Fifth Physical and Life Science

FOOD AND ENERGY: Animal and Plant Energy

Background Information

Energy exists in many forms and is constantly being transferred between forms. All energy types can be sorted into two main categories: potential and kinetic. Potential energy is stored energy. Chemical energy, nuclear energy, stored mechanical energy, and gravitational energy are all examples of potential energy. Kinetic energy is the energy of motion. Radiant (light) energy, thermal energy, sound energy, and electrical energy are all examples of kinetic energy. Energy cannot be created or destroyed, only transferred between the types of energy. Most energy we use on Earth stems from the nuclear energy from within the sun.

All living things require nutrition. Nutrition serves as chemical energy that living things then use or convert into other forms in order to carry out life's necessary processes. Humans get their nutrition primarily from other animals or plants. Plants produce their nutrition via photosynthesis, which requires water (H_2O), carbon dioxide (CO_2) from the air, and radiant energy from the sun. Soil provides nutrients and a medium for roots to grow and stabilizes growing plants. However, if plants can get nutrients from another source it is not necessary for successful plant growth.

Hydroponics is the science of growing plants without soil, using nutrient and oxygen rich water instead. There are many environmental and fiscal benefits affiliated with hydroponics, including but not limited to: less water used/wasted, less diseases, less need for pesticides or chemicals, faster growing, and higher yield production.

Performance Expectations

5-PS3-1 ENERGY 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 https://www.nextgenscience.org/pe/5-ps3-1-energy

5-LS1-1 FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES Support an argument that plants get the materials they need for growth chiefly from air and water.
https://www.nextgenscience.org/pe/5-ls1-1-molecules-organisms-structures-and-processes

Disciplinary Core Ideas

PS3.D: Energy in Chemical Processes and Everyday Life: The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).

LS1.C: Organization for Matter and Energy Flow in Organisms: Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.

LS1.C: Organization for Matter and Energy Flow in Organisms Plants acquire their material for growth chiefly from air and water.

Science and Engineering Practices

Planning and carrying out investigations: Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

Analyzing and interpreting data: Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.

Engaging in argument from evidence: Support an argument with evidence, data, or a model.

Crosscutting Concepts

Energy and Matter: Matter is transported into, out of, and within systems. Energy can be transferred in various ways and between objects.

Activity 1 Materials

- Energy Transfer Cards
- Construction Paper
- Energy Graphic Organizer

Activity 1 Suggested Implementation

Ask students to consider the two questions out loud. It is recommended that students use the 'think, pair, share' strategy to fill out the graphic organizer. Give students some time to write down their individual thoughts for each questions, before directing them to pair up, share their ideas with a partner, and write down anything new that they come up with together. Prepare a space with each question where the entire class can see (either on the board, large post-its, etc…), and have pairs share out their ideas as the teacher collects the class ideas on the board.

In the next activity, students will work in groups and use their new ideas about energy and energy transfer in order to sort twelve cards into a system that represents energy transfer between the organisms and food products. There are not necessarily right or wrong answers but each group should be prepared to explain to the rest of the class why they arranged their cards. Some guiding questions you might make are:

- **Where does each person get their energy?**
- **Where does our food come from?**
- **Where do other animals get their food?**
- **Is there more than one way to arrange the cards?**

After giving students some time to play around with different card arrangements, ask them to pick one of their arrangements to glue or tape down on large paper leaving spaces between the cards. They can draw arrows between the cards to indicate the flow of energy or underneath each card they can write "gets its energy from ________" For example: Athletes get their energy from bacon. Bacon is processed from a pig. Pigs get their energy from corn, or berries and leaves. Where students may struggle is the last card. Where do corn/grass/berries and leaves get their energy?

Instruct each group to brainstorm ideas, writing them down on scrap paper if needed. Facilitate a class discussion where each group can share their ideas, and (hopefully) come to the conclusion that all plants get the energy that they need to grow and live from the sun. If your students are not very knowledgeable about farm animals, allow them access to resources to research food production. It is possible that some students may not know where hamburger or bacon come from.

Activity 2 Materials

- Glue or Tape
- Seeds (or seedlings*)
- Small Plates
- Soil
- Paper Bags
- Water
- Small Containers with Drain Holes
- Grow lamps or very sunny window
- Ziploc Bags
- Perlite (or other soil substitute)
- Rulers
- Hand Lenses

Activity 2 Suggested Implementation

In this section of the activity, students will determine which factors are necessary for plant growth through brainstorming and scientific testing. The first step will be to pass out the 'growing greenery' page to the students, and giving them an adequate amount of time to individually fill out the thought bubble. Students should be able to pull from prior knowledge gained from their discussions in Part One.

Come together as a group and ask students to share out their thoughts. It is recommended that you write down student ideas for the class to see as they are shared. If multiple students have the same variable, feel free to emphasize that by placing tally marks or underlines next to the original word. You should see a lot of students with 'sun, water, soil, & air'--if this is not the case, try to facilitate a class discussion that nudges them in that direction. The end result should be a class consensus that plants need sun, water, soil, and air, which they will record on the bottom half of their 'growing greenery' sheet.

The next step of the lesson is to split the class into eight 'lab' groups (depending on class size, each group will have 2-4 students). Each lab group will be in charge of planning a controlled

experiment to test and see if the plant can survive/grow without one of the four variables (sun, water, soil, and air); there will be 2 lab groups working on each variable. The teacher will be in charge of 'control' plants that receive all four variables.

*It is highly recommended that the teacher either a) plants seeds ahead of time so that students are dealing with seedlings or plants, or b) buys small 'filler' plants from a nursery or home improvement store for students to use. Starting with seeds may increase difficulty and extend the length of time needed for the experiment, but it is possible to do.

The teacher will have a couple plants set up as 'control' plants. These plants will receive water, sun/light, soil, and air. Depending on the size of the seeds/seedlings/plants you are using, you will want to set a 'standard' amount of light and water for all groups to abide by. For example, 12 hours of light, and ¼ cup water every other day.

Once students are in their groups, they will begin to brainstorm ways to grow their plant without water, sun, soil, or air. Ideally, students will be able to see the materials available to them to help guide their planning. While variations are possible, and even encouraged, standard setups for each group are listed below:

- **No Water**. The plant will be in soil in a small container with drain holes. The plant will be exposed to 12 hours* of light a day. The plant will be exposed to air. The plant will never receive water.
- **No Sun**. The plant will be in soil in a small container with drain holes. The plant will be exposed to air. The plant will receive ¼ cup* water every other day. A paper bag (or other opaque container) will be placed over the plant at all times so that it is never exposed to light.
- **No Soil**. The plant will be in a small container with drain holes. Instead of soil, perlite (or another soil substitute) will be used. The plant will be exposed to 12 hours* of light a day. The plant will be exposed to air. The plant will receive ¼ cup* water every other day.
- **No Air**. The plant will be in soil in a small container with drain holes. The plant will be exposed to 12 hours* of light a day. The plant will be placed in a Ziploc bag with as much air removed as possible. ½ cup of water will be placed in the bottom of the bag so that the plant has adequate water throughout the experiment without having to open the bag.

*These values are up to the teacher to decide--as long as the class amounts are constant for each.

After the experiments have been set up, it is up to the teacher to determine the overall length of the experiment. It is recommended that data is recorded over the course of at least two weeks for students to see meaningful results. When students record their data, they will measure height (cm or in) and color, as well as any other meaningful notes (new leaves, dropped leaves, bending/tilting, etc.).

At the end of the data collection, students will go around and observe each other's experiments, and draw/collect data for each one. As a class, students will compare observations and decide together which variables plants were able to live and grow without.

<u>Debrief Questions</u>

- **Where does the energy in our food come from?**
- **What do plants *need* to grow?**
- **Why did we have a control plant?**
- **Why did you only test for one variable?**

Assessment

The following single point rubric can be used to assess student understanding. For each of the four criteria listed below, either circle the proficient description or add notes to a box indicating why the student's performance was either lacking or exceptional.

Areas that need improvement. **Developing Performance**	Criteria for: **Proficient Performance**	Evidence of exceeding standards. **Advanced Performance**
	Explained that energy from food once came from the sun.	
	Explained that plants get materials for growth from air and water.	
	Developed a model that traces energy back to the sun.	
	When asked "How do you know?" students referenced observations from their own investigations.	
	Explained that energy is transferred through food or other means.	

Accommodations

Designing and putting together seed starters under the various required conditions may require **fine motor skills**. Students with difficulty can be partnered appropriately.

Reading aloud instructions with students can help those still developing **grade-level reading** skills.

Possible Extension Lessons

The extension lesson allows students to use their knowledge about plants and energy to create possible solutions to real world problems using engineering techniques. There are three parts to the extension, and you may incorporate just part 1, parts 1 & 2, or parts 1, 2, & 3 into your classroom. Part 1 involves presenting the class with a specific problem related to creating a garden without soil. You will then facilitate as the class (as a whole or in groups) work through the various criteria needed to hone in on the problem. For example, this may involve defining the problem, determining necessities for success, materials, costs, time, etc. Part 2 involves students working in groups to create possible design plans that follow the criteria set in Part 1. Part 3 involves students carrying out the plans they created in Part 2, analyzing efficiency, and making improvements as needed.

Extension- Part 1

Initially, students should be presented with a scenario specific to their school or area. Examples include:

- Our school wants to start a garden, but we do not have a lot of space.
- Our school wants to start a garden, but we do not have a large budget.
- NASA wants to start a garden on the ISS, but soil weighs too much to send up on a space shuttle.

After you present your chosen scenario to the students, allow them time to brainstorm ideas--encouraging them to pull from the knowledge gained in the lessons, remembering that all living things get their energy from the sun, and that plants also need air and water (but not soil) to grow.

Here are a few articles you could use to supplement the problem solving process or inspire ideas (specifically about hydroponic systems), however, if there are articles or resources more relevant to your geographic or regional area those would be fine to use as well.

- https://newsela.com/read/lib-drought/id/37539/
- https://newsela.com/read/arctic-farming/id/24019/
- https://www.ilfbpartners.com/farm/new-day-hydroponics-grows-flow/

By the end of Part 1, students should have a well-defined problem with set constraints (time, money, space, available materials, etc.). Specific constraints will vary based on school and classroom resources available.

Extension- Part 2

Students will utilize the defined problem from part 1 to draw or design possible solutions. It is recommended that students work in partners or in groups as they create their design plans. The goal for this part of the lesson is for the class to have a number of design plans that follow the constraints set in part 1 that they can compare, as well as analyze strengths and weaknesses of each.

Extension- Part 3

In Part 3, students will build a prototype and test their gardening solution. The ability to build a class hydroponic system will depend solely on budget, however there are low-cost options available.