

TTCD Lesson Plan (18): Antifreeze in Plants & Animals

Unit: Antifreeze in Plants & Animals	Grade(s): All	Class Size: 1-30	Lesson Duration: 1 hour	Location(s): Classroom
Topic(s):	Antifreeze			
Student Prerequisites:	N/A			
Essential Questions:	What is antifreeze? How does antifreeze prevent some plants and animals from freezing? How does sugar prevent freezing?			
Student Objectives:	Students will learn about the concept of plant and animal adaptation to the cold. Students will observe how a water-sugar mixture freezes slower and thaws faster than a 100% water mixture. Students will link knowledge of the freezing point of water mixed with sugar to understand how certain plants and animals adapt to the cold. Students will learn how sugar prevents the formation of ice crystals.			
Standards:	Supports NGS Standards: 5-PS1-3: Make observations and measurements to identify materials based on their properties. 5-PS1-4: Conduct an investigation to determine whether the mixing of two or more substances results in new substances. 3-LS4-3: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. 4-LS1-1: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. Relevant NGS Crosscutting Concepts: Cause and Effect: Cause and effect relationships are routinely identified and used to explain change. Cultural Standards E.2: Culturally-knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of interaction of all elements in the world around them by: understand[ing] the ecology and geography of the bioregion they inhabit;			

Local Context:	Species such as the wood frog, found in Alaska, will be used as an example during the lesson on animals with antifreeze properties. [Extension Opportunity]: Students will harvest carrots at the Tyonek Grown Farm (alternatively: eat Alaskan grown carrots) to better understand the role of antifreeze in plants.
Vocabulary:	Antifreeze: A substance added to a liquid to lower its freezing point. Glucose: Sugar (a sugar molecule). Freezing point: the temperature at which a liquid solidifies. Ice crystals: a small densely packed crystal of ice. Protein: a protein is a large molecule made of amino acids that serve many critical roles in the body. Molecule: the smallest unit of a substance that has the same properties as that substance.
Dena'ina language words:	
Materials:	• Sugar • 4 identical containers for each group of students • Water • Access to a freezer or freezing temperatures ∄ Spoons, or something else to stir the solution ∄ 1-cup measuring cup that has delineations for 1/4, 1/3, 1/2, etc. ∄ Paper and pencils
Instructor Prep:	There are many ways to facilitate this experiment, depending on how much time you have with the students. Depending on the circumstances, the following should be prepped by the instructor ahead of time: • Mix one part sugar to one part water in two of the containers. (I used 1/3 cup water and 1/3 cup sugar). Stir until sugar is completely dissolved. • Fill the second two containers with water equal to the amount of solution in the sugar containers. Label the sugar cups with the number 1 and the water cups with the number 2. • The night before the lesson or at least 8 hours before, freeze one sugar-water container and one water container in the freezer. • Two hours prior to your lesson, place one sugar-water container and one water container in the freezer or outside in freezing weather. • Before the lesson begins, take the two overnight containers out of the freezer and allow them to sit on a counter or desk to thaw.
Introduction:	Explain that today we are going to be exploring the concept of antifreeze. Ask students: what do you think anti-freeze means? Think about the two parts of the

	word “anti” and “freeze.” Antifreeze is a substance added to a liquid to lower its freezing point. Freezing point is the temperature at which a liquid turns to a solid. Some plants and animals have antifreeze proteins in them. Sugar is a key component of natural antifreeze that prevents things like frogs and carrots from freezing by preventing ice crystals from forming. In the case of frogs, sugar prevents frogs from freezing solid to death. In the case of carrots, sugar helps prevent the carrot structure from being damaged and it helps make carrots sweet in the winter. Ask the class: Can someone describe to me some of the differences between an ice cube and a popsicle? The sugar in the popsicle keeps the ice crystals from forming into a solid block, softening it for you to enjoy. Or another word for softening in this context, lowering the freezing point. In a couple of minutes, we are going to look at an example of how antifreeze works in a wood frog. Wood frogs live throughout Alaska, from the Brooks Range to the mainland in Southeast Alaska. And they are the only amphibian that lives north of the Arctic Circle - we are going to find out why that is! Wood frogs prevent themselves from freezing by sending sugar, or glucose, throughout their bodies so that ice crystals don't form inside of them and turn them into a frogcicles! They are amazing creatures because they can be in really cold places and parts of their body will freeze but they will keep the important parts of them (the parts that would kill them if they froze) just warm enough to stay alive. Play this video on wood frogs for the class: https://www.youtube.com/watch?v=pLPeehsXAr4
Activity	1. Divide students into groups of 2: A and B. Distribute the two cups that have been in the freezer overnight to one group and the two cups that have been sitting out on the counter thawing to the other group. 2. Explain that each group has a cup that is just water and a cup that is half water and half sugar. Tell the groups which group has the two cups that have been in the freezer overnight and have been thawing and which group has the two cups that have only been in the freezer for a couple of hours. Do not tell students which cup has sugar, and which cup has only water. 3. Instruct the students to investigate and hypothesize about which cup has sugar and which cup has water. Ask all of the students to write down at least three things they observe about their cup set/ 4. Then ask the students to switch tables and observe the two new cups. Ask all of the students to write down at least three things they observe about their cup set.
Wrap-Up:	Ask students the following and call on them to share what they observed: 1. Which cup was freezing faster?

	2. Which cup was thawing faster? <i>Evidence of learning:</i> Ask student to respond verbally to the following: Why might a plant or animal having antifreeze be especially important in a place like Alaska? (possible answers: Alaska can have extremely cold temperatures so it's important that plants and animals can adapt to it, important for food access into the fall, etc)
Lesson Adaptations:	At the end of the two-cup observational experiment, surprise students with popsicles. Ask the class: How is this popsicle different or similar to the cup with the sugar in it? (possible answers include that the popsicle and the sugar cup were at different stages of freezing).
Extensions:	- After the observational experiment, pivot to a conversation on antifreeze in plants. Not all plants have antifreeze properties. - Ask the students: "Can anyone give me an example of a plant that does not do well in the cold?" (basil, tomatoes, lettuce – they all freeze) - Give the example of a carrot, highlighting that Alaska carrots are very famous. Ask the students: "Why do you think carrots are sweeter when you harvest in the cold season?" - Ask the students: "Why do you think Alaska carrots are so famous?" - Take a trip to the Tyonek Farm or a local farm growing carrots to harvest and sample the carrots as a class. Alternatively, bring in local Alaska carrots for the students to sample. - Play this video on the antifreeze properties of carrots: https://www.youtube.com/watch?v=W8isLHTZN-Q - Instruct students to use their laptops to pick out a plant or animal with an antifreeze property that they are excited about. Create a blank slide deck for students to add a picture of the plant or animal and three fun facts. Give each student two minutes to present to the class.
Reflections:	How did it go? What did students understand most/least? What could change about instruction or lesson plan?
Resources Used:	Antifreeze Animals Activity: Exploring Extreme Animal Adaptation Wood Frog Video: https://www.youtube.com/watch?v=pLPeehsXAr4 Carrot Video: https://www.youtube.com/watch?v=W8isLHTZN-Q