Fire Ecology Learning Lab
Share with Wildlife Grant Report, 2022

Author Information:

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Update on Project Progress:

1. Curriculum Development: Lessons and materials from the initial scope of the project have been completed. See attached for a sample lesson and a one-page overview of all lessons. The curriculum writer worked with New Mexico Game and Fish staff to develop a list of approximately 30 animals to include in lessons 1 and 5. These primarily include animals that are of concern in New Mexico. These animal profiles are currently being edited by the Southwest Fire Science staff and will then be shared with New Mexico Game and Fish by mid-July to identify additional changes. They will be included in the student materials by the end of August.
   Below is the list of the animals, organized by biotic community (species endemic to New Mexico marked with "NM"):
   1. Mixed conifer forests:
      - Mexican spotted owl
      - Jemez Mountains salamander, Sacramento Mountain Salamander
      - Peñasco least chipmunk- NM
   2. Ponderosa forests:
      - Grace’s warbler
      - Red-faced warbler
      - Silver Creek woodland snail - NM
   3. Pinyon-juniper woodlands:
      - Piñon jay
      - Gray vireo
      - Western yellow bat
   4. Sagebrush steppe and shrublands:
      - Sagebrush sparrow
      - Loggerhead shrike
      - Gunnison’s prairie dog
   5. Grasslands:
      - Sprague’s pipit
      - Lesser prairie-chicken
      - Black-footed ferret
      - Pronghorn
   6. Desert scrub:
      - Bendire’s thrasher

- Aplomado falcon
- Lesser long-nosed bat
- Gila monster

7. Desert grasslands:
    - Burrowing owl
    - Black-tailed prairie dog
    - Desert massasauga
8. Interior Chaparral
    - Mexican gray wolf
    - California kingsnake
    - Desert bighorn sheep
9. Oak Woodlands
    - Jaguar
    - Lucifer or violet-crowned hummingbird
    - New Mexico ridge-nosed rattlesnake
    - Roundtail chub

2. Piloting Lessons: Lessons and materials were piloted by teachers through the spring. They shared feedback with the curriculum developer.

3. Revising Curriculum: Lessons and materials were edited after receiving feedback from scientists, teachers, and wildland fire professionals. This process will continue through the summer as additional feedback comes in from educators.

4. Teacher Recruitment: A flyer and sample lessons were printed and distributed at the STEM Symposium in mid-June in Albuquerque. This advertised the online teacher training that will occur on September 17, 2022. This outreach will continue into the late summer.

5. Teacher Training: We will offer a teacher training on September 17, 2022. It will be online to allow teachers from around the state to attend. Teachers will receive a $100 stipend. We are applying to present a session at the Arizona Science Teachers Association meeting in the fall. In addition, Cerise staff is collaborating with the regional Forest Service to train federal and state wildland fire management staff to visit classrooms to support teachers as they conduct these lessons, especially those that suggest fuel experiments.

6. Implementation and Teacher Support: Wildland fire experts, curriculum developers, and others are available to answer questions, visit classrooms, and offer support.

7. Evaluation: Teachers will be given a post-training survey. The Fire Science Consortium staff is also working with Cerise Consulting and evaluation experts at

Northern Arizona University to develop a student assessment. This will be designed to track changes in knowledge and attitudes. We also encourage the teachers to share anecdotal information and the final project with the Southwest Fire science team.

Overview of the Fire Ecology Learning Lab

The Fire Education Learning Lab is a place-based, experiential middle school science unit designed to help students understand the biotic communities of the Southwest, how these communities are adapted to wildland fire, and how the land can be thoughtfully managed. The lessons are aligned with state standards and follow the 5E model of science education. The free lessons are available as an interactive lab notebook and downloadable PDFs and via Canvas and Google classroom. This was funded by the Southwest Fire Science Consortium.

Theme 1: Biotic Communities

Lesson 1: Biotic Communities Mural: Students will become experts in different ecosystems, climate zones, and plants across New Mexico and Arizona. Students will become experts in a biotic community and a plant and will use this knowledge to teach their classmates. Together they will create a model of the biotic communities in the form of a mural.

Lesson 2: Local Biotic Community Investigations: Students will apply what they learned about ecosystems to investigate their local environment. They will investigate the plants and climate of the local environment and will compare this with the biotic communities in Lesson 1.

Lesson 3: Energy in the Ecosystem: Students will compare how energy stored in carbon bonds is released (burning, rotting, and cellular respiration) to understand how dead plant material is broken down. They will create a diagram of this process.

Theme 2: Biotic Communities, Plants, and Wildland Fire

Lesson 4a: Fire Safety and a Trauma-Informed Approach: Students will learn how to safely conduct experiments and use fire extinguishers. Teachers will share how students who might have been affected by wildland fires can feel safe as this topic is addressed.

Lesson 4b: Fuel Properties: Students will observe three models of how fuels burn and make observations about how fuel properties affect the way a fire burns. They will then learn what these fuel properties are called.

Lesson 5: Biotic Communities, Plants, and Fire Adaptations: Students return to the biotic community they investigated in Lesson 1 and read about how different plants and ecosystems evolved with or without fire. They will also learn how changes, such as invasive species and climate change, have altered the relationship between the biotic communities and fire.

Lesson 6: Fuel Experiment: Students build on what they learned about fuel properties in lesson 4b, as they research, design, and conduct their own fuel and fire experiment in class.

Lesson 7: Fire Regime: Students apply what they learned about fire, biotic communities, and climate to determine the fire regime of their region.

Theme 3: Fire Management

Lesson 8: Indigenous Uses of Fire Management: Students use tree ring data to learn about how indigenous communities have used fire to manage the land.

Lesson 9: Fire Policy and the Community: Students each research a different community member's perspective on fire and fire management. They hold a mock city council meeting to debate the way that fire should be managed in a fictional community.

Lesson 10: Recommendations for Wildland Fire Policies: Students use everything they have learned to create policy recommendations for wildland fire managers in their region.

Lesson 3: Energy in the Ecosystem
Estimated Time: 1 hour + 20 minutes homework

Guiding Question, Phenomena, and Assessment
GQ: How does energy move through an ecosystem? P: Fire impacts our local biotic communities and the way that we live in the Southwest. What are the living and nonliving factors that shape the relationship between biotic communities and fire? How can we make informed decisions about how to manage wildland fires across our region? A: Presentation on ecosystem, diagram contribution, and participation

NGSS and AZ Science Standards	Related Learning Goals
NGSS Content LS1.C: Organization for Matter and Energy Flow in Organisms: Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. PS3.D: Energy in Chemical Processes and Everyday Life, The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. **Arizona Science Standards** AZL2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms. AZP1: All matter in the universe is made of very small particles. AZP4: The total amount of energy in a closed system is always the same, but can be transferred from one energy store to another during an event.	Students will know: ● Energy is stored in molecules. ● Molecules can be broken apart in several ways. ● Animals and plants can use the energy stored in molecules. ● Fire can also break apart molecules. Students will be able to: ● Explain how atoms are split apart and reformed (Boundary: will not discuss electrons or covalent). ● Create a model and diagram demonstrating conservation of matter and conservation of energy.

NGSS Crosscutting Concept: Energy and Matter: Within a natural system, the transfer of energy drives the motion and/or cycling of matter. **NGSS Practices:** Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories. Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	
Common Core **RST.6-8.1**: Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-6) **WHST.6-8.2**: Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS1-6) **WHST.6-8.9**: Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS1-6)	Students will be able to: ● Use the readings they are provided to help them understand the material. ● Share their thinking verbally and in writing. ● Cite evidence supporting what they state.

Student Materials	Teacher or Whole Class Materials
● Molecule page: 1 per student ● Fire, Fungus, Cow pages: 1 per 3 students ● Student Notes page: 1 per student ● Scissors ● Tape ● *Optional*: science journal	● Dry grass or a dry leaf ● Matches ● Tub of water ● Tongs or clamp ● Goggles

Vocabulary	
● Cellular respiration ● Chemical potential energy ● Combustion ● Decomposition ● Energy ● Fire ● Heat ● Kinetic energy ● Photosynthesis ● Potential energy	● Molecule ● Chemical bond ● Carbohydrate ● Glucose ● $C_6H_{12}O_6$ ● Water ● H_2O ● Carbon dioxide ● CO_2 ● Oxygen ● O_2

Agenda and Timing	Teaching Notes
Engage - 15 minutes ● Journal reflection: imagine that all living plants and animals that had ever lived on Earth were still here because they didn't rot or get eaten by decomposers. What would it look like if you looked out the window? ● Hold up dry grass and ask how this might be removed from "circulation". ● Then burn the grass. ● Review photosynthesis and storage of energy. ● Review molecules and atoms. **Explore** - 15 minutes ● Let students explore how carbohydrate molecules break down and are converted into other substances. ● Each student in a group of 3 will become an expert on a different way that molecules release energy: fire, decomposition, and getting eaten by a consumer **Explain** - 5 minutes ● Relate this to storage and release of energy. ● Create diagram showing where the energy came from and where it went. **Elaborate** - 15 minutes ● Have students with different processes share with each other.	Inform supervisor you will be doing this. If you do not have a fume hood, burn a minimal amount to avoid smoke. Wear goggles and have a fire extinguisher available.

● As a class discuss the different methods of breaking down materials and releasing energy. **Evaluate** - 10 minutes ● Have students look back at what they learned about the local ecosystem in the previous lesson and discuss how materials are broken down locally.	
	Before class: ● Make copies of student handouts. ● Set up for burning dry grass.

Opening	Student Differentiation and Supports
5 minutes: Journal Reflection ● Imagine that none of the living organisms on Earth had ever been decomposed, fossilized, eaten, or otherwise destroyed. What would it look like outside the window? Write a paragraph or draw and label your response. 10 Minutes: Set up activity ● Teacher: hold up dry grass. ● Discuss where the grass came from and how it functioned as a part of the plant. ● Review photosynthesis and how energy is stored in the grass in bonds between atoms. ● Mention carbon bonds and how these store energy when they are formed and release energy when they are broken. ● Review symbols of atoms: ○ C = Carbon ○ O = Oxygen ○ H = Hydrogen ● Ask: Where will this grass be in 100 years? Will it look the way that it does now? ● Have students brainstorm what could happen to it. Make sure they cover that it could be eaten, decomposed, or set on fire. ● Using the tongs, set the grass on fire and then drop it in the water. ● Explain that they are going to explore how the bonds in the grass might be split through different processes and how that	This curriculum is built with the assumption that students have been introduced to the concept of chemistry. If this is new, a few concepts to pre-teach are: ● Conservation of energy. ● Conservation of matter. ● Difference between atoms and molecules.

energy might be released and used in different ways.	

Work Time and Discussion	Student Differentiation and Supports
15 minutes: Individual Exploration Students explore how energy can take different paths through an ecosystem. ● Assign students to groups of 3, ● In each group, each student will become an expert on a different way that the grass could be broken down. ● Options: ○ Fire: Burning. ○ Fungus: Decomposition. ○ Cow: Cellular respiration. ● Students will cut apart the molecules and reform them to show how the glucose molecule was broken down and what byproducts were released. 5 minutes - Individual Exploration ● Students will create a diagram showing how energy (sunlight) entered the system, how it was stored, and what happened to it when the grass was broken down. 10 minutes - Small Group ● In their groups of 3, have students share the processes they each became an expert in. ● Compare the byproducts, where the energy went, and how long it took. 5 minutes - Whole class ● Ensure that everyone understood the three ways that energy could move through the ecosystem.	If this is the first time you have covered chemistry, this could be done as a group, using an Elmo or similar projector.

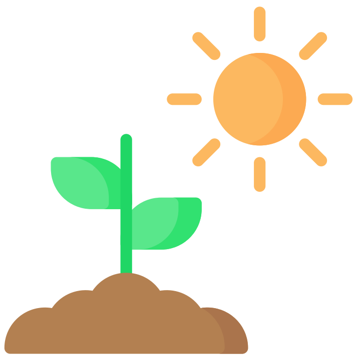
Closing	Student Differentiation and Supports
5 minutes - Whole Group / Small Group ● Discuss how water and temperate climates are necessary in the decomposition process. ● Discuss how only a small fraction of what	

grows in an area will be consumed by animals. ● Relate what they learned back to the ecosystems the students explored in Lesson 1. Which areas are moist and would allow decomposition to occur? Which are dry? 5 minutes - Whole Group ● Have students predict which ecosystems would have more decomposition or fire. ● Ask why. 5 minutes - Whole Group ● Explain homework.	

Homework	Student Differentiation and Supports
On the worksheet students will: ● Compare and contrast how energy is released by burning, rotting, and being consumed. ● Reflect on what happens if plants are not decomposed or consumed. What will this do to the potential for fire in a region? ● Consider what this means about the conservation of energy.	

Name:__________________
Date:__________________

Energy Release: Fire, Fungus, and Cows



As plants grow, they store energy from the sun through photosynthesis. This energy is saved in molecules through chemical bonds. Using solar energy, the plants convert carbon dioxide and water into chains of carbon atoms with oxygen and hydrogen. The molecules plants produce include glucose and other carbohydrates. Carbon bonds are good at keeping energy safe until the plant needs to use it. However, most plants store more energy than they use. This extra energy is stored in the plant's leaves, stems, and roots.

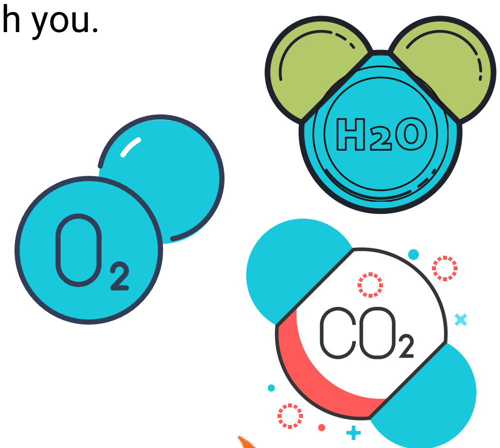
Plants provide the energy most forms of life on Earth need to live. Animals (consumers) eat plants, use the energy, and convert the leftovers into scat and carbon dioxide. Fungus decomposes plants, uses the released energy to grow, and returns the leftover matter to the soil. If it is too dry, fungus is unable to decompose plants. Fungus is only able to grow in wet areas. Many locations across Arizona and New Mexico are too dry and require a different way of breaking down dead plants: fire.

If it weren't for decomposition, consumers, and fire, every plant or animal that had ever existed would still be on Earth. Dead plants and animals would cover every inch of land and fill the water. It is only because of the cycling of energy and matter that life can continue. We can add compost to enrich the soil, clear land so more plants can grow, and feed ourselves. Energy and matter are constantly being converted from one form to another.

Today you are going to compare and contrast what happens to molecules during cellular respiration, fire, and decomposition. For this activity you will need a **Molecules** page, **scissors**, **tape**, and either the **Cellular Respiration**, **Fungus**, or **Fire** page. You will learn about how a plant's chemical energy is released. You will then share what you learned with your classmates, and they will share what they learned with you.

Instructions:

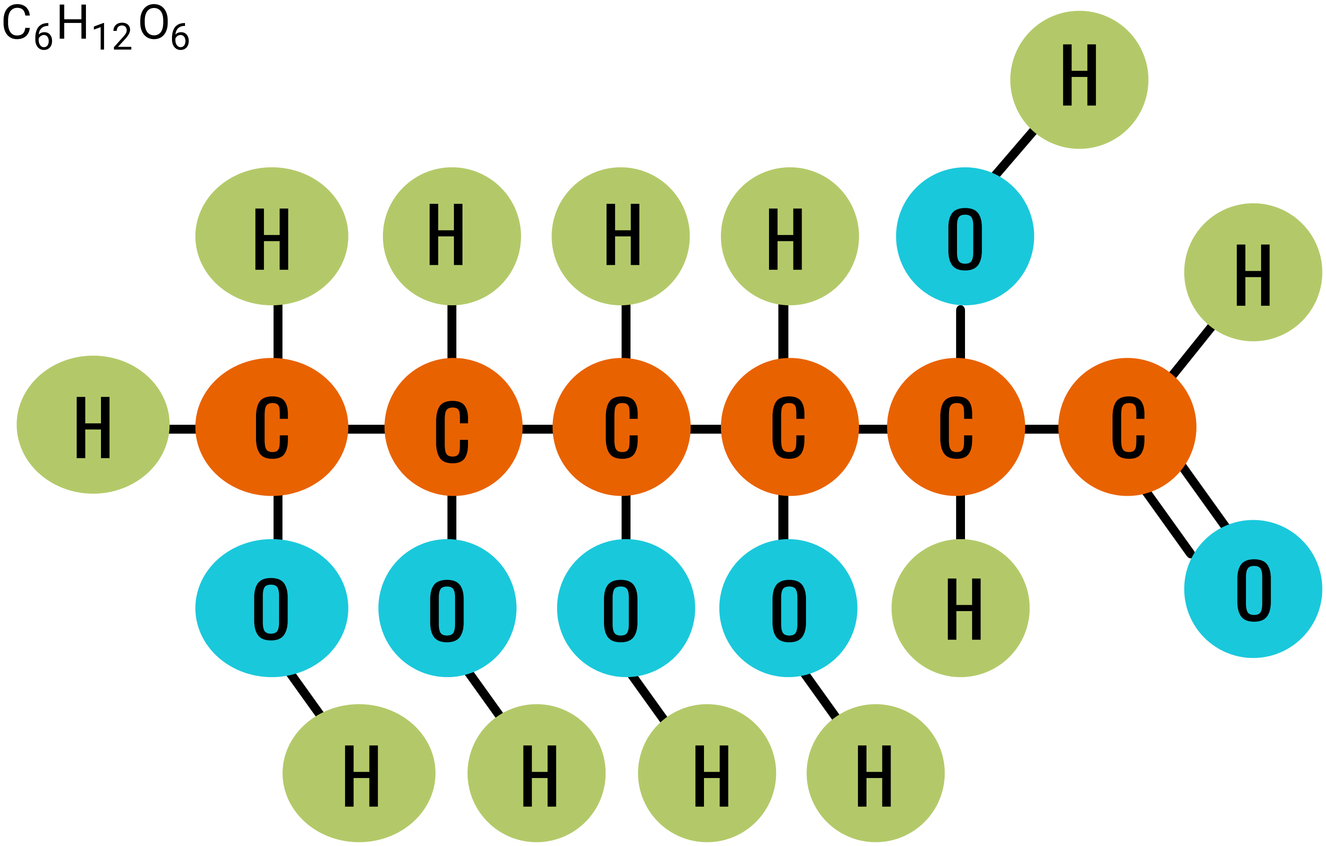
- Read the top of your handout
- Cut out the molecules
- Follow the instructions in the boxes on your handout
- Take notes below and diagram the way energy moved
- Share what you learned with your two team members
- Record what they learned on the Notes page
- Discuss, compare, and contrast using the Discussion page



Molecules

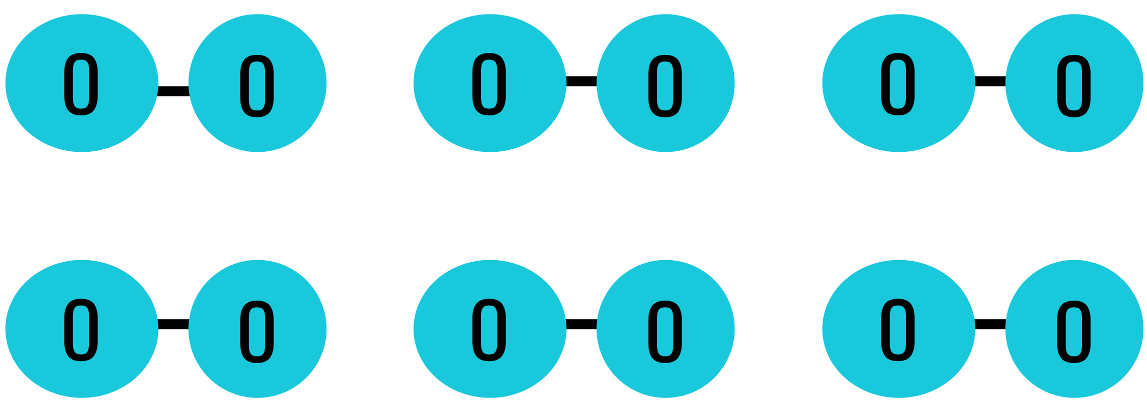
Glucose Molecule

$C_6H_{12}O_6$



Six Oxygen Molecules

$6\ O_2$



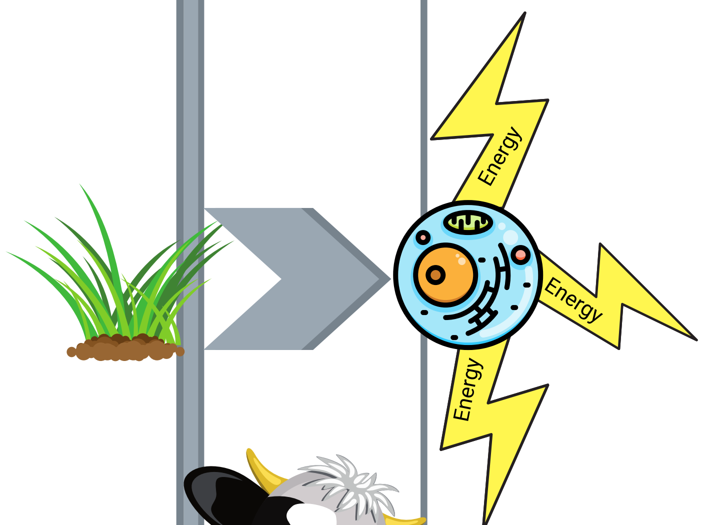
C=Carbon, H=Hydrogen, O=Oxygen

Fire Ecology Learning Lab
Igniting Curiosity in Young Minds

Name:__________________
Date:__________________

Cellular Respiration in an Animal Cell

A cow eats grass that contains glucose, a form of sugar. The glucose is absorbed by the cow's cells. The cells also absorb oxygen from the cow's blood. The cell then goes through cellular respiration. Chemicals break the carbon bonds in the glucose. When these bonds are broken, they release energy that the animal uses to live. It takes a cow about two days to digest grass and go through cellular respiration.



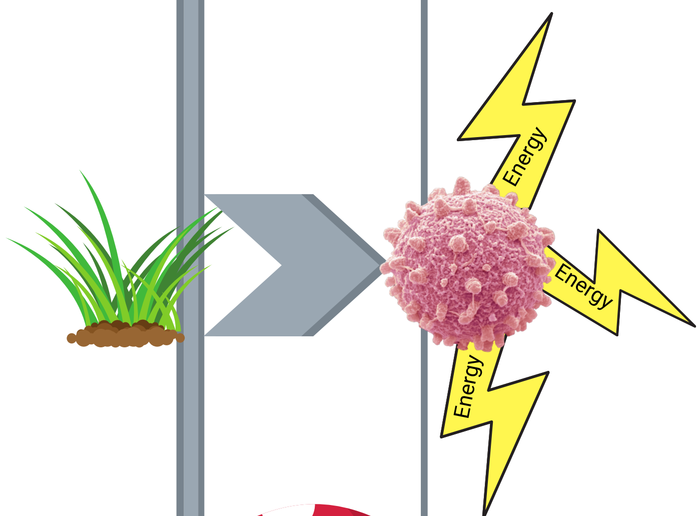
Cut out the glucose and oxygen molecules and place them above.

Cut apart the bonds so that you have 6 carbon, 12 hydrogen, and 18 oxygen atoms. Each bond you cut releases energy for the animal to use to stay warm, move, think, grow, and continue to live. Reform the atoms into 6 carbon dioxide and 6 water molecules. Tape them down above.

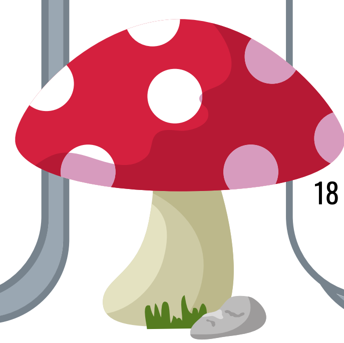
Name:_______________
Date:_______________

Decomposition by Fungus

When grass grows, it makes glucose, a form of sugar. When grass dies in a wet area, it will start to rot. Fungus breaks the grass apart and uses the glucose for food. The fungus also absorbs oxygen from the air. Chemicals excreted by the fungus break the carbon bonds in the glucose. When these bonds are broken, they release energy that the fungus uses to grow. It takes fungus about two weeks to decompose the grass.



Cut out the glucose and oxygen molecules and place them above.

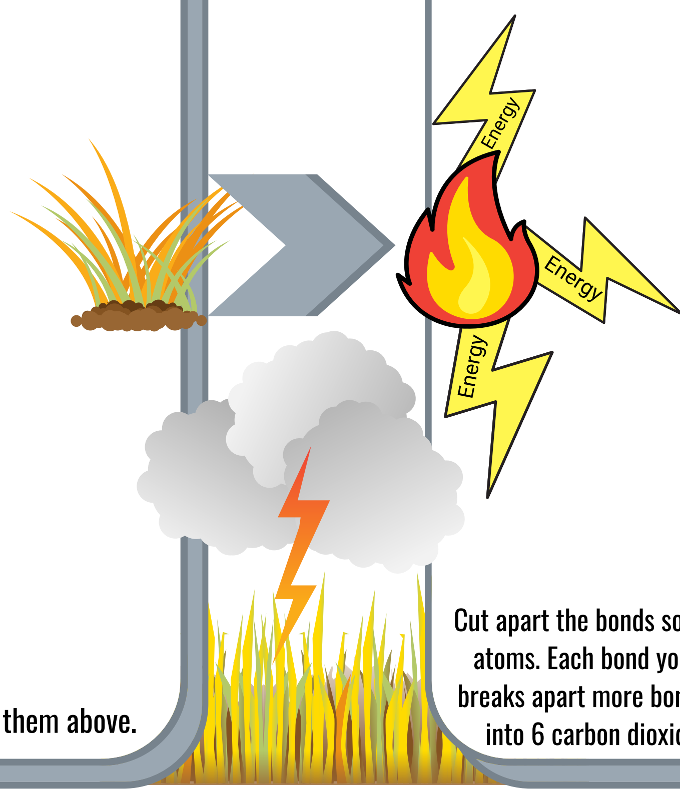


Cut apart the bonds so that you have 6 carbon, 12 hydrogen, and 18 oxygen atoms. Each bond you cut releases energy for the fungus to use to grow. Reform the atoms into 6 carbon dioxide and 6 water molecules. Tape them down above.

Name:____________________
Date:____________________

Fire and Combustion

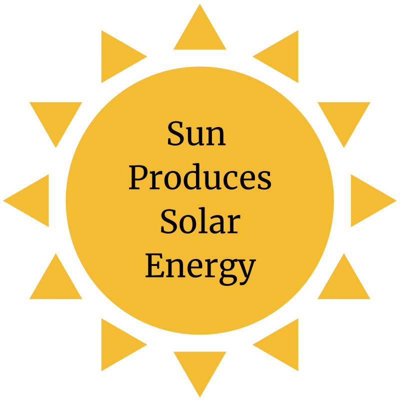
When grass grows, it produces glucose, a form of sugar. When grass dies and dries, it creates fuel for fire. A spark can light the dry grass on fire. Fire requires oxygen from the air, fuel to burn, and a heat source. When the carbon bonds in glucose are broken, they release energy. That energy continues to break apart more carbon bonds, and the fire spreads. It takes fire about twenty seconds to burn the grass.



Cut out the glucose and oxygen molecules and place them above.

Cut apart the bonds so that you have 6 carbon, 12 hydrogen, and 18 oxygen atoms. Each bond you cut releases energy in the form of heat. This heat breaks apart more bonds and the fire continues to burn. Reform the atoms into 6 carbon dioxide and 6 water molecules. Tape them down above.

Use this page to complete a diagram showing how the energy was stored in the grass and how the energy was released. Label your diagram.



Notes: Energy Release: Fire, Fungus, and Cows

Cellular Respiration in an Animal Cell

What molecules did you start with?______________________________

What happened to the molecules?______________________________

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What happened to the energy that was released?________________________

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How long did it take?____________________________________

Decomposition by Fungus

What molecules did you start with?______________________________

What happened to the molecules?______________________________

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What happened to the energy that was released?________________________

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How long did it take?____________________________________

Fire and Combustion

What molecules did you start with?______________________________

What happened to the molecules?______________________________

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What happened to the energy that was released?________________________

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How long did it take?____________________________________

Homework Questions: Energy Release: Fire, Fungus, and Cows

How were decomposition, cellular respiration, and fire similar? How were they different?

What would happen in an area if there was no decomposition and there were no animals eating the grass? How would this change the potential fire danger in that area?

Stretch your brain: The energy stored in the plants started as light energy from the sun and was converted into potential chemical energy through photosynthesis. What did this potential chemical energy become in each example? *Remember*: energy is never lost, it is just converted from one form to another.