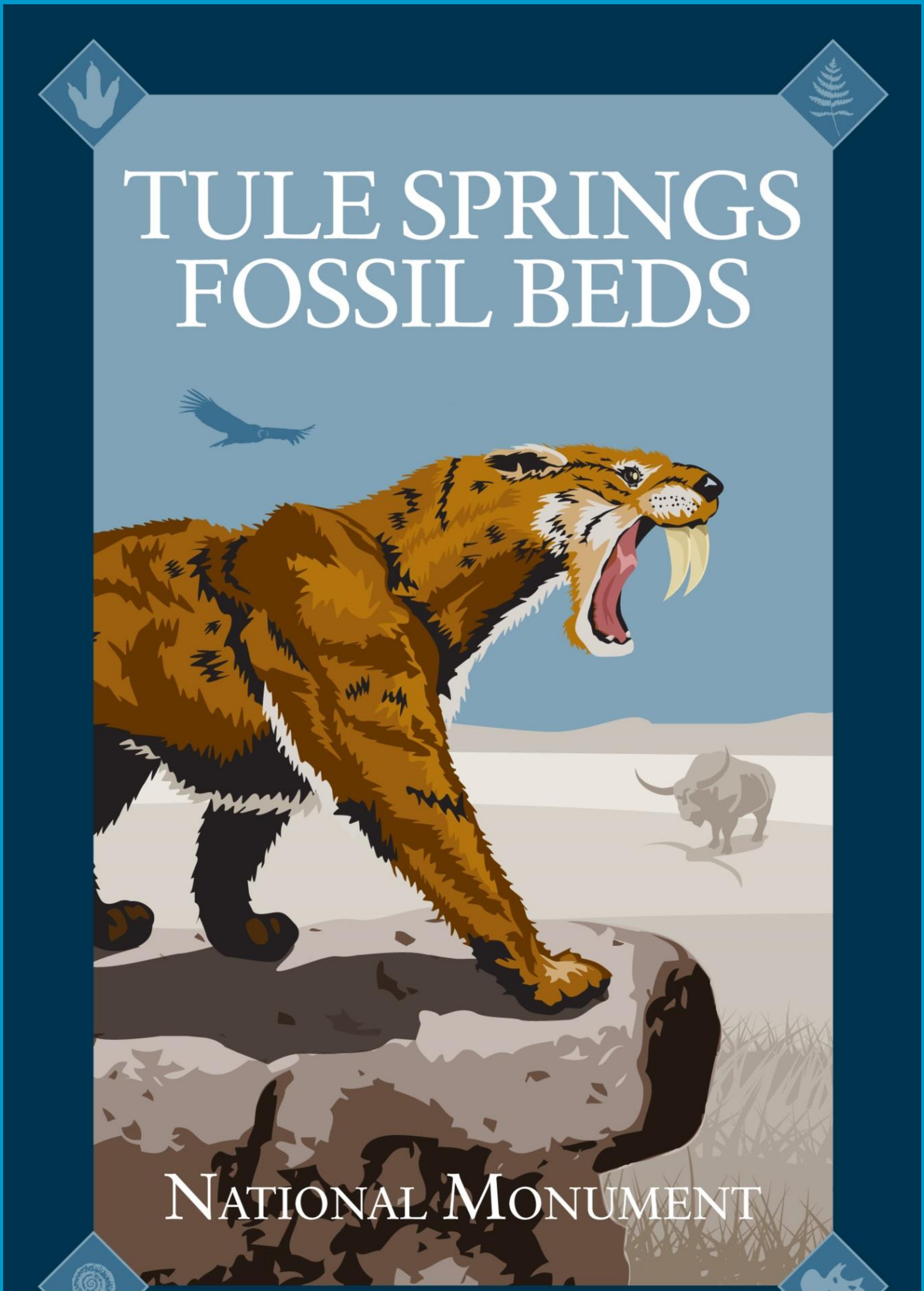
Teacher Resources



9th – 12th Grade

Tule Springs Fossil Beds National Monument is one of our newest National Park Service sites and it is located right here in the Las Vegas Valley. The National Park Service and our partners, the Protectors of Tule Springs, are pleased to be a great resource for teachers looking for innovative ways to teach topics through the amazing resources of this fossil site.

The park preserves an amazing collection of fossil sites that have the potential to help us learn about a specific segment of the Pleistocene Era, also referred to as the Ice Age. Within the chalky soils of the park a wide range of animals are preserved. They include large, iconic animals like Columbian Mammoth, Shasta Ground Sloth, two extinct species of Bison, camel, and horses. These animals were drawn here at a time where the climate was cooler and damper and supported a variety of plants fed by spring waters. Where there are plant eaters, there are meat eaters. Saber-toothed cats, American lions, and dire wolves were fierce and canny predators. All of these animals are found in the soils of Tule Springs and many have been collected by paleontologists.

The park is in its infancy. It does not have a visitor center or facilities. We are entering the planning phase to determine what this national park site should offer. Undoubtedly, there will be a curriculum-based education program. We will need the assistance of dedicated teachers, like you, to help develop this curriculum so that it meets your needs.

Within this packet are some grade-specific activities that will allow you to introduce the idea that right here in our own backyard, fossils are preserved that tell us much about the world in which we live. We hope you find time to introduce the park to your students and we look forward to working with you on this exciting endeavor. We are grateful to the Waco Mammoth National Monument and Clark County educators for permission to use their activities.

NATIONAL PARK SERVICE

Protectors of Tule Springs

www.tulespringslv.com

Taphonomy Lab

Waco Mammoth Site—9th to 12th Grade Activity

Summary

In this four-week lab, students use oranges to recreate what happens to a body after death in three different environments: desert, swamp, and permafrost. The effects of these environments will be compared against a control.

Objectives

- Learn vocabulary used in biology labs
- Work cooperatively in a group
- Gather data in an objective manner
- Make predictions based on observations

In this pack, you will find:

- Lesson plan and TEKS alignment
- Lab procedure sheets
- Data journal sheets
- Data analysis sheets

Supplies Needed for Each Group

- 4 plastic shoe boxes with lids (disposable food containers that are approximately 6 quarts also are suitable)
- 6 medium-sized oranges
- Scale that measures in grams
- Measuring cups
- Knife
- Disposable safety gloves
- Dust masks
- Empty baby food jar
- Paper plates with raised edges
- Play sand (3 cups)
- Peat moss (3 cups)
- Soil (3 cups)
- Water
- Silica gel (found in desiccant packets with new shoes, also sold as "water gems" with floral supplies) enough to fill the jar
Access to a freezer and microwave
- Colored pencils

Procedure

1. Introduce the concept of taphonomy, the study of changes that happen to bodies after death. Discuss how this study can be useful. Paleontologists use it to learn how to interpret fossils they find. Forensic scientists also use it to solve crimes or determine cause of death.

2. Prompt students for ideas on things that happen to body after death, such as decay, scavenging, or drying out.

3. Ask how these processes can be studied scientifically. How would such a study be set up? Tell students about "body farms," such as the University of Tennessee Anthropological Research Facility, where human bodies decompose in different settings.

4. Go over the lab procedures. Explain that rather than use a human or animal body, you will be using oranges.

5. Conduct the lab using the provided data journal sheets.

6. At the end of the four-week activity, discuss the class's findings using the provided data analysis sheets.

Taphonomy Lab

9th to 12th Grade Activity

Ideas for Expanding the Experiment

- Add a lake model: box with 4 cups of water, 1 tablespoon of soil.
- Add a cave model: box with 1 jar of desiccant, kept in a refrigerator set to 21°C (70°F).
- Add a scavenger model: Cut holes in lid and place box outside, where insects may feed on the oranges.
- If multiple groups are conducting the experiment, have them compare their results to find similarities or differences.
- Finish with an "autopsy." After taking final data measurements on Day 28, have students cut open whole oranges to examine the preservation of the wedges, which represented organs. This will require setting the permafrost model in a refrigerator the day before to allow it to thaw.
- Coordinate with other departments. Have students write papers, create posters, or manipulate the data in a computer program.
- An alternative to reconditioning the silica gel is to replace it each week. This eliminates the risks of burns and ensures the best results in the desert model.

Designed by Dava Butler for the Waco Mammoth Site, January 2014.

Name: ____ Period: ________

Taphonomy Lab: Introduction

Paleontologists specialize in different areas of study. They may specialize in fields such as cartography (map-making), ancient climates, migration patterns, or genetics. One important area of study is taphonomy, or how bodies move, decay, and are preserved, becoming part of the fossil record.

In this lab, you will research the first part of the taphonomic process—what happens to bodies before burial.

You will use oranges as analogs for animal bodies. The porous peel represents skin, the segments represent organs, and the seeds represent hard parts, such as bones and teeth. In addition, you will recreate three environments of deposition, which have geological conditions that can affect how well a body preserves. These environments may speed up or slow down an orange's decay. To judge these effects, you also will set up a control environment.

Vocabulary

Analog—an organ or structure of one organism that is similar in function to one in another organism but is of different evolutionary origin. Bird wings and insect wings are analogs.

Conglomerate—a mass or cluster made of heterogeneous (differing) elements.

Constant—a feature or factor that stays the same with all test subjects. See *variable*.

Control—a person or object that serves as a standard of comparison in a scientific experiment.

Deposit—to lay down or leave behind by a natural process.

Desert—a dry, usually sandy, *environment of deposition* that gets little rainfall. A desert can have any temperature.

Environment of deposition (EOD)—the setting in which sediment and organic material accumulate.

Extrapolate—to apply known information to an unknown situation by assuming that existing trends are constant.

Permafrost—an *environment of deposition* with permanently frozen soil.

Substrate—an underlying surface on which organisms live or grow, such as soil.

Swamp—a wet, spongy *environment of deposition* that is usually overgrown and sometimes partially forested.

Taphonomy—the study of the processes affecting an organism after death, which result in its fossilization. This includes processes such as scavenging, decay, burial, and permineralization.

Variable—a feature or factor that is changed from the *control* to test the effects.

Taphonomy Lab: Lab Safety

Safety is the main concern in any lab setting. Follow these guidelines to protect yourself, your lab partners, and the equipment you are using.

Cutting Utensils

When using a knife or other cutting utensils, always **cut away** from your body and others around you. When handing a cutting utensil to someone else, turn the utensil around so they may grab the handle, not the sharpened end.

Fungus

Many people are sensitive to mold spores. Wear gloves and dust masks when you handle any moldy specimens.

Silica Gel

Silica gel must be reconditioned to remove any moisture it has absorbed. This should be done at least once a week. Follow these instructions to recondition the silica:

- Remove the jar from the desert model and pour the silica gel onto a paper plate, spreading them out.
- Heat the gel for 3 minutes in a 700 watt microwave oven, or 2 minutes in a 1000 watt microwave oven. To avoid overheating the gel, heat it for 1 minute at a time, stirring the beads before heating again. If you smell smoke or strong fumes, turn off the microwave immediately.
- Remove the plate, only touching the edges. The silica gel is **VERY HOT**.
- Allow the gel to cool 5 minutes. Putting hot gel into the glass jar may cause it to shatter.
- When the gel is cool enough to touch, pour the gel back into the jar.
- Nestle the jar back into the sand in the desert model. This will prevent the jar from tipping over and spilling the gel. An alternative to reconditioning the gel is to replace it once a week.

Clean Up

After completing the lab on Day 28, discard all of the substrate and oranges in a garden or compost bin. The boxes should be washed thoroughly with dish detergent and left to dry in sunlight. Be sure they are completely dry before storing them. Failure to completely clean the boxes may introduce contaminants into future experiments.

Taphonomy Lab: Setting up your Environment Models

Desert

1 jar of silica gel, pushed into sand
3 cups of sand
1 whole orange
1 half orange
Keep at room temperature

Deserts can have any temperature. While the Sahara Desert is scorching hot, the Gobi Desert is very cold. What all deserts have in common is a lack of water.

Silica gel absorbs moisture from the air. This will keep your desert model dry.

Swamp

3 cups of peat moss
2 cups of water
1 whole orange
1 half orange
Keep at room temperature

Swamps are wetlands filled with partially-decomposed plant material, called peat. The mixture of peat and water is acidic and anaerobic, which means it has low oxygen levels.

Using peat moss will create a damp, acidic, low-oxygen model. Add water if the substrate dries out.

Permafrost

3 cups of soil
1 tablespoon of water
1 whole orange
1 half orange
Keep in freezer

Permafrost is permanently frozen terrain. It may contain bedrock, soil, organic material, and ice.

This model will be kept in a freezer, replicating the subzero conditions of permafrost. The small amount of moisture will allow ice to form.

Control

The control box has no soil.
1 whole orange
1 half orange
Keep at room temperature

The control will let you observe how an orange changes on its own over time.

Things to Keep in Mind!

- Keep lids on the boxes when the oranges are not being weighed.
- Be sure the boxes are disturbed as little as possible.
- The desert, swamp, and control boxes should be stored near each other, so they have the same temperature and light exposure.
- Silica gel must be **reconditioned or replaced** at least once a week. Refer to the Lab Safety sheet for instructions.

Name: ____ Period: ________________

Taphonomy Lab: Hypothesize

Identify the Variables

Before you can make a hypothesis, you must compare and contrast each model.

Under each model, make a check for factors that are same as the control, and then make an X for factors that are different from the control. The desert model has been done for you.

Desert

Swamp

Permafrost

Control

	Desert	Swamp	Permafrost
Box	✓		
Oranges	✓		
Time	✓		
Temperature	✓		
Moisture	✗		

1. The factors that <u>all of the models</u> have checked are the constants. List the constants:

2. The factors that make a model different from the control are variables, which you marked with X. List the variables for the desert model:

   the swamp model:

   the permafrost model:

Make Your Predictions

A good hypothesis is written as a formula that shows cause and effect. You will use an IF/THEN formula:

IF (a constant) is (paired with variables), THEN (an outcome will happen).

Desert

3. If an orange is put in desert conditions, then…

Swamp

4. If an orange is put in swamp conditions, then…

Permafrost

5. If an orange is put in permafrost conditions, then…

Control

6. If an orange is put in control conditions, then…

7. Which oranges do you expect to lose mass at a higher rate, half or whole? Why?

8. Which environment do you predict will cause the highest rate of mass lost? Why?

9. Which environment do you predict will cause the lowest rate of mass lost? Why?

10. What is the purpose of the control?

Name: ____ Period: _________

Taphonomy Lab: Data Journal

During this 28-day lab, you will collect data at least twice a week. This data should include the mass of each orange and observations about their appearance. On days no data is collected, leave that space blank. On days you recondition or replace the silica gel, check next to "Silica."

Mass: For this lab, you are measuring a conglomerate, in this case, an orange and anything growing on it. Conglomeration is part of the taphonomic process, so it is important to include this in the data. Before measuring the mass, wipe off any substrate (soil), but leave any mold or other growth in place.

Safety: Many people are sensitive to mold spores. Wear gloves and dust masks! When you recharge the silica gel, the silica beads will be **VERY HOT**! Please refer to the Lab Safety sheet for instructions.

		Whole Orange	Half Orange
Example Date: *April 16* Silica: ✓	Desert: Swamp: Permafrost: Control:	*228g. Starting to dry, no discoloration.* *206g. Appears fresh.* *187g. Frozen solid, no discoloration.* *202g. Developing dark spots.*	*106g. Cut surface is dry to the touch.* *105g. Some shrinkage.* *88g. Frozen solid, no discoloration.* *92g. Some drying at edges of peel.*
1. Date: Silica:	Desert: Swamp: Permafrost: Control:		

		Whole Orange	Half Orange
2. Date: Silica:	Desert: Swamp: Permafrost: Control:		
3. Date: Silica:	Desert: Swamp: Permafrost: Control:		
4. Date: Silica:	Desert: Swamp: Permafrost: Control:		

		Whole Orange	Half Orange
5. Date: Silica:	Desert: Swamp: Permafrost: Control:		
6. Date: Silica:	Desert: Swamp: Permafrost: Control:		
7. Date: Silica:	Desert: Swamp: Permafrost: Control:		

		Whole Orange	Half Orange
8. Date: Silica:	Desert: Swamp: Permafrost: Control:		
9. Date: Silica:	Desert: Swamp: Permafrost: Control:		
10. Date: Silica:	Desert: Swamp: Permafrost: Control:		

		Whole Orange	Half Orange
11. Date: Silica:	Desert: Swamp: Permafrost: Control:		
12. Date: Silica:	Desert: Swamp: Permafrost: Control:		
13. Date: Silica:	Desert: Swamp: Permafrost: Control:		

		Whole Orange	Half Orange
14. Date: Silica:	Desert: Swamp: Permafrost: Control:		
15. Date: Silica:	Desert: Swamp: Permafrost: Control:		
16. Date: Silica:	Desert: Swamp: Permafrost: Control:		

		Whole Orange	Half Orange
17. Date: Silica:	Desert: Swamp: Permafrost: Control:		
18. Date: Silica:	Desert: Swamp: Permafrost: Control:		
19. Date: Silica:	Desert: Swamp: Permafrost: Control:		

		Whole Orange	Half Orange
20. Date: Silica:	Desert: Swamp: Permafrost: Control:		
21. Date: Silica:	Desert: Swamp: Permafrost: Control:		
22. Date: Silica:	Desert: Swamp: Permafrost: Control:		

		Whole Orange	Half Orange
23. Date: Silica:	Desert: Swamp: Permafrost: Control:		
24. Date: Silica:	Desert: Swamp: Permafrost: Control:		
25. Date: Silica:	Desert: Swamp: Permafrost: Control:		

		Whole Orange	Half Orange
26. Date: Silica:	Desert: Swamp: Permafrost: Control:		
27. Date: Silica:	Desert: Swamp: Permafrost: Control:		
28. Date: Silica:	Desert: Swamp: Permafrost: Control:		

Half Oranges

Color Key: ☐ Desert ☐ Permafrost ☐ Swamp ☐ Control

Mass (grams)																												
120																												
115																												
110																												
105																												
100																												
95																												
90																												
85																												
80																												
75																												
70																												
65																												
60																												
55																												
50																												
45																												
Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Date																												

Whole Oranges

Color Key: ☐ Desert ☐ Permafrost ☐ Swamp ☐ Control

Mass (grams)																												
250																												
245																												
240																												
235																												
230																												
225																												
220																												
215																												
210																												
205																												
200																												
195																												
190																												
185																												
180																												
175																												
Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Date																												

Name: ____ Period: _________

Taphonomy Lab: 28 Days Later

Calculate Change in Mass

Fill out the chart with the data you've collected, and complete the formula to calculate the change. Note: If an orange *gained* mass, it will have a *negative percentage lost*.

	(Original Mass - Day 28 Mass) ÷ Original Mass X 100% = Percentage Lost
1. Whole—Desert	(-) ÷ X 100% = %
2. Whole—Swamp	(-) ÷ X 100% = %
3. Whole—Permafrost	(-) ÷ X 100% = %
4. Whole—Control	(-) ÷ X 100% = %

	(Original Mass - Day 28 Mass) ÷ Original Mass X 100% = Percentage Lost
5. Whole—Desert	(-) ÷ X 100% = %
6. Whole—Swamp	(-) ÷ X 100% = %
7. Whole—Permafrost	(-) ÷ X 100% = %
8. Whole—Control	(-) ÷ X 100% = %

9. Which combination of orange and environment caused the highest percentage of mass lost? Why?

10. Did any of the oranges gain mass? If so, which ones, and why?

11. Which environment best preserved the original texture of the skin? Why?

Extrapolate the Data

The purpose of taphonomy is to learn how bodies change in different environments, so scientists can look at fossils and determine what happened to those bodies. Apply your own data to these fossils. Using the observations you made during this lab, which kind of environment were each of these bodies deposited in?

 **Bison Tooth Fossil** From the collection of the Waco Mammoth Site, Waco, TX. Photo by Dava Butler, used with permission. This piece of bison tooth dates to the Pleistocene Epoch. Natural forces have polished it smooth and stained it dark brown. None of the soft tissue that surrounded the tooth remains.	 **"Lyuba" Replica Fossil** From the collection of The Mammoth Site, Hot Springs, SD. Photo by Dava Butler, used with permission. This baby woolly mammoth, named Lyuba, dates to the Pleistocene Epoch. It has all of its internal organs. The organs and skin are still supple and flexible, and patches of fur are intact. The stomach contains Lyuba's last meal.	 **"Leonardo" Fossil** From the collection of the Great Plains Dinosaur Museum, Malta, MT. Photo by Joe Iacuzzo, used with permission. This imprint of a Brachylophosaurus, named Leonardo, dates to the Cretaceous Period and is highly-detailed. The skin, which is stretched tightly over the bones, shows the original texture. Many of the organs, although shriveled, are still in place.
12. What was the environment of deposition? Defend your answer.	13. What was the environment of deposition? Defend your answer.	14. What was the environment of deposition? Defend your answer.

Discuss the Findings

Science is cumulative, that is, new ideas and findings are added to previous knowledge. Science also is a community effort. When a scientist publishes the results of an experiment, he or she will state what could be tested differently, or what needs further study. Other scientists will conduct more research to see if they get the same results, which is called peer review.

15. At the beginning of this project, you wrote a hypothesis for how each environment would affect the oranges. Did any of your hypotheses prove not to be true? If so, which ones? Why?

16. Based on your research, which elements from the different environments could be combined to create the best preservation of a body? Why?

17. This lab explored the first step of the taphonomic process, decay. To become a fossil, a body must be buried. Choose an orange (desert, swamp, or permafrost) and describe a natural event that would cause it to be buried in that environment.

18. How could this experiment be changed or expanded to get more information? What could be done to improve accuracy?