Soy Where's Fido?

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3D-Student Science Performance
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Grade: 9-12 Integrated Biology

Lesson Topic: Cycling of Matter

NOTE: THIS IS A MULTI-DAY LESSON

Lesson Title
Soy Where's Fido?

Performance Expectations from State Standards or NGSS:

BI-LS2-3: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. [AR Clarification Statement; Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration and flow of nutrients in different environments.] [AR Assessment Boundary: Assessment does not include identification of steps or specific processes involved in cellular respiration.]

BI-LS2-4: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. [AR Clarification Statement: This PE is fully addressed in this course. Emphasis is on the transfer of matter and energy between trophic levels and the relative proportion of organisms in each level.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]

AR Literacy, English, and Math Connections:
Connections to the Arkansas Disciplinary Literacy Standards: RST.9-10.8, Assess the extent to which the reasoning and evidence in a text support the author's claim of a recommendation for solving a scientific or technical problem.

WHST.9-12.2, Writing informative/explanatory texts including narration of historical events, scientific procedures, experiments, or technical processes.

Connections to the Arkansas Mathematics Standards: MP.2, Reason abstractly and quantitatively.

Soy Where's Fido?

MP.4: Model with mathematics

HSN.Q.A.1,2,3: Use units as a way to understand problems and to guide the solution of multi-step problems, choose and interpret units consistently in formulas, chose and interpret scale and origin in graph and data displays. Define appropriate quantities for the purpose of descriptive modeling. Choose a level of accuracy for the purpose of descriptive modeling.

Lesson Performance Expectations:

- **Plan and carry out an investigation to develop evidence for the causes of cycling of matter between plants and organic material.**
- **Develop and communicate an explanation for the lack of growth in soybean plants due to a lack of release of nutrients from the organic material buried beneath the plant.**
- **Develop an argument of why the evidence supports an explanation for the lack of soybean growth in terms of lack of cycling of materials in the system.**
- **Develop and use models to describe the poor growth of soybean plants due to a lack of cycling of matter and a flow of energy from the organic material to the plant.**

Engage: Tell the hypothetical story of how soybean farmer Mr. Edamame's dog Fido went missing from his yard two days ago. Now this dog was known for causing issues with Mr. Lamb's sheep on one side of the soybean farm and raising havoc with Ms. Bird's poultry on the other side of the soybean farm.

Student Science Performance

Phenomenon: Soybean plants grown over fresh organic material do not grow as well as plants grown over decomposed organic material.

1. Students obtain information on how organic materials decompose and how plants respond to levels of decomposition in organic material during a literature search on cycling of matter, nutrition of plants and the decomposition of organic material.
2. Students plan and carry out an investigation to answer the question of whether freshly buried organic material will cycle nutrients to plants as well as decomposed organic material.
3. Students obtain information on how organic materials decompose and how plants respond to levels of decomposition in organic material by implementing an experiment involving burying a piece of chicken below a soybean plant and then monitor its growth for two weeks.

Teacher Suggestion: The description of the lesson set up, experiment description and materials are in Appendix B.

Soy Where's Fido?

Needless to say, the only person who missed Fido was Mr. Edamame! After some sleuthing, it was very apparent to Mr. Edamame that the dog hadn't run away nor was it stolen, but where was Fido?

Before Mr. Edamame can decide who, the culprit is, he needs to find out where his dog went.

The clues:

There was blood splattered around the dog kennel and run with the door chain having been cut by wire cutters.

It looked like something had been dragged from the dog kennel to the soybean field where the drag marks ended.

Explore: Ask the students for hypotheses here: What could have happened to Fido

Reasoning:

Students construct an explanation for why the lack of cycling of matter and flow of energy is causing the soybeans planted over the fresh organic material to not thrive as well as the control soybeans.

Students develop an argument using evidence that supports the explanation (claim) that the soybeans planted above fresh organic material do not thrive as well as the control soybeans because of a lack of cycling (and flow of energy) from the organic material to the plants.

Students, in groups, develop a model to show the cycling of matter and energy from the organic material to the plant showing a flow of energy in both anaerobic and aerobic conditions.

Class Discussion:

Questions to initiate Discussion:

Q: What happens after an animal dies on the surface of the soil? When they are buried?
Q: What do we know about decomposition?
Q: How do plants eat? How do plants get their nutrients?
Q: How are plant affected by the decomposition of organic matter?
Q: How are plants and decomposition tied into the cycling of matter and energy?

Teaching Suggestion:

Usually someone will note that the dog got buried in the soybean field. Ask your students 'How could we go about proving this?' 'What do we know about the early decomposition of bodies and their impact on plants?' 'What could we do to research this?'

Assign the students to teams and then ask them what they think should be researched to answer these questions. Ideas such as soybean nutrition, soil dynamics, newly buried bodies and their impact on growing plants etc. should come up in the brainstorming session. Give the students as many days as you want for research.

Communicate:

Students individually use their model to present an argument for how a lack of cycling of matter will slow down or stop the flow of energy in aerobic and anaerobic conditions.
(Students will be asked to write in their own words a research paper of the experiment and add a reflection section about what they learned in this project.)

Teaching Suggestion:

Discuss the results of the experiment with the class. Students now know what happens to soybeans when a fresh body is buried underneath them so ask them to use this information to help the farmer find out if Fido is buried in his soybean field.

based on the clues so far? Have students write down the question being asked and what they think the hypothesis is. **Explain:** When the students have completed their research, have each group tell what they learned by writing it on a white board or easel, so each group contributes their knowledge. Discuss the information with the class and add information where needed. Website Options: http://www.thecorpseproject.net/decompositionscience/ https://www.sciencenewsforstudents.org/article/recycling-dead **Elaborate:** Students should have discovered by now that newly buried bodies make for poor	• Have students break into groups and come up with a plausible way to figure out if Fido is really pushing up soybeans. • The students should determine the best places to look for a possible Fido eternal resting place are in small areas where the soybeans are not growing as well as the plants around them. • Ask the students the following questions: 1. what would be the next best step to determining if they are correct? 2. Tie in the data from the experiment…could the data be like what you would find in the field? 3. Could it be used there? Why or why not? 4. If Fido is found, what steps could be taken scientifically to figure out who did it? End the lesson with how decomposition is important to plants and the cycling of matter as it breaks down organic material into minerals and ions the plant can absorb and use. These nutrients are in turn used in both photosynthesis and cellular respiration by the plants. Plants are eaten by animals and the cycle begins again. So, decomposition is not only important to the cycle of matter, but it also can help solve a crime!

nutrition for plants so…how can we prove this statement and how can it help us find Fido? Ask the students to come up with a way to prove that newly buried Fido isn't good for soybeans. Students should figure out the most obvious way is to plant something (most likely fresh meat) under soybeans and see what happens. More experiment details can be found in Appendix B. **Evaluate:** Students should now have everything needed to write a paper on what happened to Fido. The following should be included: a stated research question, hypothesis, how they conducted the experiment, a created data table and graph, and what their conclusion was based on their data.	

If everything goes according to plan, the chicken plants should not have grown as well as the controls and this should come out in the conclusion of the experiment. *Students will add a reflection paragraph about what they learned regarding the cycling of materials in the soil and their impact on plant nutrition and growth.*	

Formative Assessment for Student Learning

Elicit Evidence of Learning: *This box is the individual communication performance from the student prompts in Appendix A*

Evidence of Student Proficiency	Range of Typical Student Responses	Acting on Evidence of Learning
Students will come up with valid hypothesis and will find valid research for this project. *Students will perform experimentation that will validate their hypothesis and the concepts learned will be used for critical thinking on the forensics of the missing dog.*	*Descriptors of grade-level appropriate student responses:* ● *Full understanding: Student answers show the understanding of the cycling of matter and energy and its impact on plant growth.* ● *Partial understanding: student answers show understanding of the cycling of matter and energy but not its impact on plants.* ● *Limited understanding: students understand what matter and energy are but not the concept of cycling or plant impact.*	*Description of instruction action and response to support student learning.* ● *Action for student who displays partial or limited understanding: concepts will be re-taught using visual clues and hands-on activities.* ● *Extensions of learning for student who displays full understanding: students will be encouraged to explore a more forensic side of the problem using the concepts gained from this lesson.*

Soy Where's Fido?

SEP, CCC, DCI Featured in Lesson	**Science Essentials** *(Student Performance Expectations from Appendix C, D, E)*
Science Practices Developing and Using Models Constructing Explanations and designing solutions Using Mathematics and Computational Thinking	• Use a model based on evidence to illustrate the relationships between systems or between components of a system. (BI-LS1-5, BI-LS1-7) • Construct and revise an explanation based on valid reliable evidence obtained from a variety of sources including student's own investigations in regards to the disappearance of Fido based on the assumption that Theories and Laws that describe the natural world are consistent in the past, present and future. (BI-LS-2-3) • Use Mathematical representations of phenomena or design solutions to support claims. (BI-LS2-4)
Crosscutting Concepts Energy and Matter System and System Models	• Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (BI-LS1-5) • Energy cannot be created, or destroyed-it only moves between one place and another place, between objects and/or fields, or between systems. (BI-LS1-7, BI-LS2-4) • The total amount of energy and matter in a closed system is conserved. (BI-ESS2-6) • Energy drives the cycling of matter within and between systems. (BI-LS2-3) • Models can be used to simulate systems and interactions. (BI-LS2-5)
Disciplinary Core Ideas Organization for Matter and Energy Flow in Organisms (LS1.C) Cycles of Matter and Energy Transfer	• As matter and energy flow though different organizational levels of living systems, chemical elements are recombined in different ways and form different products. (BI-LS1-7) • Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (BI-LS2-3)

in Ecosystems (LS2.B)	

Appendices: This section contains the lesson performance that students will see during the lesson and any other resources students will use to engage in the science performances. The appendices may also contain examples of student work.

Appendix A - Student Prompts

Student Prompts for the Lesson

Phenomenon: Soybean plants grown over fresh organic material do not grow as well as plants grown over decomposed organic material.

Group Performances:

1. Ask questions to plan an investigation:

Ask students what happens after an animal dies on the surface of soil. Make a KWL graphic organizer about what we know about decomposition, then ask how plants are affected by decomposition of organic matter. Ask questions such as 'What do plants eat?' and 'How do plants get the nutrients they need from the soil?' Now ask the questions 'What happens to organic matter (dead animal) after it is buried?' and 'What will happen to a plant if it is planted over a newly buried dead animal versus an animal that is decomposing?'

2. Plan an investigation to gather evidence for the cycling of matter and energy within an ecosystem and to determine how plants are affected by this cycle.
3. Construct an explanation for what happens when the cycling of matter is interrupted in regard to plant growth.
4. Use experimentation to show when the cycling of matter is interrupted, plants do not grow as well.

Class Discussion

Individual Performances:

5. Develop an argument for how the evidence you collected supports or refutes your explanation for what happens when the cycling of matter (and energy) are interrupted in the

growth of a soybean plant.

Appendix B:

Materials:

- Plastic containers (can be margarine tubs, yogurt tubs, cut 2L soda bottles etc.) at least four per group of four students.
- Soybean seeds
- Soil from the school yard and spoons for soil (potting soil may be used also)
- Chicken meat with skin from a grocery store (any meat part will do)
- Rulers
- Student notebooks for data collection
- Water
- Scissors for cutting chicken
- *OPTIONAL:* Allow students to take daily photos of the soybean plants with their phone cameras for comparison at the end of the project. This will throw a 'technology and expanded data collection' aspect into the lesson.

Preparation: Seeds can be obtained through the SSC on-line seed store (www.uaex.uada.edu/soywhatsup). Seeds are shipped out within a week of ordering. Soybean seeds take about eight to ten days to germinate and emerge from the soil. You can either plant the seeds and introduce the seedlings at the beginning of the project or have the students do the planting/watering in anticipation of the lesson.

Time Duration: From planting to writing the paper, anticipate about three to four weeks although the daily time amount for measuring/photographing will be minimal, maybe 10 minutes each day.

The experiment:

- Assign a minimum of four pots of soybeans to a group. Ask the students why at least four? (for controls and verification).
- Have the students cut up two thinner pieces of chicken that are about two thirds the size of the diameter of one container. The students need to carefully dig up the soybean seedlings with roots from the designated 'chicken' pot and place one piece of chicken in the hole. The seedlings are then placed carefully on top of the one piece of chicken and the second piece is gently placed over and around the roots of the plants, covered with dirt and watered. *NOTE: the roots must be completely covered by the chicken so cutting the second piece halfway up will help surround the roots!*
- Students then need to carefully dig up the pots of control plant seedlings and replant them in the soil, then water. Ask the students why it is necessary to dig up the control plants (for consistency in the experiment, eliminating the variable of digging up the roots as a cause for growth differences).
- Students will need to do an initial (base) measurement of height of all plants, number of leaves, overall color etc. Base pictures and daily pictures are recommended!
- Students will do a height measurement, count the number of leaves and leaf color, and check daily for two weeks or until plants die. Plants should be watered at least every other day and noted in a logbook with the data collected.
- After two weeks, students will do a comparison of the control plants vs the chicken plants.
- *Teacher Hint: Plant two soybean pots and leave 'as is' so students have a visual of undisturbed plants.*
- ***NOTE: If the experiment is going outside, keep the pots in a protected area away from furry critters wanting to dig up the chicken.***

- ***FYI: Previous experimentation showed soybean seedlings died a week after being transplanted over chicken. Mature plants would take longer to be affected.***

The results:

- Students will need to put together a data table that has the height of plants and number of leaves of plants. Students should also do a color chart comparison of leaf color. Data point graphs should also be done to show differences in the plants over time.
- *If students do not know how to do a point graph, refer them to https://nces.ed.gov/nceskids/graphing/Classic/ and have them follow the prompts for making a graph.

Appendix C –

Website Options:

http://www.thecorpseproject.net/decompositionscience/

https://www.sciencenewsforstudents.org/article/recycling-dead