest knife.

If you have never made sauerkraut, watch a couple YouTube videos and do a practice run before attempting a class project. It is easy and delicious. The biggest success factor is to keep the cabbage submersed during the ***fermentation*** process. The fermentation is best done at 65ish degrees; any warmer and the cabbage will finish much quicker, as soon as 4 or 5 days. I have done this project as a class many times. Sometimes using one large crock as a community project, and other times having students work in groups of 4 to make one quart of sauerkraut together. Both ways are fun and exciting. The new fermenting Ball jar set is great for a successful first go.

Procedure:

1. **Watch:** Growing Cabbage (2 ½ minutes) (https://www.youtube.com/watch?v=cOyU_VUD_dE), from Burpee.
2. **Discuss:** Go over the farm journal questions as a class.
3. **Recipe: Sauerkraut**

   After ~2 weeks: Eat after cooling and refrigerate until finished. This sauerkraut should be fine for at least six months in the refrigerator, if not longer. Trust your nose and taste buds.Your sauerkraut should never smell bad when you go to eat it. (NOTE: Cabbage keeps a long time in the fridge, but there may be school rules that it has to be eaten by a certain time after harvest.)

   Supplies

   For each group

   - 1 medium to large cabbage (preferably organic and locally grown)
   - 1 tablespoon sea salt (no iodine)
   - 1 large mixing bowl
   - *Optional:* 1 teaspoon of spice of your choice. Traditional spices include caraway seed, mustard seed, dill seed or 2 cloves garlic.

- 1 mason jar per recipe with seal and rim. (I recommend Ball Jars' inexpensive fermentation kit, a spring and lid for any standard canning jar that makes keeping the cabbage submerged in its juices an easy job.)

Directions

1. Set aside one full leaf of cabbage, then chop the cabbage in quarters and cut out and compost the core(this step could be done as a demonstration while having all the cabbage prepared this way and ready to pass out).
2. Shred the cabbage by cutting it into thin slices. This is a great knife skills practice step. I do review safety steps including to always have a flat side down when cutting cabbage. For younger students I pre cut the cabbage quarters before distributing them.
3. Have a bowl for each student to place cabbage and salt together. Instruct them to squeeze and knead the cabbage and salt together with their hands (or provide 1" wooden dowels with the end rounded) until the cabbage is soft and the salt has pulled the natural liquid out of the cabbage. This should take 5-15 minutes.
4. Pack the cabbage mixture into a quart (32-ounce) glass jar as you fill. Every couple inches, give it a forceful push down with your fist or other tool. Stuff the cabbage with its brine into the jar as tightly as you can, pushing out any air pockets and filling to within an inch of the lid.
5. Place the reserved full cabbage leaf on top of the shredded mixture, covering the mixture as much as possible. Apply pressure to the leaf to submerse it under the cabbage juices. Place a clean rock on top of this leaf to keep the shredded cabbage submerged (this can also be done with the new *Ball* brand canning jar set, check them out online).
6. Screw the lid loosely onto the jar so that pressure (CO_2 gasses) can escape during fermentation. Put the jar on a plate to catch any brine which will likely overflow out of the jar as fermentation progresses.
7. Place in a cool place, ideally around 65 degrees and out of direct sunlight.
8. Let sit for up to one week, checking daily that solids are submersed in liquid. Begin tasting the cabbage for flavor after fermentation begins. Fermentation will bubble and become fragrant (microbes at work), the cabbage colors will dull, and the flavor will develop an acidic edge. If the fermentation went too far it will be obvious from the smell and could also have mold-like growths on the surface. If it has spoiled, over fermented, compost or feed it to your vermiculture. When the flavor suits you remove the top leaf, tightly seal and move the whole jar to the refrigerator to stop/slow the fermentation process. This will not kill the probiotics, but will keep them from further fermenting.
9. Eat and enjoy until the jar is empty!

4. **Evaluation**:
    a. What does a mature cabbage plant look like in the field ?
    b. How does cabbage contribute to a sustainable food system?
    c. Describe fermentation and explain it's unique characteristics as a preserving method?

Modification: Students unable to journal can demonstrate what they've learned orally, pictorially, or another medium of their choosing.

November Kitchen Project: Brussels Sprouts

Goal(s): To learn how brussel sprouts grow and to taste them fresh for best flavor.

Learning objectives:

1. Students can describe the look and taste of brussels sprouts by using a comparison to another vegetable.
2. Students can describe brussel sprout plant structure.
3. Students can list two nutritional benefits of brussels sprouts.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-2) Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-4) Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-3) Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Time: 45 min

Lesson supplies:

- Oven for roasting (or hot plate for steaming)
- Large mixing bowl
- 1. 5 lbs of Brussels sprouts or enough for all to taste test
- 3 tbs. olive oil for roasting
- 1/2 tsp. (kosher) salt

Background review for the instructor:

- Choose if you are going to roast or steam your brussel sprouts based on supplies available to you.

Vocabulary:

Brussel sprouts: A member of the brassica family; looks like miniature cabbages that grow on the stem of the plant, one at the base of each leaf and are harvested after the first frost for best flavor.

Overview:

Brussels sprouts are another member of the mustard (brassica) family. ***Brussels sprouts*** are nutritious and many people find them delicious especially when eaten fresh after the first frost. A perfect fall treat, they are a slow growing crop, planted in late spring or early summer.

To get the sweetest brussel sprouts, harvest them after the first frost. Brussels sprouts grow on a tall, thick stem with rings of green leaves below each sprout. To harvest sprouts, I snap the sprouts down and off the stem, then rinse before cooking. If you are using sprouts at a later date they are best stored on the stem but can also be harvested, bagged and kept in the crisper drawer of the refrigerator. Like cabbage, brussel sprouts have a long shelf life if stored in a cold, not freezing, dry crisper or root cellar.

Brussel sprouts, like most brassicas, have a biennial life cycle, so be sure to leave a couple stalks in the garden to produce seeds next year. Brussels sprouts are high in vitamins K, A, and C, and antioxidants that help our bodies fight disease. Have a stem of brussels sprouts pre-purchased from the market for this project if you aren't growing them.

Before the kitchen demonstration, the instructor should lead the class in discussion by listing what they know about brussels sprouts. If there is an outdoor green space currently growing brussels sprouts, take a walk so that students may be able to see, touch, feel, and taste.

Procedure:

1. **Discuss:** What do you know about brussel sprouts? Choose if you're going to roast or steam your brussel sprouts.
2. **Recipe: Brussel Sprouts**

   While the sprouts roast (or before steaming) watch: How to Grow Brussels sprouts (10 mins) (https://www.youtube.com/watch?v=N46a4sc0G6c) from ML Gardner I.

   Supplies
   - Oven for roasting (or hot plate for steaming)
   - Large mixing bowl
   - 1. 5 lbs of Brussels sprouts or enough for all to taste test
   - 3 tbs. olive oil for roasting
   - 1/2 tsp. (kosher) salt

   Directions for roasting
   1. Allow them to see the brussel sprouts before cooking
   2. Preheat the oven to 400 degrees.
   3. Wash and clean the sprouts, setting them in a large mixing bowl. Add the olive oil and salt and mix until evenly coated. I cut large sprouts in half for faster roasting or steaming.
   4. Roast the sprouts for 30 minutes, shaking the pan occasionally for even browning. Sprouts should not blacken but be evenly browned. Consider steaming for younger children as a burnt look can deter taste testing.
   5. Cool sprouts enough to serve. Ask students to comment using positive language on the taste of the sprouts. Some ideas: delicious, chewy, and flavorful.

   Directions for steaming
   1. Bring 1 inch of water to a boil in a saucepan with a steam tray insert.
   2. Prepare brussels sprouts by removing any damaged leaves and cutting off ends.
   3. Place on the steam tray and cover until the sprouts are bright green.
   4. Remove from heat and toss with one teaspoon of olive oil or butter and salt.
   5. Cool sprouts enough to serve. Ask students to comment using positive language on the taste of the sprouts. Some ideas: delicious, chewy, and flavorful.
3. **Evaluation**:
   a. List four descriptive words to describe tasting brussels sprouts?
   b. How does a brussel sprouts grow?

c. List two nutritional benefits of eating brussel sprouts?

Modification: Students unable to journal can demonstrate what they've learned orally, pictorially, or another medium of their choosing.

November Kitchen Project: Pumpkin Pie

Goal(s): To learn about pumpkin growth and nutrition and experience making pumpkin pie; To present the differences in minimal and highly processed products.

Learning objectives:

1. Students can list two nutritional benefits of pumpkin.
2. Students can describe the process of cooking a fresh pumpkin to be used for making pumpkin pie.
3. Students can compare and contrast the level of processing of commercially made pumpkin pies and home baked, citing two or more examples of like and unlike characteristics.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *5. Matter and Its Interactions* (5-PS1-4) Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-4) Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- *MS. Matter and its Interactions (MS-PS1-3)* Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Time: 45 min

Lesson supplies

- Label for a store bought pumpkin pie
- Stove
- Mixing bowls/measuring cups and spoons
- One whole pumpkin
- Pie crust (Use a familiar recipe or have a parent come in and do a demonstration for students, ideally allowing students to roll the dough out and form the pie crust. If time is limited, have pie crust balls prepared in advance to be used after a demonstration.)
- **For One Pie Filling:**
    - 1 cup condensed milk

- ½ tsp nutmeg
- 1 small pinch cloves (optional)
- ½ tsp ginger
- 1/2 cup sugar(consider honey as a local sweetener)
- 2 cups fresh pumpkin
- 3 medium eggs
- 1 tsp cinnamon

Background review for the instructor:

- Secure an ingredient label from commercial baked pumpkin pie and bakery made pumpkin pie for discussion during baking time.

Vocabulary:

Winter squash family: Winter squash are distinguished from summer squash by their hard skin. Allowing the hard skin to dry out before storing makes winter squash long lasting. One of the most hardy winter squash is the butternut which I have had last six months on my kitchen counter.

Overview:

The pumpkin originated in North America and has a rich Native American history. The pumpkin is part of the ***winter squash family*** and a key participant in the three sister garden; one of the oldest recorded companion planting garden designs originated by indigenous cultures and shared with the early pilgrim settlers and handed down for generations. Native Americans used to dry pumpkins into mats in addition to eating them.This important food source was shared with the early European settlers and thought possibly to have saved the lives of the pilgrim who did survive that first winter in America.

Irish and Scottish immigrants helped to make pumpkins popular in the United States. They brought their culture of placing jack-o-lanterns, carved from large turnips, on their front porches at Halloween time to scare off wandering souls. Pumpkins were bigger and hard and became the American jack-o-lanterns source. People today in the U.S. place pumpkins, either whole or carved, on their front porches during fall.

Pumpkins, and all winter squash, are planted in the late spring and harvested in the Fall. They are a long season planting and usually require over 100 days to mature. The large hard fruits grow on vines and can make a great ground cover. If your space is limited, use a trellis and allow the vines to travel upward. Pumpkins get heavy so a strong trellis is required.

Bright colors in whole foods mean rich nutrients. Pumpkin is a good source of vitamin A, E, and C. The seeds are also nutritious and can be roasted for a treat or dried for next year's crop.

Making pumpkin pie from your freshly harvested pumpkin makes a fun and delicious demonstration of a farm to table lesson for any age. If held in a root cellar or cool dry environment, pumpkin and many winter squash will remain usable for months. You may also choose to use canned; or previously cooked, frozen and thawed pumpkin.

Before the kitchen demonstration, the instructor should lead the class in discussion by listing what they know about pumpkins. If there is an outdoor green space currently growing pumpkins, take a walk so that students may be able to see pumpkins growing on a vine and touch pumpkins in the field or review this activity from an earlier harvest.

<u>Interesting Pumpkin Facts for Cooking</u>

- Small immature pumpkins provide the most flavorful dish. Pumpkins smaller in size are more tender and less stringy than the larger variety. Select pumpkins anywhere between five to eight pounds.

- While pumpkins provide an alternative to the usual winter vegetables, they also help fulfill daily nutritional requirements. One serving, a half cup cooked, supplies enough Vitamin A for the day. Since the pumpkin is a vegetable high in water content, a cup of uncooked unseasoned pumpkin contains only 38 calories.
- When selecting a pumpkin, make sure there are no blemishes or decay spots and that there is a bit of the stem left in place. Store the pumpkin in a cool dry place and it will last for several months.
- Pumpkin can be substituted in recipes that call for winter squash or sweet potatoes (and vice versa).
- Pumpkin can be substituted for banana in virtually any recipe that calls for bananas, such as banana bread, muffins or pancakes. Sweeten and add pumpkin pie spices to taste.

Procedure:

1. **Discuss:** This lesson can include review of concepts previously introduced, including seed saving, native plants, and food preserving. Winter squash meat can be cooked and frozen; raw pumpkin meat can be dehydrated in strips or mats (much like the Native Americans did); whole pumpkins can be cured, letting the skin dry out, and stored in a root cellar or cool dry environment. Try an experiment in longevity of any of these preservation methods. We are reminded that the winter squash family is a very sustainable food source in the coldest midwest states.
2. **Prepare:** Consider a number of ways to make this project doable and meaningful. Group work can include making enough pies so that each student can have a taste, a slice, or take a whole pie home for Thanksgiving. Youngest students can enjoy an interactive cooking show style demonstration to create one pie where each student can have a taste. With older students, I post the recipe and have blender stations set up with ingredients for working solo or in pairs.
    a. While your pies are baking, make a food product label and compare it to a store bought version. Labels should list all ingredients by quantity used, starting with largest quantity to smallest.
3. **<u>Recipe: Pumpkin Pie</u>**

    Supplies
    - Stove
    - Mixing bowls/measuring cups and spoons
    - One whole pumpkin
    - **For One Pie Filling:**
        - 1 cup condensed milk
        - ½ tsp nutmeg
        - 1 small pinch cloves (optional)
        - ½ tsp ginger
        - 1/2 cup sugar(consider honey as a local sweetener)
        - 2 cups fresh pumpkin
        - 3 medium eggs
        - 1 tsp cinnamon
    - **Pie Crust:** Use a familiar recipe or have a parent come in and do a demonstration for students, ideally allowing students to roll the dough out and form the pie crust. If time is limited, have pie crust balls prepared in advance to be used after a demonstration.

Cooking the pumpkin:

1. Preheat the oven to 350 degrees.
2. Wash pumpkin and remove stem
3. Lightly coat the exterior of the pumpkin with cooking oil.
4. Place whole pumpkin(s) on a cookie sheet and bake in the oven until soft to touch, approx. 1 hour. (if you are saving seed you can cut the pumpkin in half, remove seed and bake pumpkin with the open bowl shape down).
5. After the pumpkin cools, peel off skin and scoop out meat. Roast, compost or feed the seeds to livestock; compost the skin and stringy fibers.
   Chill, freeze or can the pumpkin meat to be used at a later date. You can complete this step in October when you harvest fresh pumpkins, then thaw the meat to continue this recipe in November.
6. Use your prepared(cooked and cooled) freshly harvested pumpkin meat or previously frozen and thawed pumpkin meat in the following recipe .

Directions:

1. Have pie dough and pumpkin meat prepared and ready to use.
2. In a blender or hand mix , add the following ingredients in this order (most blenders will hold double the ingredients): condensed milk, nutmeg, cloves, ginger, cinnamon, sugar, eggs, fresh mashed pumpkin.
3. Blend on high until all ingredients are completely mixed and smooth consistency is achieved. You may want to pause and scrape down the sides once to make sure all spices are evenly distributed.
4. Pour filling into the prepared pie shell and place on the middle oven rack. Bake at 400° for 15 minutes. Turn the oven down to 350° until the center of filling is cooked solid, about 50 minutes (this time will naturally vary due to the amount of water in your fresh pumpkin). When filling bounces back when touched it is ready.

4. **Discussion:** Discuss levels of processing by comparing and contrasting the ingredient levels of a commercial made pumpkin pie, a bakery made pumpkin pie and your homemade version. The labels for the bakery and box store could be photographed and distributed to students or listed on a poster board or blackboard. Note the number of ingredients; the kinds of sugar and any ingredients you might not recognize. Compare the prices.Why might the bakery made pie (minimally processed) cost more than the others?
5. **Evaluation**:
   a. Is a pumpkin plant a vascular plant and how does it grow?
   b. Name three nutritional benefits of eating pumpkins?
   c. Give two examples of mildly and highly processed pumpkin products?

   Modification: Students unable to journal can demonstrate what they've learned orally, pictorially, or another medium of their choosing.

Week 3: Science Enrichment

Week 3 of each month features three different science focus areas: botany, zoology, and microbiology. Instructors can choose to use lessons based on their science requirements.

Botany: Microgreens for Winter Production

Goal(s): Students will learn that seeds have stored energy for germination and cotyledon development; students will learn about using microgreens.

Learning objectives:

1. Students can explain the value of winter food production in regards to sustainability.
2. Students can list the environmental needs of a seed for germination giving two examples.
3. Students can define germination and the role of the cotyledon.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *3. Heredity: Inheritance and Variation of Traits (3-LS3-2)* Use evidence to support the explanation that traits can be influenced by the environment.
- *5. From Molecules to Organisms: Structures and Processes* (5-LS1-1) Support an argument that plants get the materials they need for growth chiefly from air and water.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-4) Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- *HS. Ecosystems: Interactions, Energy, and Dynamics* (HS-LS2-3) Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

Time: 60 Min

Lesson supplies:

- Farm journals and writing utensils
- Microgreens seeds -A brassicas mix is great for beginners (there are many micro seed varieties
- Three (or more) seed starting containers or trays (must be the same size if you want to stack them)
- Growing medium moistened (a hand squeeze should easily produce multiple drips of water)
- Spray bottle for misting
- Grow light or natural sun light by south window
- Growing medium for seed starting
- Lights (minimum room temps should be 55 degrees F (windowsill, grow light))

Background review for the instructor:

- Growing Microgreens from Sowing to Harvest (6 mins) (https://www.youtube.com/watch?v=ZCMzrKIsQEE)
- A Simple DIY Microgreen at Home Setup (13 mins) (https://www.youtube.com/watch?v=OcoJ_k2BdJY)

- Beginners Guide to Growing Microgreens (8 mins) (https://www.youtube.com/watch?v=DskT6ppASjk)
- Avoid These 5 Microgreen Growing Mistakes (8 ½ mins) (https://www.youtube.com/watch?v=o1ESKWFS-H0)

Vocabulary:

***Microgreens*:** Small greens; seeds that are germinated and eaten at the cotyledon or first true leaf stage.

Germinate: The beginning of growth of a seed, spore, or bud. The germination of most seeds occurs in response to warmth and moisture. The seed opens and a sprout and root appear.

Cotyledons: The first leaves of a plant, also called the embryonic leaf, that starts inside the seed and contains high levels of nutrients for the early seed growth (about 2 weeks worth). These leaves eventually fall off after the true leaves (second set of leaves) arrive and photosynthesis takes over the feeding of the plant.

Overview:

This month we will look at microgreen production. ***Microgreens*** are easy to grow inside and provide fresh whole food nutrition when the fields are too cold for fresh greens production. Microgreens make farming doable in any home or classroom all year round, since no green space is required. Many micro-green farms are constructed with grow lights in home basements. This lesson demonstrates edible winter plant production that can be done indoors. Gardening microgreens this way can be quite easy and successful for the beginner gardener, with minimum inputs and overhead, and serves as a great introduction to seeds in general. You can grow microgreens starting in November and/or December when fresh greens from the garden are finishing. Microgreens can be grown without soil but need a moisture holding medium. What medium is most sustainable in your area? Some of the common options include: recycled paper products, coconut coir, peat moss or sterilized soil. Sterilized soil can be made by heating soil to kill any microbial pathogens. This can be important in indoor gardening because of the dense growing conditions that make it easy for spreading pest problems.

Procedure:

1. **Discuss:** Discuss/review the Persephone period. Introduce winter gardening, both indoor and outdoor, as an option for continuing food production during the Persephone Period locally. Introduce the concept of holding vegetables in the field and also growing microgreens indoors as winter gardening options
2. **Watch:** Germination of a Seed (Time Lapse) (1 ½ mins) (https://www.youtube.com/watch?v=oDBX2gCXxYw)
3. **Activity: Growing Microgreens** (1 hour)

   This is a great activity to introduce students to indoor gardening and seed starting in general. You'll also be able to enjoy fresh microgreens in just 2 weeks.

   Supplies
   - Farm journals and writing utensils
   - Microgreens seeds -A brassicas mix is great for beginners (there are many micro seed varieties
   - Three (or more) seed starting containers or trays (must be the same size if you want to stack them)
   - Growing medium moistened (a hand squeeze should easily produce multiple drips of water)

- Spray bottle for misting
- Grow light or natural sun light by south window
- Growing medium for seed starting
- Lights (minimum room temps should be 55 degrees F (windowsill, grow light))

Directions

1. Moisten your growing medium by adding water and stirring until absorbed. I use a five gallon bucket or a dish bussing tub. Your growing medium can be a fine peat moss, purchased seed starter soil(no fertility needed), sterilized topsoil or any clean and absorbent material. Remember the energy in a seed has everything it needs to ***germinate*** and grow for 2 weeks.
2. Fill 2 or more containers such as seed starting flats, with an inch of growing medium;.
3. Sprinkle seeds evenly over the soil. You can incorporate math concepts if desired including averaging; calculating seed density; germination hypothesis (using germination % listed on package). Look at seed density directions for seed variety. It is usually stated by square inch and may require the counting of the seed and measuring a square inch to experience the suggested seed density for planting first. Have students use the visual to guide the broadcasting of these seeds to cover the planting area. You can use salt and pepper shakers to help broadcast small seeds more evenly.
    a. Optional-Cover the seeds with a super thin, 1/8 inch, moist layer of medium. Not much is needed. This helps keep the seeds from sticking to the tops of stacked seed starting containers; and helps keep the seed evenly moist resulting in better germination.
4. Spray the seeds with a water mister.
5. Stack up to 4 seed starting trays. Place an empty tray on top of each stack and add weights to hold trays down for moisture retention. You can use a couple of heavy rocks on each stack. Seeds do not need light to germinate, they only need warmth and moisture.
6. Keep trays in the suggested temperature range. This should be listed on the seed packages. 55 -65 degrees F is a good temperature range for brassicas, roots, and lettuce microgreens. Specific varieties may have suggested ideal temperatures.
7. Check the seeds once a day and mist with water if medium is not damp to touch. Once the seeds begin to sprout (“germinate”), 3 -5 days, remove trays from the stack. The sprouts should be white from lack of sun/light. Place trays in a single layer by a light source. As photosynthesis begins the greening takes place. Water each day to keep growing medium moist, not flooded. This will take more water as the greens get bigger.
8. At approximately two weeks the greens will be tall enough to be cut with scissors, rinsed, and eaten. Be sure to have students make journal entries to record stages of growth: germination, ***cotyledon*** and first true leaves. These are a power packed supply of nutrition!

4. **Evaluation**:
    a. Explain seed germination?
    b. What challenges do midwest farmers and fresh produce consumers face: give 3 examples?

c. What are microgreens and why are they popular?

Modification: Students unable to journal can demonstrate what they've learned orally, pictorially, or another medium of their choosing.

Zoology: Livestock for Meat Production

Goal(s): Students will discuss and discern ethical questions in livestock farming with regards to quality of life, nutrition and sustainability and learn the terms and concepts of slaughtering and butchering.

Learning objectives:

1. Students can explain why livestock can be a valuable part of sustainable living and farming giving at least two examples.
2. Students can describe meat as a farm product that is the result of livestock raising and animal butchering.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *5. Earth and Human Activity: Human Impacts on Earth Systems* (5-ESS3-1) Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- *MS. Earth and Human Activity: Human Impacts on Earth Systems* (MS-ESS3-3) Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- *MS. Earth and Human Activity: Human Impacts on Earth Systems* (MS-ESS3-4) Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- *HS. Earth and Human Activity: Human Impacts on Earth Systems* (HS-ESS3-3) Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
- *HS. Earth and Human Activity: Human Impacts on Earth Systems* (HS-ESS3-4) Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Time: 60 mins

Lesson supplies:

- Farm journal and writing utensils
- Crayons/colored pencils
- Research materials

Background review for the instructor:

- Meat Consumption in the U.S is Increasing at an Alarming Rate (https://sentientmedia.org/meat-consumption-in-the-us/)

- SUSTAINABLE BEEF PRODUCTION | Wsu (9 pages) (https://s3.wp.wsu.edu/uploads/sites/2073/2014/09/Sustainable-Beef-Production.pdf)
- Just how many animals do Americans eat? And how many would you save by going meatless one day a week? - EnvironMath! (2019 - (http://environmath.org/2020/09/08/just-how-many-animals-do-americans-eat-and-how-many-would-you-save-by-going-meatless-one-day-a-week)

Vocabulary:

CAFOs: Stands for confined animal feeding operation and is characterized by large numbers of animals that are kept indoors in an overcrowded space.
Free-range: Animals kept in natural conditions where they have freedom to move about. You see this term on some egg cartons.
Pasture-raised: Animals that receive a good portion of their nutrients from pasture (vs grains).
Grass-finished (vs grass fed): Animals that receive 100% of their nutrients from grasses.
Farmed fish: Fish raised commercially in tanks or enclosures.
Butcher: The processing of cutting slaughtered livestock into usable (meat) cuts.
Slaughter: The process of killing livestock in meat production.
Omnivore: A person or animal that eats both meat and plants.
Small livestock: Small animals farmed for meat or products that can be raised on relatively small property; pigs, goats, poultry, rabbits and lambs are examples.

Overview:

This month we look at the ethics and realities of meat production and livestock farming. Meat is a common part of the western diet. It has been part of our history since the beginning of human evolution. Survival in harsh winters at one time depended on eating meat which now, for many, is not the case today. Consider creating a timeline of the midwest diet with references to meat consumption and livestock farming practices (including routine use of antibiotics, feed changes, chemical use and the introduction of CAFOs). Some say the American diet today relies too heavily on meat which is lacking in nutrition, causing unnecessary greenhouse gas emissions (methane) and human disease. I agree with these conclusions when referring to meat raised in overcrowded indoor production facilities especially in the case of ***Confined Animal Feed Operations (CAFO***'s) but believe that livestock, when raised in a natural environment and given adequate space, fresh air and pasture can provide high nutrition and are invaluable for the natural soil fertility cycle so important in regenerative farming operations. Joel Salatin, author of *Holy Cows and Hog Heaven*, writes that, "a chicken tastes like a chicken when it is allowed to live like a chicken". So much of our meat has been devalued by the way it is grown. I say yes, let's eat less meat and make sure the meat we eat is raised ethically which will also translate to sustainably.

If you want to know what ethical livestock operations look like, do some farm visits in person or virtually. Make some observations taking the position of the animals you are observing with regards to health and quality of life. I like to think of the animals natural habitat and compare accordingly. Some of the questions I ask include: Is the animal allowed to graze freely in fresh air with unlimited exposure to grass and fresh water **(*free range*, *pasture raised* and *grass finished***); is there plenty of room allowed for the number of grazing animals; is there animal shelter, natural or constructed, from severe weather. Apply these same concepts to ***farmed fish***. Animals that are content are usually friendly too.
Meat farmers should be grass farmers. Grass is nutrition! Consumers are eating this nutrition through the meat of the pastured livestock. When you are looking for quality meat products

remember that late fall is a common time to ***butcher*** animals for meat on small farms. I have had success in raising pigs, poultry and rabbits as meat animals since they mature in short periods of time. Late November butchering is efficient and sustainable because it allows our animals to remain on their natural diet of grass and bug life for the majority of their life cycle, eliminating costly and highly processed food supplements. There is also less money spent on purchase and transport of winter feed; and less work keeping water from freezing. These farming methods have given greater efficiency in our production including lowering our carbon footprint.

If you will be starting any livestock, schedule your butchering dates shortly after purchase. This is more important if you don't ***slaughter*** and butcher yourself. In the midwest, November is the time when many small butchering operations are filled with orders from other small farmers and deer hunters, who book their appointments during deer season, October 15 - December 15. It is important to make sure you understand the legal guidelines for your area before you sell any processed meats. I prefer to sell animals live and have the purchaser take it from there. If I am growing for myself I can legally slaughter and butcher myself. Some say it is more humane, less frightening to the animal and better for the meat quality if slaughtered at home. There is rich culture around slaughtering meats for celebrations or rituals in the Muslim and Jewish communities historically that continue to this day. I find it interesting and refreshing to know the appreciation and thanksgiving that is part of those practices.

If you live in the Midwest you may notice an abundance of rabbits around the natural landscape. Rabbit meat consumption has a low impact on the earth and is rich in nutrition as well as providing good fertility for gardening. If you decide to keep rabbits, they can live essentially wild by fencing in a large rabbit yard. You will have minimal management if the pasture can provide the rabbits food needs naturally and you keep the right number of animals for the space available. Be sure to add an owl decoy to help keep predators at bay. Your biggest work will be harvesting the rabbits for processing. Rabbit may be the meat of the future!

To introduce the ethical issues around meat production I remind students that animals are living creatures- if you try to think like an animal you will know what a good vs a bad environment is. Start this interactive conversation by reviewing their animal research from last month focusing on livestock needs and what meeting those needs will look like on the farm. This month students can complete their animal livestock research projects by adding an anatomy poster that includes familiar meat cuts, for each livestock animal. You can easily find these on the internet or in encyclopedias.

Butchering can be a sensitive subject for students, even if it is the reality of eating meat. I find children to be accepting when presented with the facts. I am respectful of both meat eaters and non-meat eaters in these lessons, both should understand the ethics and practices involved in raising livestock. In the coming livestock/meat lessons we will focus on giving animals a high quality of life and the practice of respectful husbandry, butchering and consumption.

Procedure:

1. **Discuss:** How many of you are ***omnivores***? Meat consumption is a common part of the western diet. Meat production on the farm is called raising livestock. Ask students to make a list of livestock (guessing) from most consumed to least in the USA in their journals (see background review for answers).
    a. After a few minutes write the correct order on the board for them to compare and discuss. I added weights at the time of butchering if you want to do some math together and determine how much meat an average American eats daily or weekly. I think it's worth noting here that we can no longer sustain meat

consumption in the US without livestock production. Use discussion points from above and last month's animal research to discuss: For older students; which came first, the CAFO farming or excessive meat consumption? What do you know about raising meat? Why is late fall a common time for ***small livestock*** processing?

b. Introduce terms slaughter and butcher. Humane slaughter happens quickly and is thought to be painless.

2. **Watch**: This video is about butchering a ½ steer (there is no slaughter footage included) How To Butcher An Entire Cow: Every Cut Of Meat Explained | Bon Appetit (18 mins) (https://www.youtube.com/watch?v=WrOzwoMKzH4&t=272s). Can be watched at double time or stopped to use the Steer Anatomy pictured as a poster demonstration.
3. **Create:** Butcher Anatomy Posters by tracing or freehand. Have books and/or computer resources for livestock anatomy/meat cuts available. These posters can be shared with the class now or used later to present as part of the completed animal research project students started last month. Have students note any interesting uses for livestock parts.
4. **Optional:** This website also shows the amount of meat saved, by number of animals, when an individual has one meatless day per week. I think this can be a great part of the conversation as well. Can we eat meat and still be responsible earth stewards? What kind of compromises could be environmentally friendlier?

- Just how many animals do Americans eat? And how many would you save by going meatless one day a week? - EnvironMath! (2019 - (http://environmath.org/2020/09/08/just-how-many-animals-do-americans-eat-and-how-many-would-you-save-by-going-meatless-one-day-a-week)

5. **Evaluation:**
    a. What is a CAFO; what does the acronym stand for?
    b. Compare and contrast animals who are raised under best and worst conditions.
    c. What are some advantages and disadvantages of livestock farming?

    Modification: Students unable to journal can demonstrate what they've learned orally, pictorially, or another medium of their choosing.

Microbiology: Soil Structure

Goal(s): Students will look more closely at the topsoil horizons; horizons O- organic and A- topsoil, to better understand building soil fertility and soil structure.

Learning objectives:

1. Students can define the function of topsoil.
2. Students can define soil texture particles including sand, silt and clay and the affects each has on water drainage.

Next Generation Science Standards connections (grades 3-12):

- 4. *Earth's Systems* (4-ESS2-1) Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
- *5. Ecosystems: Interactions, Energy, and Dynamics* (5-LS2-1) Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-5) Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- *HS. Earth's Systems* (HS-ESS2-6) Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

Time: 90 min

Lesson supplies:

- Quart jar/jar with a large mouth [one for each group]
- White out or marking pen.
- Soil (it's good to have soil from different places to compare later)
- Pen/pencils
- Journal or paper

Vocabulary:

Topsoil horizons: Parallel layers of soil, each defined by unique features, color and permeability. There are four layers of soil horizons (organic, topsoil, (eluviated), and subsoil) but usually three are present. Studied together, they form a soil profile.
Soil texture: Refers to the combination of particle sizes in soil (sand, silt and clay). Soil structure types are based on % combinations of these three: Particles of sand range in size from 2 to 0.05 mm in diameter; those of silt from 0.05 to 0.002 mm and those of clay smaller than 0.002 mm. These particles can be made up of various rocks and minerals.
Soil structure: Refers to how particles of soil fit together.
Humus: Decomposed organic matter, rich in fertility.
Erosion: To wear away surface soils (minerals and or organic matter) mostly when unprotected from wind, water, tillage or overgrazing.
No-till farming: A farming practice that doesn't disturb the soil surface. No-till is known for minimizing soil erosion and maximizing carbon sequestering/sinking.
Sedimentation: When particles settle out of a liquid.

Overview:

Today's lesson reviews **topsoil horizons,** and introduces assessing **soil texture** and building soil fertility. Soil occurs in layers known as horizons. The horizons and components in each horizon make up the **soil's structure.**
Each horizon has certain characteristics common to most soils:

1. Horizon O: organic matter layer **(humus)**
2. Horizon A: topsoil; the interface (place where they come together) between the O, and the B horizon(minerals)
3. Horizon B: rock and minerals
   https://www.soils4teachers.org/soil-horizons

Top soil is where roots will live and grow, supporting and feeding our plants. Topsoil is where we find living organisms, from the smallest microorganisms to larger insects, worms, and other invertebrates. This community of life, fed and nourished by carbon in the organic matter, digests and makes minerals available to plants through their roots.
Unfortunately, the earth is losing topsoil at an alarming rate due to soil exposure to wind and rain. Tillage in agriculture is the largest cause of soil **erosion** in the Midwest and globally. Overgrazing of pastures and deforestation, the cutting down of trees, are the other major causes. Without healthy topsoil we can not ensure our own health. It takes as much as one hundred years for nature to build one inch of topsoil unassisted. We can help by accelerating this natural process: we can mimic the work of the forest and build organic matter on the ground by using

regenerative farming practices, including **no-till farming** methods. These methods focus on building health by building healthy topsoil. Healthy soil holds nutrients for the soil food web (see October week 1), supports the nitrogen and carbon cycles that clean our air, and holds moisture to support plant and animal life.

Before I start a new garden, I like to get an idea of what kind of water holding my top soil will offer. Water holding capacity is largely dependent on soil texture and nutrients can be either plentiful (dense) or scarce. Do some simple tests, offered in this lesson, to determine your soil texture. This will give you some idea of how water will move through your soil and its nutrient density. To do this, we study the amounts of sand, silt and clay in the A horizon. The size of soil particles and the amounts of sand, silt and clay give some ideas of our mineral nutrient level and how our soil will interact with water. Regardless of soil texture and structure imbalances that we might find using these tests, the solution is the same- adding COMPOST (see October week 3 year 3 and/or December week 3 year 3). Too much sand, doesn't hold water? Compost. Too much clay, can't move water? Aerate and compost. You will find there is an underlying message in regenerative farming; yes, that's it- building soil and composting whenever possible!

Procedure:

1. **Discuss:** How can we help build fertile soil naturally; what are some practices you have learned that we can use? (Composting, protecting soil from erosion, mulching, eliminating chemical use, don't compact). Discuss living soil and how we can support microbial life in the soil (the soil food web).
2. **View:** To prepare for the activity, first review How to Determine Soil Type Using Jar Test Method (5 mins) (https://www.youtube.com/watch?v=E-QWHLt9qJ0)
3. **Activity: Soil Texture Analysis** (40 mins)
   (from Ted Sammis at New Mexico State University)

   Supplies
   - Quart jar/jar with a large mouth [one for each group]
   - White out or marking pen.
   - Soil (it's good to have soil from different places to compare later)
   - Pen/pencils
   - Journal or paper

   Directions
   1. Use a quart jar with a tight fitting lid for this experiment..
   2. Fill the jar half full of soil removed from the topsoil layer (3-6"deep). Have each group work in a different area of the school property so you will have some comparisons when you get the finished product. (You may also want to have some samples in the classroom that you gathered elsewhere for some comparison and conversation; the beach, cropland, your backyard etc. Those could be prepared a few days ahead to examine and discuss while waiting on their soil test results).
   3. Remove any rocks and break up any soil clumps from your sample before you begin
   4. Fill jar ½ full with the soil sample
   5. Add a tablespoon of dish soap to the solution to encourage quicker settling
   6. Add water to within an inch of the top of the jar. Shake to thoroughly mix the soil and water.
   7. Put the jar on a table and let the soil settle for at least a day. When you can see the three layers you can determine your soil texture.

8. The sand will settle first on the bottom. Mark the top of the sand.
9. The difference between the bottom mark, which is the sand, and the top of the second layer is the silt portion of the soil. Make a second mark to distinguish the silt layer. The total sand plus silt is the distance from the bottom of the jar to the second mark.
10. After a few days the clay should be settled and you can calculate the percentage of sand, silt and clay to determine your soil type. Use your ruler to find the percentage of the total soil each particle size measures.The percent of each is the depth of each divided by the depth of the total.
11. The depth of the sand measurement is divided by the total soil depth.
12. The percent of silt is the depth of the silt divided by the depth of the total soil.
13. The percent of clay is the depth of the clay divided by the depth of the total soil.
14. After determining the percentage for each, compare results with the simple chart below to find your soil texture type. You can be more exact by using a soil triangle or the online calculator at Soil Texture Calculator | Natural Resources Conservation Service. (https://www.nrcs.usda.gov/resources/education-and-teaching-materials/soil-texture-calculator)

Soil Classification Table

Soil Classification	***Clay Soil***	***Loam Soil***	***Sandy Soil***
Percent clay	40-100%	7-27%	1-10%
Percent silt	0-40%	28-50%	1-15%
Percent sand	0-45%	23-52%	85-100%

4. **Evaluation:**
    a. Name the three components of soil texture and give at least one characteristic for each.
    b. Draw and label the soil texture test you conducted - What was the result and why?

Modification: Students unable to journal can demonstrate what they've learned orally, pictorially, or another medium of their choosing.

Week 4: On the Farm

Farmer Spotlight- Sunchoke Farms

Overwintering

Goal(s): To introduce students to late season farming as a technique in creating more sustainable farming systems in the Midwest region.

Learning objectives:

1. Students can explain with examples how winter farming is a sustainability practice.

2. Students can define and contrast overwintering practices to winter farming giving two examples of each.

Next Generation Science Standards connections (grades 3-12):

- *5. Earth's Systems* (5-ESS2-1) Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- *5. Ecosystems: Interactions, Energy, and Dynamics* (5-LS2-1) Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-3) Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-5) Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- *HS. Ecosystems: Interactions, Energy, and Dynamics* (HS-LS2-5) Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
- *HS. Ecosystems: Interactions, Energy, and Dynamics* (HS-LS2-3) Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
- *HS. Earth's Systems* (HS-ESS2-6) Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

Time: 45 min

Lesson supplies:

- Seeds (carrots, beets, onions, parsnips, garlic)
- Prepared garden area (raised beds work well)

Background review for the instructor:

- A comparison of winter vs. overwintered hoop house production - MSU Extension (https://www.canr.msu.edu/news/a_comparison_of_winter_vs._overwintered_hoop_house_production)

Vocabulary:

Overwintering crops: Crops that are planted in the fall for harvest in early spring. Most often overwintering is done in combination with season extension practices.
Winter farming: Crops should be timed to be 75% mature by the beginning of the Persephone period (10 hour day) to be held, with season extension, like a refrigerator for winter harvest and use.

Overview:

In addition to wrapping up the current growing season (winterizing, harvesting and preserving), November can include preparations and plantings for our next growing season. ***Overwintering*** practices include preparing garden beds for early spring transplanting and planting seeds of cold hardy vegetable varieties that will tolerate a bit of freezing and thawing, popping up in the early spring and growing strong for a March harvest. Plant into prepared garden beds and/or randomly broadcast seed onto bare soil in perennial garden areas. These practices begin in late October and last until the freezing weather sets in. In covered areas, such as a hoop house or cold frame, the timing of plantings can be different. Using correct timing and vegetable varieties allows for the earliest spring harvests. Overwintering is limited to hardy cold crops that include spinach, beets, carrots, parsnips, onions, kale, and garlic. Seed at 1.5 times the usual rate to allow for some loss and lightly cover seeds for wind protection if possible. *Theri's*

Tip: Make sure to check on your sauerkraut recipe from Week 2, it should be finished around this time!

Procedure:

1. **Discuss:** Review ***winter farming*** and introduce overwintering as a farming practice that allows for more year round production of fresh nutrition. How are they the same and how are they different? Use a planting chart for your area to determine what you can still safely plant for overwintering. Reference the working calendar that is included for each chapter to find the winter and overwintering planting dates.
2. **Activity:** Seed spinach, beets, onions or parsnips in a prepared garden. Lightly cover this planting with a ground cover to eliminate soil erosion. This could be light mulch or a garden cloth. If you have raised beds this is a nicely protected area to use for overwintering.
3. **Evaluation:**
    a. Describe the differences between winter farming and overwintering; give at least three examples.

    Modification: Students unable to journal can demonstrate what they've learned orally, pictorially, or another medium of their choosing.

Additional November Resources

Compiled by Sean Connolly

Grades 3-5

- **Website-** Lessons and Activities | Soils 4 Teachers (http://www.soils4teachers.org/lessons-and-activities#Chem5)
    - For soil chemistry projects, conservation, and plant life lessons.
- **Article-** Food processing Facts for kids (https://kids.kiddle.co/Food_processing)
    - Short article that gives an overview of food processing, explaining the benefits and drawbacks.

- **Short Video-** Soil Basics: Soil Profiles (5&½ mins) (https://www.youtube.com/watch?v=xoTd7ctj-e0)
- **Short Video-** Mayo Clinic Minute: What are ultraprocessed foods? (1 min) (https://www.youtube.com/watch?v=7HeS6kG7NLQ)

Grades 6-8

- **Book-** *Braiding sweetgrass for young adults: indigenous wisdom, scientific knowledge, and the teachings of plants.* (2022). Robin Wall Kimmer. Zest Books, an imprint of Lerner Publishing Group, Inc..
- **Article-** Overwintering Vegetable Crops Planting Chart | Johnny's Selected Seeds (https://www.johnnyseeds.com/growers-library/methods-tools-supplies/winter-growing-season-extension/overwintering-planting-chart.html)
    - Guide to planting winter gardens.
- **Article-** The persephone Period and winter gardening explained- https://www.wenatcheeworld.com/community/understanding-the-persephone-period-to-master-the-winter-garden/article_309eb

Grades 9-12

- **Book-** *Four Season Harvest*, Elliot Coleman (https://www.fourseasonfarm.com/copy-of-find-our-produce)
    - Resource for winter and overwinter gardening from Chelsea Green Publishing Company.
- **Article-** Processed foods: What you should know - Mayo Clinic Health System (https://www.mayoclinichealthsystem.org/hometown-health/speaking-of-health/processed-foods-what-you-should-know)
    - This article connects unprocessed food to obesity.

DECEMBER

Focus: Upcycling & Recycling

Key Concepts: *Sustainable Systems*

Think Ahead

- Consider purchasing multiple copies of the book *Zero Waste* by Bea Johnson, a great addition to your classroom library and relevant to December's themes.
- Consider purchasing the book *Worms Eat My Garbage* by Mary Applehof to be used in our Week 3 microbiology lesson.
- If you want to include spinach in your winter farming and haven't yet planted it, plant it this month for harvest in March.

December Lesson Outline

- *Week 1 Sustainability Topic*
    - Upcycling & Recycling
- *Week 2 Theri's Fall Kitchen*
    - December Kitchen Project: Horseradish
    - December Kitchen Project: Rosehip Tea
- *Week 3 Science Enrichment*
    - Botany: Plant Anatomy
    - Zoology: Farming Livestock
    - Microbiology: Vermiculture 101
- *Week 4 On the Farm*
    - Straw vs. Hay

Introduction

Conservation is foundational to any sustainability curriculum. This month's conservation focus is on waste and our ability to convert waste into valued products. Waste is created as a byproduct of biological activity, mainly human activity. Our ability to recycle waste can prevent or lessen the overuse, or misuse, of energy, matter, and time.

The Laws of Physics tell us that energy and matter are never lost, but they can change, naturally or with human help. This concept is alive and thriving on the farm. Review previous lessons and

farm practices that demonstrate natural recycling (or *cyclical systems of sustainability)* of matter and energy. Include photosynthesis and composting as interconnected examples and review them by presenting each stage using the universal recycle symbol as the cyclical visual:

1) Photosynthesis; the energy of sunlight, captured in the chlorophyll of plant leaves, produces chemical energy in the form of sugars (carbohydrates) by drawing in Carbon Dioxide (and nitrogen in the case of legumes) from the atmosphere. These sugars feed the plants and microbes that live on and around the plant root system energizing new plant growth and the production of fruits and vegetables and then seed to drop and start the life cycle again.

2) Composting: Food waste breaks down to create rich humus, added to the soil to energize the soil and new plant growth provides more food and waste.

After sharing these examples students can add other cyclical systems that come to mind on the farm (i.e. animal life cycles, deciduous tree life cycles, forest succession…).

Mass and energy are working together in these physical and chemical reactions. This is nature at work in the constant cycle of life and death; upcycling and recycling. Knowing how these natural systems work allows us to accelerate nature in positive ways. These are foundational principles of regenerative farming.

Linear systems of production, on the other hand, are those in which the waste byproduct does not naturally recycle and will ultimately end up in a landfill. Upcycling and recycling can extend the linear lifespan but will require some kind of energy to do so. If your waste doesn't rot or mix with nature's energy systems to create a new product how will it be managed? - We know that mass does not go away; sometimes it can be changed into new productive products but even these will ultimately end in a landfill. Packaging is an easy example of byproduct waste. Many things we purchase, especially online, have layers of packing.

What kinds of waste are you creating? Conducting a simple waste audit in your home, classroom or business can give you an idea of the regular waste that you generate. This audit can be done by going through your trash several times over a few week time period. List what items are naturally recyclable (compostable carbon and nitrogens); What items can be sent to a recycling center; What are you left with and how can we reduce or reuse these items?

Muda is a Japanese term for waste. I learned this term from Ben Hartman's book, *The Lean Farm* (2015). Ben applied "lean theory", a revolutionary organizational theory published in *The Machine that Changed the World* (1990), to his small farming operation. The lean theory was engineered and published by three men who studied inefficiency in manufacturing production. They based their book on their observations at the Toyota factory in Japan. Essentially they came up with ways to increase production/profit by removing waste. This theory has traveled the world and been applied to all kinds of business. The theme of "leaning" your operation includes greater efficiency through removal of muda. Muda can be wasted materials or wasted time. On the farm, muda can be the disorganized tool shed, the misplaced garden, the storage of unused bulk supplies, the money spent on unneeded tools and equipment, and the time spent in any of these activities that generate waste. The end of each year is a good time to look more closely at your production (and lifestyle) and assess where you can eliminate the muda. By doing this exercise yearly you will become more efficient and sustainable. Be brave and eliminate the muda!

Suggested December Field Trip

Visit an evergreen tree farm; one that includes different kinds of trees and allows for a winter walk while discussing the types of trees. I like to bring an Audubon book on conifers for looking at classification characteristics and introducing some new vocabulary around this family of trees. Start this discussion by asking your students, “what do you know about evergreen trees”? Share holiday traditions. In the past I have been able to collect wild rose hips on our winter walk. They make a delicious cup of tea or a beautiful pop of red for wreath decorating. Be sure to preview the tree farm you will visit to note any added opportunities to take advantage of; maybe obtaining any unsold trees or branches to use in composting, mulching, or animal feeding.
If cutting a tree to take back to school be sure to collect loose branches and pine cones for additional projects. Many of these tree farms will have extra tree trimmings you can get free and use for wreath making and bird house decorating. Consider putting a tree outside your home or classroom window to create a natural winter habitat for wild birds; sheltering them from the winter wind. I add homemade ornament feeders and, if I've planned ahead in the garden, dried out large gourds for houses. This tree provides an observation activity throughout the winter with lots of cross curriculum opportunities. It is important though that once you start feeding the birds you commit until the spring thaws come. The birds will come to depend on your tree stop for valued nutrition.

Week 1: Sustainability Topic

Upcycling & Recycling

Goal(s): To understand that capturing waste is a foundational principle of sustainability and conservation practices.

Learning objectives:

1. Students can define waste and give three examples.
2. Students can recite the five R’s for *zero waste* living.
3. Students can define the practices of upcycling & recycling, and give two examples of each.

Next Generation Science Standards connections (grades 3-12):

- *5. Earth and Human Activity: Human Impacts on Earth Systems* (5-ESS3-1) Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment.
- *MS. Earth and Human Activity: Human Impacts on Earth Systems* (MS-ESS3-3) Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- *MS. Earth and Human Activity: Human Impacts on Earth Systems* (MS-ESS3-4) Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-5) Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

- *HS. Earth and Human Activity* (HS-ESS3-2) Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources.
- *HS. Earth and Human Activity: Human Impacts on Earth Systems* (HS-ESS3-3) Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
- *HS. Earth and Human Activity: Human Impacts on Earth Systems* (HS-ESS3-4) Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Time: 45 min. +

Lesson supplies:

- See the project options for this week's activity.

Background review for the instructor:

- The book *Zero Waste* by Bea Johnson
- Recycling plastic is practically impossible — and the problem is getting worse (https://www.npr.org/2022/10/24/1131131088/recycling-plastic-is-practically-impossible-and-the-problem-is-getting-worse)
- From birth to ban: A history of the plastic shopping bag (https://www.unep.org/news-and-stories/story/birth-ban-history-plastic-shopping-bag)

Vocabulary:

Waste: As a noun, another word for garbage. As an adjective; careless use or overuse of a resource, time, energy, or product.
Recycling: To reuse a product, often by returning it to its original state (by a manufacturer) and reshaping it (melting glass to make a new glass product).
Conserve (conservation practices): Actions taken to limit use of natural resources and prevent waste.
Upcycling: To repurpose; to reuse a product by enhancing the product to add value and new or better function, usually done by the consumers (long pants that are too short are cut off to become shorts).

Overview:

What is ***waste*****?** I like to start this discussion with the Bea Johnson story, author of *Zero Waste.* Hers is a story that might seem extreme but offers a host of ways we can be inspired to remove muda from our lives and some easy rules to guide us in doing so. I suggest getting a couple copies of her book, *Zero Waste*, for your library. It is packed with a host of natural and environmentally friendly gift giving, and living, ideas. I always remind my students that sustainable change comes over time. Rarely does changing your whole waste culture happen successfully overnight. Our goal is long term, sustainable transition. Like a New Year's resolution, we can make small changes, one at a time. When one change becomes natural to us, we can add another change. Consider making a commitment to eliminate some kind of waste in your shared environment; something you can brainstorm as a class or family. Share your trials and successes, creating a support system amongst yourselves.

Introduce this week's vocabulary by asking students to define these in their own words and give an example. I am always surprised by their range of knowledge and ideas. I try to use and review our sustainability language when introducing any new vocabulary or concepts to emphasize interconnectedness throughout the curriculum. How do these familiar terms relate to waste and ***recycling***? Carbon footprint, local and fresh, natural resources, cyclical vs linear systems.

When introducing recycling (look at the cyclical symbol), take some time to discuss what is and isn't recycled. There are numerous websites that address the "Top 10 -20 Things You Can't Recycle". Some may surprise you. Bottle tops are one thing most people don't realize are not typically recyclable, yet there are so many DIY (do it yourself) projects to do with them. I have seen a program for schools and neighborhoods where you can turn in bottle tops, lots of them, to have an outdoor bench made that is virtually indestructible. These programs come and go but are worth checking out for a community project. Culminate this discussion by looking at gift giving with sustainability in mind. Explore the questions, how/what do we ***conserve*** when we decrease waste? What are the most wasteful practices in gift giving? Where does the waste go? Have you ever been to a landfill? And finally, how can we improve our practices around gift giving?

There are so many ways to bring excitement to a gift giving project. For Jr High students I find hosting a microeconomy fair, making and selling, offers a range of cross curriculum experiences. Service projects around ***upcycled*** production are also rewarding. Note that a microeconomy project will require multiple work sessions and more pre-thinking to collect supplies. I have a recycle center set up year round to collect the things I reuse throughout the year including; clamshell produce containers in four sizes, cardboard egg cartons, plastic grocery bags, wax candle ends, wool sweaters, jars rated for preserving, large cardboard (for sheet mulching) and newspaper (no shiny inserts). Do not cause more muda by collecting things you do not reuse, and always have items cleaned before they are donated. This is an area to re-evaluate each year.

Procedure:

1. **Discuss:** What is waste? Introduce Bea Johnson and watch Zero Waste with Bea Johnson (9 mins) (https://www.youtube.com/watch?v=6N-rPTJVk80)
2. **Discuss:** The 5 R's of zero waste lifestyle choices; have students give examples for each: Refuse what you don't need; Reduce what you need; Reuse, replace single use products with reusable (glass preferred), Recycle & Rot: what can not be refused, reduced or reusable should be recyclable or compostable. How can we apply "no waste" to our own lives? In gift giving? Explore upcycling as an option. Try doing an upcycle project together. Use one of these activities or an idea of your own.
3. **Proceed to:** Choose an upcycling activity from the options listed. Directions are included for each after the evaluation below..
    a. *Activity: Plastic Bottle Bird Feeder*
    b. *Activity: Recycled Plastic Bag Projects*
    c. *Activity: Recycle Bird Seed or Feed Sacks*
    d. *Activity: Birthday candles*
    e. *Activity: Wool mittens*
4. **Evaluation:**
    a. What is waste and where does it go?
    b. What are the five R's Bea Johnson lives by when making a purchase?
    c. How can you contribute/support eliminating wasteful manufacturing?

    Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Activity: Plastic Bottle Bird Feeder (25 mins):

Supplies

- Plastic bottles
- Twine/wire
- 1 set of chopsticks or sturdy twigs for perching
- Scissors, small, pointed work best
- Thumbtack

Directions

1. **Follow directions in:** Plastic Bottle Bird Feeder (4 mins) (https://www.youtube.com/watch?v=XqNgXBDi9Mw)

Activity: Recycled Plastic Bag Projects (40+ mins)

Supplies

- Duct tape
- Plastic grocery bags
- Scissors
- Large crochet hook

Directions

1. **Discuss:** Remember the best thing for our environment is to eliminate plastic bag use altogether (refuse!), but let's be creative about upcycling the ones that are currently in circulation. It takes 1000 years for a plastic grocery bag to naturally decompose. Imagine all the landfill space we can free up by discontinuing the use of these bags. How did this problem arise?
2. **Project options:**
    a. Bracelets: DIY Plastic Bags into Friendship Bracelets!! (7 mins) (https://www.youtube.com/watch?v=QKahKvABkc8)
    b. Jump ropes: How to Make Your Own Plastic Jump Rope (Out of Plastic Bags) (2 mins)
        - Jump ropes make great exercise tools for indoor play during the winter months and holiday gift giving too. *I have found the key to braiding crafts is to keep everything as tight as possible and make sure they are age appropriate. I find these work nicely for 6th grade and up. (https://www.youtube.com/watch?v=h0ExVd9WlMY)
    c. Sleeping mats: How To Make Plastic Bag Sleeping Mats (Where You Live) (3 mins)
        - A more advanced project that would be a great service project. (https://www.youtube.com/watch?v=5JNe-hce0sY)

Activity: Recycled Bird Seed or Feed Sacks (1 hour)

Supplies

For garden or art apron

- Empty feed bags, washed and dried
- Two 30″ pieces wide ribbon for the waist ties
- Coordinating spool of thread and bobbin
- Sewing machine fitted with a 90/14 medium-weight needle
- Tape measure
- Pinking shears

- Sewing scissors
- Straight Pins

For tote/grocery bag

- Empty and cleaned bird seed or feed bag
- Sewing materials as listed above

Directions

- **Choose between:**
    - **Garden/art apron:** Upcycle your empty feed bags: garden/chore apron tutorial | The Scoop from the Coop (https://www.scoopfromthecoop.com/upcycle-your-empty-feed-bags-gardenchore-apron-tutorial/)
    - **Tote bag:** Feed Bag Tote Bag : 3 Steps - Instructables (https://www.instructables.com/Feed-Bag-Tote-Bag/)

Activity: Birthday Candles (after prep, 30 minutes to complete one set)

Supplies

- Candle wax collected for recycling (collected from candle ends)
- Wicks cut into 10-12" lengths (each makes 2 candles)
- Hot plate (Double boiler system(I use old pans))
- 4 Heat resistant jars for melting the wax in (1&½ pint canning jars work well)
- Small stock pot wide enough to hold 4 jars
- Dowel rod for hanging candles to dry
- Crayon ends for coloring wax - choose 4 colors
- One pitcher of very cold water for each workstation

Directions

1. Cover the entire workstation with a protective covering before starting. Use newspaper, cardboard or old drip cloths Set everything up on a table approximately 3" X 6" for ease of work. Place the single or double burner hot plate in the center of the covered table and plug in making sure the cord is not a tripping hazard.
2. On each hot plate burner place a stock pot(s)with approximately four inches of water. Turn burners on high until water boils then turn burners to simmer.
3. Fill your 4 jars with candle wax and melt. Keep adding solid wax until jars are full of melted wax, keeping like colors together in 3 of the jars. In the fourth jar, keep the wax clear or light color, if possible. The jar will be used to refill the other 3 jars as wax is depleted while making candles. Continue to melt wax in the fourth jar and use it for refilling the other three jars as needed for dipping height. Add crayon pieces to the three colors as needed to keep color robust.
4. Prepared wicks can be folded in half for dipping two candles at a time. The first two dips will concentrate on straightening the wick for candle making. Straighten the wick after dipping, totally submersed to the count of 2 seconds, by opening the wick to full length and using your hands to roll the cooling waxed wick on a flat clean surface, allowing the wick to cool and harden completely before refolding and redipping. I like to prepare all the wicks in this way before moving to the next steps of building up the wax - Fold, hand dip(holding the mid fold and dipping ½" from the top of the folded wick, open, roll, repeat; then dry on a dowel rack. When this step is completed for as many as 1 dozen wicks per person, continue to the next step.

5. Situate the pitcher of cold water(as cold as possible with no ice) next to the heating wax. For the next 5 wax dips, the candles will be built up to their finished size. Dip one set at a time and count: one one thousand, two one thousand; lift and dip into the cold water; count one one thousand , two one thousand, and hang on the dowel rack to cool until all 12 sets have been dipped. Repeat this process 5 times.. If the candles are not straight, roll them on a flat clean surface again while they are still warm and let cool completely before dipping again. If you start to get lumps on the candles, your wax is getting too cool, increase the heat a notch or two on your hot plate. When dipping you do not want to hit the bottom of the hot wax jar. You can minimize this by using a taller jar than the length of your wick set and keeping the wax filled.
6. When all candle sets are done and cooled, I cut them apart and trim bottoms for consistent size.
7. Theri's Tip: I use jute (a natural and compostable fiber) to tie together bundles of 12 -18 candles for each unit. Wrap the jute around each bundle twice and finish with a bow. We display these in a basket at our microeconomy upcycle fair. They are best sellers!

Activity: Wool Mittens (40+ mins)

Supplies

- 100% wool sweaters
- Strong scissors
- 100% wool yarn
- Large eyed needles

Directions

1. Follow: DIY: Make Mittens from Sweaters in Minutes (2 mins) (https://www.youtube.com/watch?v=OEhOP3fstC0)
2. Wool sweaters can be felted (agitated in a hot water wash cycle in a washing machine) to make the wool thicker and warmer. I like to make the mittens first, and then felt (agitate them in a hot water wash cycle). The mittens will shrink to a smaller size so always make a size or two bigger than you need. If the sweater is already felted, from prior washing, cut mittens true to size.
3. A couple tips I have learned when making these; 1) make cardboard patterns for the mitten shape for ease of tracing and consistent sizing; 2) Use 100 % wool yarn for sewing and decorating and then felt (again). This fuses the wool together.
4. There are many creative ways to finish these mittens. Mitten making is a great service project for area shelters. Wool is a farm product that has been used in winter wear for centuries. It is waste free as it is a natural fiber that can be rotted in your compost pile. No waste here!

Week 2: Theri's Fall Kitchen

December Kitchen Project: Horseradish

Goal(s): To learn about horseradish, its flavor, uses, and how to prepare.

Learning objectives:

1. Students can list two nutritional benefits of horseradish.
2. Students can describe the taste of horseradish root.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *5. From Molecules to Organisms: Structures and Processes* (5-LS1-1) Support an argument that plants get the materials they need for growth chiefly from air and water.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-2) Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-3) Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Time: 45 min

Lesson supplies:

- Bowl for mixing
- Whisk
- 2 tbsp horseradish
- 1 tbsp cider vinegar
- 1 tsp dry mustard
- 3 tbsp mayo
- ⅛ tsp ground red pepper
- ½ cup sour cream
- Crispy bacon for taste testing (use local)

Vocabulary:

***Horseradish*:** A perennial root vegetable from the brassicaceae family.

Overview:

A root vegetable from the brassica family, ***horseradish*** is a perennial plant (see August week 4). A root cutting, about four inches long with a diameter of ¾" is planted in the spring on a 30 degree angle, a couple inches below the ground surface to propagate. The root is planted in the spring of year 1 and left to grow for a couple years before the first harvest in late fall of year 2 or ideally 3. For a larger root, wait til year 3. Use multiple planting cycles for yearly harvesting. The mature plant reaches 4' X 4' each season. Horseradish flowers in the spring and has a baby powder aroma, much in contrast to the roots' strong spicy flavor. The root is harvested after freezing temperatures in the late fall, early winter or before the ground freezes. Once you start harvesting you can leave a piece of root cutting in the ground to begin the life cycle again in the spring. Horseradish is best planted on the edge of your garden for ease of digging the harvest and to minimally disturb any garden beds. Horseradish, as a border, serves as a natural pest

deterrent and fungicide. It can invade the garden so put an impermeable barrier between it and any other planting beds.

Horseradish is known for its ability to clear the sinuses. In ancient medicinal doctrines horseradish was prescribed for colds. Horseradish is still used as a natural fungicide in horseradish tea. It is known to lower blood pressure, promote heart health, help digestion and build strong bones. Unlike most crops, however, horseradish is high in sodium, so use sparingly for people who have trouble digesting salt.

Horseradish is commonly used as a spice or condiment. It can be mixed with other ingredients for specialty meat sauces. Tomato bases usually mean shrimp and creamy mixtures; mayo or sour cream bases for red meats. One of the most famous shrimp sauces, created by St. Elmo's restaurant, is known far and wide for its spicy bite and tear jerking response. Tasting this, available in grocery stores across the country, is a memorable experience. Use great caution if you are taste testing horseradish with students. Horseradish sauces are a holiday tradition and are easily preserved for gift giving.

Procedure:

1. **Discuss:** Lead this class in discussion by listing what they know about horseradish. If there is an outdoor green space currently growing this plant, take a walk so that students may be able to harvest for the following recipe. Have students wear kitchen gloves when working with horseradish and eye protection glasses. Horseradish is delicious but requires special care.
2. **Recipe: Horseradish**
   Recipe from Horseradish Sauce on AllRecipes.com
   Supplies
   - Bowl for mixing
   - Whisk
   - 2 tbsp horseradish
   - 1 tbsp cider vinegar
   - 1 tsp dry mustard
   - 3 tbsp mayo
   - ⅛ tsp ground red pepper
   - ½ cup sour cream
   - Crispy bacon for taste testing (use local)

   Directions
   1. In a small bowl, whisk together all the ingredients.
   2. Have students taste test by dipping a ½ slice of bacon (no double dipping).
3. **Evaluation:**
   a. What is horseradish?
   b. Describe the lifecycle of a horseradish plant.
   c. What nutritional benefits does horseradish provide?

   Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

December Kitchen Project: Rosehip Tea

Goal(s): To learn about rose hips, one of nature's gifts of beauty and nutrition, and learn how to use them.

Learning objectives:

1. Students can explain what a rose hip is.
2. Students can list two nutritional benefits of rosehips.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *5. From Molecules to Organisms: Structures and Processes* (5-LS1-1) Support an argument that plants get the materials they need for growth chiefly from air and water.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-2) Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-3) Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Time: 45 min

Lesson supplies:

- Rosehips
- Spice mill or blender
- Hot water
- Dried mint (optional)

Vocabulary:

Rosehip: The seed pod of wild roses.

Overview:

What are rose hips? ***Rosehips*** are a small red seed pod left on the wild rose bush at the end of the growing season. It is the end and the beginning of the plant life cycle. Wild roses propagate from these naturally as they fall to the ground and start new bushes in the spring. They are perennial and spread from year to year, often found on a wooded edge. My farm lane bordered a twenty foot windbreak hedge row that was dotted with wild roses. I didn't notice the blooming stage of these roses so much but when winter came each year the clusters of red seed pods stood out among the dormant trees and bushes and especially against the bright white snow. It was always something to look forward to on a December walk. Roses are known for their thorns and wild roses are no exception. Wear your leather garden gloves, take a pair of sharp pruners and a basket to carry the hips in. November and December are good months to look for rose hips at your local farmers market. They are one of nature's many gifts. If you have a wooded area in your environment, consider dispersing some of these hips along the protected edge to start a natural rosehip crop of your own. Make sure before dispersing to correctly identify wild rose or prickly wild rose (*Rosa acicularis*) and not spread or encourage multiflora rose (*Rosa*

multiflora), an invasive species. Multiflora rose is easily distinguished from wild rose by its large recurved thorns.

Rosehips of any variety are high in Vitamin C, which is good for warding off infection. They are edible so chewing on them is great but you might want to spit out the seeds. Birds love to munch on rosehips all winter. They are commonly used in teas, oils, jams and night creams. Lead the class in discussion by listing what they know about rosehips. If there is an outdoor green space currently growing rose hips, take a walk so that students may be able to touch, feel, taste and harvest. Purchase rose hips at your local farmers market at this time of year and use in recipes, wreath making and bird ornaments/feeders.

Procedure:

1. **Discuss:** Ask the students what they know about rosehips; discuss where to find them and what nutrients they offer us (vitamin C).
2. **Watch:** A Guide to Rose hips: How to identify, harvest and eat (4 mins) (https://www.youtube.com/watch?v=iDD1xJTv0-M) from Flannel Acres.
3. **Recipe: Rosehip Tea**
   Theri's Tip: This makes a festive activity paired with a winter walk or holiday gift making activity.
   Supplies
   - Rosehips
   - Spice mill or blender
   - Hot water
   - Dried mint (optional)

   Directions
   1. Grind the rosehips (and dried mint) in a spice mill to open for more flavor.
   2. Steep the rosehips (and mint) in hot water for 3-5 minutes.
   3. Drain through a coffee filter or tea bowl.
   4. Optional- Add a couple drops of honey (another natural gift)
   5. Enjoy!
4. **Evaluation**:
   a. What is a rosehip?
   b. What are the nutritional benefits of drinking rosehip tea?

   Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 3: Science Enrichment

Week 3 of each month features three different science focus areas: botany, zoology, and microbiology. Instructors can choose to use lessons based on their science requirements.

Botany: Plant Anatomy

Goal(s): To become familiarized with plant anatomy basics and understand the functions of each of the main plant parts.

Learning objectives:

1. Students can diagram the six parts of plant anatomy.

2. Students can explain the function of the six main parts of the plant anatomy.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *5. From Molecules to Organisms: Structures and Processes* (5-LS1-1) Support an argument that plants get the materials they need for growth chiefly from air and water.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-4) Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Time: 60 min.

Lesson supplies:

- Large potted vascular plant for teacher demonstration (will be dissected)
- Plants for student dissection -Microgreens from previous seed starts or green beans (pole plants) are ideal (small plant or microgreens for each student)
- Magnifying glasses or a microscope (optional)
- Paper (can use farm journal)
- Markers/colored pencils etc
- Knife or scissors

Background review for the instructor:

- You'll need plants to dissect for this activity. Ideally use green bean plants that you started growing in October or November.

Vocabulary:

Plant anatomy: The study of the internal structure of a plant. Also called phytotomy.
Vascular plants: Plants made up of tissues that distribute water and nutrients through the plant.
Leaves: A flat structure, usually green, attached to the stem; where photosynthesis and transpiration take place (where sunlight, water and air are converted into energy for the plant).
Stem: An above the ground central structure, branch of the main system, of a plant that typically bears leaves. Stems carry water and nutrients to all parts of the plant.
Roots: A hairy, net-like, or vertical/carrot-like structure below the ground of a plant; the anchoring system. Roots absorb water and minerals from the soil and can store nutrients.
Flowers: The blossoms that hold the reproductive parts; where the plant is pollinated (to become the fruit) by pollinators (bees, birds, butterflies, etc).
Fruit: The mature seed pod of a plant or tree that can be eaten as food; the edible flesh of a fruit grows around the seeds to protect them.
Seeds: The reproductive result of a flower; that which will become a like plant

Overview:

This lesson is an introduction to ***plant anatomy.*** Each of these can be further studied and labeled as other lessons are presented. Today's lesson introduces the general components with some detail of the six main parts of ***vascular plants***: ***leaves, stems, roots, flowers, fruit*** and ***seeds***. Gather a plant from your garden to bring life to this lesson.

Procedure:

1. **Discuss:** Review what we know about plants. Introduce the 6 general parts of vascular plants (leaves, stems, roots, flowers, fruit and seeds).
2. **Watch:** Plant Anatomy and Structure (8 mins) (https://www.youtube.com/watch?v=JNdfoO_HBEc), from Professor Dave Explains.
    a. This video divides the plant into root and shoots anatomy, above and below the ground plant parts. It introduces a vascular plant with a perfect flower (both male and female parts in one flower). Pause the video after each new anatomy description to discuss new detailed parts and vocabulary and to allow students to transcribe the picture with labeling into their journals. They should end with 6 pages of labeled anatomy. This YouTube channel is a great resource for other lessons also.
3. **Activity: Dissecting A Plant** (30 mins)

    Supplies

    - Large potted vascular plant for teacher demonstration (will be dissected)
    - Plants for student dissection -Microgreens from previous seed starts or green beans (pole plants) are ideal (small plant or microgreens for each student)
    - Magnifying glasses or a microscope (optional)
    - Paper (can use farm journal)
    - Markers/colored pencils etc
    - Knife or scissors

    Directions

    1. Start with a class demonstration using a potted plant (fruiting and flowering if possible) in the center of an open space with students and their journals. Have the students reference their farm journals to identify the anatomy parts from the plant video and discuss the functions of each part identifying: stems, roots, leaves (cotyledons will be gone), fruit, flowers, seeds. Students can take notes.
        a. Include in your demonstration a dissection of each plant part: remove, observe, cut open, observe. Start with the shoot parts and finish with the roots. What do you see inside the plants - moisture? How does the exterior appear - color, texture? Do the roots have a hairy structure or are they carrot-like, called a tap root? Do the roots have nodules on them (if so, it's a legume). (20 mins)
        b. Allow students to dissect their own plant. Ask and discuss why it might be important for a farmer to know the anatomy of a plant and to occasionally dissect one?
4. **Follow-up:** Read Soybean Plant Biology: History, Plant Structure & Growth Cycles, from Dr. Harold Willis. This article is a great addition to the lesson - it summarizes the history and the growth cycle of soybeans (a legume). (https://www.ecofarmingdaily.com/grow-crops/grow-soybeans/soybean-crop-science/biology/?utm_source=Acres+U.S.A.+Community&utm_campaign=f143c13d2b-ACRES-1-24-22_soybean-biology-harold-willi

s&utm_medium=email&utm_term=0_65283346c2-f143c13d2b-184703445&goal=0_65283346c2-f143c13d2b-184703445&mc_cid=f143c13d2b&mc_eid=04fda1ae5c)

5. **Evaluation**:
    a. Draw a vascular plant, include and label the six main plant parts. Give a short description of the function of each part. with a description in a vascular plant and what function does each provide?
    b. Why do farmers inspect the inside of a plant when doing a crop observation?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Zoology: Farming Livestock

Goal(s): Learn about the minerals in animal manures (waste) and how manure can be used in a positive and sustainable way in agriculture.

Learning objectives:

1. To understand the term husbandry.
2. To understand grass feeding livestock systems versus grain feeding systems and the environmental implications of each.
3. To be able to describe a grass feeding livestock system.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *5. Earth and Human Activity: Human Impacts on Earth Systems* (5-ESS3-1) Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- *MS. Earth and Human Activity: Human Impacts on Earth Systems* (MS-ESS3-3) Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- *HS. Earth and Human Activity: Human Impacts on Earth Systems* (HS-ESS3-4) Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Time: 45 mins

Lesson supplies:

- Journal or paper
- Pen or pencil

Background review for the instructor:

- Is Grass-Fed Beef Really Healthier Than Grain-Fed? (5 mins) (https://www.youtube.com/watch?v=EjEV0VFYCUc)

Vocabulary:

Husbandry: The care and breeding of livestock on the farm.
Livestock: Animals raised in farming for profitable products.
CAFO: Confined Animal Feeding Operation

Nitrogen: An element that is part of the chlorophyll molecule in vascular plants, which helps the plant capture sunlight and energizes photosynthesis which then stimulates growth of the green plant (encouraging more photosynthesis and plant growth). The nitrogen cycle is discussed in depth in September's week 2 green beans lesson.
Vegetative plant: The green parts of a growing plant before setting fruit.
Rotational Grazing: A system of moving livestock through pasture to maintain a pasture diet without negative effects on the pasture.
Phosphorous: An important element for healthy plant growth found in manure. It helps tissue growth in plants and is associated with strengthening roots.

Overview:

Animal ***husbandry*** is the practice of caring for and breeding animals on the farm. These animals are referred to as ***livestock***. Large livestock farming is often referred to as ranching. A ranch that breeds and sells large animals like cows, sheep and pigs should focus on growing good pastures to meet their animals' nutritional needs. The larger the animal, the more pasture, and time, it will require to reach maturity. In his book *You Can Farm*, Joel Salatin mentions that he is a grass farmer, not a cow rancher. In healthy agricultural systems, animals raised for meat should eat lots of grass, which is their natural diet. He calls himself a grass farmer because grass is his farm focus - growing nutritious grass. If his pastures are lush, all he has to do is move the cows around in it and let them be cows. If you are an omnivore, eating both meat and plants, it should be important to you to know how your meat is raised. Pasture raised and finished meat is the closest to nature an animal comes on the farm or ranch. If we limit our meat consumption (conservation) and commit to eating only/mostly meats (animals) that are raised on their natural diet; unlimited access to pasture, fresh air and water, we can go a long way in shrinking our carbon footprint.

Manure is a byproduct of raising animals. This can be thought of as waste if it is overabundant; usually due to housing too many animals in a given area. ***CAFO's (confined animal feeding operations)*** have to deal with manure management as a waste product. What we know about manure is that it does not have to be waste but can serve as a great fertility asset on well managed farms. Manure from pasture raised animals is digested grass, which is full of important minerals including nitrogen and phosphorus. Nitrogen and phosphorus are important for healthy plants and healthy people.

Nitrogen is part of the chlorophyll molecule in vascular plants, which helps the plant capture sunlight and energizes photosynthesis which then stimulates growth of the green plant (encouraging more photosynthesis and plant growth). Nitrogen increases the green mass of a ***vegetative plant***. We refer to green organic matter as "nitrogen" because of this. Manure is an exception to the "green" rule. Why is pastured animal manure a good source of nitrogen (think: you are what you eat)?

Nitrogen can also cause harm to plants or lower fruit production when there is too much. Too much nitrogen causes a burning effect on soil and plants. In a healthy pasturing system the animals need to move regularly. If they are kept in one area too long they will kill the grass by over fertilizing (N) and overgrazing. Keeping a balance is the work of the farmer/rancher and involves moving animals to fresh pastures in a well calculated system and is referred to as ***rotational grazing***. In this way manure is a fertility asset and grasses are not overgrazed.

Phosphorus is another important element for healthy plant growth found in manure. It helps tissue growth in plants and is associated with strengthening roots. Root crops and perennials use a lot of phosphorus. In the human body phosphorus is known for building strong

bones and teeth. It works hand in hand with calcium as the two most present minerals in the body. Phosphorus, like nitrogen, also works to maintain and repair tissue growth in plants and humans.

The great thing about manure nutrients is that they are soluble to plants very quickly. There is no faster digester of nitrogen than the digestive system of grazing animals. That means the nutrients in manure can be taken in by plant roots as usable nutrition soon after falling to the ground. By moving animals around the farm we can also naturally deliver and spread this fertilizer. In this way animals can contribute a key role in creating a closed system of fertility on the farm. Closed systems are cyclical systems and are key to sustainability.

Procedure:

1. **Watch:**
    a. CAFO Farming- This is what a CAFO looks like (1 min) (https://www.youtube.com/watch?v=rGz5VMDFzmc)
    b. Rotational Farming- 5 Cattle, 17 sheep, 250 chickens on 4 Acres - Multi-species rotational grazing (6 mins) (https://www.youtube.com/watch?v=u_gwqGOowUc)
2. **Discuss:** Include comparing and contrasting:
    a. Which system grows more meat/animals in a smaller area? Why might a farmer prefer this method? Why might a consumer prefer this method?
    b. Which system is grass fed; grain fed?
    c. Which system do you think has more waste, why?
    d. How is the waste handled?
    e. What kind of system is each - linear or cyclical?
    f. From the perspective of the animal; the farmer; and the consumer, which system is better?
    g. Which do you think is better for the environment, why?
    h. How will you know what system your meat comes from?
3. **Evaluation:**
    a. How can we reduce/eliminate confined animal feeding operations?
    b. If you were to make a commercial for rotational grazing what selling points would you include?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Microbiology: Vermiculture 101

Goal(s): To understand that worms are biological indicators for the soil food web, beneficial to farmers as nutrient cyclers, and provide natural tillage to bring water and air into the topsoil layers.

Learning objectives:

1. To identify the benefits of worm castings and explain why they are better than chemical fertilizers.
2. To explain the interaction between humans and worms through the soil food web.

Next Generation Science Standards connections (grades 3-12):

- *3. Biological Evolution: Unity and Diversity* (3-LS4-4) Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

- *5. Ecosystems: Interactions, Energy, and Dynamics* (5-LS2-1) Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-5) Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- *HS. Ecosystems: Interactions, Energy, and Dynamics* (HS-LS2-4) Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

Time: 45 mins

Lesson supplies:

- Vermiculture nin- (make it yourself or purchase)
- Approximately 1 pound of red wiggler worms
- Bedding (any combination of moist carbons including shredded newspaper)
- 2 cups of finished compost (inoculate with microorganisms)
- 1 cup of sand (sand adds grit for worm digestion)

Background review for the instructor:

- The book *Worms Eat My Garbage* by Mary Applehof
- *What is the Soil Food Web? | Soil Food Web School* (6 mins) (https://www.youtube.com/watch?v=uAMniWJm2vo)
- Bin building ideas
    - Building a Stackable DIY Worm Farm for $30 🐛 (10 mins) (https://www.youtube.com/watch?v=UaajjQ0FhM4) (I like this model)
    - We Built a Worm Bin for $5 and it Was EASY! (15 mins) (https://www.youtube.com/watch?v=AxKrXeVtPdY)
    - Vermicomposting 101: How to Create & Maintain a Simple Worm Bin (22 mins) (https://www.youtube.com/watch?v=AF-jzWKMdwE)

Vocabulary:

Worm castings: A mixture of soil and nutrients that are excreted by worms as they eat . Worm castings can be very dense in nutrition when the worms' diet is nutrient rich.

Soil food web: A community of living organisms in the soil that represent different levels of consumers. Each level of consumer depends on the level below it to get food energy and is the energy source for the level above it. These levels of consumers are often depicted in concentric circles or layers showing who eats who, with a carbon food source at the center (organic matter). The smallest microorganisms are fed by the organic matter layer and go on to be the food or produce the food that will be eaten by the next level of life and so on. No level of consumer can exist apart from the others.

Microorganism: A living organism too small to see without magnification. Common single celled microorganisms in soil include viruses, bacteria, protozoans, and protists. Multi-celled nematodes (which are not microorganisms but tiny invertebrates), fungi and many other multicellular but still microscopic creatures live in soil.

Vermiculture: Vermi means worm, culture is an environment for growth. These definitions together appropriately describe vermiculture as a worm farm.

Composting: The natural breaking down process of organic matter (including nitrogen and carbon matter) into a rich soil like product that contains fertility and biology. It is used for fertilizing soil.

Overview:

Worms provide a number of important functions in soil. They digest organic matter and create fertile ***castings*** that help plants grow; they move and mix nutrients throughout the soil improving soil structure; they create tunnels for air and moisture to move through the soil supporting other levels of soil life.

Consider purchasing Mary Applehof's book, *Worms Eat My Garbage* for great ideas and building plans for worm bin farming of all sizes. She's also published a companion workbook with fun activities for youth. Building, or purchasing, the worm bin can be done prior to your lesson or for older students can be part of the lesson. Make sure there are plenty of tools and supplies for each group when building bins together.

One of the easiest and cheapest soil quality tests is to count worms in your soil. The more worms you have in a given volume of soil the more fertile the soil is. Worms indicate the presence of the complete ***soil food web*** because they live in relationship with all other levels of soil consumers, including billions of ***microorganisms***. The soil food web has an amazing ability to digest organic matter, including food waste, and create soluble (plant ready) fertility. Worms are a farmer's best friend.

I introduce ***vermiculture*** (worm farming) as an indoor ***composting*** option during our cold winter months. Worm bins offer a perfect environment to study the soil food web while creating some rich fertilizer for spring planting. Worms eat organic matter, like grass clippings, leaves, and plant residue outside and they are also a great source of carbon cycling inside. Your vermiculture bin bedding can help you naturally recycle a number of inside carbons including paper products and shredded cardboards. Brainstorm all the paper products a school or home produces. Where do these go? Along with the bedding, worms will digest almost all kinds of food waste. Vermiculture eats your garbage(!) and excretes worm castings rich in phosphorus, calcium, nitrogen and magnesium, all of which are essential nutrients for strong plant growth. Vermiculture is a cyclical, sustainable system of upcycling food and carbon waste.

Procedure:

1. **Discuss:** Introduce new vocabulary, and/or review vermiculture vocabulary if this is already an established practice. Another way of saying vermiculture is worm farming. Anyone can do worm farming with a small aerated container, worms and food and paper scraps. Who doesn't have that? If you are worm farming correctly it should be odor free and can be kept anywhere there is a ventilated space between 40-80 degrees (65-75 degrees is perfect.)
2. **Watch:** Turning Trash into Treasure | Vani Murthy | #OneForChange (4 mins) (https://www.youtube.com/watch?v=FjeVzQyLa98). Vermiculture is a perfect demonstration of the soil food web at work decomposing. If you want to look more closely at the soil food web, watch this: What is the Soil Food Web? | Soil Food Web School (6 minutes) (https://www.youtube.com/watch?v=uAMniWJm2vo), from Dr. Elaine's Soil Food Web School. The soil food web lives in a vermiculture system. Healthy soil has more living organisms in one cup than there are people in the world. Vermiculture is one way to upcycle food scraps, grow healthy worms (and biology) and make your own organic fertilizer all at the same time.
3. **Activity: Setting up a Vermicompost Bin** (20 mins)

Supplies

- Vermiculture nin- (make it yourself or purchase)
- Approximately 1 pound of red wiggler worms
- Bedding (any combination of moist carbons including shredded newspaper)
- 2 cups of finished compost (inoculate with microorganisms)
- 1 cup of sand (sand adds grit for worm digestion)

Directions for construction

1. Watch Worm Composting 101 (2 mins) (https://www.youtube.com/watch?v=6UYac_8rWec), from Planet Natural Garden Supply.
2. Shred newspaper to fill the container with bedding 6 to 8 inches deep, keeping it loose and airy. I like to rip the newspaper, as small as possible into narrow strips and moisten in a 5 gallon bucket. Other carbons can be added to this mix including dead grass clippings, brown leaves, shredded cardboard. Be sure to moisten all before filling the bin. This can be a fun activity to hand shred if you have time. Machine shredded newspaper, leaves, and cardboard can be used instead of ripping.
3. Mix together in the new bin: moist carbon, 2 cups of finished compost and 1 cup of sand.
4. Bury 1-5 lbs of finely chopped food scraps under the wet carbon making sure to bury this food. Worms only eat underground. Foods left above ground will attract unwanted elements. For dramatic effects you can use rotten food from your refrigerator to feed the worms. I consider this an awesome characteristic of the worm bin and worms in general. Worms can eat rotting foods and their castings are germ free, all due to the amazing digestive system of the worms.
5. Place the worms on top of the bedding, letting them work their way in.
6. Keep a ventilated lid on the container at all times.
7. Store in a well-ventilated dark space inside or outside, avoiding extreme temperatures. (best temps are between 40-80 degrees fahrenheit).

Daily/Weekly Bin Care

1. **Feeding:** Feeding the worms is a weekly or daily chore and should be organized in a way that flows with other chores/responsibilities in the home or classroom. Worms are living creatures and like all life forms need fresh food and water.
2. **Moisture:** Your worm bin materials should always be moist like a worm's body. Worms will die if the carbon is too dry or too wet. When squeezed, the paper should release a drop or two of water. Usually the addition of food scraps regularly keeps the bin evenly moist. Holes or a drain on the bottom of the bin will keep the system from flooding. When needed, use a spray mister to add moisture.
3. **Food:** Worms can eat half their body weight each day, once they get acclimated to their new environment, which may take a few weeks. Feed them 1-2 lbs of food scraps a week for the first month. After one month they should consume 5 lbs of food scraps a week. I keep a hand rake and trowel close to my worm bin to dig a hole when serving the food scraps, weekly or daily. Make sure to cover food scraps back up with moist bedding. Worms will only eat buried food. Food that is not buried will break down causing odor and pests. Inside the bin you can rotate

the locations you feed the worms. I rotate amongst the four corners. If you notice a food build -up take a break from feeding.

4. **Address problems as needed:** If bedding gets too wet add some dry paper; for too dry, mist with water. If worms are not keeping up with the volume of feed back off quantity for a while. If they are eating all food daily, increase food supply to meet demands.
5. **Observations/data collection:** Have a communal data book near the worm bin. Have students record:
    a. Any visual observations of bin conditions?
    b. The weight of each food scrap feeding?
    c. The density of the worm population
    d. If a microscope is available take an occasional microbe count.

Foods To Use:

- Vegetable and fruit scraps (cut into small pieces or blend for faster consumption)
- Table scraps
- Refrigerator waste
- Finely crushed egg shells
- ***Do <u>NOT</u> use:*** Dairy, meats/bones, citrus, hot peppers, onions

Carbon sources for base (must be kept moist):

- Shredded paper
- Shredded paper towels from restroom and kitchen
- Shredded cardboard
- Dead leaves or grass
- Fine wood shavings

I***n Moderation ("treats" for the worms):***

- Tea bags
- Coffee grinds

Harvesting:

1. Every 3-6 months, or when you see the contents of the worm bin is nearly all castings, move all the castings(and worms) to one side of the bin, adding new bedding and food to the other side of the bin. Feed only in the new bedding.
2. After a few weeks of feeding only in the new bedding, the worms will relocate to the new material.
3. Extract the castings from the finished side of the bin. Examine castings, these are rich in fertility.
4. Sprinkle castings on your garden or household plants. I use castings as a side dressing of fertility when transplanting.

Interesting facts about red wiggler worms:

1. Red wigglers in nature are found in horse manure, where they burrow to lay eggs. Generally they live just under the surface of the soil or compost
2. Red Wigglers are photosensitive, therefore, they only work in the dark.
3. Red Wigglers will excrete a foul smelling liquid when handled roughly.
4. Red Wigglers when happy and healthy can eat about half of their weight in food each day.

5. Red Wigglers have gizzards that need grit to help grind up their food. Sand, shredded leaves and coffee grounds are examples of things that support the Red Wigglers digestive process.
6. Red Wigglers are hermaphroditic (they have both male and female sex organs) but two worms are needed to reproduce. The two worms join together and exchange sperm and both worms secrete cocoons that contain eggs. Red wigglers can lay 2-3 egg cocoons weekly in ideal conditions, each hatching up to 20 babies. Sweet (and blended) foods encourage reproduction including: watermelon, soft bananas, pumpkin and sweet corn cobs. Have some fun with this math.
7. Red wigglers mature and start reproducing in 27 days with an average life span of 1-5 years.
8. Teenage Red Wigglers eat more than adult Red Wigglers. (From: YOUR SOURCE FOR THE DIRT ABOUT SOIL (https://www.soilthedirtguide.com/10-interesting-facts-about-red-wigglers) Resource: Mary Appelhof, Worms Eat my Garden, FlowerFower Press 1997))

4. **Optional extended projects:** A number of great micro-economy projects can be associated with vermiculture including selling worms to bait shops/fisherpeople, or marketing castings as organic fertilizer.
5. **Evaluation:**
    a. What are two benefits worms provide in the soil?
    b. Draw a simple soil food web and label each layer.
    c. What is a vermiculture bin?
    d. How does vermiculture and composting relate to sustainability?

    Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 4: On the Farm

Straw vs Hay

Goal: Students will understand the difference between hay and straw and learn some primary uses for each on the farm.

Learning objectives:

1. To explain the difference between straw and hay material.
2. To know the process of cutting, drying and storing straw and hay.
3. To know how straw is used as an insulating material.

Next Generation Science Standards connections (grades 3-12):

- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *5. Ecosystems: Interactions, Energy, and Dynamics* (5-LS2-1) Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-3) Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-5) Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- *HS. Ecosystems: Interactions, Energy, and Dynamics* (HS-LS2-3) Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

Time: 45 min

Lesson supplies:

- A box of paper straws
- String to hold the straws together

Background review for the instructor:

- Using old hay or straw- 337 lbs of Potatoes! NO digging, NO watering, and VERY LITTLE work! (9 mins) (https://www.youtube.com/watch?v=GlratwBT5OI)
- Using straw for gardening- How to Begin "Hay Bale" Gardening or How to Start a Straw Bale Garden (25 mins) (https://www.youtube.com/watch?v=3YlEsdXMft8)
- Using straw to build animal shelters- BUILD A STRAW BALE HOUSE FOR YOUR DOG IN TWO MINUTES (2 mins) (https://www.youtube.com/watch?v=AlE84IQTB18)

Vocabulary:

Straw: Insulation or bedding. Straw is the stem, or shaft, of a small grain plant, often wheat in the midwest. The grain is harvested off the top few inches of the plant and the shafts are left to die and dry. The shafts are cut down and then raked up to bale. The shaft of the straw is much like a drinking straw as it is hollow and full of air. This is what makes straw a great insulator. Although straw has very little nutrition, it's mostly carbon, it has many uses where hay is primarily used for food.

Hay: Herbivore food made from dried grasses. It is usually green compared to straw that is more yellow. Hay is a source of nutrition, especially in the midwest, for overwintering livestock. Grass is cut, then dried in the sun, raked together and then baled for ease of storing and stacking out of the elements. Anyone who grows grass can make hay. Baling can be done on a large scale with big machinery or in the case of Small farmers(and historically) can be done manually. The baling system is the same for straw or hay but the material is very different.

Overview:

Winter weather usually arrives on the farm in December. Outdoor activity in the fields stops for a couple of months but animal care continues, even in the worst weather. We get outside everyday, at least once, to feed, water and check for any additional animal needs. Winter animal care includes protecting your animals from harsh winds. In the worst weather, we add ***straw*** to living areas or build straw structures for added insulation against the winter winds. Microgreens through the winter months can add fresh nutrition for chickens, rabbits and any small livestock. Consider starting a few extra trays each week for the animals if you no longer have an outside source of fresh nutrition for them. Do some research to determine what variety and quantity of microgreens is appropriate for any animals you are feeding.

Straw and ***hay*** are both important materials for overwintering livestock. One is food and one is bedding and insulation. If you haven't had this lesson yet, take some time to distinguish them. Straw and hay can be baled much alike in size and shape but used very differently on the

farm. Sometime before the worst of winter gets started, calculate your winter needs for both straw and hay, making sure your supply will be adequate for the coming months or for as long as your storage space allows. Add what you can to simplify winter work; you'll want to bypass lugging these bales through the snow during the winter months if possible. I like to take an inventory check for quantity and quality by December 1, removing and replacing any compromised bales that are still in storage from the past season. I keep my animal environments as fresh as possible until weather no longer permits the weekly mucking out of cages and barns. At this point I layer fresh straw to keep a fresh top layer. Layering straw in the worst weather has an additional warming effect for the animals by the heat that is generated from the composting, or decomposing, that happens with the straw and manure combination (nitrogens and carbons). Loose, soiled or decaying old hay or straw can be used to set out next year's potato garden (see the first video in background review).

If weather gives me a chance, temps over 40 for the day, to muck out cages or barns/sheds during the winter months I will continue to layer this soiled hay and straw on my potato field up to a month before planting the potatoes (average planting date April 15).
Theri's Tip: Consider adding your own baling enterprise (how?) to your spring and summer production if you are growing any small grains or mowing grass on your landscape.

Procedure:

1. **Discuss:** Lead the students in a discussion on the difference between hay and straw.
2. **Watch:**
    a. Hay Vs Straw: What Is The Difference? (11 mins) (https://www.youtube.com/watch?v=_DdYp0RQEZY).
    b. A great look at the steps involved in making hay- Hay In A Day - Part 1 (3 mins) (https://www.youtube.com/watch?v=_sYyGwc9sas).
    c. Simple baling (vs stacking) manually- Baling Hay bales without a tractor or any equipment! (2 mins) (https://www.youtube.com/watch?v=TqUPIP49qCs). This simple baling method can easily be done on any mowed green space. Grass should be grown as long as possible before mowing and drying. It gives you the opportunity to further close the gap for nutrient cycling if you are purchasing winter nutrition for small livestock. There are also many simple machinery blueprints online for building a more sophisticated simple machine for baling larger amounts, that can be used for both hay and straw. Here is a video on How to build and use a hand baler (9 ½ mins) (https://www.youtube.com/watch?v=c_dYfTc1Wsc) and the plans he used A Low Cost Pine Straw Box Baler (http://www.ncforestservice.gov/publications/LongleafLeaflets/LL11.pdf).
3. **Evaluation:**
    a. Compare and contrast straw and hay production giving at least two similarities and two differences..
    b. Which is more expensive, straw or hay, and why?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Additional December Resources

Compiled by Margaret Lenhart
For March or April: This Technique of Starting Seeds Will Change Your Life

Grades 3-5

- **Poems-** Earth Day Songs & Poems | A to Z Teacher Stuff Lesson Plans (http://lessons.atozteacherstuff.com/607/earth-day-songs-poems/)
    - Earth day themed poems and songs about recycling and taking care of the planet, set to the tune of well known children's songs.
- **Book-** *Of Things Natural, Wild and Free: A Story of Aldo Leopold,* Marybeth Lorbiecki
- **Book-** *The Giving Tree*, Shel Silverstein
- **Book-** *Thank You Earth: A Love Letter to Our Planet*, April Pulley Sayre
- **Book-** *Roots, Stems, Leaves and Flowers*, Ruth Owen.
    - Goes well with Week 3's ***Plant Anatomy*** lesson.
- **Website-** Fun Websites for Teaching Kids About Recycling and Sustainability - Parenting (https://www.parenting.com/activities/family-time/fun-sites-teaching-kids-about-recycling/)
    - A list of websites to teach kids about recycling.

Grades 6-8

- **Poem-** Silicon Adventures, Richard Thomas (https://allpoetry.com/poems/about/recycling)
    - Curriculum connection: Highlights themes of recycling and upcycling
    - This writing depicts the different products a piece of silicon is crafted into over a one-hundred-year period. Clever rhyme scheme and personification makes this a lighthearted and intriguing composition.
- **Book-** The Line Tender, by Kate Allen (https://www.penguinrandomhouse.com/books/561889/the-line-tender-by-kate-allen/)
    - Page count: 384, relatively few words per page
    - Suggested age range: 10+
    - Curriculum connection: Coming to realize and explore the gifts nature provides.
    - Set in Cape Cod in the wake of her mother's sudden passing, 12-year-old protagonist Lucy learns to find resiliency in her connection to nature. The opening line of the book articulates this idea well, saying, "Those who contemplate the beauty of the earth find reserves of strength that will endure as long as life lasts."
- **Book-** Strange Birds: A Field Guide to Ruffling Feathers by Celia C. Pérez (https://www.penguinrandomhouse.com/books/553181/strange-birds-by-celia-perez/)
    - Page count: 384
    - Suggested age range: 8-12
    - The story of Ofelia Castillo, Aster Douglas, and Cat Garcia, three small-town Floridian girls of different interests and backgrounds coming together to take a stand against an "endangered-species-unfriendly tradition carried about by a local scout group" (11 Middle Grade Books for Environmentally Conscious Kids). Themes of summertime adventure, meaningful friendships, and taking unpopular stances to achieve justice abound. Find additional discussion questions and activities here.

- **Article-** The Conservation of Matter During Physical and Chemical Changes | National Geographic Society (https://www.nationalgeographic.org/article/conservation-matter-during-physical-and-chemical-changes/)
- **Article-** 19 youth climate activists you should be following on social media (short article) (https://www.earthday.org/19-youth-climate-activists-you-should-follow-on-social-media/)
    - Curriculum connection: Inspire students to give to society and the earth by highlighting an eclectic group of young environmentalists with whom they can connect
- **Article-** Improving Old MacDonald's Farm Protecting streams from "fruited plains" (from the EPA) (https://www.epa.gov/sites/production/files/2016-01/documents/farm_article.pdf)
    - Curriculum connection: Giving to others and the earth through stewardship and restorative practices. Engages the Cross-Cutting Factor: Cause and effect.
    - This newspaper-style article, written for kids, describes common sources of water pollution and reinforces the importance of environmental stewardship with regards to human health.
- **Article-** Generation Wild: Saving Life on Earth (https://www.biologicaldiversity.org/youth/index/conservation_for_kids.html)
    - Curriculum connection: Appreciating the earth through preservation.
    - This article provides a call to action for youth to actively engage in environmental conservation, and connects them with accessible resources to learn more about environmental issues and ideas for taking action in their homes and schools.
- **Short Video-** Home Sweet Habitat: Crash Course Kids #21.1 (5 mins, start at 1:11) (https://www.youtube.com/watch?v=p15IrEuhYmo&list=PLhz12vamHOnZv8kM6Xo6AbluwIIVpulio&index=8).
  Follow with- Food Webs: Crash Course Kids #21.2 (4 mins) (https://www.youtube.com/watch?v=Vtb3I8Vzlfg&list=PLhz12vamHOnZv8kM6Xo6AbluwIIVpulio&index=9)
    - Curriculum Connections: Learning objective: Explain and draw a simple food web, Cross cutting themes: Cause and Effect; Systems and Systems Modules
    - The first video presents a definition of the **food web** as an expansion of the food chain; the second video reinforces previously learned concepts, such as the habitat and ecosystem, and provides an example of the multilateral effects of removing a single species from an ecosystem. Watch the two sequentially. Designed for younger students, but engaging graphic design and clear explanations of fundamental concepts make it fruitful for learners of any age. The video's pace of information flow is relatively fast, thus, you might want to consider setting its speed at .75.
- **Short video-** Environmental Justice, explained (3½ mins) (https://www.youtube.com/watch?v=dREtXUij6_c)
    - Curriculum connection: Advocating for environmental justice allows students to 'give' to others by working to ensure environmental "benefits and burdens" are equally shared by members of a city or community.
    - This video illustrates the connection between social justice and environmental issues by describing the ways in which environmental hazards disproportionately affect the health and livelihoods of racial and ethnic minorities and low-income community members.
- **Short Video-** Teen Activism for Urban Access to Green Spaces (4 ½ mins) (https://lsintspl3.wgbh.org/en-us/lesson/envh10-health-spls912/7)
    - Video on page 7 of "Taking Action for a Clean Environment," a self-paced lesson plan for students. This video depicts the actions, successes, and challenges experienced by a young person-of-color in advocating for more inclusive access to a public park for residents in her industrial neighborhood of the Bronx in New York City.
- **Short Video-** How Wolves Change Rivers - George Monbiot (4 mins) (https://youtu.be/W88Sact1kws)

    - Important ecology concept
    - Appropriate for older students as well.
- **Documentary-** Fresh: New Thinking About What We're Eating (2009) (1hr 12min) (https://www.imdb.com/title/tt1637620/)
    - Curriculum connection: Focuses on preserving and restoring our land; reinforces the connection between human and environmental health.
    - Recommended for kids and families by Michael Pollan, author of *the Omnivore's Dilemma*, this documentary highlights diverse, community-based efforts to reinvent the U.S.' industrialized agriculture system in order to mitigate the negative effects it has had on public health and carbon emissions.

Grades 9-12

- **Poem-** Rings of Fire, Craig Santos Perez (https://grist.org/article/this-poet-captures-the-madness-and-injustice-of-our-burning-planet/)
    - Curriculum connection: Continues the theme of giving and reflection on our gifts as the poem is contextualized in a young girl's birthday celebration.
    - The full poem, written by Guam native Perez, is found at the end of the article, though the article is content-rich and could stand alone as its own resource. After reading the poem, consider fostering discussion and/or contemplation on the meaning of the ambiguous "wish" mentioned in the final stanza.
- **Book-** Belonging: A Culture of Place, by Bell Hooks (https://www.goodreads.com/book/show/207369.Belonging)
    - Page count: 230
    - Curriculum connection: Reflection on the gifts given to us by nature and the environment, the focus of Week 1.
    - A read that serves to widen both perspectives and vocabularies as author Bell Hooks illustrates passionately the inseparable relationships between the societal issues of race, class and sexuality and the environmental considerations of sustainability and personal connection to the land. Bell Hooks is an African American woman who was raised in an economically disadvantaged household in rural Kentucky, graduated from Stanford University, and now serves as a professor of Appalachian Studies in the historically well-integrated town of Berea, Kentucky. Unable to evade discrimination and stereotyping in metropolitan Stanford and New York City, Hooks tells the story of what brought her home: calling us all to action for more inclusive communities and a deeper appreciation of our natural environment.
    - Overall: Challenging, but worthwhile with a unique perspective and poetic writing.
- **Book-** What the Eyes Don't See: A Story of Crisis, Resistance, and Hope in an American City, by Dr. Mona Hanna Attisha (https://www.barnesandnoble.com/w/what-the-eyes-dont-see-mona-hanna-attisha/1127238148)
    - Page count: 329
    - Curriculum connection: Reinforces our abilities to give to our communities by advocating for environmental justice and accountability for our public officials.
    - Dr. Attisha is the founder of the Flint Pediatric Public Health Initiative. This book is a beautifully interwoven narrative of Iraqi history, the economic decline of Detroit, Michigan, and the acute environmental injustice encountered by the marginalized populations of Flint, Michigan and Washington D.C., written by a female pediatrician on the front lines of the Flint water crisis.
    - Overall: Interdisciplinary, insightful, and approachable for those without a background in science.

- **Website-** 19 youth climate activists you should be following on social media (https://www.earthday.org/19-youth-climate-activists-you-should-follow-on-social-media/)
    - Curriculum Connections: Inspire students to give to society and the earth by highlighting an eclectic group of peer and near-peer environmentalists with whom they can connect and influential online communities into which they can integrate themselves.
- **Article-** The art of upcycling, National Geographic (https://www.nationalgeographic.com/environment/2019/09/partner-content-the-art-of-upcycling/)
    - Curriculum Connections: Expands on the sustainability topic of upcycling from Week 1.
    - This article, and accompanying video, detail a man's humble entry into a career of automobile upcycling and his appreciation for upcycling as an art form. This is an ideal resource material to supplement the curriculum as it highlights the intersection of environmental stewardship with the auto industry, thus, it might engage students who have struggled to connect directly with other materials in this month's lessons.
- **Short Video*-** Environmental Justice (4½ mins) (https://www.khanacademy.org/test-prep/mcat/social-inequality/social-class/v/environmental-justice)
    - Curriculum connection: Advocating for environmental justice allows students to 'give' to others by working to ensure environmental "benefits and burdens" are equally shared by members of a city or community.
    - From Khan Academy. This video defines environmental health and focuses on the disproportionate amount of environmental benefits, such as green spaces, that fall on wealthy community members, and the similarly disproportionate distribution of environmental burdens, such as waste facilities, among the disadvantaged members of a community. It then discusses the factors that perpetuate these inequalities and the adverse health effects they cause.
- **Short Video-** Crash Course: Conservation and Restoration Ecology (10 mins) (https://www.youtube.com/watch?v=Kaeyr5-O2eU&t=208s)
    - Curriculum connection: Introduce the career fields of conservation biology and restoration ecology as ways for your students to give themselves and their communities the gift of environmental health.
    - This video is energetic and targeted for youth, but is a bit face-paced, thus, it is worth considering pausing during the video if necessary to debrief and respond to any questions.
- **Documentary-** Fresh: New Thinking About What We're Eating (2009) (1hr 12min) (https://www.imdb.com/title/tt1637620/)
    - Curriculum connection: Focuses on preserving and restoring our land; reinforces the connection between human and environmental health.
    - Recommended for kids and families. From Michael Pollan, author of *the Omnivore's Dilemma*, this documentary highlights diverse, community-based efforts to reinvent the U.S.' industrialized agriculture system in order to mitigate the negative effects it has had on public health and carbon emissions.

Extra Teacher Resources

- Activities, videos and brief articles (https://kids.niehs.nih.gov/lessons/index.htm) on topics in Environmental Public Health by the National Institute of Environmental Health Sciences. Suggested for grades 6-8. Fair amount of career-exploration content.
- Videos and self-directed lessons (https://www.pbslearningmedia.org/collection/enh/#.XuExKy2z1N0) on Environmental Public Health (for grades 5-8 and 9-12) from PBS.
- Vermiculture Supplies- Uncle Jim's Worm Farm (https://unclejimswormfarm.com/)

- See also “Grades 9-12”

JANUARY

Focus: Life Cycles on the Farm

Key Concepts: Cold cellar storage, garden planning, companion planting

January Lesson Outline

- *Week 1 Sustainability Topic*
    - Cold Crop Storage
- *Week 2 Theri’s Winter Kitchen*
    - January Kitchen Project: Root Cellar Cook-Off (1 hour 15 mins)
    - January Kitchen Project: Easy French Fries (prep 20 mins, cook 45 mins)
- *Week 3 Science Enrichment*
    - Botany: Plant Reproduction
    - Zoology: Reproduction of Chickens and Rabbits
    - Microbiology: The Soil Biome
- *Week 4 On the Farm*
    - Garden Design & Seed Ordering

Introduction

January and February are the coldest months on our farm and naturally lend themselves to research and planning. Each year my class chooses an animal to breed and raise as a life cycle project. We start with the research in January and carry the project throughout the spring. The rural landscape at Bertrand Farm allowed for a diverse selection of farm animal breeding; pigs

were always a favorite. On the urban farm we are limited to rabbits, chickens, quail, turkeys, and bees (which doesn't mean it needs to limit the research projects). Sometimes, in the case of chickens we are eventually changing over our flock. This allows our egg production to remain at its peak and our hens to be butchered while the meat is still usable. Studying life cycles of plants, animals, and microbes includes reproduction and breeding lessons.
Our farm work this month moves the garden reflection work of December forward into the planning and seed ordering stages. Planning starts with a review of the past years trials, errors and accomplishments. Good note taking and documentation last year will benefit you greatly at this stage. Look over your journals making sure to note what you did well and not so well; what tasted good and what didn't; what to plant more of and what to retire. Get out the stack of catalogs and engage your students in some of the "behind the scenes" winter work of farming. Our seed ordering exercise this month will segway nicely into the February theme of human nutrition.

Suggested January Field Trip

If you are lucky enough to have a year round farmers market, a winter trip can help students see first hand what is in season, what fresh produce stores well and how the season changes affect local production. If you charted the carbon footprint of fruits and vegetables during your first summer market visit you can do a similar exercise and compare results. Students will note that the fruits and vegetables grown locally on the summer market trip had a low carbon foot, discuss how and why that changes when these fruits and vegetables are at the market in the winter.
You should be able to get fresh storage crops in the midwest including cabbage, winter squash, potatoes and other roots. Students can take their journals and record which crops are still coming in locally and how different farmers store their fall crops to keep them fresh longest. Some season extension practices might even provide fresh greens throughout the winter.

Week 1: Sustainability Topic

Cold Crop Storage

Goal(s): Students will learn about root cellar food storage as a sustainable option for long term storage for fresh produce

Learning objectives:

1. Students can define root cellar.
2. Students can give examples of the advantages of using a root cellar over a refrigerator.
3. Students can define three essential elements of a root cellar.
4. Students can give five examples of produce that hold well in a root cellar.

Next Generation Science Standards connections (grades 3-12):

- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *5. Earth and Human Activity: Human Impacts on Earth Systems* (5-ESS3-1) Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-4) Use argument based on empirical evidence and scientific reasoning to support an explanation for how

characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- *HS. Earth and Human Activity: Human Impacts on Earth Systems* (HS-ESS3-3) Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.

Time: 45 mins

Background review for the instructor:

- Article- 13 Vegetables and Fruits You Can Store in a Root Cellar (https://www.homesteadingwhereyouare.com/2021/12/15/root-cellar-fruits-vegetables/)

Vocabulary:

Root cellar: Subterranean spaces that are dark and damp, used to store vegetables and other foods. They keep food from freezing in the winter and protect food from heat in the summer.

Frost line: The depth at which the groundwater in soil is expected to freeze.

Overview:

Until ice boxes (1834) and home refrigerators (1913) were invented, people had to be more precise with their storage of perishable goods. Many had ***root cellars*** and did quite a bit of preserving to keep a diverse amount of foods available for winter consumption. Root cellars still exist today and are a great and sustainable solution to storing some varieties of produce and canned goods throughout the winter months.

Root cellars are cold storage rooms dug into the ground. I call them nature's refrigerators. They are dug below the ***frost line*** so produce will not freeze (at least 48” in northern Indiana) and include a vent system to let gasses released by produce out and fresh air in, allowing produce to stay fresher longer. A door for getting in and out is often level with the ground with steps going down. The goal is to keep the root cellar temperatures above freezing, humid and fresh (air). Not all produce can be stored this way.

The most common fruits and vegetables that are stored in root cellars include: apples, winter squash, cabbage and roots like carrots, parsnips, potatoes and turnips. Canned goods do well in these cellars also as they are cool and dark.

Root cellar storage life extension for common storage crops:

- Cabbage: 3- 4 months
- Apples: 2 - 7 month depending on variety
- Potatoes: 4 - 6 months
- Sweet Potatoes: 2 - 3 month
- Carrots: 4 -6 months
- Beets: 3 - 5 months
- Pears: 2 - 3 months
- Parsnips: 1 - 2 months
- Garlic: 5 - 8 months
- Onions: 5 - 8 months
- Winter squash: 5 - 6 months
- Rutabagas 2 - 4 months

Root cellars are making a comeback as a sustainable option for long term fresh produce storage. They do not rely on fossil fuel inputs, just nature.

Procedure:

1. **Connect:** Use your farmers market trip and the following cooking project this month to enhance this lesson on sustainable root crop storage. If you didn't go to the market together, consider going yourself and having some storage crops for this activity.
2. **Discuss:** Use the summary to discuss the history of cold food storage. Looking at the three options mentioned; root cellars, ice boxes, and refrigerators discuss the pros and cons of each with reference to food longevity, energy input and quantity.
3. **View:** What is a root cellar? These can be large or small. Let's look at two root cellar builds: Our Simple Inexpensive Root Cellar Build (12 mins) (https://youtu.be/NedV9TPZCiQ) and How To Build A Root Cellar - Root Cellar Construction Ideas (2.5 mins) (https://youtu.be/m70ZAXm00k) (Can view at 1.5 speed).
4. **Discuss:** After viewing, discuss your area's frost line depth and what an appropriate root cellar might be for you. Why would a root cellar be a great idea for produce storage?
5. **Evaluation:**
    a. What is a root cellar? Why is it more sustainable than a refrigerator?
    b. Describe three essential elements of a root cellar design.
    c. List five vegetables that keep well in a root cellar.

    Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 2: Theri's Winter Kitchen

January Kitchen Project: Root Cellar Cook-Off

Goal(s): To engage students in planning and preparing a recipe using local produce that was preserved using cold storage.

Learning objectives:

1. Students can give examples of local produce that is appropriate for cold storage preservation.
2. Students can record a recipe in their journals.
3. Students can reflect on their group work using language that displays feelings of success or failure.

Next Generation Science Standards connections (grades 3-12):

- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *5. Earth and Human Activity: Human Impacts on Earth Systems* (5-ESS3-1) Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-4) Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- *HS. Earth and Human Activity: Human Impacts on Earth Systems* (HS-ESS3-3) Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.

Time: 45 min

Lesson supplies:

- Farm Journal
- Pens or pencils

Background review for the instructor:

- This kitchen project will require knowledge from last week's cold crop storage lesson, so feel free to review that lesson for ideas.

Overview:

A fun follow-up to your winter trip to the farmers market can include a cooking challenge using locally grown, cold storage produce; a cook off project where students, grouped appropriately, receive a bag of supplies and have 1 hour to prepare a dish for the class. Each group gets 15 minutes of research and 45 minutes of prep time. All ages love this challenge. For younger students include an adult guide in each group. Keep in mind any cooking restrictions when putting your bagged produce items together.

Procedure:

1. **Discuss:** Review cold crop storage discussed in week 1's lesson. Answer any questions or concerns.
2. **<u>Activity: Root Cellar Cook-Off</u>** (1 hour 15 mins)

   Supplies
   - Cook books and/or computers for group use
   - Hot plates
   - Cutting boards
   - Bowls
   - Grating tools
   - Knives
   - Condiments: mayo, salt and pepper, butter, olive oil, common seasonings
   - Brown bagged cold storage crops suggestions-
     - 1. Potatoes, eggs, onions and carrots
     - 2. Carrots, cabbage, parsnips and apples
     - 3. Apples, raisons, carrots
     - 4. Greens, beets, onions, nuts

   Directions
   1. Divide students into groups.
   2. Explain the challenge: Each group gets 15 minutes of research and 45 minutes of prep time to choose and create a recipe using common winter storage vegetables and fruits.
   3. Pass out bagged produce.
   4. Have students work together to complete the recipe and be prepared to share your finished dish.
3. **Evaluation:**

a. Have students record the ingredients and directions for the recipe they made with their group(these could be shared also).
b. Reflect and record what went well, what didn't and any suggestions for improvement.

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

January Kitchen Project: Easy French Fries

Goal(s): Students will learn how to make easy french fries with potatoes and sweet potatoes.

Learning objectives:

1. Students understand potatoes and sweet potatoes belong to different plant families.
2. Students learn to make french fries with only two ingredients (plus seasoning).
3. Students learn appropriate single serving sizes for french fries.

Next Generation Science Standards connections (grades 3-12):

- *3. Inheritance and Variation of Traits: Life Cycles and Traits* (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.
- *3. Inheritance and Variation of Traits: Life Cycles and Traits* (3-LS3-2) Use evidence to support the explanation that traits can be influenced by the environment.
- *3. Inheritance and Variation of Traits: Life Cycles and Traits* (3-LS4-2) Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.
- *5. Matter and Its Interactions* (5-PS1-3) Make observations and measurements to identify materials based on their properties.
- *5. Matter and Its Interactions* (5-PS1-4) Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Time: 1 hour 20 minutes

Lesson supplies:

- Farm journal
- Pens or pencils
- Fresh, washed large russet potatoes, ½ per student (regular or sweet potato)
- Olive oil, approx. 2 Tsp per 8 potatoes
- Salt and pepper to taste
- Oven, toaster oven

Background review for the instructor:

- Homemade French Fries (Crispy and Healthy) (https://www.deliciousmeetshealthy.com/homemade-french-fries/)

Vocabulary:

Dextrose: A type of sugar, the most commonly occurring form of glucose.
Fiber: The roughage of our food and the parts of our diet that our body does not absorb,

and so is removed from our body as waste.

Tuber: Underground part of a plant that is thick and can be eaten (common potato), also buds to create new plants.

Sodium acid pyrophosphate: An inorganic preservative.

Overview:

Potatoes, sweet or regular, are two of the most popular root cellar storage vegetables. Potatoes are ***tubers***; a root crop that is part of the solanaceae family. They are close cousins to tomatoes. They are a starchy vegetable. Although potatoes don't compare to greens on the health food scale they do provide some nutrients including carbohydrates, ***fiber***, vitamin C and potassium. Potatoes alone are not high in calories but their nutrients can be devalued when they are over cooked, eaten with high fat and calorie additives like butter, cheese and sour cream or peeled, because most of the potato's nutrients are right below the skin. Potatoes are cold tolerant, planted from April to June and can be harvested young as *new potatoes* in about 10 weeks. Mature thick skinned potatoes will store in the ground long after the green plant dies above ground, usually until the soil freezes. Potatoes are also the tuber seed for next year's planting. They will last all winter in a cool root cellar. Eat some and save some for seed.

Sweet potatoes are also a root crop. They are part of the morning glory family, also called the convolvulaceae family. They are easily distinguished by their bright orange flesh and sweet flavor. They are less starchy than regular potatoes and are a great source of vitamin A in addition to being a carbohydrate and a good source of fiber and vitamin C. Sweet potatoes are cold sensitive and are planted in June when the soil warms to at least 60 degrees. They are planted by slips, sprouts that are grown and harvested from a mature sweet potato. Both sweet potatoes and potatoes are grown as annuals. Sweet potatoes are said to be healthier than regular potatoes.

Before the kitchen demonstrations, the instructor should lead the class in discussion by listing what students know about both sweet and white potato plants. Consider both sweet and regular potatoes, and have students visit your root storage system to gather potatoes/sweet potatoes for this easy french fry recipe. This recipe has a significant cook time, so get back to regular work while the fries are baking.

Procedure:

1. **Ask** students how they like to eat their potatoes - create a list on the board for them to record in their journals.
2. **Discuss:** Use the overview, vocabulary and background review to share some knowledge about both varieties of potatoes, comparing and contrasting planting and growing characteristics, looks, textures, colors etc. Have examples of both potatoes available to use in your presentation and to pass around for observations before evaluation journaling.
3. **Recipe: Easy French Fries** (prep 20 mins, cook 45 mins)

   Supplies

   - Fresh, washed large russet potatoes, ½ per student (regular or sweet potato)
   - Olive oil, approx. 2 Tsp per 8 potatoes
   - Salt and pepper to taste
   - Oven, toaster oven

   Directions

   1. Preheat the oven to 375°F
   2. Wash potatoes and cut potatoes into thin fries (I prefer ¼" thick) leaving peels on. You can also use a French fry cutter for even fries.

3. Let potatoes soak in cold water in a bowl for at least 30 minutes. Remove from water and dry very well with a paper towel.
4. Toss fries with oil (just enough to coat)and seasoned salt (optional). Spread evenly in a single layer on a parchment-lined baking sheet.
5. Bake for 20 minutes. Turn the oven up to 425° and cook fries until golden, about 20-25 minutes more.
6. Wait to cool, serve, and enjoy!

1. **Discussion:** While sharing fries, I like to review the ingredients and compare them to fast food fries. Fast food fries have been known to add preservatives and addicting sugar products. A fast food french fries ingredient label: potatoes, vegetable oil (which contains canola oil, corn oil, soybean oil, and natural beef flavor with wheat and milk derivatives), ***dextrose***, ***sodium acid pyrophosphate***, and salt.
2. **Evaluation:** Have both potato types on hand for this journal entry so students can see and touch the potatoes.
    a. Do sweet potatoes and white potatoes belong to the same plant family; why or why not?
    b. Compare and contrast sweet and white potatoes - how many similarities and differences can you list?

    Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 3: Science Enrichment

Week 3 of each month features three different science focus areas: botany, zoology, and microbiology. Instructors can choose to use lessons based on their science requirements.

Botany: Plant Reproduction

Goal(s): Students will gain an understanding about the reproductive process of flowering plants (angiosperm classification) including pollination and cross pollination.

Learning objectives:

1. Students can classify flowering fruits and vegetable plants in the angiosperm classification of the plant kingdom.
2. Students can label the reproductive anatomy of perfect and imperfect flowers.
3. Students can list abiotic and biotic pollinators.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *3. Biological Evolution: Unity and Diversity* (3-LS4-2) Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *5. Ecosystems: Interactions, Energy, and Dynamics* (5-LS2-1) Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-4) Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-1) Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- *HS. Biological Evolution: Unity and Diversity* (HS-LS4-3) Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

Time: 45 min

Lesson supplies:

- Student journals
- Colored pencils and or pens
- Poster or handout of the 5 common plant families of agriculture with in the angiosperm classification (A Beginner's Guide to Vegetable Plant Families | The Seed Collection)
- Create or replicate a silhouette of a perfect flower and an imperfect flower(s) with anatomy labeling including the male and female reproductive parts.

Background review for the instructor:

- A Beginner's Guide to Vegetable Plant Families | The Seed Collection (https://www.theseedcollection.com.au/blog/a-beginners-guide-to-vegetable-plant-families#:~:text=Brassicaceae%20)
- A beautiful clip about biotic pollination and the endangerment of bees and butterflies. Make sure to preview before using (language on sex)- The hidden beauty of pollination | Louie Schwartzberg (8 mins) (http://www.youtube.com/watch?v=eqsXc_aefKI)
- Sample (many options online)- Plant Kingdom Poster by MissScience | TPT (https://www.teacherspayteachers.com/Product/Plant-Kingdom-Poster-9972078)

Vocabulary:

Seeds*:* Seeds are the mature, fertilized ovules of plants and the means by which plants reproduce. A seed is the embryo of a new plant that will grow upon certain conditions.
Plant life cycles: Plants produce seeds on different timelines; we categorize plants based on the length of their life cycle, and thus seed production.

Annuals - one growing season life cycle (seed to seed)
Biennial - two year life cycle
Perennial- more than two years

Perfect Flowers: Individual flowers that have both male and female reproductive organs.
Imperfect flowers: Plants that require two different flowers to pollinate, divided into two categories;

1. ***Monoecious***: Plants that have both male and female flowers on one plant - squash is a great example and most food plants are monecious.

2. ***Dioecious***: Plants have only one type of imperfect (male or female) flower on each plant and require a second plant to reproduce. Spinach and asparagus are well known dioecious crops.

Pollination: The means to seed reproduction in flowers. When the pollen grains unite with the ovules, fertilization occurs, and the flower produces seeds.
This is either carried out through self or cross pollination.
Self pollination: Pollination by pollen from the same flower or another flower on the same plant
Cross pollination: Pollination from another flower or plant
***Biotic pollinators*:** Mechanisms rely upon animals and can be conducted by bees, moths, bats, birds, and many other organisms.
***Abiotic pollinators*:** Mechanisms are wind and water, which can carry the pollen grains to other flowers. Common for grasses.

Overview:

Today's plant reproduction lesson starts with a review of the plant kingdoms. Most of our food comes from flowering plants- the angiosperm family. Angiosperms are further divided into ***monoecious*** and ***dioecious*** categories, which distinguish between perfect and imperfect flowers and self and cross pollinating processes. Understanding these can help us better understand the processes of plant reproduction, namely pollination and how the placement of plants to each other in our gardens can be important for reproduction.

Simply put, flowers contain sexual organs, the stamen (male) and pistil (female). The stamen has a specific part, the *anther*, that produces *pollen grains* that contain the male germ cells. The ovules of the pistil produce female germ cells. When the pollen grains unite with the ovules, fertilization occurs, and the flower produces seeds (offspring).

Monoecious flowers have perfect flowers; both male and female are present in each flower and are ***self-pollinating.*** These are the easiest flower types from which to ensure pure seed collection. Dioecious flowers do not have both male and female organs so need a second flower of the opposite sex. Dioecious plants can have both male and female flowers on the same plant, or have only male or only female flowers. The latter would require knowing you have both for produce/seed production. The most common category of food producing plants are in the monoecious category.

Procedure:

1. **Discuss:** Review the plant kingdom. The Plant Kingdom poster shows how plants are classified (by like characteristics) through 7 layers as we move from the more general characteristics to the most specific variety. Most fruit and vegetable plants come from the angiosperm (flowering) family.
2. **Review:** Plant food families- A Beginner's Guide to Vegetable Plant Families | The Seed Collection (https://www.theseedcollection.com.au/blog/a-beginners-guide-to-vegetable-plant-families#:~:text=Brassicaceae%20)
3. **Discuss:** In the angiosperm family reproduction occurs in flowers, where male and female parts exist. Seeds are produced through the fertilization process called pollination within or between flowers of the same species, known as self pollination or cross pollination. This process creates the seeds that will be next season's plantings. Without this important part of the plant life cycle (or farming seed) we could lose varieties of food forever.

4. **Discuss:** Pollination. Review the male and female anatomy of the flower as it might look in monoecious and dioecious categories. Why is knowing these flowering categories important for seed farmers? (Dioecious will need both male and female plants to be planted in proximity to each other to produce seeds).
5. **View:** What is Pollination - More Science on the Learning Videos Channel (4 mins) (https://youtu.be/Smb5ZbykWQk) , stopping the clip when the perfect flower is fully labeled with reproduction parts and have students transpose the drawing into their own farm journals being sure to include all male and female parts.
6. Continue the discussion of the importance of seed saving. Have students reflect on the endangerment of pollinators. How can we design our gardens to invite/protect important pollinators?This can be a reflection question.
7. **View:** The hidden beauty of pollination | Louie Schwartzberg (if age appropriate) and talk a bit more about sensitivities to pollinators. (http://www.youtube.com/watch?v=eqsXc_aefKI)
8. **Evaluation:**
    a. What are two defining characteristics of the angiosperm family (i.e. flowering fruits & plants)?
    b. Have students draw and label the reproductive parts of a perfect and imperfect flower.
    c. What is the difference between biotic and abiotic pollinators?

    Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Zoology: Reproduction of Chickens and Rabbits

Goal: To learn the reproductive anatomy and breeding process of rabbits (mammals) and chickens (birds).

Learning objectives:

1. Students can define animal husbandry as raising and breeding animals as a farming practice.
2. Students can explain, using correct anatomy, the reproductive practices of rabbits and chickens.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-4) Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- *MS. Biological Evolution: Unity and Diversity* (MS-LS4-5) Gather and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms.

Time: 1 hour (both lessons)

Background review for the instructor:

- Find online a reproducible reproduction anatomy poster of male and female chickens and/or rabbits to display or pass out for the appropriate lesson. This can be used as an overhead visual as well if a screen is available.
    - Hen examples- https://bitchinchickens.com/2019/08/12/chicken-reproduction-101/hen-reproductive-system/, https://backyardpoultry.iamcountryside.com/chickens-101/a-hens-reproductive-system/
    - Rabbit example- https://www.bioscience.com.pk/topics/zoology/item/418-reproductive-system-of-female-rabbit
- Reproduction in the hen: Chicken Egg Production (10 mins) (https://www.youtube.com/watch?v=5gdX04NgEMs)
- Chicken Mating: How Does that Work? (https://the-chicken-chick.com/chicken-mating-how-does-that-work/#:~:text=The%20hen%20inverts%20her%20cloaca,semen%20into%20her%20reproductive%20tract.&text=So..how%20DO%20they%20do,steadying%20himself%20with%20his%20feet)
- How To Hatch Chicken Eggs Using an Incubator (https://blog.meyerhatchery.com/2017/06/how-to-hatch-chicken-eggs-using-an-incubator/)
- The Guide to Raising and Breeding Rabbits for Meat – Mother Earth News (https://www.motherearthnews.com/homesteading-and-livestock/breeding-rabbits-zmaz70mazglo/)
- Building a Pastured Rabbit Tractor (6 mins) (https://youtu.be/BMZleocFsdU)

Vocabulary:

Animal husbandry: Raising and breeding animals as a farming practice.
Breeding: The process of mating animals to produce offspring.
Gestation: The process of development inside the womb between conception and birth, or the length of pregnancy. Average for meat rabbit gestation is 30-32 days. Average for chickens is 20 to 21 days.

Chicken reproduction vocabulary

Cloacal kiss*:* The coming together of the male and female chickens to pass semon from the male cloaca opening into the female cloaca opening. This is chicken mating.
Hen: A mature female chicken, whose reproductive organs include:

Ovule**:** The young ovum of an animal. Ovum is the egg cell in a female animal.
Oviduct**:** The tube through which an ovum or egg passes from an ovary
Cloaca: Cavity at the end of the digestive tract through which the egg comes out of the female hen also where the semon enters from the male cloaca during the cloacal kiss (mating).

Rooster**:** A mature male chicken**,** whose reproductive parts include:

Testicals**:** The rooster reproductive organs consist of two testes, each with a different duct that leads from the testes to the cloaca. The testes are located against the backbone at the front of the kidney.
Cloaca: Orifice that excretes the semon that enters the female cloaca during the cloacal kiss.

Rabbit reproduction vocabulary

Buck*:* A mature male rabbits, whose reproductive parts include:

Penis- The organ of a male rabbit through which sperm and urine leave its body.
Testes- The organ of the rabbit that produces sperm.
Sperm- The whitish fluid that carries spermatozoa, the reproductive cell of male rabbits.

Doe**:** A mature female rabbit, whose reproductive organs include:

Uterus- The female rabbit has a bicornuate duplex uterus, meaning two separate uterine horns with their own cervical canal. The two cervices open into one vagina.

Vagina- Muscular tube that leads from outer genitals to the cervix.

Mating: The act of intercourse between animals.

Intercourse: The act of penetration of the penis into the vagina.

Litter: The kits that are born from one mating, usually 4- 12 offspring.

Kits: Rabbit offspring

Overview:

On my farm I have bred both mammals and birds with my class. We rotate the study from year to year to include either rabbits or chickens as examples of these animal classifications. I will continue the ***animal husbandry*** lesson for rabbits and chickens in March and April respectively.

Breeding can be a sensitive subject.Make sure to adapt your lesson for age appropriateness. I find it goes quite well by being direct, using correct anatomy and not overlaboring the facts. While I usually use this lesson for 6th grade and older, there are times that it is natural to review mating habits with younger students who are interested.

(Theri's Tip: I find using a good anatomy poster (reproductive parts included) of rabbits or chickens helps start the conversation and gives a great visual. These lessons work well as precursors to human reproduction lessons as well.)

Procedure:

1. **Activity: Chicken Reproduction Lesson** (30 mins)
    1. Let's review all the names that classify a chicken -
        - Mature, egg laying female = hen
        - Mature, sperm producing, male = rooster
        - Immature female = pullet
        - Immature male = cockerel
    2. Hold up an egg and ask the class - How do I know if this egg has a baby chick forming inside it (come back to this in closing and candle the egg)? What has to happen for an egg to be a chick? When and where does fertilization occur? Let's look at how chickens(and most birds) reproduce.
    3. Using the chicken anatomy poster, and the vocabulary, review the chicken anatomy of both hen and roosters and then draw attention to the differences, the reproductive parts of the female, and the male chicken. Point out the opening both male and female have called the cloaca. When pointing out the reproductive parts be sure to explain the function of each. These terms will probably be new to students so writing them in their journals is a good way to follow.
    4. Many are surprised to know that eggs are fertilized inside the hens body before they are fully formed and laid. Fertilization begins when the sperm from the rooster is transferred to the female in a process called mating or in the case of chickens, the ***cloacal kiss***. Chicken cloaca kiss - Chicken Mating (30 seconds) (https://youtu.be/zYO-fB-MGXk)
    5. Watch this short video on how an egg is formed inside the female and note during the process when the fertilization occurs (egg meets sperm) - How EGGS Are Formed Inside The Chicken? (2 mins) (https://youtu.be/qsCJL11Tol0) It is worth

noting that the sperm from one chicken mating can continue to fertilize eggs for up to 10 days in the hens body.

6. Fertilized eggs will hatch after 21 days of incubation. The female will incubate the eggs by laying on them and turning them each day. She will wait until the nest is full of eggs to begin the incubation process. She keeps them moist and at about 99 degrees fahrenheit.. Ths same process can be simulated by using an incubator.
7. Chicks do not need their parents to survive. They instinctively know how to eat and drink when they are hatched. Most often farmers buy day old chicks and raise them without a mother hen.
8. **View (optional):** Raising chickens- Raising chickens 101, getting started & what they don't tell you (5 mins) (https://youtu.be/1rDArRNSDBE)
9. If you have the environment and are interested in raising chickens consider hatching them yourself; continue the discussion to include what materials are needed.
10. If you can get fertilized eggs consider doing a candling exercise to test eggs for fertilization. LED candling lights are great to use because they are so bright. You can order these through Amazon for $15, or use this easy way to candle eggs using your phone flashlight- Super Simple Way to Candle Eggs Using a Mobile Phone (6 mins) (https://youtu.be/wB8n0OiA-eE. You can finish your discussion by candling an egg.

2. Activity: Rabbit Reproduction Lesson (30 mins)

1. **Ask:** What do you know about mammal reproduction? Make a list on the board. Have students use their farm journals to take notes.
2. **Discussion**: Use the overview and vocabulary to present the reproductive anatomy of the rabbits, male and female, and the mating process.
    a. **Classifications of rabbits:**
        i. **Doe**- mature female rabbit that can reproduce, approximately 4-8 months of age(larger rabbits take longer)
        ii. **Buck**- mature male rabbit that can produces semon, approximately 6-8 months of age
        iii. **Kits** - immature rabbits
    b. Rabbits belong to the animal kingdom classification called **mammals**. Look at the cross cut visual of the male and the female anatomy posters to discuss and explain the function of the reproduction parts. The reproductive parts have familiar names as we are also part of the mammal classification.
    c. Reproduction:The doe does not have an ovulation cycle but is stimulated to ovulate by the act of intercourse. The doe is brought to the buck for intercourse - passing sperm from the male to the female through a process called mating. Male bucks mount the female and his penis penetrates the does vagina quickly passing sperm. The buck “falls off” the doe after sperm is passed.
3. **View:** The BREEDING Process. An In-Depth Lesson. Raising Rabbits for Meat. (30 mins, watch at 1.75x speed to reduce time) (https://youtu.be/WF7Yw3sNV) Rabbit meat is considered one of the most sustainable meat sources due to a number of

factors; Rabbits do not require large pastures, they eat a simple inexpensive diet, they are easy to manage and they breed quite often.

4. Explore the idea of raising rabbits at your home or school. A pasturing rabbit tractor can raise meat while fertilizing the property. See the background review section for a video on building a rabbit tractor. This is further explored in the March lesson.
5. Add some math and economics to this discussion about the cost of getting started with rabbits and the potential for profits. You always want to have potential for profit when you start a business. Discern if this could work for you as a business or a meat source for your family. Use the following information and problem solve(remember profit equals income - expenses): Is a thriving business possible? How much meat would this business produce if each kit weighs 5 lbs at harvest(after slaughter)? How many kits would be produced in year 1? How would year two's business projection look? What is the profit/loss for each kit?
   Rabbit tractor, building cost - $250.each (probably need 2)
   Small hutch for Buck. $100.
   Feed container (garbage can style, tight lid) $25.
   Breeding pair of california rabbits $100.
   Breeding schedule for year one(52 weeks) - breed female every 10 weeks.
   Average litter is 7 kits, removed from Doe at 8 weeks.
   Each kit sells for $10. at 10 weeks old
   Average feed supplement per kit 4 pounds.
   Feed cost for a 50 lb bag is $19.00.
   Labor includes help at $10/per hour at an average of 15 minutes per day.
6. **Evaluation:**
   a. What is animal husbandry, give some specific responsibilities.
   b. Have students record and label the reproductive parts of whatever animal you are studying . This can be a handout that can be affixed to a journal page.

   Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Microbiology: The Soil Biome

Goal(s): To research the organisms that make up the soil food web and their unique functions.

Learning objectives:

1. Students can name common organisms of the soil biome and their unique functions.
2. Students will advance research and writing skills by completing a research paper.
3. Students will practice presentation and communication skills when presenting a 3 minute soil biome research project to their peers.

Next Generation Science Standards connections (grades 3-12):

- *3. Biological Evolution: Unity and Diversity* (3-LS4-2) Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *5. Ecosystems: Interactions, Energy, and Dynamics* (5-LS2-1) Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-3) Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *MS. Biological Evolution: Unity and Diversity* (MS-LS4-2) Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.
- *MS. Biological Evolution: Unity and Diversity* (MS-LS4-4) Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

Time: Four 45 Min periods.

Lesson supplies:

- Access to resource books/the internet
- Note cards

Vocabulary:

Microfauna: Living creatures less than 0.1mm in size, so can only be seen through a microscope. Nematodes and protozoa belong in this group.
(Soil) Mesofauna: Invertebrates that are between 0.1 and 2mm in size, like arthropods.
Megafauna: Any living creature who can be seen with the naked eye. This group includes everything from termites and earthworms, to cows, chickens and goats.

Overview:

January is a month of research on the farm. This project can include learning research skills while discovering living organisms in the soil. Students can work in pairs or individually to conduct research and present their findings to their classmates. The depth of this research is age relevant.

Procedure:

1. **Discuss:** Review what we know so far about life on the farm, especially in the soil. What lives in the soil? Introduce the terms micro, meso, and macrofauna.
2. **Research Project: The Soil Biome** (45 min+)
   Supplies
   - Access to resource books/the internet
   - Note cards

   Directions
   1. Create a list of soil organisms that will allow for each student in the class to have a unique project. Assign or use a creative way to distribute organisms - draw names out of a container.
      Possible list:
      Miro biology: Bacteria, fungi, protozoa, nematodes, molds, actinomycetes,

Mesa Biology: Mites, sow bugs, roundworms, springtails, millipede, landsnails,
Mega Biology: Earthworm, ground beetles, row beetles, predatory mites, pseudoscorpion, centipedes, flatworms, ants

2. Introduce the preliminary steps in writing a research paper, gathering the facts. Use these questions to guide fact gathering:
    a. Introduce their organism and how it got its name?
    b. What animal family does it belong to?
    c. Find a visual of the organism, how small is it?
    d. What are its body parts?
    e. What are the organisms needs, where does it live happily?
    f. What is/are the functions of the organism?
    g. What relationships does this organism have with other organisms, the soil, animals, or us?
3. **3.** This project can include an introduction to citing resources, using a public library, formatting research or whatever research and writing skills are appropriate to the age group.
4. **4.** To stimulate creativity and interpersonal learning, students will give presentations on what they have learned. Possible presentation formats can include powerpoint, drawings, posters, hand made models, living specimens.
5. **5.** Students will take notes during each presentation to formulate a comprehensive list of soil fauna.
6. **6.** Where does each organism fit into the soil food web?

3. **Evaluation:**
    a. Draw and label in concentric circles the soil food web; what is at the center; label the general classifications and include three organisms examples in each classification.

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 4: On the Farm

Garden Design & Seed Ordering

Goal(s): Students will understand that plants have relationships to each other and to us; that by creating gardens with diversity we can include essential nutrition for humans and by placement of plants we can create greater vitality for our plants.

Learning objectives:

1. Students can connect color to nutritional components given a matching challenge.
2. Students can understand the concept of companion planting, giving examples of plants that grow better together and plants that do not grow well together.
3. Students can use math skills to estimate the amount of seed to purchase when given necessary variables.

Next Generation Science Standards connections (grades 3-12):

- *3. Biological Evolution: Unity and Diversity* (3-LS4-4) Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-5) Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-4) Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- *HS. Biological Evolution: Unity and Diversity* (HS-LS4-5) Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

Time: 45 mins

Lesson supplies:

- Seed catalogs, 1 per student (Theri's Tip: Johnny's Select Seed catalogs are great)
- Colorful companion planting chart

Background review for the instructor:

- Companion planting chart, my favorite- Companion Planting Chart - Growin Crazy Acres (https://growincrazyacres.com/companion-planting-chart/)
- Companion Planting Made Easy (6 mins) (https://youtu.be/-NLPmuXCzFY)
- The book *Carrots Love Tomatoes* by Louise Riotte.
- Super food rainbow charts (plentiful online)

Vocabulary:

Companion planting: A practice based on the science of what plants give and take from the soil, and the best ways to combine different types of plants for maximum soil health.
Germination: The period of development from a seed to a sprout.

Overview:

It's important to get your seeds ordered early. I sometimes find some varieties are already out of stock by January. Remember warmer states are already underway in their planting schedule. If you experience shortages, order your seeds earlier. Do the following lesson regardless as an example of the true work of garden planning while knowing your seeds are already safely stored. I find that students of all ages love to be involved in shopping seed catalogs. It gets the excitement started for spring and growing and tasting.

I love to use the Johnny Seeds Catalog because of organic options, colorful pictures and descriptions and a library of information on how to calculate seed needs, planting schedules and video tutorials. They are also employee owned and kind enough to ship me a box of catalogs for my class free every year.Ordering your garden seeds will require some thoughtful planning. Flesh out the particulars with your students and let them shop away.

In addition to the following lesson, seed germination testing can be done on any stored seeds you may have or acquire from donations. It is always more efficient to know you are working with viable seed before you plant. Consider this step when doing your seed inventory prior to ordering. Go through your seed collections and pull out seed packets that are older than two years. ***Germination*** rates, or seed viability, typically declines over time. This is a good reason not to over order seed. Do germination testing on 2 year old seeds to determine the percentage of viable seeds. If you have abundant seeds, have your students try starting 20 -100

seeds in a shallow germination tray to determine the germination rate in percentages. If the seeds are less abundant, test ten at a time to determine germination rates. I consider rates of less than 80% of poor quality and do not use them for direct seedings. For seed starting indoors I will use the 80% seed for one more year being sure to overseed to make up for the low germination rates. Don't throw old seeds away. Feed them to the birds or if you have an animal pasture, prodcast old seeds on top of winter snow. You might get some spring treats for your animals.
Once you know what you are low in you are ready to make a seed order.

Procedure:

1. Start this lesson with a review of the super food rainbow chart. The fruits and vegetables that are most vibrant in color will have the most nutrition and health benefits. Each color group represents a unique set of nutrients and health benefits. We need to eat a rainbow of color a day to meet our daily needs in nutrition naturally. Our seed orders should reflect this rainbow of color. When students, working in pairs or individually, fill out the order forms have them organize by color to include foods from each color group:
   Red: Fruits and vegetables, such as tomatoes, strawberries and red beans, are packed with vitamin C, vitamin A, potassium and antioxidants.
   Blue and Purple: Fruits and vegetables, including such favorites as cranberries, purple grapes, raisins and eggplant, boost urinary tract health and memory function and promote healthy aging.
   White: Mushrooms, bananas, onions and other white fruits and vegetables are good for the heart and help to control cholesterol levels.
   Orange and Yellow: Fruits and vegetables, including carrots, peaches, squash and pineapple, are also loaded with vitamin C, vitamin A and potassium. They can also boost the immune system and enhance vision.
   Green: Means lots of heart-protective potassium and vitamin K, which aids the blood clotting process. Green fruits and veggies also help to maintain vision health and strong bones and teeth. Dark green, leafy vegetables have the highest concentration of antioxidants and fiber. From: Eat a Colorful Diet- Rush University System for Health (https://www.rush.edu/news/eat-colorful-diet#:~:text=Fruits%20and%20vegetables%20get%20their,%2C%20minerals%2C%20fiber%20and%20antioxidants.)
2. Pass out a companion planting chart, introducing companion planting as another level of planning. Simply stated companion planting is based on the science that what plants take and give to the soil affects the other plants around them. It can be a positive relationship or a negative one; the greater diversity in your plantings, including flowers and herbs, the greater vitality your garden will have naturally, eliminating the need for inputs like pesticides. Review your companion planting chart together and use this chart in your seed ordering process.
3. Pass out *Johnny's Select Seeds* catalogs and have your students begin shopping with some guidelines. Have them write the guidelines in their journals before beginning.
   Examples:
   A. Assign different plant families to each student/group
   B. Require each order to reflect a rainbow of nutrition
   C. For each fruit or vegetable include at least one beneficial companion plant for that variety(tomatoes love nasturtiums, have reference charts available).
   D. Make sure your garden has at least one herb to work as a natural insecticide.
   E. Make sure your garden will have at least one flower to attract pollinators.

4. **Optional:** Add more cross curriculum practice here as appropriate to students' level of learning. Examples:
    - Alphabetize their seed order
    - Give students a certain amount of money they can spend
    - Using Johnny's catalog information on production, lbs per plant, you can add a more complex level of thought that requires students to determine the amounts of seed needed to feed their family yearly for their favorite fruit or vegetable, taking into consideration how often their family eats X, how many lbs of X per meal, how many lbs of X does each plant produce etc.
    - Ask them to buy 1 packet of each seed variety and find the total costs
    - Have students create a rainbow by cutting out the pictures of the produce they are ordering, see optional activity below.
    - Have students pull out descriptive words from each product description and give their definition of that word
5. **<u>Optional Activity: Color is Nutrition Posters</u>** (45 mins)
   This project can be done in conjunction with ordering seeds. It reminds us that we are growing foods for nutrition and that requires diversity. It also exposes students to more fruits and vegetable availability.
   Supplies
    - Farm journals and writing utensil
    - Large piece of paper/poster board
    - Markers/colored pencils etc, old seed catalogs for veg and fruit pictures
    - Nutrition books/access to computers for research

   Directions
    1. **Review:** Plants make vitamins, we get these vitamins from eating fruits and vegetables(plants). These are 6 essential vitamins for human health. They are associated with colors in our fruits and vegetables. Eating a rainbow a day ensures us all these vitamins.
       Top 5 vitamin color associations
       Red - A, C
       Orange -A, C
       Yellow - A,C
       Green - A, B, C, E, K
       Brown- B, E
       Vitamin D comes from sunshine and is found naturally in eggs, fish and some butters.
    2. Divide class into working groups. Assign a nutrition color to each working group. Have each group make a collage using food pictures from their seed catalogs or food magazines that contain that color, vitamin or combination of vitamins. List the color associated vitamins on each collage.
    3. If time allows, students can research each vitamin to make a list of its health benefits.
    4. Allow students to share their posters with the class (or teach a younger class this lesson) and display them in your eating environments - cafeteria.
6. **Evaluation:**

a. Think about colors as vitamin indicators. Identify what vitamins are present in fruits and vegetables knowing their color; include reds, orange/yellow and greens
b. Explain how companion planting works in the garden design and why we use it.

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Additional January Resources

Compiled by Jennifer Eburuoh

Grades 3-5

- **Book-** Plant Life Cycles (A True Book: Incredible Plants!) by Mara Grunbaum (https://www.barnesandnoble.com/w/plant-life-cycles-mara-grunbaum/1131055555)
    - Also available on Amazon.
- **Website-** Plant and Animal Life Cycles (https://www.generationgenius.com/plant-and-animal-life-cycle-lesson-for-kids/)
    - A website that introduces key terms in plant and animal life cycles such as germination and reproduction.
    - Also appropriate for 6-8th grade
- **Short Video-** Make a Calendar of Seeds! | Squeaks Grows a Garden! | SciShow Kids (7 mins) https://www.youtube.com/watch?v=J48m_QncBVM
    - An introductory video for younger kids to garden planning and seed ordering.

Grades 6-8

- **Article-** Inexpensive Root Cellars: 13 Literally Cool Ideas to Chill with
    - This article pairs with the "Cool Ideas for Inexpensive and Easy to Make Root Cellars" video.
    - Also appropriate for 9-12th graders.
- **Short Video-** Root Cellar off grid food storage (9 mins) (https://www.youtube.com/watch?v=ndwHbfb2niE)
    - A man gives a tour of a root cellar he built and explains his process of building it
    - Also appropriate for 9-12th graders.
- **Short Video-** Cool Ideas for Inexpensive and Easy to Make Root Cellars (15 mins) (https://www.youtube.com/watch?v=0aocW4oJEVg)
    - Can watch at 1.25x speed
    - Also appropriate for 9-12th graders.
- **Documentary-** *The Biggest Little Farm*
    - Follows a couple on an eight year journey to develop an organic, biodynamic and regenerative farm
    - https://www.uphe.com/movies/the-biggest-little-farm

Grades 9-12

- **Poem-** The Seven of Pentacles by Marge Piercy
    - Piercy evoke imagery of the natural life cycle in connection with human life
- **Book-** *Dirt to Soil: One Family's Journey into Regenerative Agriculture* by Gabe Brown
    - Tells the story of Gabe Brown and his efforts to restore the soil on his farm through regenerative agriculture; explores the negative impact of industrial agriculture on the living biology of the soil and the subsequent effect on plant and animals

    - https://bookstore.acresusa.com/products/dirt-to-soil
- **Short Video-** Regeneration of Our Lands: A Producer's Perspective | Gabe Brown
    - A TEDx Talk by Gabe Brown (author of *Dirt to Soil*) in which he addressing the state of soil in the US and his efforts to restore the land through regenerative agriculture
- **Documentary-** *The Biggest Little Farm*
    - Follows a couple on an eight year journey to develop an organic, biodynamic and regenerative farm
    - https://www.uphe.com/movies/the-biggest-little-farm

FEBRUARY

Focus: Human Health & Nutrition

Key Concepts: *Micro & macro nutrients, photosynthesis, respiration*

Think Ahead

- Plan on ordering free trees from the arbor day foundation so that you receive them in time for your March botany lesson on trees.
- I recommend doing a practice round of the sourdough bread recipe before you do it as a class (found in Week 2).

February Lesson Outline

- *Week 1 Sustainability Topic*
    - Human Nutrition and the Six Essentials (90 mins or two 45 min periods)
- *Week 2 Theri's Winter Kitchen*
    - February Kitchen Project: Easy Berry Jam (Strawberry or Raspberry)
    - February Kitchen Project: Sourdough Bread
    - February Kitchen Project: Making Butter
- *Week 3 Science Enrichment*
    - Botany: Photosynthesis and Respiration for Health
    - Zoology: Fats

    - Microbiology: The Human Biome
- *Week 4 On the Farm*
    - Seeds Arrive! Create a Working Calendar

Introduction

Producing nutritious food is at the heart of farming. February's lessons demonstrate the interconnected reality of our health. It should be easy to draw parallels and reference relations between environmental health, soil health, and animal health as you move through these lessons. Keep an image of the soil food web, an above and below ground view, posted in the learning environment this month. While the farm is covered in snow, let's look more closely at some key factors of human nutrition.

The human body relies on two categories of nutrients: macronutrients and micronutrients. Macronutrients, we need in larger quantities, include: protein (~ 30%), carbohydrates (~ 50% for growing kids), and fat (~20%), in a good ratio. Micronutrients are equally important, but needed in smaller quantities, and come in the form of essential vitamins and minerals.

Making colorful and creative posters to display in lunchroom areas can serve as resources and daily reminders on the important lessons of food and nutritional values.

Suggested February Field Trip

Visit a winter farm: microgreens, aquaponics or hydroponics would be great. Try to find one that uses renewable energy resources.

Week 1: Sustainability Topic

Human Nutrition and the Six Essentials

Goal(s): Students will understand that the human body needs water and nutrients to be healthy and sustain itself; both macronutrients and micronutrients are responsible for aiding bodily functions. Students will be able to determine the organic or inorganic status of a compound or element by the presence or absence of carbon molecules in its composition.

Learning objectives:

1. Students can define and describe six essential nutrition elements for human health.
2. Students can define how the energy of macronutrients is measured.
3. Students can define elements and compounds as organic or inorganic based on their molecular composition (carbon or no carbon).
4. Students can describe how soil influences human health.

Next Generation Science Standards connections (grades 3-12):

- *5. Energy (5-PS3-1)* Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-7) Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-3) Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-6) Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-7) Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.

Time: 90 or two 45 minute periods

Lesson supplies:

- Farm journals and writing utensils
- Research materials
- Catalogs with fruit and vegetable pictures
- Poster of the periodic table, hung in the presentation environment
- Projector, computer, or smart TV for a YouTube video
- Lightweight poster board, precut approximately 6" X 12" for flash card making (at least 1 per student)
- Colored pencils/markers
- Optional- toothpicks and marshmallows for 3D building

Background Review for the instructor:

- Harvard Review: Vitamins and Minerals | The Nutrition Source | Harvard T.H. Chan School of Public Health (https://www.hsph.harvard.edu/nutritionsource/vitamins/)
- Great nutrition posters available online- Eat Your Vitamins Poster - Vitamin and Mineral Chart Poster (https://nutritioneducationstore.com/products/eat-your-vitamins-poster-vitamin-and-mineral-chart-poster) and Soil and Human Health: Current Status and Future Needs (https://journals.sagepub.com/doi/pdf/10.1177/1178622120934441)

Vocabulary:

Macronutrients: Nutrients that provide our bodies with energy and are needed in larger amounts for human health including:
Proteins: Organic compounds made up of amino acids.Protein is found throughout the body—in muscle, bone, skin, hair, and virtually every other body part or tissue. It makes up the enzymes that power many chemical reactions and the hemoglobin that carries oxygen in your blood. At least 10,000 different proteins make you what you are and keep you that way. From https://www.hsph.harvard.edu/nutritionsource/what-should-you-eat/protein
Carbohydrates:Organic compounds of sugar or starch
Fats*: Also known as lipids,* are a fuel source for our bodies; found in meats, butters, and dairy products. Good fats store energy including vitamins A, D, E and K. There are good and bad fats. If we eat more fat than our bodies need it becomes stored as body fat.
Micronutrients: Those nutrients in human food needed in smaller amounts, including vitamins and minerals.

Vitamins*:* Naturally occurring, organic, compounds that help us grow and develop. With the exception of vitamin D they all come from plant production. They are essential for human health.

Minerals: Natural occurring elements or compounds that are inorganic. In top soil they are fine, dust like, granules having broken down over hundreds of years from large parent rock. Rocks usually contain more than one mineral.

Enzymes: Substances created in living organisms. They work with vitamins and minerals in digestion to facilitate chemical reactions. Without these, much of the plant nutrition can be lost.

Overview:

Nutrition begins in living soil. All living creatures and plants have nutritional needs that can be traced back to the soil. Nutrition is the result of soil biology (minerals made soluble by microbiology) and plant chemistry (vitamins and enzyme compounds derived from solar chemical energy/photosynthesis).

Plant varieties vary in their ideal soil composition needs. Animal life, of which we are included, is no different. Some animals are carnivores, eating only meat. The prey of carnivores are typically herbivores, eating only plant life. In this way all animals are dependent on plant life for essential nutrition.

We have studied the soil food web, which demonstrates the layers of consumers underground, and now we move our study above ground and take a look at ourselves, humans, as part of the food web. Where does human nutrition come from? Where does our food come from? Food supplies a host of different compounds that influence our health. The human body relies on two categories of nutrients; **macronutrients** include: protein (around 30%), carbohydrates (around 50% for growing kids), and fat (around 20%), in a good ratio. Within these macronutrients we find a smaller group of essential nutrients called **micronutrients**, which are essential as well but needed in smaller amounts, and include vitamins and minerals. Because our bodies can not make vitamins and minerals, we rely on the food we eat to provide these. This lesson looks at our nutrition building blocks, vitamins and minerals, the foods that provide them and how they work in our bodies.

Eating whole foods from a diverse range of food groups, with a rainbow of natural colors in fruits and vegetables, is a good way to ensure a mix of nutrition and a healthy daily diet. Vitamins and minerals are most concentrated in the fruit and vegetable food groups and should make up the majority of your plate. While the USDA suggests at least 5 servings of fruits and vegetables a day, some nutritionists suggest as much as 5-9 servings daily. What appears to be universal is that eating more non-starch vegetables is the best way to increase nutrition intake for better health.

Deficiencies in nutrition, macronutrients or micronutrients, happen when we don't eat enough foods rich in vitamins and minerals or we consume too much food with empty calories, like junk food and other highly processed foods. A diet low in nutrition will lead to disease. The following lists include essential vitamins and minerals for the human diet.

- **Minerals** -There are 16 essential minerals for human nutrition (there seems to be some discrepancy on the inclusion of several minerals including Fluoride. I have left it out here). These are divided into two groups; Macrominerals, of which we need more, include: calcium, phosphorus, potassium, sodium, and magnesium. Microminerals, of which we need small amounts, include: iron, zinc, copper, manganese, molybdenum, iodine, selenium, sulfur, chloride, and chromium.

- **Vitamins-** There are 13 essential vitamins for human health: A, C, D, E, K, and the(8) B vitamins (thiamine, riboflavin, niacin, pantothenic acid, biotin, B_6, B_{12}, and folate). All but Vitamin D is a plant derived vitamin. The bulk of our Vitamin D comes naturally from the sun but studies show smaller amounts from fleshy foods too, especially fish and eggs.. Vitamins are divided into two groups; water soluble, meaning they dissolve in water and pass easily through our body. These need to be replenished daily and include B (there are 8) & C vitamins. Fat soluble vitamins, A, D, E & K need fat to dissolve and to be used in our body(one reason we need good fat in our diet).

These vitamins are stored in our body fat and can stay with us longer. Because of this nature it is almost impossible to get too much B and C vitamins. Our body will simply eliminate the excess in our urine, that is the work of the kidneys. Because fat soluble vitamins are stored in our bodies, there is a potential to get too much. The USDA suggests a daily general allowance. You will see these labels on any processed food packages.

Procedure:

1. **Display**: The periodic table of elements in the presentation environment
2. Have students describe/define nutrition in their own words; ask them to write a definition in their journals before you begin.
3. **Discuss:** Share definitions made by students on nutrition. Share your definition and continue discussion:
    a. Introduce macronutrient categories (this should be review). Macronutrients provide us with energy, measured in calories. Our daily diets should include: protein, carbohydrates, fats (also known as lipids), and water. Ask, where do these nutrients come from?
        i. Have students write macronutrient category headings in their journals to record notes as they view this clip on macronutrients: What are Nutrients? What are Macronutrients? (7 mins) (https://youtu.be/3aeX8qQt6-g)
    b. Introduce micronutrients, vitamins and minerals. Micronutrients have no calories but are responsible for helping our body grow and function; our organs and digestive system work (Week 1 of the yearly focus will go into more detail on digestion).
        i. Have students use journals to record essential vitamins and minerals and the foods they are found in as they view: Every Vitamin & Mineral the Body Needs (Micronutrients Explained) (9 mins) (https://www.youtube.com/watch?v=gwGr4N1BcLI)
        ii. Discuss the reference to organic and inorganic nutrients. What does all organic material have in common? (CARBON molecules);- Let's look at the chemical formula of vitamins and minerals to determine if they are organic or not.
    c. **Discuss:** What is a chemical formula? Break, and continue as a second class session when appropriate.
4. **Activity: Nutrition Flashcard Project** (45 mins)

Supplies

- Research tools (books or computers)
- Paper to make flashcards
- Writing and coloring utensils
- Magazines, photos ect. for collage

Directions

1. Assign each student an essential vitamin or mineral to research and present to the class. Each presentation should include the nutrient name, the chemical formula, sketched or 3 D model, the foods this nutrient can be found in, the functions in the body it supports and the disease(s) that are caused by a deficiency. The final presentation product will be a large flashcard. Provide students with a premade flash card template for consistency throughout the class. Decide on a template that works and does not stifle creativity. For example- the front is covered with foods that are relative (collage, drawn, text depending on age and time constraints), the back of the flashcard is divided into two equal parts for 1- the chemical formula, 2- name(s) and scientific notation. You can add another level of information by color coding with the common color of foods this nutrient is associated with. Make research resources, food magazines, and old seed catalogs available to create flashcards.
2. Summary review (if time permits): The 6 Essential Nutrients You Need to Power Your Performance! (https://youtu.be/SFWCdhjT9j4).
3. Ask the class how we know which elements are organic or inorganic? What conclusions can you make from this work? (Vitamins are organic and minerals are inorganic)
4. These flashcards can be displayed or collected and used as a set for a study resource on nutrition. At some point a non-food set of the remaining elements could be made as well.

5. **Evaluation:**
    a. Name the six essential nutrients for human health?
    b. What form of measurement is used to indicate the amount of energy in a food??
    c. What needs to be present in an element in order to classify it as organic? What does organic mean in this context?
    d. How does soil influence human health; give at least two examples?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 2: Theri's Winter Kitchen

February Kitchen Project: Easy Berry Jam (Strawberry or Raspberry)

Goal(s): To learn how to cook with previously preserved, dehydrated or frozen berries.

Learning objectives:

1. Students can give two examples of berry nutrition.
2. Students can give two examples of simple carbohydrates and explain their energy cycle.
3. Students can explain methods to reconstitute dehydrated foods.
4. Students can define the aggregate fruit classification.

Next Generation Science Standards connections (grades 3-12):

- *4. Energy (4-PS3-4)* Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-7) Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.
- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-3) Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *HS. Ecosystems: Interactions, Energy, and Dynamics* (HS-LS2-3) Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

Time: 45 mins

Lesson supplies:

- Bowl for soaking dehydrated berries
- Water
- 1-½ pint container with lids (1-8 oz or 2-4oz baby food jars are great)
- Dehydrated berries
- ¾ cup mashed berries with juice (per recipe)
- 1/4 cup honey or sugar (per recipe)
- 2 Tablespoons pectin, freezer jam variety/no cook variety (per recipe)

Background Review for the instructor:

- Reconstituting dried fruits- How to rehydrate dried fruit (1 min) (https://youtu.be/kIv-psQJ0Zo)

Vocabulary:

Reconstitute*:* Adding moisture, rehydrating
Fruit*:* A plant product that grows from a single flower/ovary, with seeds inside.
Aggregate fruit*:* A plant product *that contains seeds from multiple ovaries of a single flower. In aggregate fruits like blackberries, the individual "fruitlets" making up the fruit can be clearly seen. (wikipedia)*

Overview:

This project reinforces the advantages of preserving produce in times of plenty. Review the preserving method you used and how it benefits us now. This easy jam recipe can be done with either dehydrated or frozen berries, so preparation will vary. Dehydrating is more nutritious and less energy input, so I like to use dehydrated berries if possible. In the fall we learned about dehydrating and freezing as ways to preserve our food. The berries we are using today were dehydrated, or frozen, in the summer. They were picked fresh on our farm and the moisture was removed to prevent rotting. This process extends the life of food. Strawberries might last a couple weeks in our refrigerator after we pick them, but when dehydrated or frozen they can last up to one to two years. Berries are also delicious eaten as dried fruit, so save some to try before reconstituting. Naturally sweet and chewy, they are a nutritious alternative to processed sweets. Berries are a simple sugar carbohydrate. They digest quickly and provide a short lived boost of energy.

We are going to make jam. Jam is a moist spreadable product so we need to ***reconstitute,*** add moisture back to our berries, before we begin. Reconstituting dried fruit is easy and can be done with hot or cold water. Hot boiling water works faster but cool water is still effective. I

prefer to use the cool water method because it maintains the fruit's nutrition. Remember, heating above 120 degrees starts to kill nutrients and/or enzymes. I place the berries in a bowl and add enough water to just cover them, then soak in the refrigerator overnight. If you are using frozen berries for this recipe, simply remove them from the freezer and allow them to thaw in the refrigerator a couple days before you need them. When the berries thaw or reconstitute you will notice they are flat and juicy. That juice is flavorful, so be sure to use it in your recipe.
When berries are at their ripest, they are the sweetest and have the most nutrition. Strawberries, raspberries and blackberries are high in Vitamin C, manganese, antioxidants, and Vitamin K. Berries are an important food to purchase and/or to grow organically because of their many crevices that can hold pesticides.

Strawberries, raspberries and blackberries are considered berries to you and me, but scientifically they have a special classification called ***aggregate fruit***. Aggregate fruit refers to fruits produced from numerous ovaries in one flower. They appear like lots of tiny fruits bunched together. True berries are fruits produced from a single ovary, on a single flower. They have an outer shell and the seeds grow inside the ovary which is the fleshy part we eat. In addition to other berries like blueberries, goji berries, and currants, many common fruits are in the berry family- tomatoes, cucumbers, bananas, etc.

Before the kitchen demonstrations, the instructor should lead the class in discussion by listing what students know about the plant. At this time of year you won't find these berries outside but you will be able to see the canes they grow on. Winter can be a great time to prune these. You can probably find berries fresh at the grocery store year round- this can fuel great discussion on environmental considerations of buying fruit off season, like where does it come from? What kind of energy is used to get them here? How can they be so cheap? Do they taste as good?

Procedure:

1. **Recipe: Jam (Strawberry or Raspberry)**

   Supplies

   - ¾ cup mashed berries with juice per recipe
   - 1/4 cup honey or sugar
   - 2 Tablespoons pectin (freezer jam variety/no cook variety)
   - 1-½ pint container with lids (1-8 oz or 2 -4oz baby food jars are great)

   Directions

   1. Display recipes and allow students to work at their own pace after reading through together. (*Theri's Tip:* Add some math skills by doubling up students and having them double the recipe or having students convert the recipe to ounces or grams)
   2. Wash and dry 1 jam jar with lid for each student.
   3. Prepare 3/4 cups of fruit (strawberries, raspberries, mixes). Remove any visible stems from fruit. Do not rinse, that should have been done before freezing or dehydrating. Crush berries in a flat bottom bowl (a potato masher works great for crushing). You need 3/4 cup berry mash for each recipe.
   4. In a separate small bowl mix together 2 tablespoons pectin (freezer jam/no cook variety) and ¼ cup sugar.
   5. Slowly add pectin to the berry mash while stirring constantly. When all pectin is dissolved, set the timer for 5-10 additional minutes, instructing students to stir constantly. Working in pairs helps and encourages cooperation.

6. Fill jar(s), cap hand tight and let sit for 30 minutes to thicken before refrigerating.
7. You can freeze for up to one year. If freezing, loosen the rim until the jam is frozen and then hand tighten. Remember to leave ½ inch expansion space when freezing.
8. Keep refrigerated until gone. This delicious treat is a favorite for all and makes great gift giving. Enjoy!

Evaluation:

1. Why are raspberries and strawberries classified as aggregate fruit; are there others?

a. List three nutritional benefits of eating berries?

b. How does simple sugar, carbohydrates, work in our bodies; what does the cycle of energy feel like?

c. What is an aggregate fruit?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

February Kitchen Project: Sourdough Bread

Goal: Students will enjoy baking bread together and learn how to judge bread nutrition by analyzing labels, paying attention to ingredients and nutrition breakdown, especially fiber and whole grains.

Learning objectives:

1. Students can share two facts about the history of bread.
2. Students can state the difference between leavened and unleavened bread giving two examples of leavening.
3. Students can read bread labels and analyze nutritional value based on ingredients, giving examples to support their conclusions.
4. Students can explain the general ingredients that go into bread making.
5. Students can provide a description and biochemical equation to explain the work of sourdough fermentation.

Next Generation Science Standards connections (grades 3-12):

- *5. Matter and its Interactions (5-PS1-3)* Make observations and measurements to identify materials based on their properties.
- *MS. Matter and its Interactions* (MS-PS1-1) Develop models to describe the atomic composition of simple molecules and extended structures.
- *MS. Matter and its Interactions* (MS-PS1-2) Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
- *MS. Matter and its Interactions* (MS-PS1-4) Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
- *MS. Matter and its Interactions* (MS-PS1-5) Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

Time: 90 min and overnight rising in the refrigerator **(**Consider using two lesson periods if time is limiting: 1. History and nutrition, and 2. Making bread.)

Lesson supplies:

- Gather 6 bread labels from various levels of processing of bread; best to worst. Create a handout that includes all six in random order.
- Display Poster - Science of sourdough (https://www.google.com/search?q=science+of+sourdough+poster&rlz=1C1CHBF_enUS926US926&oq=science+of+sourdough+poster&aqs=chrome..69i57j0i546l4.6793j0j15&sourceid=chrome&ie=UTF-8#imgrc=93vkXBNWEQ4QfM)
- Yeast of sourdough- https://docs.google.com/presentation/d/1nTN82-VVZQpEIyL4VXJuM7qKK1IpKSaq6i_bhIp0jVY/edit#slide=id.g1edf49a5af3_0_0

Background review for the instructor:

- The history of bread- How bread was born and its evolution in human history (https://www.technogym.com/us/newsroom/bread-history/)
- Michael Pollan's Netflix series *Cooked,* episode 3. Can be watched at 1.5 speed to cut down viewing time (50-55 minute episode). This is a great preview for students before making sourdough bread, if age appropriate and time allows.
- Capturing Wild Yeast (Yeast Water) - Nourished (https://nourishedkitchen.com/wild-yeast/) Kitchen
- Make your own sourdough starter- Sourdough bread is a microbial mystery/UNC-TV Science (7 mins) (https://www.youtube.com/watch?v=i6rdK_3_8Wg&t=1s)
- Chemistry of starter and dough posters- Sourdough Chemistry - ChemistryViews (https://www.chemistryviews.org/details/ezine/11280260/Sourdough_Chemistry/)

Vocabulary:

Ionic structure: A compound made of ions (an atom or molecule with a net electric charge)
Chemical reaction: A process that involves rearrangement of the ionic structure of a substance.
Biochemical reaction: When chemical reactions (above) take place in a living organism.
Fermentation: The chemical breakdown of a substance by bacteria and other microorganisms.
Probiotics: A substance that stimulates the growth of microorganisms, especially those with beneficial properties.
Unleavened: Made without yeast or another leavening agent.
Gut biome: Microbiology community found in our stomach that aids digestion.

Overview:

Bread dates back many centuries and is said to be one of the oldest man made foods. Even today it is one of the most popular carbohydrates eaten. There is comfort in warm bread in the chill of winter. While jam is a simple carbohydrate, whole grain breads are complex carbohydrates, meaning they provide a longer energy supply. The first breads were **unleavened**, much like the pita breads of today. One of the oldest and still popular naturally leavened breads is sourdough. Sourdough uses a natural **fermentation** process that adds nutrients, aids in grain digestion, and creates gas (CO_2) that makes the bread rise. The fermentation process is a great example of both chemical energy and biology at work; it's a **biochemical reaction.**
You will notice the biological activity when you make the sourdough starter. The microbial community is attracted from the surrounding air by the warmth and moist food source you are providing (water and whole wheat flour). The fermentation process grows good bacteria,

probiotics, that are known to improve our **gut biome**. The gut biome is the microbiol community found in our stomachs that aid in digestion and overall health. Science seems to suggest that the greater the biological diversity in our gut biome, the stronger our digestive system will be. Diversity breeds strength; what does that remind you of? Where else in nature does microbial life aid in digestion?

The chemical change in sourdough bread is demonstrated when yeast transforms the sugar (carbohydrates) in the dough into gas (carbon dioxide) and alcohol (ethanol). The trapped carbon dioxide makes the dough rise, and the alcohol produced by fermentation evaporates during the baking process.

$$C_6H_{12}O_6 \rightarrow 2\,C_2H_5OH + 2\,CO_2$$

Not all bread is created equal. Some breads are highly processed, coming from wheat that is stripped of its nutrients and then mixed with chemicals and sugars in order to extend the bread's shelf life. These have given bread a bad name and have caused many human allergies. Highly processed white bread (think Wonder Bread) has many additives including sugar and is a simple carbohydrate with very little, if any, nutritional value.

Bread doesn't need preservatives or sugars to be delicious. It can be made with whole grains that provide long term energy, complex carbohydrates, and fiber a necessary part of our diet. **Fiber** is the bulk or roughage in our food. It helps keep the large intestines walls clean and helps excrete waste from our systems. When shopping for better breads read the labels and look for breads that have high fiber, low sugar, and whole grains. Nutritionally speaking, whole grain sourdough is one of the best bread choices for health.

Although this recipe looks complicated, it is not. But I do think it is important for the teacher/leader to do a practice round if you have not made this bread before. It will work out any kinks and make you much more comfortable in the demonstration.

Procedure:

1. **Discuss:** Ask the class what they know about the history of bread, consider watching a video about this. Review the terms chemical reactions and biological reactions, giving examples of each. Ask students- What do you suppose a biochemical reaction would mean?
2. **Review:** The process of sourdough bread making before you begin Light Whole Wheat Sourdough (7 mins) (https://www.youtube.com/watch?v=r-MmIM5HgtY) Students could record the recipe in their journals as they follow along.
3. **Recipe: Sourdough bread**
    a. Have the sourdough starter prepared and ready before beginning this recipe/lesson. It could be started a week in advance as a class project - feeding daily until using. This is a great observation on anaerobic biological activity. Make sure to make enough starter for the number of recipes you will make. This bread making activity can be done as a demonstration or hands on project.
    b. Choose a day when you have time to take several breaks during regular work to fold the dough up to 3X before storing overnight. Sourdough is more involved than other breads but provides rich education that makes the time well worth it. If this won't work for you there are many other nutritious bread recipes to choose from, leavened or unleavened, that keep a focus on whole grains.
    c. Make the dough and set aside for 1 hour; follow the steps for folding and stretching below (as viewed on video).

d. Make your last folding at the end of the school day and place the covered dough in the refrigerator to rise overnight.
e. Follow recipe below:

Supplies

- Kitchen Scales for weight measurement(weight can be converted to volume to add some math)
- Bread scraping tool (optional)
- Large Bowl
- Extra flour for surface

Light whole wheat Sourdough Bread

Taken from The Clever Carrot by Emile Rafa

Ingredients:

- 50g bubbly, active starter
- 350g – 375g warm water (80–85 F)*
- 400g bread flour
- 100g whole wheat flour
- 9g fine sea salt

Make the Dough (see Light Whole Wheat Sourdough for demonstration).

Combine the sourdough starter and water in a large bowl. Add the flour and salt. Mix with a fork and then finish by hand to fully incorporate the flour. It will feel very wet and sticky. Cover with a damp towel or wrap and let rest for 1 hour on your countertop, returning to the bowl after the first 30 minutes to work the dough into a rough ball.

Bulk Rise with Stretch and Folds

- After the dough has rested for 1 hour, do your first fold.
- Gather a portion of the dough, stretch it upward, and fold it over toward the center of the bowl. Give the bowl a 1/4 turn and repeat 3 more times, stretch and folding the dough to come full circle around the bowl (4 folds = 1 set). If the dough still feels slack after the 1st set, do an additional 4 folds around the bowl to tighten the dough.
- For best results, do 4 sets total spaced 30 minutes apart resting the covered dough in a warm spot in between each set (see tip below). Notice how the dough will tighten after the 4th set. See video for technique.
- When finished with the folds, cover the bowl and continue the bulk rise (untouched) at 75-78 F for about 2-3 hours. The dough is ready when it has almost doubled in size. Wrap and chill the whole bowl overnight; the dough will continue to rise only slightly in the fridge.

Shape the Dough

- The following morning, make sure the dough has **doubled in size.** If not, give it more time to bulk up, if needed. This is important to build strength.
- Line a small bowl with a cotton or linen cloth. Sprinkle with flour. You're going to shape the dough twice to build extra strength.

Preshape

- Remove the cold dough onto a floured surface. Let rest for 10-15 minutes to take some of the chill off. Shape the dough into a loose ball using the envelope technique. Starting at the top of the dough, stretch and fold it over toward the center. Then stretch and fold the bottom of the dough toward the center. Repeat on

the left side…and then the right side. Using a bench knife, scoop up the dough and flip it over so the smooth side is facing up. Cover and rest for 20-30 minutes.

Final Shape

- After the dough has rested, flip it over again (the smooth side should be facing down now). Shape it again following the steps above. Flip it back over. With floured hands, gently cup the dough and pull it toward you in a circular motion to tighten its shape. Place the dough into the lined bowl, seam side up. Cover with the cloth overhang.

Second Rise

- Rest in the warm spot you used earlier for 30 minutes to 1 hour. The dough is ready when it looks puffy and has risen slightly, but has not yet doubled in size. The dough should not be very cold prior to baking.
- Preheat your oven to 450 towards the tail end of the second rise.
- Cut a sheet of non-stick parchment paper to fit the size of your baking pot, leaving enough excess around the sides to remove the bread.

Score the Dough

- Place the parchment over the dough and invert the bowl to release. Sprinkle the dough with flour and gently rub the surface with your hands. Using the tip of a bread lame, small, serrated knife or a razor blade, make four shallow 4-inch long cuts at 3, 6, 9, and 12 o'clock around the dough. Use the parchment paper to transfer the dough to the baking pot.

Bake the Dough

- Bake the dough on the center rack for 20 minutes, covered. Remove the lid, and continue to bake for 40 minutes and golden brown.
- When finished, transfer to a wire rack. Cool for 1 hour before slicing, for best texture.

4. After making the bread dough and sitting aside for the first rise, discuss the simple ingredients of a good bread recipe and the value of whole grain vs processed grains as a better choice for health.
5. Introduce fiber as a key ingredient for a healthy bread choice. Fiber and whole grains have a positive relationship. Make sure to discuss the benefits of whole grain- fiber and nutrients. Optional viewing: White Bread vs. Whole Wheat (Grain) (3 mins) (https://www.youtube.com/watch?v=418KSrmpMwc).
6. Distribute the handout that includes varying bread labels. Which do you think are better choices and what do you base that choice on? (ingredients, fiber, nutrition profile, packaging).
7. For planning remember: The temperature of the dough environment will affect how fast or slow it rises. Try to get at least three fold sessions in before the end of the day. End with the final rise in a refrigerator.
8. After making, baking and tasting bread, have students journal on the evaluation questions and reactions to sourdough texture and flavor.
9. If your day allows, make butter (next recipe) to go with your fresh bread.
10. Sample schedule for making sourdough during the school day.
    - 9 AM: Mix the dough/Rest for 1 hour
    - 10:30 AM: 1st Stretch and Fold
    - 11 AM: 2nd Stretch and Fold
    - 11:30 AM: 3rd Stretch and Fold

- 12 PM: 4th Stretch and Fold
- 1pm PM: Bulk rise for 2-3 hrs @ 75- 78 F
- 3pm PM: Cover and chill the bowl overnight in the refrigerator
- 8:00 AM (the following morning): Shape, preheat oven to 450
- 9:00 AM Bake

11. **Evaluation:**
    a. What are two facts about the history of bread?
    b. What is the difference between leavened and unleavened bread? Give two examples of leavening.
    c. What are the general ingredients that go into bread making?
    d. What is the biochemical equation going on during sourdough fermentation?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

February Kitchen Project: Making Butter

Goal: Students will learn an age old manual process of making butter from whole cream and understand the nutritional benefits of fats in our diet.

Learning objectives:

1. Students can describe steps for making butter from whole cream.
2. Students can categorize butter as a macronutrient; fat.
3. Students can list three benefits of butter eaten in moderation; dissolve and store vitamins(A,D,E and K), and store energy.
4. Students can explain the concepts of pasteurization and homogenization

Next Generation Science Standards connections (grades 3-12):

- *5. Matter and Its Interactions* (5-PS1-4) Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-7) Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.
- *MS. Matter and its Interactions* (MS-PS1-2) Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
- *MS. Matter and its Interactions (MS-PS1-3)* Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Time: 45 min

Lesson supplies:

- Fresh raw milk with fat intact (unprocessed- not pasteurized or homogenized) OR combine ½ quart of milk and ½ quart of whole cream
- Clean jars with lids

Background review for the instructor:

- An argument for pasteurization: What is Pasteurized milk? | Ask Organic Valley (3 mins) (https://youtu.be/nB-jOi_bO0w)

- An argument against pasteurization and homogenization: Raw Milk: Is It Good or Bad?-Transformation TV-Episode #014 (5 mins)
  (https://www.youtube.com/watch?v=OkSDm710vx0)

Vocabulary:

Whey: The watery part of milk that remains after the formation of curds
Buttermilk: The slightly sour liquid that is left after butter is churned
Dairy product: Containing or made from milk.
Pasteurization:A heat treatment aimed at reducing harmful microorganisms in our milk.
Homogenization: This process uses heat and pressure to separate cream molecules and mix them with the milk in a way that they will not separate.

Overview:

Like bread, butter has been part of our food history for hundreds of years. Butter is made from the cream of animal milk, usually cow or goats. It is a dairy product that is known for containing high levels of fat and calories. For a long time butter was thought to clog our arteries and restrict blood flow but science now informs us that butter is actually quite good for us if eaten in moderation, 1-2 Tablespoons a day for adults. Butter can be part of the 20% fats we need daily for health. Butter can be more or less nutritious depending on how it is made and what the cows diet includes. Cows that are raised on pasture will produce a better vitamin rich fat in their cream than confined cows, including vitamin A, B12, D and E. Butter that is homemade is found to be healthier because it eliminates some of the mechanical processes of commercially produced butter. Enjoying butter in moderation may be linked to a lower risk of obesity, diabetes, and heart problems.

- Vitamin A. It's the most abundant vitamin in butter. One tablespoon (14 grams) provides about 11% of the Reference Daily Intake (RDI)
- Vitamin D. Butter is a good source of vitamin D.
- Vitamin E. A powerful antioxidant, vitamin E is often found in fatty foods.
- Vitamin B12. Also called cobalamin, vitamin B12 is only found in foods of animal or bacterial origin, such as eggs, meat, dairy products, and fermented food.
- Vitamin K2. A form of vitamin K, this vitamin may protect against heart disease and osteoporosis.
  Taken from Healthline nutrition: Butter 101: Nutrition Facts and Health Benefits
  (https://www.healthline.com/nutrition/foods/butter#vitamins-and-minerals)

To me, raw milk produces the best butter, flavor and consistency, but is not practical for all learning situations as raw milk is illegal in some states. Raw milk is unprocessed, no pasteurization or homogenization. Some people believe milk allergies are so high because of these heated processes which kill the milk enzymes that help our bodies absorb the nutrients. While your students are shaking and passing the cream/butter have a discussion about these processes. If we apply our knowledge of what heat does to other food we could infer that raw milk would have more nutrition and enzyme activity and therefore be better for us. This is a hard discussion to have in a classroom, especially since students are not usually in charge of their food purchases, however presenting both sides of the argument is appropriate.

Procedure:

1. **Recipe: Butter**
   Supplies
   - Purchase fresh raw milk from a farmer with fat intact (unprocessed- not pasteurized or homogenized) or create the illusion of doing so by combining ½

quart of milk and ½ quart of whole cream (can be whipping cream) in a glass milk jar and allow this to sit overnight to separate.

- Clean jars to shake cream in; this can be done in small groups or individually so the number of jars will vary; make sure jars have a secure lid that won't leak.

Directions

1. Use the summary and vocabulary for your introduction to milk, cream and making butter
2. Wash and dry the jar and lid.
3. Use a turkey baster to remove the layer of heavy cream that has floated to the top of the milk in the jar. One jar can be shared by the student group for shaking or it can be divided into numerous jars for sharing in small groups. Ask students why the cream is separated from the milk(fat floats)?Screw the lid on tightly
4. Shake the cream (usually about 10 minutes of constant hard shaking) until the butter forms a solid yellow ball and is sloshing around in some liquid.
5. Pause shaking to remove the liquid (whey/buttermilk) from the jar and save it for your animals or baking. The butter can be used as is right away, but for longer storage proceed with the following steps.
6. Add enough cold water into the jar to cover the ball of butter. Then replace the lid and shake until the water gets cloudy. Remove that water and replace it with new cold water. Repeat the steps until the water is clear. This removes the excess whey/buttermilk from the homemade butter.
7. If you won't be using the butter right away you can shape it and store it in the refrigerator for future use.
8. Wrap tightly with plastic wrap and store in the fridge for a few weeks or in the freezer for a few months. Enjoy!
9. **Evaluation:**

a. How is butter made, list the supplies and steps involved.
b. Is there any nutritional value to butter; if so what is it?
c. Explain the processes of pasteurization and homogenization?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 3: Science Enrichment

Week 3 of each month features three different science focus areas: botany, zoology, and microbiology. Instructors can choose to use lessons based on their science requirements.

Botany: Photosynthesis and Respiration for Health

Goal(s): Students will understand that the sun provides the energy to fuel all life.

Learning objectives:

1. Students can describe photosynthesis and respiration using a chemical equation.
2. Students can explain the food chain and the dependency on the sun to fuel the food system.

3. Students understand soil provides minerals to plants and plants use chemical energy (sun) to break bonds and create new nutrients including vitamins and enzymes.
4. Students understand the role of enzymes in digestion.

Next Generation Science Standards connections (grades 3-12):

- *4. Energy* (4-PS3-4) Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- *5. Energy (5-PS3-1)* Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-6) Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-7) Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

Time: 45 mins

Lesson Supplies:

- Farm Journals and writing utensil
- Poster of the Periodic Table of the Elements on display in presentation environment
- A poster or manikin of a human digestive system

Background review for the instructor:

- Soil food web posters; many options online - https://www.google.com/search?q=the+soil+food+web+diagram&rlz=1C1CHBF_enUS926US926&oq=the+soil+food+web&aqs=chrome.1.69i57j0i512l3j0i22i30l2j0i22i30i625l4.7023j0j15&sourceid=chrome&ie=UTF-8#imgrc=3Hz2J-XfBKHKJM
- Food chains vs webs: Food Chain | Food Web | Video for Kids (4 mins) (https://youtu.be/FFloV2J-eKI)

Vocabulary:

Enzymes: Are large proteins produced in living cells of plants, animals and microorganisms which provide the necessary energy to digest nutrition compounds. They are killed by heat above 118 degrees which is why overcooking food limits its nutritional value. Nutrients can be present but indigestible when enzymes are not present.

Food Chain: A system that shows the levels of consumers; a simple chain of what eats what.

Food web: A food web is the natural interconnection of food chains and a graphical representation of what-eats-what in an ecological community (Wikipedia). When this web is focused on consumers below the ground we refer to it as the soil food web.

Overview:

While the snow covers our gardens the soil food web is alive and working. The microbial life is busy digesting carbon and soil minerals. Spring plants will take in these soluble minerals primarily through their root systems. Plants need minerals to produce chlorophyll and carry out photosynthesis, the process by which they convert sunlight into usable energy, carbohydrates; sugars. This energy includes compounds called phytonutrients, vitamins and enzymes which allow the plant to grow and be healthy while producing fruits and vegetables that will contain these nutrients also. Minerals come from the soil. Vitamins and enzymes are made by plants.

Plant health is dependent on a number of elements that come from the air, water and soil. Plant health and human health are closely related. Can people survive without plants? Can plants survive without the sun? Let's look at how plants work-

Procedure:

1. **Review:**
   Spend 15 minutes reviewing to set the stage for the lesson that will build on this review. The periodic table of elements; some of these elements are essential for growing plants.
   View: Plant Nutrients (9 mins) (https://youtu.be/FFloV2J-eKI)
   The living soil is responsible for digesting minerals(making them soluble). Can you name some of the soil life responsible for this, think soil food web. Review these creatures by drawing three layers below the ground on the board demonstrating the three levels of soil consumers, digesters. Remember to include the ground level food source of carbons. I always like to remind students that these layers of fauna can not exist independent of the layer below them. If worms are present in your soil then all three layers exist (This is a simple and free soil test for biological activity).
   The food chain also exists above the ground and includes animals. Add these layers above the ground and include plants, plant eaters and meat eaters. Use lines and arrows to demonstrate the chain of events in this circular system of consumers- who remembers what this system is called - The carbon cycle.
   Photosynthesis and respiration are two important processes that contribute to health and the carbon cycle. Reviewing these every year is a good practice; adding details at each level of learning.
2. Watch an age appropriate review of photosynthesis and respiration: Photosynthesis & Respiration | Reactions | Chemistry | FuseSchool (6 mins) (https://www.youtube.com/watch?v=3XIyweZg6Sw&t=2s)
3. Have students record the chemical equations for Photosynthesis and respiration in their journals. What observations can we make? What is alike and different about the equations?
4. Food Chains - Ask students to think about this film and the role of food (energy): draw a picture in your journals that demonstrates multiple food chains (who eats what). In a food chain we can see how carbon (review definition) changes but never goes away.
5. **Ask:** How does the sun fuel all food chains: why do all animals need plant life; why must soil be alive with fauna to create fertility for the next lifecycle; what is this cycle referred to? This is the carbon cycle.
6. **Watch:** (As review if time permits) Food Chain | Food Web | Video for Kids (4 mins) (https://youtu.be/FFloV2J-eKI)
7. **Evaluation:**
   a. What is the chemical equation for photosynthesis and respiration?
   b. Draw a diagram to represent how photosynthesis and respiration work; remember to include all inputs and outputs in this food chain.
   c. What are enzymes and how do they aid in digestion?

   Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Zoology: Fats

Goal(s): Students will learn the nutritional value of unsaturated fats including omega 3's and 6's and foods that are good sources for these nutrients including eggs.

Learning objectives:

1. Students can list two positive functions of fat in our diet.
2. Students can label a cross cut diagram of the raw egg, noting these parts: shell, membranes, air cell, albumen, chalazae, vitelline, and egg yolk.
3. Students can list at least three characteristics of a raw egg that reflect its nutrition and freshness.
4. Students can give two examples of health benefits of diets with appropriate amounts of fat and possible health problems from overeating fat.
5. Students can give two examples of foods rich in omega 3's & 6's.

Next Generation Science Standards connections (grades 3-12):

- *5. Energy (5-PS3-1)* Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-6) Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-7) Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.
- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-6) Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-7) Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.

Time: 45 mins

Lesson supplies:

- Farm fresh raw eggs, at least 2 per participant
- Commercial grade eggs, 1 per person
- Non porous plates, 1 per student
- Pot and hotplate for preparing soft boiled eggs
- Poster of a cross cut diagram of a raw egg anatomy (online poster)

Background review for the instructor:

- About fats: Types of Fat – The Nutrition Source (https://www.hsph.harvard.edu/nutritionsource/what-should-you-eat/fats-and-cholesterol/types-of-fat/#:~:text=Even%20healthy%20foods%20like%20chicken,oil%2C%20and%20palm%20kernel%20oil)
- About egg anatomy- The Parts of an Egg & Their Purposes | Sauder's Eggs (https://www.saudereggs.com/blog/the-different-parts-of-an-egg/)
- How an egg develops in the hen- Chicken Egg Production (10 mins) (https://www.youtube.com/watch?v=5gdX04NgEMs)

Vocabulary:

***Fats**:* A natural oily substance in animal bodies, deposited as a layer under the skin and around certain organs

***Omegas 3 fatty acids**:* Omega-3 fats are an important type of unsaturated fat. The body can't make these, so they must come from food.

Omega 6 fatty acids: A family of fats found in plant oils and seeds that play an important role in brain function and growth and development.

Vitamin A: A compound made in plants and found in orange and green vegetables, helps support healthy eyes and immunity.

Vitamin D: A compound necessary for strong bones, and is found in eggs and fish but is more commonly gotten from sun exposure.

Vitamin E: A compound made in plants with antioxidant properties that protects human tissues and boosts immunity; found in nuts, seeds, and green leafy vegetables.

Overview:

The human body needs fat to operate properly. Fat in our diet helps us to absorb vitamins and minerals, maintain and store energy. Fat should make up about 20% of our meals according to the USDA guidelines. Fat is divided into two main groups; saturated and unsaturated. Unsaturated fat is the healthier group and contains the essential fatty acids known as Omega 3's and 6's. Saturated fats tend to be solid at room temperature and come mainly from animal sources, while unsaturated fats are usually liquid and mostly from plant sources. Because of their solid form, saturated fats, when overeaten, are known for clogging our arteries. All fats should be eaten in moderation and should come from the unsaturated variety whenever possible.

Our bodies require omega 3 and omega 6 fatty acids to function properly. We do not make these so we must get them directly from our food. Good sources of omega 3's include flaxseed oil, chia seeds, walnuts, flaxseeds, walnut oil, canola oil and soybean oil. Fats that have low amounts of omega 6 include butter, coconut oil, lard, palm oil and olive oil. Sunflower, corn, soybean and cottonseed oils are high in omega 6 and should be eaten less frequently. Omega-3s support good blood flow. Blood flow is associated with better performance in "thinking" tasks. Good blood flow supports memory and may decrease the risk of developing dementia or Alzheimer's disease. Omega 6's are important as well and have been shown to decrease heart problems by lowering inflammation, when eaten in moderation. A healthy ratio of 3's to 6's is 4 to 1. We need to eat more omega 3's than omega 6's. Most people get plenty, or too much, of the 6's but not enough of the 3's. Adding omega 3's to your diet is important. Two good sources of omega 3's are fish and eggs. The following lesson explores eggs.

Eating eggs can be an affordable and good source of unsaturated fat, including lots of omega 3's. Unfortunately not all eggs are created equal. How hens are raised affects the nutrition of their eggs. Chickens that are raised on pasture with a natural and varied diet have been shown to produce eggs with less cholesterol and saturated fat then their counterparts and more omega-3 fatty acids, and vitamins A, E, and D. Some say these eggs make cakes fluffier and omelets more delicious! Let's take a closer look at eggs and some ways we can judge their quality.

Procedure:

1. **Discuss:** Use the summary and vocabulary to have a discussion about fats and fatty acids; omega 3's and 6's. What foods provide a good source of Omega 3's? Eggs are an easy and affordable choice. Have some on hand.

2. **View:** **A video about raising chicken eggs**
   https://www.google.com/search?q=youtube+about+pasture+raised+eggs&rlz=1C1CHBF_enUS926US9#fpstate=ive&vld=cid:947721e7,vid:4lXYhoBPwIY,st:0
   (*Theri Tips* - play speed at 1.5 to reduce length of video)
3. **Experiment:** Eggs have a porous shell and overtime air will flow through the shell and gather in the air sac inside the egg. Point out on the egg anatomy poster where the air sac is located. Knowing this location and what you know about air and water, can you hypothesize what will happen when a fresh (no or small air sac) egg is dropped into a reservoir of water? Try this with a variety of eggs including the best- farm fresh and the worst-older factory farmed. Have students journal their hypothesis and conclusions:
   a. If the eggs sink on their sides, they are very fresh. If they sink in the upright position or tilted, they are older, but still okay to eat. If they float, the egg is too old to use, regardless of expiration date. We know that nutrition is strongest closest to the day of harvest- what can you hypothesize about sinking and floating eggs?
4. **Activity: Egg Anatomy & Taste**
   a. Have students work in pairs. Crack a farm fresh egg on one plate and an older commercial egg on the other. Remind students not to touch the eggs until we are finished or they won't be able to distinguish the parts we will be looking at. Use your egg anatomy poster as a guide and have students use their journals to record the following observations, for each, as you lead them through the anatomy exercise:
      i. **Shell**- Notice the thickness and hardness
      ii. **Membranes**- Using the pointed ends, can you find the two layers of membrane inside the shell and if so describe. The fresher an egg is, the stronger this material is.
      iii. **Air cell**- Located at the wider end of the egg between the two membranes. Is it intact, and if so, how big is the space where the air is trapped? (Compare the two ends)
      iv. **Albumen**- The clear, thick, water like liquid around the yolk. There should be a thick area closest to the yolk and then a thinner amount outside the thick area. The thicker albumen is more present the fresher the egg is. As the egg ages the albumen thins out. Compare and contrast these two eggs with regards to the thick and thin albumen liquid.
      v. **Chalazae-** A twisted, milky colored material on the sides of the yolk. This material holds the yolk centered in the albumen (to protect the yolk if and when it would be fertilized and become a growing chick). Note if you can find these in each egg.
      vi. **Yolk-** The yellow/orange ball in the center. The yolk is where the majority of nutrition is located. Healthy hens lay eggs with many vitamins and minerals including vitamins A, B's, D, E and K. Minerals include calcium, iron, magnesium, phosphorus, potassium, sodium, zinc.
      vii. Compare and contrast the yolks to each other. A brighter orange indicates more nutrients in the yolk. Compare the color of the yolks; can you make any assumptions?

viii. **Vitelline membrane**- The membrane around the egg yolk. It holds the yolk together. This too thins out over time and is more easily broken when the egg ages. If your yolk is whole, use your finger to gently move the yolk around to see how the inner liquid is held together by the vitelline, but try not to break it.

b. End your experimenting with a taste test or a comparison taste test. Soft boil eggs or hard boil eggs enough for everyone to try, whole or halved. (*Theri's Tip:* I like to soft boil for higher nutrition. I have a 7 egg steamer that does both methods. It is easy to boil or steam eggs in a large pot. I steam by starting with two inches of boiling water, placing eggs on the bottom, single layer. Cover and steam for 6 minutes for softer and 12 for firm yolks. Others tell me using an Instapot saves time and makes fresh eggs easier to peel.) For soft boiled eggs, make sure to cool right away to stop the cooking. Students can pay attention to the air sac effect on the egg shape when peeling.

5. **Evaluation:**
   a. What nutritional elements do chicken eggs provide?
   b. Ask students to label a cross cut diagram of a raw egg, noting these parts: shell, membranes, air cell, albumen, chalazae, vitelline, and egg yolk. They can draw the diagram or a photocopied diagram can be passed out and affixed in their journals.
   c. List three characteristics of a raw egg that reflect its nutrition and freshness.

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Microbiology: The Human Biome

Goal(s): Students will gain an understanding of the microbial community that makes up the human biome and the important role it plays in digestion.

.Learning objectives:

1. Students can define the term gut microbiome and associate it with the digestive system.
2. Students can give two examples of the role of the gut microbiome in the intestines (influences metabolism and protects from pathogens)

Next Generation Science Standards connections (grades 3-12):

- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-3) Use arguments supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-1) Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-2) Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-3) Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Time: 45 mins

Lesson supplies:

- Display a poster or manikin of a human digestive system. I have an apron that has velcro organs that work great for looking at parts individually. Use an age appropriate visual.

Background review for the instructor:

- The Invisible Universe Of The Human Microbiome (6 mins) (https://youtu.be/5DTrENdWvvM)

Vocabulary:

Human biome: A community of microorganisms that live on and throughout our bodies.
Gut microbiome: A microbial community that lives in the digestive system, especially the intestine tract.

Overview:

Digestion is important because your body needs nutrients from food and drink to work properly and stay healthy. The six essential nutrients for human health include proteins, fats, carbohydrates, vitamins, minerals, and water. Your digestive system breaks nutrients into parts small enough for your body to absorb and use for energy, growth, and cell repair.

- Proteins break into amino acids
- Fats break into fatty acids and glycerol
- Carbohydrates break into simple sugars

The digestive system is made up of the gastrointestinal tract, also called the GI tract or digestive tract. The GI tract is a series of hollow organs joined in a long, twisting tube from the mouth to the anus. The hollow organs that make up the GI tract are the mouth, esophagus, stomach, small intestine, large intestine, and anus. The liver, pancreas, and gallbladder are the solid organs of the digestive system. They aid in digestion but do not carry food.
Our digestive system is at the heart of our overall health; physical and mental. It relies on the macro and micro nutrients we have introduced this month but also needs a healthy set of microorganisms to facilitate the work of the intestines especially. We refer to this community of beneficial microbiology as the gut biome.

Procedure:

1. Pass out a picture that outlines the human digestive system (easy to find on google). Explain the project: As you introduce each part of the digestive system organs students will color, cut and paste each to a page in their farm journals and label them. Choose a different color for each, and pause between introductions to give students time to color, label and describe in writing. Students can use the left page for headings and descriptions and the right page of the open journal for the colored and labeled digestive system.
2. **Activity: The Human Digestive System**
   Procedure
   1. Introduce the digestive system poster or manikin and use it for reference in your presentation while presenting these important steps in human digestion:

   Food passes through the digestive system in the following order:
   a. **Mouth -** Food is taken in and chewed up into small pieces called bolus.

b. **Esophagus -** A large muscular tube that connects the mouth (also known as pharynx) to the stomach. From the mouth the bolus enters the esophagus and is pushed, in wave-like motion, to the stomach. Have students squeeze a cooked bean through a straw to experience the work of the layers of muscles that move food through the esophagus. The mouth and the esophagus are responsible for mechanical digestion.
c. **Stomach -**The stomach receives the bolus and contracts acids and enzymes while churning the bolus into a liquid mixture called chyme. This is a chemical change. The chyme is next passed to the small intestines. This next section of the digestive system is called the **intestinal tract** and includes the small and large intestines, the rectum and anus. This is an area where the gut biome is especially important to support digestion. Let's take a look at the parts and also the role of the gut biome.
d. **The small intestine** receives the chyme and adds juices from the pancreas, liver and intestine to further break down food while absorbing nutrients and moisture including: water, vitamins, minerals, carbohydrates, fats and proteins into the bloodstream. The small intestine continues to move undigested food along to the large intestine.
e. The **large intestine** includes the colon, rectum, and anus.
    i. **Colon-** The large intestine, also known as the colon, receives any undigested food from the small intestine. Most, if not all nutrition has been removed by now. The colon continues to transport undigested material while absorbing any water and salts (electrolytes) and using mucus and bacteria to help ferment and store the resulting feces, which is next delivered to the rectum.
    ii. **Rectum -** The rectum receives the feces and holds it until elimination occurs through the anus.

2. View and discuss: The Invisible Universe Of The Human Microbiome (6 mins) (https://youtu.be/5DTrENdWvvM) Have students take notes on the important role of the gut biome. (Defense for germs/pathogens, can spew out antibiotics, protects the immune system, regulates metabolism, ect.)

3. Discuss: How can we help grow our gut biome community? (Lots of fresh/living plant based food and fermented foods).

4. Evaluation

a. What is the gut microbiome and where does it exist in our bodies?
b. What are two examples of the gut microbiome's functions in our intestines?
c. How can we care for and create a healthy gut biome?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 4: On the Farm

Seeds arrive! Create a working calendar

Goal: Students will engage in designing a working calendar that defines the timeline of work involved in growing annual food production from seed to harvest.

Learning objectives:

1. Students can define succession planting and give an example.
2. Students can format a work timeline for the planting and care of an annual garden, given an informative seed packet with regards to seed starting, planting, and harvest dates.
3. Students can recall local average first and last frost dates.
4. Students can choose good and bad companion plants for an assigned vegetable based on a proven and developed companion planting chart.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-4) Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- *HS. Ecosystems: Interactions, Energy, and Dynamics* (HS-LS2-1) Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- *HS. Ecosystems: Interactions, Energy, and Dynamics* (HS-LS2-2) Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Time: 45 min

Lesson supplies:

- Blank calendar packets including each month in your growing season(for me it's Feb - Dec). Print a letter size calendar for each month and staple each set together at top left corner. This will be used for charting and taking plant specific notes for each student.
- Seed packets (that you will be planting together)
- A good general resource book (I like Rodale's *Encyclopedia of Organic Gardening*)
- A companion planting guide: https://growincrazyacres.com/companion-planting-chart/
- Seed catalogs

Background Review for the instructor:

- Season Planning: Growing Ecological Eaters (3 mins) (https://www.youtube.com/watch?v=8buqBaS5uSA)
- Seed storage can be done by taxonomy classifications but I prefer common planting similarities. **Plant families based on taxonomy:**
    - ***Umbelliferae Family:*** plants that have flowers in the shape of umbels. dill, carrots, celery, cilantro, fennel, parsley.
    - ***Lamiaceae Family:*** plants that are highly fragrant, as their glands give off essential oils. Mint, lavender, lemon balm, rosemary, sage, oregano, thyme.
    - ***"Night Shade" Solanaceae Family:*** herbaceous plants like eggplants, bell peppers, potatoes and tomatoes,
    - ***"Brassicas" Brassicaceae Family:*** cabbages, watercress, turnips, radishes.

    - ***Rosaceae Family:*** woody plants like apples, cherries, raspberries, strawberries and plums.
    - ***"Cucurbits" Cucurbitaceae Family:*** herbaceous plants that climb using spiral tendrils. Pumpkins, squash, cucumbers.
    - ***Chenopodiaceae Family: s***wiss chard, beets, spinach.
    - ***"Legumes" Fabaceae Family:*** pulses. beans, lentils, peanuts, fava beans.
    - ***Poaceae Family:*** corn, rice, wheat, barley, oats, rye, millet.
    - ***Liliaceae Family:*** garlic, asparagus, chives, shallots, onions, leeks.
- **Plant families by planting similarities**:
    - Roots: carrots, radishes, beets, turnips,
    - Herbs:All varieties
    - Flowers: All varieties
    - Greens: Hardy - kale, swiss chard and collards, Rotational: lettuce,mixes, asian etc
    - Brasicus: Broccoli, cauliflower, cabbage
    - Squash: Summer: soft skinned squashes and Winter: hard skinned, long season and storage
    - Tomato:tomato varieties, hot and sweet peppers, okra, eggplant,
    - Legumes: beans, peas,
    - Grains: corn, all other varieties
    - Cover crops: clover, buckwheat, oats
    - Microgreens: all varieties
    - Sprouts:all varieties

Vocabulary:

First frost: Your geographical location determines when the first frost will occur. In northern Indiana, it averages October 15.
Last frost: The final frost of the season. Average last frost in northern Indiana is May 15.
Direct seeding: When you plant seeds directly into the ground.
Seed starting indoors: When you plant seeds in containers indoors, in a controlled and protected environment. Typically this is done to start seeds well before the outside environment is ideal for them giving seedlings a jump on the season.
Tap root: Root style that has a single, long central root. Think carrots.
Fibrous roots: Root style containing many branching roots.
Succession plantings: Plantings that are done multiple times in a growing season for a given seed variety. Succession planting is typically done with varieties that have shorter growing seasons.
High rotational crops: crop varieties that have very short growing seasons, around one month, to be planted many times a season(succession planted), including: most greens, and fast roots like radishes.
Companion planting: Some plants have good relationships and are more healthy and productive because of their proximity to each other in the soil (It is also true that some plants have bad relationships and grow more poorly when they are planted too close to each other). These relationships are scientifically proven and should be taken into account when designing a garden,

Legumes: Plants that have a special nodule of bacteria on their root system that allows them to fix nitrogen in the soil. Legumes fertilize surrounding plants with nitrogen naturally. They are an important companion plant and include: beans, peas, clover,

Overview:

Our new seeds have arrived! Organize them into plant families and create a file system for seed storage. I use one small rubbermaid tub, with tight fitting lids for each plant family, and further divide using zip lock bags that are labeled for each species within the family.
February can include setting up your season work schedule based on the valuable seed packet information. I call this work schedule my working calendar and create one for each seed species. I use the information on the seed packet and a trusted resource book to guide me through this scheduling. Each finished calendar also includes companion planting information, good and bad, and any unique circumstances to look out for during the plant's life cycle including common pests, which includes disease, and preventative organic practices. I find students really enjoy putting these working calendars together and it provides a deep dive into what gardening includes for a market gardener.

Procedure:

1. **Ask** students what they know about planting a garden? Make a list on the board.
2. **Discuss:** Use the overview and vocabulary to review and introduce setting up a working calendar.
3. **Activity: Creating the working calendar**

Supplies

- Variety of seeds
- Blank calendar sheets for students to fill in
- Writing utensils
- Companion planting chart

Directions

1. Use the board to display a list of all the plants you will be growing together organized by species/variety (tomato/SanMarzanos, beans/provider, cabbage/Tendersweet etc). Have all the seed packets for this list available for students. Make sure you are using an informative seed packet. I recommend Johnny's seeds (johnnyseed.com). They are the best for packet information and seed quality. To save space on the working calendar, on the board include abbreviations for each working step in the gardening timeline including: DS- direct seed, SS- seed start indoors, TP- transplant to the field, H- harvest. Add a subscript to each abbreviation for succession plantings (DS2, H2, DS3, H3 etc)
2. Give each student a calendar packet and a Companion Planting Chart. Review the chart.
3. Assign one seed packet to each student (or pairs). They will be in charge of teaching the class how the seasonal work will go for this seed variety.
4. Explain that our growing season is defined by the average last and first frost dates. This can vary within states. In my area, southern Michigan/northern Indiana, May 15 is our average date for the last frost and October 15 for the first frost. The seed packets will often guide you by this information, so it is important to know. Write this information on the board for later reference by students.
5. Review the vocabulary and important components of information included on each seed packet that will guide students in setting up a work schedule for these

seeds, including: gestation, days to harvest, how and when to plant, how often to plant.

6. Practice this process together with one seed variety. I use green beans because it is an easy succession planting variety (every 2 or 3 weeks). Go through each guide from number 5 and use the seed packet and any other resources to record the work and harvest schedule that will be required for that seed.
7. Introduce yourself to this plant by reading an excerpt from a gardening resource book. Most gardening primers have a short chapter on each plant and will introduce any common characteristics, good and bad, to be aware of. I like *Rodales, Organic Gardening Encyclopedia,* available at used books stores for a couple dollars. Have students take notes on the calendar back side including any unique information to be aware of in the plant life cycle including common pests and .Also include in these notes, using a companion planting chart, good and bad companion plants. Follow the following prompts to fill in the calendar work schedule for each seed/plant:
8. Where and when to seed start-- direct seed vs seed starting indoors. This is usually based on length of growing season and type of roots. Typically root crops are directly seeded due to their quick growing tap roots and tolerance of cooler temperatures.
9. Days to germination(how long before the seed should pop open)?
10. Transplant time frame - when should seed starting begin indoors and when should the seedlings be moved to the field?
11. Harvest date - How long after planting outside should we expect to harvest the crop?
12. Succession planting schedule - how often and when will this variety be planted during a season. Consider how much you will eat/sell/have room for as a guideline and how long the days to harvest are. Many varieties of plants are only planted once or twice a season..
13. If you still have the catalogs from ordering the seeds, which I suggest you hold on to, have students affix a picture of their mature plant on the front page of their calendar.
14. Have students present their assigned seeds and working calendars.
15. End the lesson by comparing and contrasting seeds/plants with any shared characteristics and assumptions they can make - How many of you have cold loving crops, warm loving crops, short seasoned, long seasoned, what do root crops have in common? Etc.
16. **Evaluation:**

a. What are seeds and how do you get them?
a. What crops are good for succession planting and why?
b. What important information do you need to know when setting up a working calendar for a crop variety you want to grow; list at least 5 things
c. What is the local average first frost and last frost dates for your area?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Additional Resources for February

Grades 3-5

- **Poem-** February Twilight by Sara Teasdale (https://allpoetry.com/February-Twilight)
    - A short and simple poem.
- **Short Video-**Introducing The Human Gut Microbiome (3 mins) (https://youtu.be/fr2TuoLjvLk)
    - 3 minute introduction to gut microbiome and its functions

Grades 6-8

- **Short Video-** Human Digestive System (https://www.youtube.com/watch?v=S6sv0Bv1iTY&feature=youtu.be)
    - This is an 11 minute review of nutrition, digestion and excretion.

Grades 9-12

- **Article-** What do Plant Enzymes do? (https://www.foodenzymeinstitute.com/content/What-do-Plant-Enzymes-do.aspx#:~:text=Four%20plant%20enzyme%20groups)
    - This is an article on food enzymes and their function in digestion
- **Short Video-** How do carbohydrates impact your health? - Richard J. Wood (https://www.youtube.com/watch?v=wxzc_2c6GMg)
    - A video that explains what carbohydrates are and how they affect our bodies.

March Working Calendar

Key: SS= Start indoors, DS= Direct sow, T= Transplant, H= Harvest, TC = Transplant cuttings/bulbs, P=Prune

	March			
	Week 1	Week 2	Week 3	Week 4
Head Lettuce	SS1			SS2
Cabbage/Cauliflower			S1	
Collards			S1	
Kale/Kohlrabi	SS1	DS1	S1	
Radishes/Turnips		DS1	DS1	

Swiss Chard	SS1			
Perennial herbs & flowers from seeds	SS1			
Onions	DS1			

Plant Family Key

Asteraceae	Brassicaceae	Amaranthaceae	Lamiaceae	Liliaceae

MARCH

Focus: Conservation

Key Concepts: Water conservation, trees, maple syrup, seed starting

Think Ahead

- Plan on ordering free trees from the audubon society for this month's week 3 botany lesson on trees.

March Lesson Outline

- *Week 1 Sustainability Topic*
  - Water Conservation
- *Week 2 Theri's Winter Kitchen*
  - March Kitchen Project: Spinach
  - March Kitchen Project: Sap to Syrup
- *Week 3 Science Enrichment*
  - Botany: Trees
  - Zoology: Adding small livestock-Chickens
  - Microbiology: Sugar and the Gut biome
- *Week 4 On the Farm*
  - Seed Starting

Introduction

When we talk about caring for the environment, we acknowledge all living things. I hope our study of soil has illustrated this interconnection and that it is clear the system functions as a whole. Human health does not exist separately from the health of soil, air or water.

Our 26th president, Theodore Roosevelt Jr. (1858-1919), was known for his great love of nature and work as a conservationist. He was the first president to put significant political energy into conserving American land as he was witnessing the loss of animal species and forestry. His work later influenced his cousin Franklin D. Roosevelt, the 32nd president, who went on to make even greater strides in the conservation movement with respect to farming. One of FDR's most notable quotes, from a letter written to all the US governors during his presidency, read, "The nation that destroys its soil destroys itself." This set the stage for FDR's natural resource conservation work. During FDR's presidency, 1933-1945, USDA programs evolved to address air, soil, and water conservation and to help farmers. A notable one that still exists today is the Department of Natural Resource and Conservation Service (NRCS). This is a branch of the USDA that is located in every county of the USA, providing educational and financial resources to farmers and teachers in the pursuit of encouraging and installing conservation practices in farming operations. Consider adding a history lesson to March or a timeline project that looks at key players and their accomplishments in the conservation movement over the last 125 years.

Suggested March Field Trip

Consider a field trip to a local sugar bush, maple syrup farm, as a perfect way to introduce the awe inspiring work of trees. Trees feed us, they shelter us, they warm us, they sink Co2 and atmospheric nitrogen (greenhouse gasses), they give us clean air (oxygen), and they draw down water to our underground aquifers. I find students marvel at the process of sap to syrup and they are usually eager to help if the possibility is there. Collecting the sap and depositing it at the sugar shack is no easy job but lends itself to a feeling of great satisfaction when followed by a pancake and maple syrup treat. There are often volunteer opportunities at local sugar bushes during this time of year. Consider seeking one out or tapping a tree of your own and donating the sap or cooking it down yourself (one of our recipe projects this month).

Week 1: Sustainability Topic

Water Conservation

Goal(s): To define energy as the power for work; to understand natural resources are energy producing elements; to demonstrate potential and kinetic energy in a well designed rainwater capturing system as a conservation practice on the farm.

Learning objectives:

1. Students can define energy as power for work.
2. Students can explain, with examples, the need to conserve water.
3. Students can demonstrate, by picture or model, how water capture systems demonstrate potential and kinetic energy.

Next Generation Science Standards connections (grades 3-12):

- *4. Energy (4-PS3-4)* Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-3) Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *HS. Energy* (HS-PS3-4) Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

Time: 1 hour 40 mins

Lesson supplies:

- Paper or farm journal
- Pens/pencils
- Scissors
- Two straws for each group-try to vary size diameters; could use small water line tubing
- Popsicle sticks (10)
- Block of firm clay
- Two 4oz paper cup (one cup is to transport water)
- Paint sticks gallon size (6)
- Two 6 oz paper cup
- Legos
- Two 8oz paper or plastic cups
- Wooden blocks
- Two 16 0z plastic cup

Background review for the instructor:

- Review nature's resources- Natural resource - Wikipedia
- Activity to look over- Get the Ground Water Picture (https://www.swc.nd.gov/pdfs/get_the_ground_water_picture_activity.pdf)
- Do a water audit - CONDUCTING A HOUSEHOLD WATER AUDIT (https://mde.maryland.gov/programs/water/waterconservation/documents/www.mde.state.md.us/assets/document/resaudit.pdf)
- Useful charts- Water Cycle – Definition & Steps Explained With Simple Diagram (https://www.sciencefacts.net/water-cycle.html)

Vocabulary:

Aquifer: Underground permeable rock that holds water.
***Conservationist*:** A person who works to protect and preserve the environment
Drip line irrigation: A method of watering plants through drips coming out of a long hose onto each plant. Considered a highly efficient and conservation friendly form of irrigation.
***Energy*:** Having the ability to perform work. Energy is divided into two categories including potential energy and kinetic energy. Physics tells us energy is never lost but it can be changed or transformed. Much of our natural resources are stored in the earth as potential energy and will be transformed to kinetic energy when they are set in motion.
Fresh water: Not salt water. Only about 2.5% of the earth's water, but only 1% of this number is even accessible (most trapped in glaciers and in areas we cannot reach).
Groundwater: Water held underground.
Hydropower: Energy produced by the power of water

Kinetic energy: The energy of motion. The water that is released from the capture system, held high on the land, is transformed to kinetic energy when it is flowing down a slope and is affected by mass and velocity.
Potable: Water that is safe to drink.
Potential energy: Sometimes referred to as stored energy. This energy is in relation to how an object is positioned. For example, water held high on the landscape has more energy potential than water held at the lowest point of the property. Potential energy is affected by mass, height/distance and
Rain barrel: A large container used to catch and store rainwater
Rain garden: A garden that is designed to capture rainwater and allow it to soak into the ground (as opposed to run off and evaporate back into the atmosphere).
Reservoir: A lake (natural or artificial) that is used as water supply.
Surface water: Water that collects on the surface of the ground, i.e. a pond or a lake.
Swale: A low place, natural or human made, and can be used to aid in water capture.
Terraced: When land is formed into flat areas at varying levels, resembling steps.
Water conservation practices: Tools used by farmers (and landowners) to sequester and protect the quality and quantity of water on their landscape.
Water cycle: Cycle of evaporation, condensation, and precipitation. The journey of water through the atmosphere.

Overview:

Energy is necessary to do work. All farming production relies on energy resources to complete the daily tasks that ultimately produce nutrition. We have discussed the energy cycles that exist in the soil, namely the carbon and nitrogen cycles, and know that soil fertility and nutrition is the output of these working systems. Photosynthesis uses the energy of the sun to fuel chemical reactions in plants that are synthesized making food out of CO2 and water (while giving us fresh air). Food waste is converted to biological energy in our vermiculture systems. A key ingredient in all these systems is water. Ideally water makes up 25% of soil composition, 80-99% of fruits and vegetables, and 60% or more of the adult human body. The “rule of three” for humans says, on average, we can survive without air for three minutes, without water for three days, and without food for three weeks. All living organisms need water. It is important to understand the work and value of water and our responsibility to be water ***conservationists***.

Water scarcity and water pollution are worldwide issues.. Industrial agriculture is one of the biggest offenders in the US, with the overuse of ***groundwater*** irrigation systems, excessive cattle grazing and over production, and overtilled soils causing chemical runoff and soil erosion. Flooding, droughts, and evaporation from global warming and climate change also contribute to this dilemma. The film in this lesson discusses water scarcity issues in the US, from our homes to big business, including agriculture. Also discussed is the great work of everyday people in water conservation practices, giving examples of small and large conservation practices we can all do to be water stewards. It is important when discussing sensitive issues like water scarcity to empower students to be part of the solution at home and on the farm. The second half of this lesson will look more closely at the power of water and designing ***water conservation practices*** on the landscape.

Hydropower is probably the oldest energy resource on the planet. Mills were built along streams where water was diverted to flow over a large wheel, or turbine, to produce power and do heavy work, most notably for the grinding of grain and cutting of lumber. Towns often grew up around watermills. Water alone is not an energy source, but when combined with gravity,

energy is produced. The laws of physics divide energy into two categories: ***potential energy***, or stored energy, which relies on an object's position (PE= mass X gravity X height), and ***kinetic energy***, or the energy of motion, and is calculated using mass and velocity (distance and time). The nature of water on the landscape can demonstrate both potential and kinetic energy.
We can use this understanding of energy to set up sustainable water conservation practices as a priority on any farm design. The two most notable water conservation practices on my farm include catching and storing water both for above ground use and ***aquifer*** replenishment, and minimizing runoff and erosion.

Holding water high on a landscape will have the greatest potential energy. I have installed two 1000 gallon tanks in a position where they can be fed by gutters. Once the water is released into a water line the potential energy transforms into kinetic energy. When the water is eventually dispersed by the connected ***drip line***, it settles into the ground where it again becomes potential energy. The higher above ground the water is held, the greater the potential energy is. The bigger the water line coming out of the tank and the longer the distance the water travels before dispersing increases the kinetic energy. On landscapes with minimal or no gravity flow (flat land) you can increase potential energy by elevating the water tank on a support system. Water needs gravity to have potential energy. This same physics is demonstrated when heavy rains flow down a landscape. Water naturally flows to lower ground (gravity) and pools in flat spots. This can work against us if we have not designed our landscape with water flow in mind. Observe your landscape during heavy rain and note the natural flow and pooling patterns. Areas that consistently hold pools of water low on the landscape are the best locations for ***rain gardens***. Rain gardens are designed to capture and sink water, adding to nature's groundwater aquifers overtime. Land that has a significant slope where water moves quickly over it can be ***terraced,*** cutting out contour steps to slow water down. Terracing can include ***swales,*** ditch-like structures on contour, to increase water capture and sink. This captured water will continue to move down the slope underground, feeding root systems along the way and eventually creating underground water storage. If your landscapes are often flooded by heavy rain you will need to build up your garden beds and protect them from erosion with a heavily mulched surface, and deep rooted ground cover on the lower foot paths to move or sink excess water.

Large and infrequent rainstorms are becoming more typical on the farm due to global warming. Farmers must design water capture with this in mind. Any amount of slope on a property will increase the kinetic energy of water causing topsoil and chemical run off. These contribute locally to stormwater flooding but globally to greater problems when polluted runoff enters waterways that travel great distances through connecting rivers and streams, eventually dumping into an ocean after wreaking havoc on ecosystems along the way. (What watershed do you live in? Watch a drop of water flow from your street and eventually end up in the ocean at https://river-runner.samlearner.com/).When farm designs do not take water potential and kinetic energy into account we see erosion, runoff, and the loss of a great resource.
It is important to observe natural patterns of water before designing your farm to minimize water damage and maximize water capture. Any regenerative farming operation should address water as one of the most important design elements on the farm by proactively installing catch and storage systems and using conservation practices.

Procedure:

1. **Review and list:** What are renewable and non-renewable resources? Your list should include: air, soil, water, biology, minerals, fossil fuels, and nuclear. Address “water” last, asking, “is water a renewable resource or a non-renewable”? Ask students to reflect in

their journal on this question based on what they already know. You will come back to this question to discuss together at the end of this lesson.

2. **Discuss:** What do all of these resources have in common? They can provide energy! Go through the list and brainstorm the work each provides in our lives and on the farm. Have the students chart this conversation in their journals. End this discussion by circling water and explaining that this month we are looking more closely at the role of water in our lives and on the farm, and at some of the concerning issues that are related to water availability today.
3. Introduce the vocabulary that is part of the film in #4. Use a water cycle poster if you have one for review and a visual for these terms: reservoir, aquifer, potable, surface water, groundwater, fresh water, conservation, conservationist.
4. **View:** The Last Drop (44 mins), a documentary produced by National Geographic. Can be watched at 1.5 speed. (https://youtu.be/3VyfN30XzDM?si=MKQla4s9ILJK_smI)
    a. Appropriate for 6th grade and above.
    b. An alternative or additional view: Human Needs Threaten a Valuable Natural Resource-Saving the Dead Sea (6 mins) (https://indiana.pbslearningmedia.org/resource/nvstds-sci-humanneeds/human-needs-threaten-a-valuable-natural-resource-saving-the-dead-sea/)
5. **Review:** Discuss The Last Drop documentary by listing the water problems and solutions noted in the film. Note and define the term conservation and conservationist.
6. **Time for:** Take an exercise/hygiene break here or continue at your next class.
7. **PART II: A look at water as energy and water conservation practices**
   Discuss: Lead the discussion on water as an energy source. Introduce potential and kinetic energy and apply these to water (i.e. water that is held in a pond, reservoir, or tank are examples of potential energy). The potential energy will be greater the higher on the landscape the water is held. Once the water is released and in motion it is kinetic energy. Kinetic energy increases with weight and height/distance. Which do you think is greater, potential or kinetic? Potential energy will always be greater than kinetic energy because once an object is in motion it starts to lose some energy.
8. **Display:** Use a visual to reinforce this understanding of the power of water. Use a tub of sand to capture water coming out of a pitcher. Raise the pitcher higher and compare the sand movement. Use a larger volume pitcher and compare and contrast again. What does this demonstrate about kinetic energy?
9. **Optional:** Watch this video that uses a roller coaster to introduce potential and kinetic energy: "Our World: Potential and Kinetic Energy" by Adventure Academy (3 mins) (https://youtu.be/zCKeniklH_c?si=QDFS5xgCwMx-4Owh)
10. **Activity: Rain barrel water collection simulator** (30 mins)
    NOTE: Divide the class into working groups to practice and present an experiment that demonstrates potential and kinetic energy using a simulated water capture system. Each group will use different variables to compare kinetic energy.

        Have the supplies and directions prepared ahead for each group. In large classes consider doing multiples of each

    Supplies
    - Scissors
    - Two straws for each group-try to vary size diameters; could use small water line tubing

- Building material for each group differ to include finished products of different heights
    - Group 1: Popsicle sticks (10)
        - Block of firm clay
        - Two 4oz paper cup (one cup is to transport water)
    - Group 2: Paint sticks gallon size (6)
        - Two 6 oz paper cup
    - Group 3: Legos
        - Two 8oz paper or plastic cups
    - Group 4: Wooden blocks
        - Two 16 0z plastic cup

Directions

1. Ask students, What is a rain barrel? Allow for answers and then let students know they will be building model rain barrels using different supplies. Have them take notes while watching this instructional video: How To Install A Rain Barrel (4 mins) (https://youtu.be/ZKD3bqIItpE?si=B3SH2YyZExMLUnWH)
2. Now it is their turn. Pass out prepared supplies and give students a time allowance to use the materials to build their own rain collection model. Please build your barrel support structure as tall as your supplies will allow. In this way we can test and compare the laws of physics in regards to kinetic energy.
3. After completing their rain barrel models - review the elements of potential and kinetic energy and have each group hypothesize how their energy will compare to the three other models. Test their theories by measuring the distance the water will flow on a level surface when released. Contrast and compare.
4. Ask the students, how can a rain barrel add sustainability to our garden production?
5. Discuss what this experiment tells us to consider when setting up a rain barrel water collecting system. Where should it be located and why?

11. **Review:** Discuss and consider installing a water capture system on your landscape. Make plans to observe the landscape during heavy rain to brainstorm any water capturing ideas.
12. **Evaluation:**
    a. What is energy?
    b. Name five natural resources that produce energy.
    c. Why is it important to conserve our natural resources and which natural resources are most endangered?
    d. Name three ways to capture and store water on a farm landscape.
    e. Draw an example of potential and kinetic energy using a rain barrel water capture system for the demonstration.

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 2: Theri's Winter Kitchen

March Kitchen Project: Spinach

Goal(s): Students will taste and learn about the health benefits of eating spinach.

Learning objectives:

1. Students can describe spinach as a nutrient dense green leafy vegetable.
2. Students can list two specific vitamins associated with spinach.
3. Students can name two related vegetables in the same amaranthaceae family.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-6) Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

Time: 45 min

Lesson supplies:

- 20 oz of spinaches leaves
- 1 Tablespoon of olive oil or butter
- 2 tsp garlic salt
- Skillet
- Stove or hot plate

Vocabulary:

Superfood: Foods that offer many nutritional benefits that they are considered some of the healthiest foods available.

Overview:

Spinach is a leafy green flowering superfood that belongs to the amaranthaceae family. Its leaves are used fresh in salads or steamed as a delicious side dish. Spinach is close cousins to swiss chard, beets and lambs quarter. Spinach is one of our earliest and latest crops in the Midwest because of its exceptional hardiness. Spinach seed germinates in 40 degree weather and can freeze solid, thaw, and then continue to grow. I don't know of another plant that survives a freeze. If you are growing spinach in a hoop house, you may have enjoyed it fresh all winter long. Conversely spinach does not grow well in the heat of the summer. Be sure to take a break from your staggered planting of spinach once temperatures get above 70 degrees. Overwintered field plantings of spinach are ready to start harvesting in late March in northern Indiana. If you didn't think ahead, get your first planting in this month as soon as the ground can be worked.

Spinach is rich in antioxidants, vitamins k and a, and fiber. These nutrients help you maintain strong eyes and a healthy body; Popeye was definitely on to something! Consider making a salad out of this ***superfood***, or a simple sauteed spinach like the recipe included in this lesson.

Before the kitchen demonstrations, the instructor should lead the class in discussion by listing what students know about the plant. If there is an outdoor green space currently growing spinach, take a walk so that students may be able to touch, feel, harvest and taste fresh spinach.

Procedure:

1. **Discuss:** Introduce students to spinach, ask them what they already know about it and share facts from the overview.
2. **Watch:** How to Plant and Grow Organic Spinach at Home (3 mins) (https://www.youtube.com/watch?v=ZxQZibAsYbE)
3. **Recipe: Simple Spinach**

   Supplies
   - 20 oz of spinaches leaves
   - 1 Tablespoon of olive oil or butter
   - 2 tsp garlic salt
   - Skillet
   - Stove or hot plate

   Directions
   1. Have the students wash the spinach and pat it dry.
   2. Heat the olive oil in a large skillet over medium heat.
   3. Add spinach, stirring continuously.
   4. Sprinkle in garlic salt.
   5. Cook for a few minutes until tender.
   6. Serve and enjoy!
4. **After cooking:** Compare and contrast steamed and fresh spinach taste, texture and color. Knowing what we do, what can we hypothesize about the nutrition of fresh compared to steamed spinach? (fresh has more nutrition)
5. **Evaluation:**
   a. Name two nutrients found in fresh spinach?
   b. Why is spinach considered a superfood?

   Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

March Kitchen Project: Sap to Syrup

Goal(s): To demonstrate and engage students in the sap to syrup processing and to introduce simple carbohydrates.

Learning objectives:

1. Students can recall that it takes an average of 40 gallons of maple tree sap to produce one gallon of maple syrup by using a ratio.
2. Students can identify the top two countries for maple syrup production.
3. Students can classify maple syrup as a simple carbohydrate.
4. Students can name sugar additives on a processed food label.
5. Students can give two reasons why natural sugar is more sustainable than refined sugars.

Next Generation Science Standards connections (grades 3-12):

- *5. Earth and Human Activity: Human Impacts on Earth Systems* (5-ESS3-1) Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- *MS. Earth and Human Activity: Human Impacts on Earth Systems* (MS-ESS3-3) Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- *MS. Earth and Human Activity: Human Impacts on Earth Systems* (MS-ESS3-4) Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- *HS. Earth and Human Activity: Human Impacts on Earth Systems* (HS-ESS3-3) Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
- *HS. Earth and Human Activity: Human Impacts on Earth Systems* (HS-ESS3-4) Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Time: 45 min

Lesson supplies:

- Gather food labels that contain a large variety of sugar ingredients - one for each student is perfect.
- At least 2 gallons of sap (if you are boiling inside). If you can boil outside, fill your largest pot
- 2 gallons of sap collected from maple trees
- Appropriate sized heavy bottom pot for boiling 2 gal sap
- stove, hot plate or outside heat source
- Optional: candy thermometer
- Optional: hydrometer

Background review for the instructor:

- How To Make Maple Syrup (Small Batch Syrup For Beginners) (15 mins) (https://youtu.be/PwhdoMLUdhk?si=-pwPvT4On3VwW_Ww)
- Making Maple Syrup at School: a Project for Teachers : 6 Steps - Instructables (https://www.instructables.com/Maple-Syrup-STEAM-Project/)
- Identifying added sugars- Food Sources, Health Implications, Intakes, and Label-Reading to Identify Sugar (https://media.lanecc.edu/users/powellt/FN225OER/Carbohydrates/FN225Carbohydrates7.html)

Vocabulary:

Brix: A unit of measurement for percentage of soluble solids in a plant or product; usually refers to sugars in fruits and vegetables.
Candy thermometer*:* A tool for measuring temperatures in boiling sugar mixtures.
Hydrometer: A tool that measures sugar density.
Sap*:* Sap is the natural sugar water that trees make to wake up in the spring. Maple trees have the sweetest sap.
Spile*:* A small cylindrical tube that is inserted into a predrilled hole in the sapwood layer of a tree, allowing sap to drip out of the tree.

Overview:

Maple syrup has been around since before Europeans settled in the states; learning about it is an opportunity to honor the indigenous cultures of our land. Early settlement literature mentions mass production of maple syrup by Europeans as early as 1600 in northeastern North America. The same band of sugar bush produces the majority of maple syrup that comes out of the United States annually. Canada, number one, and the United States, number two, dominate the world in maple syrup production. Vermont, by far, leads production in the United States as it has the perfect cool climate sugar maples thrive in.

Maple syrup is the finished product of maple tree ***sap*** minus water. The water is removed by boiling the sap and letting the water evaporate. In late winter/early spring, tree roots are waking up and taking in groundwater that will change their stored starch into sugar water, or sap, and with the fluctuating weather the roots begin to push the sap up and down the tree trunk and branches. The sap is triggered to run when days are above freezing and nights are below. The up and down temperatures push up and down the sap through the tree. Above freezing temperatures by day push the sap up and freezing temperatures at night bring it back into the ground to be stored until warmer weather. The sap can be captured from the tree during this time, which can last anywhere from mid February to April in the midwest. The sap is captured by drilling a two inch deep hole into the mature Maple and collecting the sap that drips out. It takes about 40 gallons of maple tree sap to produce one gallon of maple syrup. This ratio will guide you when boiling down small amounts of sap as in the recipe below. Temperatures and density of the sap are indicators as well, but I think it is interesting to know all deciduous trees have a sap cycle that wakes them up in the spring. Many tree varieties can be tapped to gather sap but will not be as sweet as the maple varieties, so it takes more sap to get a finished product. This is helpful information if you are limited in trees to tap.

Maples syrup is a simple carbohydrate. Remember carbohydrates are a macronutrient and part of our healthy diet when eaten in moderation. Carbohydrates are classified as simple or complex. Simple carbs have gotten a bad name because things like white bread, processed sugars, sugary soda, and highly processed foods fall into this category, giving simple carbs the “bad carb” nickname. However, there are simple carbs in nutritious foods like fruits, some vegetables, and dairy. Simple carbs break down quickly in the body, raising glucose and creating a boost of energy initially and then because of the short nature of this energy boost often leave a feeling of sluggishness. Complex carbohydrates, sometimes referred to as “good carbohydrates”, are made up of chains of simple sugars that break down over a much longer period of time and don't give the yo-yo effect of energy like simple sugars. Complex carbs include starches and fiber like in whole grains and starchy vegetables. Maple syrup, unlike processed sugars, has nutritional benefits including the vitamins of manganese, riboflavin, copper, and calcium. All carbohydrates should be eaten in moderation but some are definitely better than others. Consider substituting natural sugars for processed sugars in any recipes you do together.

Before the kitchen demonstrations, the instructor should lead the class in discussion by listing what students know about the plant. If there is an outdoor green space currently growing t maple trees, take a walk so that students may be able to touch, feel, see, and smell. If you have time while your syrup is boiling down, add the *Activity: Identifying Hidden Sugars*.

Procedure:

1. **Ask:** What do you know about making maple sugar? List these on the board and/or in journals. Use the overview and vocabulary to introduce making maple syrup.
2. **Watch:** How to Make Maple Syrup (12 mins) (View at 1.5x speed) (https://www.youtube.com/watch?v=d74a6uKAz2o)

3. **Recipe: Sap to Syrup**
   You will be boiling down two gallons of sap which can easily be done inside. During the first stage of boiling the sap, because you do not need to stir, continue with the read out loud in #4 or *Activity: Identifying Hidden Sugars*

   Supplies
   - Gather and store sap until you have at least 2 gallons if you will be boiling inside. If you have a heat source and can boil outside, fill your largest pot.
   - 2 gallons of sap collected from maple trees
   - Appropriate sized heavy bottom pot for boiling 2 gal sap
   - stove, hot plate or outside heat source
   - Optional: candy thermometer
   - Optional: hydrometer

   Directions

   NOTE: Adjust project to your capabilities.

   1. Determine how much syrup will be finished from the two gallons of sap using the ratio 1:40, syrup to sap. Ask students to do this math on their own in their journal and then share and discuss. (I convert gallon to ounces /40) Review how much water is in each gallon of sap.
   1. For boiling inside, limit your quantity to 2 gallons due to the amount of evaporation required. Set your heating source on high.
   2. Use a thick bottom pot to boil down the sap to approximately 4 or so cups of condensed sap.
   3. Move the condensed sap to a smaller sauce pan and continue boiling on high until you have reached your 6.4 oz of syrup.
   4. Optional - use the candy thermometer to get a temperature reading of 219F and/or check syrup sugar density using a hydrometer that should read around 66/67 when sap is ready.
   5. Cool when finished for taste testing.
   6. Finish this lesson with taste testing and sharing descriptive words to describe the taste. Tell students to watch for a boost of energy coming their way!
4. **Optional read out loud:** *Ininatig's Gift of Sugar*: Traditional Native Sugarmaking (We Are Still Here : Native Americans Today) by Laura Waterman Wittstock (for 8-12yrs). For older students review the making of syrup section in *Braiding Sweetgrass,* by Robin Wall Kimmerer
5. **Optional:** *Activity: Identifying hidden sugars* (found in Week 3 below- Microbiology- Sugar and the Gut Biome).
6. **Evaluation:**
   a. Which of the six nutritional element classifications does maple syrup belong in?
   b. How is maple syrup made and what are the ingredients?
   c. What are the top two countries in the world for maple syrup production?
   d. Which are the top two countries for maple syrup production?
   e. Why is natural sugar more sustainable than refined sugar?

   Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 3: Science Enrichment

Week 3 of each month features three different science focus areas: botany, zoology, and microbiology. Instructors can choose to use lessons based on their science requirements.

Botany: Trees

Goal(s): Students will understand the environmental advantages of having trees on the landscape and on regenerative farms.

Learning objectives:

1. Students can give three examples of why trees are good for the environment.
2. Students can identify two reasons why deforestation has been so prevalent.
3. Students can label the anatomy of the tree and give a function for each label.

Next Generation Science Standards connections (grades 3-12):

- *4. Energy (4-PS3-4)* Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- *5. Ecosystems: Interactions, Energy, and Dynamics* (5-LS2-1) Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-3) Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-5) Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- *HS. Ecosystems: Interactions, Energy, and Dynamics* (HS-LS2-1) Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- *HS. Ecosystems: Interactions, Energy, and Dynamics* (HS-LS2-2) Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- *HS. Ecosystems: Interactions, Energy, and Dynamics* (HS-LS2-3) Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

Time: 45 min

Lesson supplies:

- Sapling
- Soil
- Water

Background review for the instructor:

- Audubon Society- get free trees to plant: Anatomy of a tree at arborday.org (https://www.arborday.org/trees/ringstreenatomy.cfm)
- The Lifecycle of a Tree (https://www.nationalforests.org/blog/the-lifecycle-of-a-tree?gad_source=1&gclid=Cj0KCQiAtaOtBhCwARIsAN_x-3K7XEodMYbPDCFfAJ_bDfcbdrpp1Jeag8vIMG58M1SzPaZcK7lN03oaAst8EALw_wcB)
- Anatomy of a tree at arborday.org (https://www.arborday.org/trees/ringstreenatomy.cfm)
- Tree Anatomy Mini-Posters (https://www.exploringnature.org/db/view/Tree-Anatomy-Mini-Posters)

- How to Plant a Bare-Root Tree - With Video - Stark Bro's (4 mins) (https://www.starkbros.com/growing-guide/article/how-to-plant-a-bare-root-tree)

Vocabulary:

Bark: Outer layer of a tree trunk- protects the inner layers.
Cambium layer: Inside the phloem, this layer is the growing layer annually.
Deciduous trees: Trees having broad leaves that fall off in the autumn.
Deforestation: The loss of forests due to the clearing of trees, often due to agriculture expansion.
Evergreens: Trees that hold their leaves/needles year round.
Hearthwood: The central, dead layer of a tree trunk. It supports the tree.
Mycorrhiza: A fungus that has symbiotic relationships in plant root systems and communication ability with nutrients, soil biology, and chemistry. Current research shows that mycorrhizal networks in the forest create a communication system between trees.
Phloem/ Inner-bark: The living tissue in a tree trunk, located under the bark, that transports nutrients from photosynthesis.
Rhizosphere: The area around roots systems in the soil
Sapwood: A living layer inside the cambium of a tree truck, the pipeline for water moving up to the leaves. This Is the layer that is tapped in maple syrup production.
Wind break: Protection from wind provided to plants and soil by a tree line.

Overview:

Trees are elongated perennial plants. They are divided into ***deciduous***, broadleaves that shed in the autumn, and ***evergreens*****,** trees that hold their leaves year round like conifers**.** Many varieties of both are present in the midwest. Field guides can help amateurs decipher a tree variety by looking at the unique characteristics of the tree including: the bark, branching, leaf shape, seed pods, and budding characteristics. Around the world there are millions of different kinds of trees and scientists are still discovering more. Trees, especially old trees, are invaluable to the ecosystem because of their life supporting functions. Trees are our biggest air cleaning machines because of their large canopies engaging in photosynthesis and their deep root systems that help store large amounts of carbon and water deep in the soil. Trees produce a wide selection of sustainable nutrition including fruits, nuts, and of course, maple syrup. They provide shelter and fuel. They create ***windbreaks*** that protect our soils from erosion. Even dying trees serve a valuable function in the forest. They shelter wildlife and feed insects and microorganisms which provides the fertility for the next generation of trees.

Agriculture has been the number one cause of ***deforestation*** around the world. In a quest to grow more and cheaper, we have compromised nature's ability to balance CO2 and atmospheric nitrogen by removing the canopy that naturally digests these greenhouse gasses. Clearing the canopy and leaving soils bare have contributed greatly to global warming and climate change.

Restoration agriculture is working to create farming systems that use tree production and perennial plantings to keep the soil covered and to maximize photosynthesis. Some refer to this as sun farming. Teaching our students the great value of trees is an important part of environmental stewardship.

Early spring and late fall are the best times to plant saplings. Use a planting guide if you are unfamiliar and remember, your biggest work in the first couple years of a tree's life is to protect it from drought.

Procedure:

1. **Ask:** What do you know about trees? List on the board (true facts only)
1. **Discuss:** Using the vocabulary and overview to introduce the anatomy and functions of a tree. See background review for a printable visual for support.
2. **View:** Anatomy Of A Tree - Easily Explained (5 mins) (https://youtu.be/7oHpiTaMhLM?si=vXjvBHOsQ26SE0fQ)
3. **View:** The Secret Language of Trees (16 mins) (https://www.youtube.com/watch?v=9HiADisBfQ0) **(**Great for 6th grade and up) (Stop at 14:05 before a commercial)
4. **Activity:** Plant a tree together if you can; fruit trees are a great addition to a school farm or landscape. Review the tree anatomy and follow the tree planting direction. When you fill the hole make sure to mix in some of your finished vermiculture for fertility. Water and wait patiently to see the sapling come to life as spring awakens. Make sure to water whenever there is less than an inch of rain weekly.
5. If you want a larger planting activity, check with your local audubon or NRCS office to see if there are any reforestation projects you can volunteer for. Farmers sometimes put in long hedgerows of trees in the early spring and welcome volunteers.
6. **Evaluation:**
    a. Explain deforestation and how it has impacted the United States landscape over the last 150 years.
    b. Why are trees an important part of the environment; give at least three reasons.
    c. What is the secret language of trees?
    Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Zoology: Adding Small Livestock- Chickens

Goal(s): Students will understand the chicken life cycle from gestation to pullet stage.

Learning objectives:

1. Students can classify chickens by their taxonomy classifications including: kingdom- animal, class- Aves, phylum- Chordata, order- Galliformes, family- Phasianidae, genus- Gallus (junglefowl), Species- ISA Brown (egg production variety)
2. Students can distinguish chicken variety characteristics for meat vs. egg laying varieties.
3. Students can define terms associated with chicken breeding including: gestation period, incubator and brooding box.
4. Students can use correct vocabulary to distinguish age and sex of chicken including: Hen, Rooster, cockerel, pullet.

Next Generation Science Standards connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-2) Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-4) Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-3) Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Time: 45 min.

Lesson supplies:

(Some of these can be produced by students)

- Large calendar (could be made by students)
- Incubator (purchased or built)
- Poster of chick embryo life stages (lots of great ones online, consider enlarging a day to day bound picture set)
- Brooder box (save a number of cardboard boxes to increase size as chicks grow) and feeding, watering and warming supplies.
- Candling tool for eggs (bright led flashlights work great for this)
- Research materials on raising chickens

Background review for the instructor:

- A complete and comprehensive guide to raising chickens- Small-scale poultry production (https://www.fao.org/3/y5169e/y5169e02.htm#TopOfPage)
- Incubating chicken eggs- 9 Rules for Hatching Eggs - Backyard Chicken Advice (https://www.thechickentractor.com.au/9-rules-for-hatching-eggs/)
- Building a brooder box- Easy DIY Chick Brooder • Longbourn Farm (https://longbournfarm.com/easy-diy-chick-brooder/)
- Chick embryo video- What's Inside a Chicken Egg? - Smarter Every Day 254 (4 mins) (https://youtu.be/zKNlPrEQwPY?si=wNM8aLQ7r5BSyres)
- Chicken embryo development chart- Embryology of the chicken - Poultry Hub Australia (https://www.poultryhub.org/anatomy-and-physiology/body-systems/embryology-of-the-chicken)
- Determining sex of 1 week chickens- Roosters or hens? Sexing week old chicks 🐥 (2 mins) (https://youtu.be/RU2hQpR-grY?si=1RokPfotwaNx-I81)
- Candling eggs- When to Candle Chicken Eggs | What is a Red Ring? (3 mins) (https://youtu.be/Jv-RqLKLgNs?si=LPhbrNhtHzIYiqI0)
- Chicken taxonomy:
    - Kingdom: Animal- chickens are vertebrates, having a backbone
    - Class: Aves- all birds are in this class
    - Phylum: Chordata- having a flexible rod supporting their backside
    - Order: Galliformes- fowl or chicken like birds
    - Family: Phasianidae- ground loving birds
    - Genus: Gallus- junglefowl ancestry
    - Species: There are roughly 500 different chicken species around the world

Vocabulary:

- ***Altricial:*** Birds that are not able to move around after hatching. Most birds fall into this category. They need parental care for their survival, including: robins, bluejays, cardinals.

- ***Precocial:*** Birds that are able to move around on their own soon after hatching, including: chickens, ducks, turkeys and more.
- ***Clutch:*** A group of eggs laid together before brooding begins.
- ***Brooder box:*** Protective enclosure for baby chicks.
- ***Candling:*** Testing an egg for fertility using a light.
- ***Humidity***: The amount of moisture(H2O) in the air
- ***Pullets:*** Female chickens that have not reached maturity
- ***Ordinances:*** Local laws enacted to curtail activities of those covered
- ***Zoning*****:** Local laws that tell how a piece of property can or can not be used.

Overview:

There are thousands of different kinds of birds in the world. Most varieties are raised with parental care, known as ***altricial***. Chickens are more abundant than any other bird. There are more than 3 times more chickens than people in the world. Chickens are among the birds that do not need parental care, or ***precocial***, after they are hatched. Chicken eggs provide enough nutrition that chicks hatch fully feathered and self-sufficient. Hens will incubate and protect their brooded clutch of chicks but it is not necessary. Most farmers purchase day-old chicks from a hatchery when they are replenishing a large flock, rather than having their own chickens brood and hatch eggs. Hatcheries take some of the guesswork out of it. Hatcheries are able to check the sex of chicks pretty accurately and are careful with breeding to ensure chick varieties. Both are important to farmers and can contribute to a more efficient business. With that said, for small farmers hatching eggs can be fun, informative, and efficient. Our lesson today is a combination of practices that I have found to be accurate and efficient when hatching my own eggs, which I do bi-annually.

There are over 500 different varieties in the world. Take care to choose a chicken variety that is right for your intentions and landscape. If you are raising chickens for eggs, it will be a very different breed than for meat production. Some chickens are both good layers and have large breasts for meat production. They are called dual purpose breeds. I find ISA browns are best at egg production, and cornish cross for meat production. It is also fun in a small flock to do multiple varieties to have different colors of eggs. There are also fancy chicken breeds that are raised for farm pets, competitions, or for insect management. There are so many great chicken raising books available to introduce these breeds. Consider checking out a dozen from your local library so everyone in class can learn more about raising chickens; great for a complementary silent reading project.

Raising animals on the farm is a big responsibility. It is important to thoroughly research and understand what you are getting into before you begin. You may have started this research back in October which has given you some time to discern your capabilities. If you haven't already, make sure you check into your local laws before getting started. If you live in a country setting, are ***zoned*** for agriculture and meet the acreage requirements for livestock, there shouldn't be any problems raising small livestock on your farm. If you live in a city or suburb be sure to check your local ordinances for any guidelines with regards to raising chickens. ***Ordinances*** are local laws made to protect neighbors. Local ordinances can usually be found online or checked with your local government clerk's office or Code enforcement department to learn more. Typically ordinances will depend on your zoning and the size of your landscape. You can sometimes get an exception for a school or urban farm by applying for an ordinance variance. This process can be a great lesson on local government. I have had to apply for a

number of ordinance variances in the past and although it seemed insurmountable it was worth the trouble.

On my 10 acre farm I have raised a variety of poultry. I have raised chickens for both meat and eggs. They are a low input livestock compared to most other choices. The biggest inputs will be your infrastructure, daily care and feed. These costs can be minimized by buying used chicken coops or using volunteers and upcycling used building supplies to build your own coop and run(a great practical life lesson for students).. If you can collect food waste from a school cafeteria or neighbors it goes a long way to minimizing the need for grain purchases. In fact you can do a food waste audit and raise only enough chickens that can be supported by your volume of food waste. In this way you are conserving water and energy and creating a sustainable system of egg production. No matter what the size of your intended flock, keep in mind it is not uncommon to lose 15% of your chicks before maturity and adjust accordingly. Also when hatching a straight run of chicks, an unsexed collection of eggs, you can expect a 50/50 chance of male and female. Small farmers that hatch their own eggs will typically use dual purpose breeds so that roosters can be raised for meat and pullets for eggs. You don't want to know what commercial hatcheries do. This means hatching twice as many eggs as you want pullets and making sure you have a venue for the meat roosters.

If you can't raise chickens long term, get creative with this lesson. The experience of incubating, hatching and raising pullets is awe inspiring and valuable education and goes a long way in teaching students about responsibility. Think about a micro economy project with neighbors or local small farmers with backyard chicken flocks. Selling pullets at 6-8 weeks (or 2-3 weeks for meat only breeds) can be a profitable farming business. This would allow you to house the chickens temporarily, maybe even until the end of the school year, bypassing ordinances and long term commitments while still having a quality educational experience. Delivering the chicks to their new home(s) could be a year end field trip in May. Make sure to pre-arrange these sales before you begin. Once your long term plan is secured, you are ready to begin incubation.

Procedure:

1. **Ask:** What do you know about raising chickens? Record on the board and n journals (true facts only).
2. **Discuss:** What is a bird? Review distinguishing characteristics (feathers, eggs). Look at the taxonomy of a chicken and review the classifications: kingdom- Animal, class- Aves, phylum- Chordata, order- Galliformes, family- Phasianidae, genus- Gallus (junglefowl) Species have over 500 varieties.
3. **Discuss:** Using the vocabulary, overview, and any previous research discuss raising chickens: Why do you think there are ordinances that restrict raising chickens in some areas? Why do most restrictions limit roosters? How can close by neighbors be impacted by chickens?
1. **View:** How to hatch your eggs#1 How to hatch your own baby chicks Part 1 | Egg Incubator 101 (11 mins) (https://www.youtube.com/watch?v=89LrxLl606k) and #2 How to hatch your own baby chicks Part 2 | Egg Incubator 101 (10 mins) (https://www.youtube.com/watch?v=MQ8zR3u6q1M)
2. **Create a working calendar together:** Use a large calendar to map out the life cycle of your pullet project. Set goals on the working calendar to be well prepared for each stage of the project including raising the chicks until sold. Assign each student a responsibility as you move through the different jobs involved in the project. Include every job you can

think of including marketing and delivery of pullets (if applicable), ordering eggs, testing incubator, starting date, candling dates, hatching date, sexing chicks at 1 week of age*, brooder box setup, brooder box cleaning, brooder box swaps to add more size, feeding and watering schedules and delivery of pullets. All participants should have a job on the calendar when you have finished. Have students record these responsibilities in their journals.

*SEXING CHICKS - It is also important to note here that not all your chicks will be female when hatching your own eggs. This is the number one drawback. Typically the cockerels would be removed and used in meat production. Having a venue for cookerals vs. pullets if you are selling them will be important too. At one week of age you can mark or separate the pullets and cockerels. See this video for instruction: Roosters or hens? Sexing week old chicks 🐥 (2 mins) (https://youtu.be/RU2hQpR-grY?si=1RokPfotwaNx-I81)

3. **Research:** With your calendar prepared and student responsibilities assigned, allow some time for research that details each responsibility. Have students consider some business questions in their research when appropriate;what supplies do you need, where can we find or purchase supplies, what is the cost, how much can we sell pullets for, what is the going rate of pullets, how, when and to whom will you marke pullets, what will you do with unsold pullets? Have students make notes in their journals and share with the class.
4. **Practice math**: Add some math and look at the income and expenses to determine if this is a sustainable business project (remember profit = income - expenses).
5. **Set up:** Before your incubation start date make sure to test the incubator and location. Choose a warm protected area for incubation but easily accessible for observation, candling and care. Test the incubator to make sure it accurately holds temperature. I suggest using the best incubator you can afford - one that self turns and has a monitoring system for temperatures and humidity. Some new incubators even have candling lights built in. I like this one: Manna Pro Harris Farms Nurture Right Egg Incubator for Hatching Chicks, https://carolinacoopsflockshop.com/products/manna-pro-harris-farms-nurture-right-egg-incubator-for-hatching-chicks-holds-22-eggs-automatic-egg-turner-with-temperature-and-humidity-control-360-degree-view-with-clear-window
6. Follow your displayed working calendar for the duration of the pullet raising project. Have students journal their experience as they move through the different steps along the way keeping track of expenses and income, trials and errors and any other key information to evaluate the finished project.
7. **Evaluation:**
    a. What animal classification do chickens belong?
    b. What is the difference between meat and egg varieties?
    c. Define the distinguishing characteristics for the following chicken classifications: Rooster, Hen, cockerel, pullet.
    d. Are eggs a sustainable food source and why?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Microbiology: Sugar and the Gut Microbiome

Goal(s): Students will learn how diets high in sugar work against human health by disturbing the human biome and how to identify added sugars in food labels.

Learning objectives:

1. Students can identify two characteristics that distinguish natural and refined sugars.
2. Students can identify plaque as the result of bacteria feeding on sugar in our mouths.
3. Students can recognize sugar additives in processed food by a number of names.

Next Generation Science Standards Connections (grades 3-12):

- *3. From Molecules to Organisms: Structures and Processes* (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.
- *4. From Molecules to Organisms: Structures and Processes* (4-LS1-1) Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-5) Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- *MS. From Molecules to Organisms: Structures and Processes* (MS-LS1-2) Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.
- *HS. From Molecules to Organisms: Structures and Processes* (HS-LS1-3) Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Time: 1 hour

Lesson supplies

- Recording device such as iphone or video camera (can also do a skit format if technology is unavailable)
- Craft supplies- markers, scrap colored paper, catalogs, scissors, glue sticks, etc.
- Empty product containers

Background review for the instructor:

- Article on how too much sugar affects the gut biome- Sugar And The Gut Microbiome | Dr. Suhirdan Vivekanandarajah (https://sydneygastroenterologist.com.au/blog/how-too-much-sugar-affects-the-gut-microbiome/#:~:text=Bacteria%2C%20however%2C%20need%20energy%2C,the%20balance%20in%20the%20microbiome)
- Article- Dental Plaque: What Is It & How To Remove From Teeth (https://my.clevelandclinic.org/health/diseases/10953-plaque)

Vocabulary:

Candida: Yeast, fungal infection.Yeast thrives on sugar.
Gut microbiome: The community of microbes that live in the intestines and are part of the digestive system.
***Leaky Gut Syndrome*:** A condition that indicates a compromised digestive system that can “leak” pathogens into the body.
Natural sugar: Comes in nature's food; fruits, vegetables, milks, and honey contain natural sugars. These are better than refined sugars as they contain nutritional value. Natural sugars in whole foods are important in a balanced diet.

Refined sugar: A form of sugar that is highly processed and lacks nutrition. They may have started from a natural source but the end product is pure sugar. For example white granulated sugar comes from sugar beets and sugar cane; corn syrup comes from corn. Corn syrup has lots of publicity as the worst kind of sugar additive, partly due to its highly addictive nature. Refined sugar is an unnecessary part of any diet.

Overview:

Did you know science is now discovering just how important microbes are to our human body? Some say we have 10 million more bacteria cells in our bodies than human cells. Wow, that's hard to believe. Bacteria and fungi are among these many microbes that greatly affect our body functions. Bacteria and fungi feed on sugar.

Sugar is a simple carbohydrate. Starches and fiber are complex carbohydrates which are basically chains of simple sugars. Our brains and bodies rely on carbohydrates to provide us with the energy we need for thoughts and action. The problem with carbohydrates/sugars is that when we eat too many, especially of the highly processed varieties, they have a negative effect on our health long term. We have talked about how important the diversity of microorganisms are to the ***gut biome***. A diet heavy in sugar overflows to the gut biome and feeds the pathogenic bacteria and fungi there. The volume of bad microbes increases disproportionately to the good microbes, decreasing the diversity of the existing microbial community that is so necessary for a healthy digestive system. When a gut biome is compromised in this way it can not absorb nutrients efficiently and can lead to what is called ***leaky gut syndrome,*** which in turn releases these pathogens to move throughout the body creating inflammation and disease. Some of the common symptoms of a compromised gut system include muscle aches, teeth problems, foggy brain, fungal infections, compromised organ function(diseases), and cancers. The good news is that our gut biome health can be restored. As we have discussed in the past, fermented foods, plant based nutrition, and only small amounts of natural sugar can, over time, heal our gut biomes and restore nutrient digestion which bolsters our immune system and allows us to fight disease naturally.

Procedure:

1. **Ask:** What can you tell me about sugar?
2. **Review**: What is the gut biome?
1. **Discuss:** Use the vocabulary and overview to discuss how sugar feeds bacteria and yeast.
2. **View**: Unlock the Secrets of Sugar's Impact on Your Gut in This Science Experiment | Gundry MD (4 mins) (https://www.youtube.com/watch?v=FLGWZYuECBs&t=189s)
3. **View:** What Does Sugar Do To Your Body? 10 Proven Negative Effects of Sugar (Stop at 3:44) (https://youtu.be/JEA-G9m9S0Y?si=4woDPKwXCTOSekMU)
4. **Discuss:** Where does granulated sugar come from?
    a. **View:** Sugar beet farming in Michigan- Sugar Farming - Farm 44 - Dinner Starts Here (7 mins) (https://youtu.be/8WCnLtrG7Po?si=sdpbP-yY676ogte6)
    b. **View:** Sugar cane to granulated sugar production in Australia (the leader in granulated sugar production)- SugarCane Growing and Harvest - Sugar Mill Processing Line - Modern Machine Harvest (8 mins) (View at 1.5 speed) (https://youtu.be/ow9c_hyNPOo?si=n_pVL1sHYwpWOOEp)
5. **Discuss:** What are the positive and negative thoughts about this kind of farming, sugar production? Can you conclude anything about processed sugar farming with regard to the environment ? (This is an opportunity to review key concepts in regenerative farming:

diverse vs monoculture farming, fossil fuel driven inputs, unsustainable (linear) system, high carbon footprint)

6. **Choose** between the two activities below
7. **<u>Activity: Create a Product Commercial</u>**

   Overview: Commercials often sensationalized highly processed foods to get people to buy them. How can a healthy alternative compete? Have students use what they have learned to create a product that is healthy for us and the environment, and make a commercial to market it.

   Supplies
   - Recording device such as iphone or video camera (can also do a skit format if technology is unavailable)
   - Craft supplies- markers, scrap colored paper, catalogs, scissors, glue sticks, etc.
   - Empty product containers

   Directions
   1. Have students work in groups of 3.
   2. Introduce the assignment and have groups start by creating a product using empty containers and craft supplies. This product should be an alternative to a heavily processed option; one they can argue is a better alternative and why. Make sure they include an ingredient label. Instruct groups to discuss their commercial ideas as they work.
   3. Suggest some steps to guide the formulation of their commercials and list them on a central board where everyone can see:
      - Design a 30-45 second commercial for the re-branded product.
      - Determine what the three most important things you want to say are.
      - Decide how to get that message across; who says what when?
      - Rehearse (timing yourselves)
      - Get recorded (have a spot for this planned)
   4. Share all video clips and then have a discussion that includes reviewing key concepts about the environment and personal health.
8. **<u>Activity: Identifying Hidden Sugars</u>**

   Overview: There are many kinds of sugars that are added to processed foods. There are well over 50 different kinds of added sugars. Some have obvious defining words like sugar, nectar or syrups including: brown sugar, cane sugar, powdered sugar, raw sugar, maple syrup, honey, agave nectar, molasses, fructose corn syrup, ect.. Others are not always as easy to recognize, including the “ose” ending group: fructose, dextrose, glucose, galactose, lactose, maltose, and sucrose. It’s a good idea to become more familiar with the many names for processed sugars to better understand your ingredient labels on food products. Asking yourself, how much of this product is sugar? Remember to use sugar sparingly, especially highly processed sugars. Diets rich in simple carbohydrates are known to cause disease. Diabetes and obesity are common sugar related diseases among children in the US. Before beginning this lesson, use a poster or write the many names for sugar in the viewing area.

   Supplies
   - Farm journals
   - Writing utensils
   - Ingredient labels/processed food containers

Directions

1. **Ask**: What do you know about sugar? Record these answers
2. **Discuss:** Review simple carbohydrates and how they work in our system. How does sugar affect the body? How does it affect the brain? How does it affect moods? (Answer: Short lived high energy and a crash afterward can lead to irritability, difficulty concentrating, stomach aches, a host of problems with the digestive system, hormone imbalance, blood sugar levels rise, tooth decay, obesity, and heart problems).
3. Review some ways to identify sugar names in ingredient labels, as described above.
4. Pass out prepared ingredient labels, or have a large collection of processed food containers, one per student. Remind students that the ingredient label is required for any processed food being sold to the public. The ingredients are listed in the order of volume in the recipe from largest amount to smallest.
5. Using journals, have students set up three columns using the headings, product, sugars listed and notes. Record the product, the identified sugar(s) any conclusions they can draw from the ingredient list under the notes column.
6. Pass the labels around for a given period of time and repeat #2 for each.
7. **Discuss:** Compare and contrast product notes; Which products do you think are more or less nutritious and why? What conclusions can you draw about processed foods? How do you think the number of sugars included in a product relates to the carbon footprint of the product?

9. **Evaluation:**
    a. Why are highly processed sugars unsustainable?
    b. What is a common ending to processed sugar names, that make them more easily recognizable in food labels?
    c. What is the daily recommended amount of processed sugar for a healthy diet?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Week 4: On the Farm

Seed Starting

Goal(s): Students will learn the process of seed starting, both direct seeding into the field and indoor seed starting and why to choose one method over the other.

Learning objectives:

1. Students can distinguish direct and indirect seed starting methods, and give two examples of why you would choose each.
2. Students can state two critical elements for successful seed germination.
3. Students can define the causes of seedling damping off disease.
4. Students can explain the process of hardening off seedlings for early field plantings and understand why this is done.

Next Generation Science Standards connections (grades 3-12):

- *5. Ecosystems: Interactions, Energy, and Dynamics* (5-LS2-1) Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-3) Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
- *MS. Ecosystems: Interactions, Energy, and Dynamics* (MS-LS2-5) Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- *HS. Ecosystems: Interactions, Energy, and Dynamics* (HS-LS2-3) Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
- *HS. Ecosystems: Interactions, Energy, and Dynamics* (HS-LS2-5) Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

Time: 50 minutes

Lesson supplies:

- Farm journal or paper
- Permanent black markers (sharpies work great)
- Plant labels (I upcycle old vinyl blinds)
- Seeds
- Growing trays or pots
- Humidity cover (inverted trays, plastic wrap cover)
- Seed starting soil (best with water absorbing ingredients)
- Water spray bottle fused or misting while the humidity tray is on, when needed
- Light/heat (windowsill, grow light, planting heat mat)
- Diffused watering can, small
- Bussing tubs for moistening soil, filling trays and watering trays

Background review for the instructor:

- Seed starting technique- This Technique of Starting Seeds Will Change Your Life (18 mins) (https://youtu.be/StgMJMn80t8?si=8Mfq2AJ86BXNqQZd) (View at 1.5 speed)
- Soil blocking vs 1020 trays- Soil Blocks vs. Trays (Growing media research) (7 mins) (View at 1.75 speed) (https://youtu.be/6ZTB4IpPUD0?si=zLTYDke_0pPKS5Hm)
- Article on seed starting- Seed-starting Methods at Johnny's Greenhouses | 3 Systems for Starting Professional-Quality Seedlings Indoors (https://www.johnnyseeds.com/growers-library/methods-tools-supplies/seed-starting-transplanting/seed-starting-systems-johnnys-research-farm.html#1)
- Article plus video- Seed Starting (6 mins) (View at 1.5 speed) (https://seedsavers.org/learn/seed-starting/?gclid=CjwKCAiAq4KuBhA6EiwArMAw1K2jk2bSWg7ROWsQJb-8A-9cWnh8AWpwuFt8t8VfJWga1o9b588oERoCizoQAvD_BwE)
- A great way to upcycle paper- Paper Pot Maker Instructions #gardening #upcycling #paperpotmaker (1 min) (https://youtu.be/0typrMNQIJE?si=Ku_xnmGAgt_tW1Bj)

Vocabulary:

***1020 trays*:** A standard size (10" X 20") plastic container that is molded with cells for potting seedlings. They are further distinguished by how many (how big) the planting cells are- 48ct, 50ct,72ct, 100ct are common sizes. The larger the cell the more time a seedling will be able to grow without restrictions.

2-week trays: Seed starting trays that provide shallow rows of soil area for seed germination before potting up to larger growing cells; a first step in seed starting to create greater efficiency in larger scale seed starting. Most smaller productions will seed directly into 50 count cells.
***Damping off*:** A common greenhouse disease among seedlings caused by soil borne fungi and mold that thrive in wet and cool conditions.
Dibble: A tool used in gardening to make concise holes for seeding or transplanting.
Direct seeding: Garden plantings that are sown into the ground vs. started indoors. These are usually quick germinators, tap roots or good overwintering varieties.
Greenhouse: A clear enclosure that is typically used for growing plants and has temperature control.
***Hardening off seedlings*:** A process of introducing seedlings to the weather outside after being sheltered indoors with controlled temperatures. The process includes moving seedlings outside on a graduated schedule. The difference between controlled temperatures and actual temperatures will indicate how long this process should take. The larger the temperature difference, the longer and slower the hardening off stage should be. Some early plantings will need cloth protection from still fluctuating temperatures anyway. Hardening off will take between one to two weeks and should be included on your working calendar. Make sure to add this work assignment to your seedling timelines during this lesson.
Humidity chamber: An enclosure that keeps evaporation from escaping.
Potting up: Moving a seedling from a smaller, seed starting cell to a larger cell during the seed starting process.
***Soil block*:** A tool that when packed with soil and released will create a planting cell that is self standing. Soil blocking is an alternative to purchased trays or pots. Blocking has a number of benefits but requires an initial capital investment. Benefits include: less or no plastic trays (fossil fuel product); blocks keep roots from circling around themselves; blocks are easily transplanted; no digging out of trays. Soil blocks do the best with soil blends that have water retention ingredients like perlite and have filtered out all chunky carbon material.
Transplanting: Removing a seedling from a cell and planting it in the field where it will grow to maturity.
True leaves: The second set of leaves on a seedling, after the cotyledons.
Rootbound: Roots that have filled a growing container and are growing around themselves

Overview:

Starting seeds is an exciting time on the farm. The hope of spring comes with these seedlings, but don't get ahead of yourself. It is important to follow your working calendar so you are timing seeds appropriately and not using unnecessary energy, space, and labor. ***Rootbound*** seedlings, plants that have been in a pot so long the roots are growing around themselves, are often stunted for life, never producing food. Let your working calendar guide you.
Seed starting in a protected, controlled environment adds a number of advantages to the farmer, including:

- Getting a jump on the season, especially for long season plants.
- Season extension

- Maintenance is more efficient; it is much less time consuming to care for seedlings that are densely populated in 3 square feet than in a large garden bed.
- Plants are easily distinguished in the garden bed when eventually transplanted and can be mulched right away.

Having a controlled environment that is appropriately sized for your seed starting production is helpful. Greenhouses, distinguished from hoop houses by the presence of heat and temperature control, are typical for larger seedling production. Light gardens, or shelving with overhanging grow lights, work great for midsize production. Window sills, though not perfect, can work great for small production. At this point in the year, your seeds should have arrived, your working calendars should be populated, seed germination testing on old seeds should be complete, and seeds should be organized in bins and ready for the next steps.

Onions are my first seeds to be started indoors (Feb.-early March). I have also overwintered these in the field but always start more as they are a great companion plant to almost every planting in the spring, keeping the pests away but also making a double harvest easy. Cooks use onion in almost everything savory. Why not locate the onions close to the foods they are cooked with, cutting down your own energy cost? Follow your March calendar to get seed starting going indoors and direct seeding outdoors. Remember the calendar is a template, not written in stone, but flexible. My general rule is to complete the listed calendar tasks as close to the guide dates as possible but even so, sometimes it can be a week or so later than planned.

Hopefully you were thinking ahead last fall. Your earliest direct seed plantings this month will need a prepared bed. Spinach and sweet peas can be planted as soon as the ground can be worked. In my area, that means mid to late March. I make sure to have a spot for each ready before winter hits. I use Sugar Ann sweet peas which need a trellis to support their weight. They will likely be harvested in May, allowing for pole beans to follow. I build all my trellis supports at least six feet tall and stationary to accommodate all my climbers: peas, beans, cucumbers, and squash. In this way I don't have to move trellis but rather rotate the crops that use them. Peas and beans, both legumes, will provide a perfect environment at the base of their trellis for nitrogen-loving plants.. When your trellised plantings mature you will have a microclimate on the northside, dropping temperatures and adding some shade. Early greens will do better on the south side of the trellis while summer greens will appreciate some heat relief. All will benefit from the nitrogen fixing offered by a companion planting of legumes.

Before you begin seed starting indoors, you will need to choose your supplies. This will depend on the scale of your production. Cardboard egg cartons make great two week trays for very small production. I use soil blocking and 1020 trays, 50 count cells most often. I start most germination in two week trays, potting up to the 50ct trays, after the second set of leaves, ***true leaves***, have developed. When soil blocking, I seed right into the 2" blocks. I use a light garden indoors to hold seedlings for at least two weeks and then a small heated greenhouse to move seedlings when they begin to overflow my indoor space. On average cood loving crops germinate well at 65-70 degrees. I usually use a purchased seed starting soil for all indoor seeding work to eliminate any contaminating factors field soil might introduce. However, later in the season, when I start seedlings outside, I will mix field soil with seed starter at a ratio of 1:1. There are also lots of seed starting recipes available in resource books and online. The main things to remember for even germination is that the initial planting medium should hold moisture, the temperature of the soil should be kept at about 65- 70 degrees for cool loving plants and 75- 85 degrees for heat loving plants, a humidity cover should be added for initial seeding germination, and don't overwater- roots need air. Moisture and ideal temperatures are key

ingredients for even germination. As soon as plants break the surface of the soil, remove the humidity cover to drop temperatures and add a light source to encourage slow, straight, and strong growth. Bottom water whenever possible to keep seedlings from trapping moisture that can cause early disease. For large plantings add extra air circulation by placing a fan nearby.

Do some research before you begin to know what plants are cold hardy, can withstand some frost, and which are frost sensitive. Frost tolerant transplants can be planted in mid/late April and direct seeded late March. Frost sensitive plants can not be transplanted until the fear of frost is over. My average last frost date is May 15. Frost sensitive plantings do not get planted until mid May.

March work:

Seed start indoors cold hardy varieties in early March for mid April field transplanting including: kale, broccoli, cabbage, parsley, cilantro,

Direct seed cold hardy varieties in March including: sweet peas, spinach, roots(except potatoes) and hardy greens. I will wait for the soil to reach 40' for my first potato planting.

. Protected seed starting and direct seeding will continue to be part of your farm work all growing season. Experiment with different methods. You will become more efficient with practice and soon will develop your own preferences. There is so much fun learning that happens with seed starting.

Procedure:

1. **Discuss:** Use the vocabulary and overview to introduce the concept of seed starting and the efficiency it provides.
2. **Introduce** your supplies.
3. Have students record the 10 steps this video mentions for seed starting. Review these before moving on. Do you have all the supplies before you begin?
   View: How to Start Seeds Indoors - 10 Easy Steps - Seed Starting Guide for Beginners | Organic Gardening (14 mins) (View 1.5 speed)
   (https://youtu.be/aF_7hSd0tms?si=ByTcxpMD0F-iGOZC)
4. **Discuss:** Talk about the common seed starting disease called **damping off.** Like all living things, plants are susceptible to pathogens and disease. One of the most common in seed starting is damping off. The best way to keep our seedlings from getting infested with this is by being proactive. This video lists 8 actions that help eliminate the threat of damping off in your seedlings- Damping Off In Seedlings - 8 Ways You Can Prevent It (8 mins) (View at 1.25 speed) (https://youtu.be/K7HAyNG_FSY?si=Wk0AEyWs2r6Z_hCX)
   a. Have students record these 8 proactive measures in their journals.
5. **Activity: Seed Starting**
   Supplies
   - Seeds
   - Growing trays or pots
   - Humidity cover (inverted trays, plastic wrap cover)
   - Seed starting soil (best with water absorbing ingredients)
   - Water spray bottle fused or misting while the humidity tray is on, when needed
   - Light/heat (windowsill, grow light, planting heat mat)
   - Diffused watering can, small
   - Bussing tubs for moistening soil, filling trays and watering trays
   - Labels (I cut up old window blinds)
   - Permanent black marker

Directions

Choose what cool crops you are going to grow and determine when each seed should be started by consulting a reliable source. I have included my planting schedule in this curriculum. In March I seed start broccoli, cabbage,

For seed starting indoors:

1. Have working stations set up for your groups before you begin or guide them to collect needed supplies. I use groupings of four students. Supplies for preparing the soil include: potting medium, filled water can, bussing tub, hand held trowel or cultivator (for stirring soil),1020 planting cells, and 1020 holding tray(unvented for indoor use).
2. Break for hand washing after soil trays are prepared. I keep a 5 gallon bucket of water handy for a pre-washing station to remove all soil particles before using sinks.
3. Pass out seed packets, labels, a permanent marker, and a pencil to each group.
4. Students can work together to plant and label the cells. The pencil will act as a ***dibble***, making a small ¼ in hole for each seed. The eraser can be the depth guide.
5. Have students seed each dibble, cover seeds lightly with soil, give each cell a final light watering, add labels, and cover with a humidity cover. You might want to list these steps on the board as using journals at this point can be messy.
6. Place covered seed trays in a predetermined temperature appropriate place to await germination. Check daily for even moisture. If any part of the surface soil appears dry, mist with the spray bottle until damp and recheck the humidity cover for leakage. Soil should stay moist and some condensation should be obvious.
7. Display a thermometer in the area the seed trays will rest waiting for germination. Check daily. As soon as seeds begin to sprout, remove the humidity covers, reducing heat, and add a grow light source.
8. Water your seedling trays with a diffused small water can until all seeds have emerged. After all the true leaves have fully emerged, switch to bottom watering, if possible. This reduces the risk of disease and damping off.
9. Your seedlings will require daily checking until transplanting into their long term growing environment. Before transplanting be sure to ***harden off***, or expose seedlings to the outside weather in graduated steps over a period of time. Check your working calendars for field transplant dates and add a note for hardening off at two weeks before transplanting in the field for spring transplants.

6. Evaluation:

a. Explain the difference between direct seeding and indoor seeding of crop plants; why would I choose one method over the other?
b. What are the two critical elements for successful seed germination?
c. Explain the disease *damping off* and include at least two practices that help protect young seedlings from getting this disease.
d. Explain the practice of hardening off seedlings including why it is done?

Modification: Students unable to journal can share what they've learned orally, pictorially, or in another medium of their choosing.

Additional March Resources

Compiled by Margaret Lenhart

Grades 3-5

- **Book-** The Sugar Bush: Laduke, Winona, Kapashesit, Waseyabin
- **Book-** Maple Moon, by Connie Brummel Crook and Scott Cameron
- **Book-** The Tree Lady: The True Story of How One Tree-Loving Woman Changed A City Forever, by H. Joseph Hopkins.
- **Website-** Water Use Worksheet by PBS Learning Media
    - To access this PDF, scroll down to Part III on the link provided above, and select the "Water Use Worksheet" hyperlink. This gives a simple chart that allows students to track the amount of water, in gallons, that they utilize for various daily activities in their homes. More pertinent than the tracking, however, is the ability for students to understand and compare the relative amounts of water used for these basic activities such as showering, dishwashing, and brushing teeth.
    - More generally, the PBS Water Conservation module is stocked with enriching videos, interactive, self-guided lessons, and lesson plans for teachers.

Grades 6-8

- **Poem-**Dear March - Come in - (1320) by Emily Dickinson - Poems
    - A deeply introspective, iconic 19th century poet, Emily Dickinson was awestruck by the wonders of nature and her vibrant writing serves to indulge in the beauty and mystery of the changing seasons she observed from her New England residence. This poem, particularly, is adept for an introduction to poetic analysis — a discussion of the identification and significance of the literary elements present.
- **Book-** A Weird and Wild Beauty: The Story of Yellowstone, the World's First National Park by Erin Peabody (Page count: 192)
    - Suggested age-range: 12-17
    - "A Weird and Wild Beauty" tells the story of the trailblazing first expedition of the territory that would become Yellowstone National Park, and details the advocacy of conservationists that led the land to be preserved from economic development. Written especially for teen readers, this novel conveys "a wonderful ecological and historical message."
- **Book-** The Story of Seeds: From Mendel's Garden to Your Plate, and How There's More of Less to Eat Around the World by Nancy Castaldo (Page count: 144)
    - Suggested age-range: 12-17
    - Drawing from a multicultural cohort of members of artistic, religious, and scientific communities, this brief-read discusses the dwindling biodiversity of edible plants that has accompanied an increase in GMO cultivation and

industrialized, centralized agricultural practices. Castaldo inspires youth to understand the global significance of the humble seed and encourages young people to actively advocate for increased biodiversity by equipping them with an arsenal of viable actions and alternatives they can pursue in their daily lives.

- **Article-** Benefits of Water Conservation
    - This article includes engaging graphics and articulates relevant, yet not commonly considered ways that **using water conservatively improves the health of individuals and communities**, such as the prevention of political conflict and reducing fossil-fuel energy consumption.
- **Article-** This is how much water you waste when you throw away food by TweenTribune with the Smithsonian institute
    - This article, in length and in diction, is intended for 5th and 6th graders, but could be extended to 7th as well. It discusses **the role of water and energy usage in food production** and highlights the significant impact small changes can have.
- **Website-**Middle School Water Education Resources by Denver Youth Education
    - This page provides interactive mini-lessons for students as well as videos and an educational resource guide for teachers. Topical to Denver and the state of Colorado, but covers widely applicable topics such as watersheds and indirect consumer water-use.
- **Short Video-** Crash Course Kids #36.2: Water Fix! (6 mins) (https://www.youtube.com/watch?v=UYROQW9IDIg&list=PLhz12vamHOnYmvLSYtQvuxDrWSi795yDa&index=21) and Crash Course Kids #36.1: Water Fight! (4 mins) (https://www.youtube.com/watch?v=4b2kdcEuWr4&list=PLhz12vamHOnYmvLSYtQvuxDrWSi795yDa&index=19)
    - Both with on-screen definitions and examples of real world application, these videos focus on **water scarcity** and **conservation**. Video 36.1 focuses on water scarcity and the subsequent legal conflicts that have arisen in the Western U.S., while 36.2 points to historical and contemporary solutions to managing water scarcity, such as aqueducts in ancient Rome, desalination plants in Israel, and waste water recycling in the International Space Station. 36.2 ends by reinforcing the need to practice conservation because the solutions to scarcity that it presented can be inefficient.
- **Short Video-** Explaining Stormwater Runoff (2 mins) (https://www.youtube.com/watch?v=GrBEEjijxaY)
    - This video uses the large proportion of freshwater that comes in the form of rain and the ability of the layers of soil to naturally improve the quality of the water to reinforce the need to collect this fallen rainwater, to let it be absorbed by the ground rather than to **runoff** into wastewater systems. It advocates for fewer porous surfaces and more greenspaces and presents ways in which households can collect rainwater. Ideal for students living in urban or suburban areas.
    - Also appropriate for grades 9-12.
- **Short Video-** How to (Literally) Save Earth (3 mins) (https://www.youtube.com/watch?v=AOefA-bSduM&list=PLElB7nLNHZvhfuBhJ73p1hnol3e3NBV5n&index=14)
    - This video describes the adverse effects of farming without the use of a cover crop as well as of deforestation on soil **erosion** and the societal implications that occur when soil is eroded more quickly than it can be replaced.

    - Also appropriate for grades 9-12
- **Documentary-** Jane (1 hour 30 mins) (https://films.nationalgeographic.com/jane-the-movie)
    - Released in 2017, this documentary "tells the story of Jane, a woman whose chimpanzee research challenged the male-dominated scientific consensus of her time and revolutionized our understanding of the natural world. Set to a rich orchestral score, the film offers an unprecedented, intimate portrait of Jane Goodall — a trailblazer who defied the odds to become one of the world's most admired conservationists."

Grades 9-12

- **Poem-** Water by Ralph Waldo Emerson
    - This brief piece, replete with figurative language, illustrates **the power of water** — its ability to sustain and to harm.
- **Book-** *Eyes Wide Open: Going Behind the Environmental Headlines by Paul Fleischman (Page count: 208)
    - This writing seeks to help teens understand the larger socioeconomic and geopolitical motivations and movements underlying the environmental narrative in the media. Recommended for helping teens think critically about and analyze the media they consume regarding contemporary environmental hot-topics such as climate change and fossil-fuel use. A rich educational resource, the interdisciplinary book draws from a range of subjects, including political science, history, and psychology; it provides a glossary and suggested resources for further engagement.
- **Book-** Living Simply: A Teen Guide to Minimalism by Sally McGraw (Page count: 112)
    - See description in "Books" section for Grades 6-8.
- **Book-** A Weird and Wild Beauty: The Story of Yellowstone, the World's First National Park by Erin Peabody (Page count: 192)
    - See description in "Books" section for Grades 6-8.
- **Book-** The Story of Seeds: From Mendel's Garden to Your Plate, and How There's More of Less to Eat Around the World by Nancy Castaldo (Page count: 144)
    - See description in "Books" section for Grades 6-8.
- **Article-** *Dale Threatt-Taylor | Conservation Career Profiles
    - This article is formatted as an **interview with** Threatt-Taylor, an African-American woman who serves as **the director of a soil and water conservation district** in North Carolina. Threatt-Taylor discusses her educational background and the factors that compelled her to work in the field of conservation and shares advice with young people.
- **Article-** *Bottled Water Is Sucking Florida Dry a New York Times Op-Ed
    - An intersectional piece on the exploitation of aquifer-sourced water and **extraction of resources from economically-disadvantaged communities by large corporations** such as Nestle. This is a fairly challenging read, but suitable for higher-level readers. This is a good piece for connecting business-minded individuals with contemporary concerns of water scarcity, reinforcing the imperativeness of conservation and energy-efficient solutions.
- **Article-** I Spent a Week Exploring How We'll Have to Live in Post-Water America

    - A narrative of a middle-aged woman who adapts her lifestyle to **limit her water utilization to less than ten gallons per day**. The author concludes with the idea that she will not continue to take such extreme measures, but that she will continue to be mindful of her water consumption, which will impact her daily decisions such as consumer purchases and in-home water employment.
- **Article-** The Dose Makes the Poison: Sugar and Obesity in the United States – a Review - PMC (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6959843/)
- **Website-** How Can You Help Protect Source Water? | US EPA
    - Detailed information for adults looking to conserve water at the household or community level.
- **Short Video-** Human Needs Threaten a Valuable Natural Resource-Saving the Dead Sea (6 mins) (https://indiana.pbslearningmedia.org/resource/nvstds-sci-humanneeds/human-needs-threaten-a-valuable-natural-resource-saving-the-dead-sea/)
- **Documentary-** *Rancher, Farmer, Fisherman (2017) (1 hour 43 mins)
    - Lifts up the voices of families from the U.S.'s Heartland who have dedicated their livelihoods to conserving the nation's natural resources and are typically underrepresented in the mainstream media.
- **Documentary-** Tomorrow (2015) (2 hours)
    - Depicts the multicultural encounters of a young couple seeking community-based alternatives and solutions to sustain the natural resources that threaten to deplete during their unborn son's lifetime. There is a focus on looking beyond American political and economic systems to seek a holistic and empowering model that is informed by various populations around the globe. See the trailer here.