Virtual *Food Build Do Waste* field trip* presented by Warner Park Nature Center
Instructor Support

Students will:

- Understand food as digestible "packages" of energy and matter
- Record how organisms use matter to build bodies and energy to do things
- Develop a model of how matter cycles and energy flows through an ecosystem
- Describe the movement of matter and energy among producers, consumers and decomposers

Science Standards

Disciplinary Core Idea

- 4th grade: Develop models of terrestrial and aquatic food chains to describe the movement of energy among producers, herbivores, carnivores, omnivores and decomposers (4.LS2.2)
- 6th grade: Draw conclusions about the transfer of energy through a food web in an ecosystem (6.LS2.3)

Science Practices

- Making Observations
- Developing and Using Models

Cross-cutting Concepts

- Energy & Matter

Student Materials Needed:

- Paper or Journal
- Pen or Dark Pencil

<u>Asynchronous Lesson</u> – approx. 18 min video

Students think about how we use matter from food to build our body structures and energy from food to do things. They follow Naturalists as they think about wastes such as solids and liquids, sweat, heat, and gases like carbon dioxide and water vapor. Students are introduced to the initial concept of a model to help explain how organisms use matter and energy as they cycle and flow through them and the ecosystem.

Students then apply this concept by creating their own Food, Build, Do, Waste diagram by observing, drawing and recording information about one of four possible organisms shown in pictures and videos.

The terms producer, consumer and decomposer are introduced, and consumer terms are further defined as herbivores, carnivores and omnivores. Students are encouraged to include this information in their diagram. A Naturalist then models how to create a more complex model to further describe how energy and matter move through organisms and the ecosystem.

Students apply this new concept by adding information to their model, showing that matter cycles (as a solid, liquid or gas), while energy flows from the sun, through organisms and back out into space (in the form of heat).

Synchronous Lesson

If possible, it is recommended students have the opportunity to discuss their findings, questions and ideas like scientists do.

During in-person class time, give students time to share their observations: what body structures their organism built using matter from food and what their organism did using energy from their food.

Encourage students to revisit what waste they think these animals must give off – ultimately they should all realize that all organisms give of energy waste in the form of heat and matter waste in the form of gases (water and carbon dioxide), plus other matter waste like poo, pee, shed skin, etc.

Possible reflection questions:

- Every organism, including the one you studied, can be food for other organisms. What other organisms (consumers) can you think of that might get their matter and energy from eating your organism?
- What animals can you think of that are very active and need food with lots of energy in it, like seeds or meat?
- What animals can you think of that are *not* very active and can eat food with less energy in it, like grass or leaves?
- How do decomposers help matter cycle and energy flow through the ecosystem? *As organisms decompose, energy continues to be released in the form of heat while gases - carbon dioxide and water - are released into the air to eventually be captured again by plants to build their structures. Other matter (organic components) become part of the soil, which can be absorbed by plants as well.*
- In one year an 8 pound rabbit eats and drinks 400 pounds of plants and water. About 140 pounds comes out as poop and pee. What happens to the other 260 pounds? *While it's hard to think of gases like carbon dioxide and water vapor having "weight", they absolutely do. Students should be able to look at their diagram and see that as the rabbit eats and drinks, some of the matter from it's food is turned into fur, lungs, ears, etc but that most of the matter is released as carbon dioxide and water as the animal breathes. It is NOT because the animal burns energy – energy doesn't take up space or have mass.*

Optional activity:

- Expand your model even further, by creating a longer food chain, showing the loss of energy (as heat) at each trophic level.

Additional Instructor Support

(excerpt from BEETLES Student Activity Guide. For the complete resource, visit www.beetlesproject.org)

Conceptual Knowledge

Matter is the "stuff" things are made of. Wood is matter, bones are matter, water is matter, and even air is matter. Matter takes up space, but it's hard to feel that with air unless you capture some in a balloon or bag. Matter also has mass (weight), but that's also hard to feel with air, because it has so little mass. We live in a "sea of air," so it can be difficult to feel the weight of air when you're surrounded by it on all sides.

Energy is much harder to define than matter, and has different definitions depending on the branch of science. In this context, energy can be defined simply as what organisms get from food that allows them to do things. If

you're introducing students to the term, "matter," energy can also be partially defined as "not matter." Unlike matter, energy doesn't take up space or have mass. But if you want to go deeper, read on. Energy has no physical form; it's not a substance. When we say energy is transferred from one organism to another, we're not talking about a physical thing being passed from place to place, rather we're talking about transferring the capacity to do things, i.e. living and growing.

Weird and confusing, huh? Want more? Well alright then...

Energy can be described as being in two different categories: the energy of motion (kinetic energy) and the energy of position (potential energy). Light, sound, heat (thermal) energy, as well as the movement of objects, are all examples of the energy of motion. Chemical, gravitational, elastic, and nuclear energy are all examples of potential energy. Since potential energy does not involve detectable movement or sensation, these types of energy are commonly unrecognized. The greater the potential energy, the more capacity there is for something to happen.

Seriously? You want even more? OK then...

Energy is a measure of how much change can happen in a system – so it's typically represented with a number. It's a quantity that's always conserved, it's neither created nor destroyed. Something needs to happen for any type of energy to be released or transferred. In other words, energy is released or transferred during interactions. As a result of an interaction, energy can transform from one type to another and the amount of energy associated with an object can change. These changes are what are being taken into account as we track the flow of energy through a system. Understanding energy flow and redistribution throughout a system is often a key to understanding the functioning of the system as a whole.

Food provides all organisms with chemical energy and matter needed to live and grow. Food needs to be digestible by the organism to provide both matter & energy for the organism to live, build its body parts and grow. Organisms also need other kinds of matter to survive, such as water, oxygen, CO_2, nutrients, vitamins, but these substances are not considered food. Plants "package" energy and matter into food substances through photosynthesis, and all plants consume the food they make. The typical convention used in drawing food webs is to draw the arrows between organisms pointing toward the organism that consumes the food. The arrow indicates the direction of the flow of matter and energy.

Food substances (carbohydrates, fats, sugars, and proteins) are specific kinds of molecules that are broken down in the body through digestive processes. All organisms (including plants, animals and fungi) grow by breaking down food (including sugars made by plants and ingested by animals & fungi) and assembling the breakdown products into their body structures. After food is broken down into sugar (glucose) it enters the organism's cells and goes through a series of chemical reactions producing ATP, which is the process by which all cells obtain energy. In this way, food serves as a fuel to do things and also provides the molecules and building materials needed by organisms. That's why it's useful for students to think of food as a package of matter and energy.

Common Misconceptions:

Misconception. Organisms convert matter into energy.

More accurate information. This is a very common misconception, even among adults. Matter is not converted into energy in life systems on Earth. Matter changes into other forms of matter, but it remains matter. When organisms eat food, energy is used to do things and can be released as heat to eventually drift off into space, but the matter in food is released as CO2 in breath, H2O in breath & sweat, and organic matter in feces and urine. Even though chemical energy in matter can be transformed into usable energy by organisms, the matter in food does not turn into energy. Remember that energy is not a substance. The chemical substances in food are transformed into new substances (through chemical reactions), but there are no new atoms created or destroyed in the process. Under usual circumstances (certainly in all ecosystems and food webs on Earth), matter does not turn into energy. Try to avoid using language that might support this misconception.

Misconception. Energy from the Sun is captured by the Earth and keeps cycling round and round in ecosystems.

More accurate information. Eek! If that were true, Earth would be a hot planet. Matter cycles through ecosystems here on Earth, and does not usually leave the planet (some air molecules are lost into space, and sometimes a spacecraft flies away). A large amount of energy flows to Earth from the Sun in the form of light energy, and is captured by plants and "packaged" with matter in the form of food. But at every link in a food chain or food web, ~90% of the energy is lost from the ecosystem when it is released into the atmosphere as heat, and eventually drifts into outer space. About 10% of the energy is passed on to the next organism that eats it. So there is a constant flow of energy from sunlight into Earths' systems (during the day), and a constant flow out of the systems into space. This is why it's important to keep these ideas separate and **not** combine energy and matter into one driving force that cycles through all the systems on Earth. For example, by including the Sun in food webs (sometimes done to try to simplify energy flow and matter cycles) this can reinforce the inaccurate idea that energy is constantly cycling through Earth systems. By teaching kids that food is energy *and* matter, and that matter cycles and energy flows, we can give students a more accurate picture. Sometimes it can be less confusing to focus first on matter, and then introduce the more abstract concept of energy.

Misconception. Most of the mass of plants comes from soil and water.

More accurate information. This is also a very common misconception, even among science educators. Soil does not provide food for plants, but provides them with essential nutrients, similar to vitamins. A tiny fraction of the mass of a plant comes from soil, but most of the mass comes from carbon dioxide and water that are chemically rearranged into glucose through the process of photosynthesis.