Fossilization And Decay At The La Brea Tar Pits

Educator Guide by Marta Toran

What determines whether an organism decays or becomes fossilized after it dies?" In "Sticking Around After Death" by Science Friday Educator Collaborator Marta Toran, students learn about the science of taphonomy (what happens to an organism from the time it dies to when it forms a fossil) and the factors involved in decomposition and preservation of organisms, and apply that knowledge to explain the unique fossilization of ice age mammals in La Brea Tar Pits. In this investigation, students design their own experiment to explore the conditions necessary for the preservation of flesh on the chicken wings. The "Tar Noir: Paleoforensics at La Brea Tar Pits" video segment is used as a hook during the Engage part of the learning cycle to get them thinking about the concept of fossilization and the information scientists can derive from fossils. Student will also explore the soft and hard tissues that make up a chicken wing through a mini-dissection in preparation for the chicken wing preservation experiment. After they investigate what causes some organisms to decay faster than others, they will learn about different methods of fossil formation through animations. By the end of the learning cycle, they will have a good idea of why some things stick around much longer than others after they die and why the degree to which fossils are preserved varies.

Target Grade(s): Grades 6-8

NGSS:

Performance expectation:

MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

Cross-cutting concept: Patterns, Stability and Change

Disciplinary Core Idea: LS4.A: Evidence of Common Ancestry and Diversity

Science and Engineering Practices: Asking Questions, Planning and carrying out investigations, Developing and using models, Construction scientific explanations

CCSS:
CCSS.ELA-LITERACY. RST.6-8.3- Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Time Required: The complete learning cycle would probably take about 1 week's worth of lessons. This does not include the time required for data collection of the chicken wing investigation, which could take 1-3 weeks.

Objective(s)

- Understand the difference between decay and fossilization.
- Identify factors affecting decay and fossil formation
- Understand fossils can be formed in different ways and under different conditions.

Assessment:

- **Formative assessment** is embedded into the different activities that make up this learning cycle. For example, there are questions to help uncover background knowledge, student handouts that they have to complete before, during and after they carry out investigations and opportunities for them to check their own understanding.

- **Summative Assessment:** Students need to demonstrate that they understand what happens when an organism dies, and what the conditions that lead to fossilization and decay are. A CER Rubric to evaluate the chicken wing investigation and a question prompt for a MindMap of taphonomy are included.

Worksheets/ Supplemental Materials:

"Tar Noir: Paleoforensics at La Brea Tar Pits" Student Worksheet
"There's a Science for That! -Taphonomy" Student Handout
"What Factors Affect the Rate at Which a Chicken Wing Decays?" Student Handout
"Explain Yourself: What Factors Determine the Rate of Decay of a Chicken Wing?" Student Handout
"Wing Investigation Teacher Notes" Handout
"Fossil-ize Me!" Card Game
Modified CER Rubric
Return to The Ice Age: The La Brea Education Guide (can be found at http://www.tarpits.org/sites/default/files/pdfs/return%20to%20the%20ice%20age.pdf)

Materials (per group of 4 students)

- 4 chicken wings (20 chicken wings= ~$9)
- fishing line or nylon string (about 10 feet) $1
- nitrile gloves (20 pairs) (http://a.co/4q9yuFw- ~$9.00)
- repurposed plastic soda bottles ($0)

Total materials for the class= $20

Safety Considerations:
Students need to be aware of the dangers of handling uncooked food. They are not consuming any food in this investigation, but they need to be trained how to handle the chicken wings safely by: always using the nitrile gloves or washing their hands thorough during and after the investigation, as well as keeping their hands away from their mouth at all times. They should be taught how to safely remove their gloves if using them.
The plastic soda bottles are best cut by the teacher, but if the students are to do it, they need to be careful with the sharp knife slipping on the plastic surface. They need to always cut away from the body in case it slips.
Fishing line can present a choking hazard when taut, students need to be aware of this.

Lesson Sequence

Timing	Sequence & Activity Description	Marta's Classroom Notes
30 minutes	**Engage:** ● Essential Questions *What happens to an animal after it dies?* *What determines how long a living thing sticks around after it dies?* ● "Tar Noir: Paleoforensics in La Brea Tar Pits" Student Worksheet ● "Tar Noir" Videoclip: https://www.sciencefriday.com/segments/tar-noir/ ● Slides of the Merriam's teratorn fossils found in La Brea, as well as artist representations of what the bird looked like. Question prompts for discussion: *What do you notice about the Merriam teratorn fossils found?* *What types of tissue have been preserved in the fossil?* ● Chicken Wing Dissection activity: "A Closer Look at a Chicken Wing" Student Handout. ● Go back to the La Brea fossils by showing an illustration of the *Merriam teratorn*, this time showing the exposed tissues, side by side with a modern chicken showing the exposed tissues, for a link to comparative anatomy/ evolutionary biology. (Ideas for this illustration concept can be found in the previous slides)	-Before students watch the Tar Noir video segment, give out the student worksheet and have them answer the first two questions. -Students discuss their answers to these questions with the person next to them. -Solicit a few student answers before moving on to the video clip in order to get an idea of their background knowledge on the processes of decay and fossilization. -The third question on the sheet is answered after they watch the video clip. -The goal of the chicken wing dissection activity is for students to explore hard and soft different tissues, so they can later apply this knowledge to the preservation of different types of tissue on La Brea fossils. The activity is meant as a quick engage and therefore little direction is given to students other than cutting open the chicken wing and identifying how many different types of tissue they find. For a more thorough dissection, teachers can Google "chicken wing dissection". (One good source for directions is: *https://www.slideshare.net/FJ*

		HScience/chicken-wing-dissection-32867001)
30 minutes 1-3 weeks	**Explore:** ● "There's a Science for That! Taphonomy" Student Handout ● Students will carry out an investigation into the factors affecting the rate of decay of a chicken wing. Each group picks only one type of substrate to focus on, and creates variation within that substrate (eg. changing concentration of a chosen solution) ○ Student Handout: "What Factors affect the Rate of Decay of a Chicken Wing?" ● The results of all the groups are combined and discussed to get a more complete picture of the factors affecting chicken wing decay. ● Sample classroom discussion prompts: ○ *Which factors seemed to affect chicken decay rate the most?* ○ *Which factors seemed to have little or no effect on the decay rate of the chicken?* ○ *What are some possible sources of error in your experiment and how could we reduce these?*	-Students should read the passage on the worksheet and answer the questions to start thinking about rate of decay before the investigation. -Students might need help identifying the independent variables to study given the constraints of each group only being able to chose ONE type of substrate. They can chose factors like pH (eg. by adding more or less lemon juice to each sample), salinity (varying concentrations of brine), exposure to air (varying the amount of solution in each sample or how much of the wing tip is exposed to the air when burying it) etc. -To help students pick a factor to investigate and how to create the variations in treatment, give the example of radioactivity. If they wanted to investigate the effect of radioactivity on chicken decay rate, they could use sand with varying amounts of trace radiation, from none to a lot. The experiment would have to be carried out in a facility designed for testing and handling radioactive materials of course! -If the outdoor area where the samples are placed can be reached by animals, metallic window screen mesh would be

		better to cover the samples than fruit mesh, as animals like racoons can chew through the plastic mesh and take the wing tips. -Photographs are probably the best way to collect data for this investigation, but students can also draw sketches and record things like changes in color, amount of "flesh" covering the bone, and smell. A useful tool for making observations similar to what is used in forensic science, would be placing a transparency with a graph grid printed on it, over the chicken wing and recording changes in amount of flesh, color, etc. using the grid. This would allow easier and more reliable tracking of changes over time.
1 hour	**Explain:** ● Construct a scientific explanation based on the data collected using the Claims, Evidence, Reasoning framework. "Explain Yourself: What Factors affect the Rate of Decay of a Chicken Wing?" Student Worksheet ● Follow up class discussion questions: *What is needed for something to rot?* *Do things rot before becoming fossils?* *Does everything that dies become a fossil?* *What are the conditions under which fossils form?*	-The Rubric attached can be used to assess the Claims, Evidence and Reasoning worksheet.
1 hour	**Elaborate:**	-Additional materials to help

	• Students learn more about different modes of fossil formation using a card game where the objective is to collect different types of organisms, sediments and environmental factors to create a fossil by trading cards with other players.
	  ○ "Fossil-ize Me!" Card Game
	• Students will then answer questions based on real "case studies" to determine the method of fossilization involved.
	  ○ Student Handout: "What's Your Type?"
	  ○ Teacher Handout: "What's Your Type? Answer Key"
	• Show the "Millions of Fossils Can't Be Wrong" SciFri video segment, found at: https://www.sciencefriday.com/videos/millions-of-fossils-cant-be-wrong/. Have students pay particular attention to the types of tissue that are preserved in La Brea fossils.
	  ○ Essay Question: *"Based on your understanding of decay and preservation, how would you explain the fact that no soft tissue is preserved in La Brea Tar Pit fossils?"*
		students answer the essay question can include:
		"Return to the Ice Age: The La Brea Exploration Guide" (Download free copy at http://www.tarpits.org/sites/default/files/pdfs/return%20to%20the%20ice%20age.pdf)

Variable depending on the Summative Assessment activity	**Evaluate:** Formative assessment is built into every stage of the learning cycle through questions in the student handouts, class discussion questions, group work and teacher interaction with groups as they design their experiments. Summative assessment: • Included is a CER Rubric to evaluate the	Possible extensions or activities to provide differentiation of materials: • Students can create a claymation illustrating the science of taphonomy. Different groups could each pick a type of organism, or a fossilization method to

	design and execution of the chicken wing decay investigation ● Student can also create an illustrated MindMap showing what happens when a living organism dies. Guiding question for the MindMap: *“What happens to an organism after it dies?” Illustrate the different outcomes and factors involved.*	do their claymation about. ● Design a museum exhibit (eg. a poster or a diorama) explaining what happens to organisms after they die and how we explain some of them sticking around for millions of years.

Rubric: What Factors Affect the Rate of Decay of a Chicken Wing?

	4	3	2	1
CLAIM	Claim is stated accurately using appropriate science terminology. Variables are identified correctly. Student has a good grasp of C-E-R Model.	Claim is stated accurately, but it could have been more complete or specific.	Claim does not address the task directly, student seems to have some understanding of the experiment but not fully, not all variables are identified correctly.	Claim is untestable, not stated correctly or incomplete (eg. variables not mentioned)
EVIDENCE	Student shows solid understanding of the use of evidence to support claim and is able to articulate understanding clearly.	Student provides sufficient evidence from observations to support the claim, could be more thoroughly explained.	Some evidence is provided which supports claim but additional evidence is missing.	Evidence is unclear and/ or does not support the claim made.
REASONING	Reasoning is thorough and not explains how evidence supports the claim but also extends it beyond the investigation.	Reasoning about how evidence supports the claim is clear.	Reasoning partially explains how the evidence supports the claim.	Reasoning does not connect claim to evidence.

Teacher score and comment:

Claim: _____, Evidence: _____, Reasoning: _____. Total= _____ / 12

Self reflection: If you were to score yourself using the rubric, what score would you give yourself in each category? Justify your answer! Use the back of the sheet for your answer.

WHAT'S YOUR TYPE? ANSWER KEY

Read the description of the fossils and determine the type they are based on the way they were formed (**cast, mold**, ***preserved, petrified, carbonized*** or ***trace***). See the worksheet that corresponds to this answer key here.

A. TRACE
B. PRESERVED
C. PETRIFIED
D. PRESERVED
E. CARBONIZED
F. TRACE
G. MOLD
H. CAST

Bonus: TRACE

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Chicken Wing Investigations: Teacher Notes

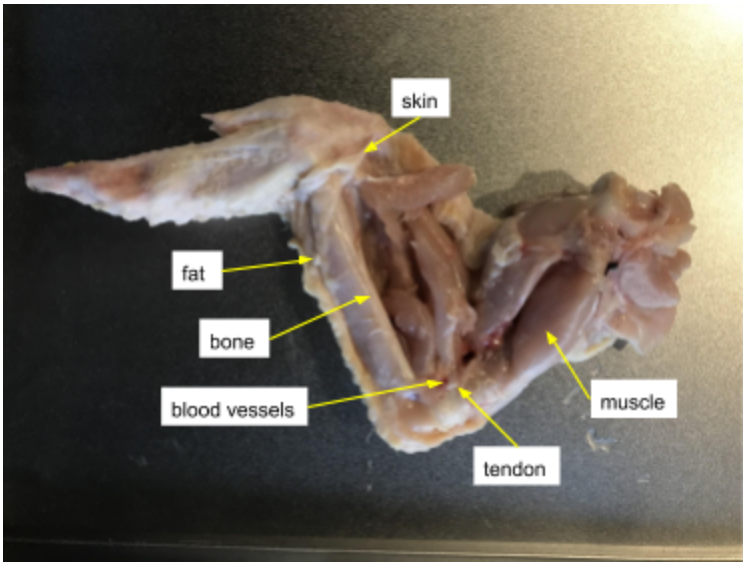
Chicken Wing Dissection

The main purpose of this activity is to get students to see that a limb consists of “soft” and “hard” tissues, as the decay and preservation of structures depends largely on their composition in terms of soft and hard tissues.

One wing per two students works best so they can work together. (You may want to use the same wings for the second part of the Exploration if you tell them to dissect everything but the wing tip!**)

In the absence of scalpels (which are ideal) sharp scissors work better than knives to dissect the chicken wing. Have both handy for the best option. Students can wear disposable gloves, or they can carry out the investigation with bare hands. The disadvantage of gloves is that they will probably keep cutting into them as they dissect. If they are to use their hands without gloves, they need to be reminded of the safety considerations when handling raw food.

This activity takes about 15 minutes with an additional 10-15 minutes to drawing a sketch of the dissected wing and answering the questions on the sheet.



Note: The chicken wing dissection is meant as a primer or hook, it is not intended as an in-depth, step by step dissection. The procedure is purposely vague so students can explore the wing anatomy and figure out their own method for doing so. If a more structured activity is preferred, many chicken wing dissection procedures can be found online by doing a quick search. For example, see
https://www.slideshare.net/FJHScience/chicken-wing-dissection-32867001

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** If the plastic soda bottles to be used for the student investigation on chicken wing decay are small, you may want to have students use the wing tips rather than the whole wing. For this, they can use the wing tips from the dissection investigation, so save them! If they use the big, 2L plastic bottles, they can use the whole wing instead.

What Factors Affect the Rate of Decay of a Chicken Wing?

The goal of this activity is for students to think about what factors affect chicken wing preservation. They will do this by looking at how quickly a chicken wing decays when it is buried in different sediments.

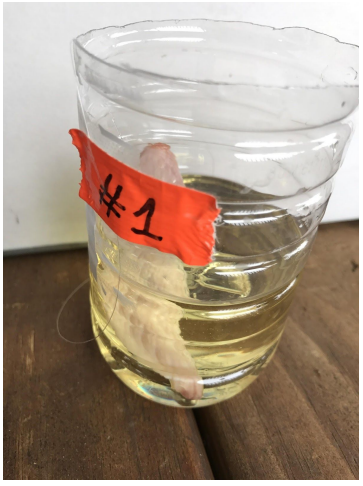
Materials for each group: 5 chicken wing tips or whole wings, empty 500ml or 2L plastic soda or water bottles, plastic or metal mesh (eg. from vegetables/ fruit, or old window screens), rubber bands, disposable latex-free gloves, ~2 feet of finish line, masking tape for labeling containers, access to common, non toxic household liquids and powders (e.g. oil, jello, slime, water, salt, sugar, dirt, sand, baking soda, lemon juice, vinegar).

Each group of students will be given 5 chicken wings and design their own experiment. They will pick their sediment and figure out how they will create the variations (e.g. degree of burial, concentration, pH, temperature). They will also need to figure out the data they will obtain and how often. Questions to help guide students during their brainstorming:

- What measurements will you take? Think about the type of evidence you will need to collect to support your claim?
- How will you make sure you are controlling other variables that might affect your results?
- How will you analyze your data?
- What sources of error can you predict and how can you avoid these?
- How often will you take measurements and how will you ensure that they are consistent through the duration of the experiment?

Some examples of data collection are: weighing the wings, examining them for signs of decay, recording decomposer activity on them, sketches, photographs, time lapse movies for wings that are just resting on the sediment rather than fully buried, etc.

Some sample set ups:



Note:
If you live in an area where pets or wild animals such as racoons could be a problem, make sure to use an upside down crate or laundry basket top use an upside down crate to protect the experiment!

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The amount of time the experiment carried out for, to see observable differences in rates of decomposition will depend on the environmental conditions in the area. It is recommended that the teacher do a test run first.

Lesson Sources:

Images:

Petrified wood- https://commons.wikimedia.org/wiki/File:Fossilized_wood_at_Petrified_Forest.jpg
Vintage note clipart- http://www.publicdomainpictures.net/view-image.php?image=182962&picture=photo-borders
Saber tooth- http://flickr.com/photos/47445767@N05/15256586380
Slug- http://clipart-library.com/clipart/438064.htm
Leaf on ice- https://commons.wikimedia.org/wiki/File:Leaf_Decay_on_the_Glacier_(21606480021).jpg
Teratorn: https://en.wikipedia.org/wiki/Teratornis#/media/File:Teratornis_BW.jpg
Teratorn and skeleton: https://en.wikipedia.org/wiki/Teratornis#/media/File:Giant_Condor.jpg
Teratorn skull: https://en.wikipedia.org/wiki/Teratornis#/media/File:Teratornis_skull.JPG
Teratorn skeleton: https://upload.wikimedia.org/wikipedia/commons/5/5f/Teratornis_merriami.jpg
Chicken wing anatomy: http://www.rtmsd.org/Page/11130
Buck: http://clipart-library.com/clipart/112033.htm
Laetoli footprints: http://www.flickr.com/photos/23165290@N00/7282890638/

Bibliography:

Chicken Wing Dissection: https://www.slideshare.net/FJHScience/chicken-wing-dissection-32867001

La Brea Tar Pits and Museum
http://www.tarpits.org/sites/default/files/pdfs/La%20Brea%20Tar%20Pits.pdf

Lab 2B Fossil Preservation (Geology 1402), Russell Smith, El Paso Community College https://www.epcc.edu/faculty/rsmith/Documents/G%201402%20Lab%202B%20Fossil%20Preservation.pdf, Retrieved on 02/26/2017

La Brea and Beyond
http://www.tarpits.org/sites/default/files/pdfs/Scott%20et%20al%202015.%20LACM%20SS%2042.pdf

Return to the Ice Age: The La Brea Exploration Guide (Download free copy at http://www.tarpits.org/sites/default/files/pdfs/return%20to%20the%20ice%20age.pdf)

B. Artur Stankiewicz, Derek E.G. Briggs, Richard P. Evershed, Ian J. Duncan (1997). Chemical preservation of insect cuticle from the Pleistocene asphalt deposits of California, USA *Geochimica et Cosmochimica Acta, 66*(11), 2247-2252
-Finding: Chitin biopolymer basically intact, proteins poorly preserved.

Xavier Martínez-Delclòs, Derek E.G Briggs, Enrique Peñalver (2004). Taphonomy of insects in carbonates and amber. *Palaeogeography, Palaeoclimatology, Palaeoecology, 203*(1-2), 19-64

-Insects have no biomineralized tissue, often considered “soft bodied” by paleos.

-Sometimes microbial mats prevent the insect from decaying as the provide a cover around them and prevent access by certain bacteria

CER rubric: http://gets.gc.k12.va.us/Portals/Tulsa/Curriculum/CER%20Rubric2.pdf