Explore: The Energy Chase: A Relay Through the Food Chain

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Objective:

In this activity, you will explore how energy flows through ecosystems. You will simulate how energy is transferred from the Sun to producers, herbivores, carnivores, and even tertiary consumers. You'll also learn about the loss of energy as heat at each level. This activity will help you understand the 10% Rule of energy transfer in food chains and how energy decreases at each trophic level.

Background Information:

Energy Flow in Ecosystems

E*very ecosystem needs energy to survive. The* ***Sun*** *is the primary source of energy for almost all living organisms. Energy flows through the ecosystem in a pattern, from the Sun to* ***producers*** *(like plants), then to* ***primary consumers*** *(herbivores),* ***secondary consumers*** *(carnivores), and finally to* ***tertiary consumers*** *(top predators). This flow of energy is known as the* ***food chain****.*

Each time energy moves from one organism to another, some of it is lost as ***heat****. This is due to energy being used by organisms for growth, movement, and other life processes. Because of this, only a small amount of energy makes it to the next level. The amount of energy lost as heat increases at each level, and this concept is known as the* ***10% Rule****. It helps explain why there are fewer animals at the top of the food chain compared to those lower down.*

Activity Overview:

In this activity, you will participate in a ***relay race*** *to simulate how energy moves through an ecosystem. Each group will start at the* ***Sun*** *and move through the* ***producers****,* ***primary consumers****,* ***secondary consumers****, and* ***tertiary consumers****. At each station, you will transfer some of the energy to the next group, but a portion of it will be lost as heat. You'll record your energy amounts at each level and calculate the amount of energy passed on and lost.*

Name: _____ Date: _____

Materials:

- **Laminated disks** (each group will have a different color).
- **Station signs:** Sun, Producers/Primary Consumers, Secondary Consumers, Tertiary Consumers, Heat Station.
- Markers or pens to write on the disks.
- Timer or stopwatch.

Steps of the Activity:

1. **Start at the Sun**: Each group begins with a specific amount of energy. One student will calculate how much energy is passed to the next group, and the other will calculate how much energy is lost as heat. Write these numbers on your laminated disk.
2. **Move to the Producers/Primary Consumers Station**: You will transfer the energy you calculated to the next group and calculate how much is lost as heat.
3. **Secondary Consumers/Carnivores**: At this station, the energy you passed along will move to the secondary consumers. One student will calculate the energy passed and the other will calculate the energy lost as heat.
4. **Tertiary Consumers/Carnivores**: The last station in the race. Transfer the energy to the next level and calculate the heat loss.
5. **Heat Station**: After calculating heat loss, the student will go to the Heat Station to leave the energy they calculated as lost.

Reflection Questions:

After completing the activity, think about the following questions:

1. **What did you notice about the energy levels at each station?**
    - **Sentence Stem**: *"At each station, I noticed that the amount of energy..."*

2. **Why is so much energy lost as heat?**

- **Sentence Stem**: *"Energy is lost as heat because..."*

3. **What would happen if energy didn't get lost as heat?**
   - **Sentence Stem**: *"If energy didn't get lost as heat, then..."*

4. **How does the amount of energy change as you move from one level to the next in the food chain?**
   - **Sentence Stem**: *"The amount of energy decreases because..."*

5. **What would happen if the tertiary consumers were removed from the ecosystem? What about if the producers were removed? Which would have a greater effect? Why?**
   - **Sentence Stem**: "If tertiary consumers were removed, then... But if producers were removed, then... The producers would have a greater effect because..."

Name: _____ Date: _____

Graph your Results:

Bar Graph: After completing the relay, draw a bar graph to represent the energy at each trophic level. Label the x-axis with the trophic levels (Sun, Producers/Primary Consumers, Secondary Consumers, Tertiary Consumers) and the y-axis with the amount of energy (in Joules).

Name: _____ Date: _____

Teacher Instructions for Energy Relay Race Activity

Objective:

Students will investigate how energy flows through ecosystems, from the Sun to producers, herbivores, carnivores, and top predators (tertiary consumers). They will simulate energy transfer in a relay race and understand how energy diminishes as it moves through each trophic level, with a focus on the loss of energy as heat. This activity also emphasizes the 10% Rule, which explains how only 10% of energy is passed to the next level in the food chain, while the rest is lost as heat.

Background Information:

Energy flows through ecosystems in a predictable pattern, starting with the Sun, which provides energy to producers (plants). From there, energy moves to primary consumers (herbivores), which are eaten by secondary consumers (carnivores), and then to tertiary consumers (top carnivores). At each level, energy is transferred, but not all of it moves to the next level—some energy is used by organisms for growth, reproduction, or movement, and much of it is lost as heat.

The 10% Rule explains this process: only about 10% of the energy from one trophic level is passed to the next. The remaining 90% is lost as heat, which is a natural byproduct of biological processes like movement, digestion, and metabolism. This loss of energy limits the number of trophic levels an ecosystem can support, which is why there are more producers than consumers in a typical ecosystem.

Materials:

- **Laminated disks (each group has a different color).**
- **Station signs: Sun, Producers/Primary Consumers, Secondary Consumers, Tertiary Consumers, Heat Station.**
- **Markers or pens to write on the disks.**
- **Timer or stopwatch.**

Steps of the Activity:

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1. **Station Setup:**
    - Create five stations in a spacious area and label each one: Sun, Producers/Primary Consumers, Secondary Consumers, Tertiary Consumers, and Heat Station.
    - Each group (3 groups of approximately 8 students) will start at the Sun station and be assigned a different starting energy amount (100 million J, 150 million J, or 200 million J).
2. **Energy Transfer Process:**
    - At each station, one student will calculate how much energy is passed to the next level (based on the 10% rule), and the other student will calculate how much energy is lost as heat (90% of the energy).
    - They will write both numbers on their laminated disks.
    - After recording the energy transfer and loss at each station, students will move to the next station, passing their energy to the next trophic level, while the student calculating heat loss moves to the Heat Station.
3. **Data Recording:**
    - As students go through the relay, they will record the amount of energy at each level and the amount lost as heat.
    - After the race, they will draw a bar graph to show the energy distribution at each level.
4. **Reflection:**
    - After completing the activity, students will answer reflection questions using sentence stems provided in the student document.

Guiding Questions for Student Thinking and Writing:

While students are working through the activity, encourage them to think critically about the energy transfer process. Use these guiding questions to prompt their thinking:

- What happens to the energy at each trophic level?
  ***Guiding Question*: "Why do you think energy is lost as heat? What role does heat play in the energy transfer process?"**
- How does the energy transfer follow the 10% Rule?
  ***Guiding Question*: "How does the amount of energy decrease from one level to the next? What does this tell you about the amount of energy available to consumers at each level?"**
- What would happen if one of the levels was removed?
  ***Guiding Question*: "What would happen if the producers were removed from the ecosystem? What about the tertiary consumers? Which would have a greater effect and why?"**

- How do you think ecosystems would change if energy didn't get lost as heat?
  ***Guiding Question*: "What might happen if the energy loss to heat wasn't so high? How would it affect the number of organisms in an ecosystem?"**

These questions will help students process the activity, make connections between energy flow and ecological balance, and think about the consequences of changes in the ecosystem.

Tips for Success:

1. **Preparation is Key:**
   Make sure that stations are set up before students arrive and that each group has the necessary materials. Label stations clearly and ensure that each group understands how to calculate energy transfer and heat loss.
2. **Clear Instructions:**
   Begin by explaining the 10% Rule and how energy flows through the ecosystem. Use a visual aid (like a diagram of a food chain) to demonstrate how energy decreases as it moves through trophic levels.
3. **Active Engagement:**
   Encourage students to actively participate by rotating between the energy transfer and heat loss roles. Keep the pace moving quickly to maintain student engagement.
4. **Facilitate Reflection:**
   After the race, give students time to complete their bar graphs and written reflections. You may want to allow them to work in pairs to discuss their thoughts before writing.
5. **Model the Graphing Process:**
   Before the activity, show students how to create a bar graph, emphasizing the importance of clear labeling and accurate data representation.

Differentiation Strategies:

To support a range of learners, use the following differentiation strategies:

1. **Modified Expectations:**
   For students who need more support, provide pre-made templates or simplified instructions for creating their bar graphs. They can work in pairs with another student who can guide them through the process.

2. **Use Visuals:**
   For students who benefit from visual learning, provide diagrams of the food chain and energy flow. Post visual aids at each station to reinforce understanding.
3. **Extended Reflection:**
   For students who excel or need additional challenges, ask them to design their own food chains, exploring how energy might transfer differently if the ecosystem included additional levels or organisms. They could also research the impact of human activities on energy flow in ecosystems.
4. **Collaborative Learning:**
   Allow students to work in pairs or small groups for reflection and graphing. This encourages discussion, peer support, and deeper understanding as students share insights and compare results.
5. **Modified Role Assignment:**
   If a student struggles with calculations, allow them to focus on the recording aspect of the activity, such as writing the energy values on the disks or assisting with graphing, while other students calculate the energy transfer and loss.

Assessment:

1. **Formative Assessment:**
   Observe students' participation and engagement during the relay. Take note of how well they understand the concept of energy transfer and the 10% Rule based on their ability to calculate and explain energy movement.
2. **Reflection Evaluation:**
   Assess the depth of students' reflections based on their responses to the guiding questions. Look for evidence that students are thinking critically about energy loss and the role of each trophic level.
3. **Graphing Accuracy:**
   Review students' bar graphs for accuracy in energy distribution. Make sure they are clearly labeled, showing the correct energy values at each level of the food chain.

Conclusion:

By the end of the activity, students should have a clear understanding of how energy flows through ecosystems and why only a small portion is passed to the next trophic level. They should also be able to explain the 10% Rule, how energy is lost as heat, and how this limits the number of consumers at

higher trophic levels. This engaging, hands-on activity offers students an interactive way to learn about energy transfer while reinforcing scientific concepts through group work and critical thinking.