

Doggos, Digestion, and Fossils, Oh My!

Digestion and the Fossil Record

Heather Shaffery, Christiana Johnson
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Grade Level	7th – 8th Grade	**Time Frame**	2-3 class period(s)
Subject	Science	**Duration**	150 minutes

Essential Question

How can we use fossils to learn about ancient organisms' diets and ecosystems?

Summary

Students will explore the relationship between the fossil record and the digestive system using coprolites (i.e., fossilized poop) as a phenomenon. Students will explain what coprolites can tell us about the diet of the organisms they came from by investigating the chemical and physical processes of digestion and connecting these to prior knowledge of fossil formation. Further exploration of scientific data behind the fossil phenomenon helps students draw conclusions about ecosystem-level interactions.

Snapshot

Engage

Students view museum images of fossilized wild dog coprolites and construct initial explanations for how it's possible for us to know how the dogs hunted based only on those fossils.

Explore

Students investigate the process of digestion using a physical model.

Explain

As a class, students discuss how waste products from digestion can provide information about an organism's diet and explain why this evidence is rare in the fossil record.

Extend

Using data from the scientific paper about the wild dog coprolites, students match the scientists' conclusions about the dogs' ecosystem to evidence that supports these claims. In addition, students provide scientific reasoning to justify the way they matched up the scientists' evidence and conclusions.

Evaluate

Students create a model to explain how digestion can produce the type of evidence found in the wild dog coprolites and why that evidence is useful for understanding ancient ecosystems.

Standards

ACT College and Career Readiness Standards - Science (6-12)

IOD302: Understand basic scientific terminology
SIN402: Understand the methods used in a complex experiment

Next Generation Science Standards (Grades 6, 7, 8)

MS-LS1-7: Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.
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-LS4-2: Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

Oklahoma Academic Standards (7th Grade)

7.LS1.7 : Develop a model to describe how food molecules in plants and animals are broken down and rearranged through chemical reactions to form new molecules that support growth and/or release energy as matter moves through an organism.

Oklahoma Academic Standards (7th Grade)

8.LS4.1 : Analyze and interpret data to identify patterns within the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth.
8.LS4.2 : Apply scientific ideas to construct an explanation for the patterns of anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer ancestral relationships.

Attachments

- CER Explanations—Doggos, Digestion, and Fossils, Oh My!.docx
- CER Explanations—Doggos, Digestion, and Fossils, Oh My!.pdf
- Digestion Model Student Guide—Doggos Digestion and Fossils - Spanish.docx
- Digestion Model Student Guide—Doggos Digestion and Fossils - Spanish.pdf
- Digestion Model Student Guide—Doggos Digestion and Fossils.docx
- Digestion Model Student Guide—Doggos Digestion and Fossils.pdf
- Digestion Model Teacher Guide—Doggos Digestion and Fossils (1).docx
- Digestion Model Teacher Guide—Doggos Digestion and Fossils (1).pdf
- Digestion System Model—Doggos Digestion and Fossils - Spanish.docx
- Digestion System Model—Doggos Digestion and Fossils - Spanish.pdf
- Digestion System Model—Doggos Digestion and Fossils.docx
- Digestion System Model—Doggos Digestion and Fossils.pdf
- Evidence and Conclusions—Doggos Digestion and Fossils - Spanish.docx
- Evidence and Conclusions—Doggos Digestion and Fossils - Spanish.pdf
- Evidence and Conclusions—Doggos Digestion and Fossils.docx
- Evidence and Conclusions—Doggos Digestion and Fossils.pdf
- Lesson Slides—Doggos, Digestion, and Fossils, Oh My!.pptx
- Model Observation Notes—Doggos Digestion and Fossils.docx
- Model Observation Notes—Doggos Digestion and Fossils.pdf
- Unveiling The Digestive System—Doggos, Digestion, and Fossils, Oh My!.docx
- Unveiling The Digestive System—Doggos, Digestion, and Fossils, Oh My!.pdf

Materials

- Lesson Slides (attached)

- CER Explanations handout (attached; one per student; print on both sides)
- Digestion Model Student Guide (attached; one per student)
- Digestion Model Teacher Guide (attached)
- Model Observation Notes handout (attached; one per student)
- Unveiling the Digestive System handout (attached; one per student; print on both sides)
- "Bone-crushing" Dogs Articles (linked; one per student)
- Evidence and Conclusions handout (attached; one per student)
- Digestive System Model handout (attached; one per student)

Below are the materials needed for the investigation (amounts vary):

- Scissors (one pair per small group)
- Gallon plastic bags (one per small group)
- Metal trays (one per small group)
- Plates/trays/dishes (one per small group)
- Small and large plastic cups (one small and one large per small group)
- Paper cups (one per small group)
- Nylon "legs" (pantyhose) (one pair per small group)
- Food samples (seeds, popcorn kernels, raisins, bananas, crackers, etc.) (one per small group)
- Orange juice (one cup per small group)
- Water (one cup per small group)

20 minutes

Engage

Teacher's Note

The Engage and Explore sections can both be completed in a single 50 minute class period. Before beginning the activity, insert any class-specific instructions into **slides 10, 11, & 13**. Despite the messy ingredients, the pie pan and plates make clean-up for the investigation easy. With rare exception, clean-up only involved the students' normal post-lab procedure of wiping down their stations with a disinfecting wipe or spray cleaner.

Using the attached **Lesson Slides** displaying **slide 2** to introduce the lesson. Students should have prior knowledge of how fossils form and how we use the fossil record to understand the past. Use **slides 3-4** to review this information. Display **slide 5** to introduce the essential question: How can we use fossils to learn about ancient organisms' diets and ecosystems?

Move on to **slide 6** to introduce the lesson objectives to the students.

Display **slide 7**. As a formative assessment, ask students to explain what they know about poop. Use the Collective Brain Dump strategy to structure this conversation. Arrange students into small groups and encourage them to collaborate with their groups to share knowledge. When groups seem to be done sharing with one another, have each group share their knowledge with the whole class. As groups share, list their items on the board to create a whole-class product. Using the whole-class list, you can guide the lesson to address misconceptions and gaps in knowledge. Use the questions on the slide to help generate interesting discussion on this topic:

- What is poop?
- Why do we poop?
- Where does poop come from?

Display **slide 8**. Show students images of the coprolites from the Natural History Museum of LA County. Tell them that scientists were able to figure out how the "bone-crushing" dogs hunted based on these fossils.

Display **slide 9**. Give students the **CER Explanations** handout. Ask them to write an initial explanation for how it was possible for scientists to draw that conclusion. After they are done writing, have students discuss their explanation with their neighbor.

30 minutes

Explore

Transition to **slides 10 and 11** to provide class-specific instructions for how to acquire the materials and complete the model.

Pass out the **Digestion Model Student Guide** for conducting the digestion model simulation. Use the **Digestion Model Teacher Guide** to help set up the parts of the model and support student understanding. Having students work in pairs is useful for this activity if the class is sufficiently small. Depending on class size and student responsibility, it may be helpful to have the entire class go through the activity at the same pace.

Display **slide 12**. Pass out the **Model Observation Notes** handout**.** As students explore the model, they should record observations of what they see happening at each phase such as:

- What the food materials look like before and after they enter each phase.
- Any "indigestible" materials in their food

Have students clean up their lab stations, using **slide 13** for any class-specific instructions.

Teacher's Note

The YouTube video "Lesson Idea: Digestive System Experiment" provides a clear demonstration of the entire model. If necessary, it can be used to help students (or teacher) assemble and use the model. If showing the video to the entire class, consider pausing between steps to ensure students are able to recreate each part of the model. A teacher demonstration of any portion of the model **should not be used as a substitute** for students doing the activity.

Alternative Structure

Instead of the entire class creating models, it may be useful to have a small group of students demonstrate the model while their classmates observe. In a class of 27, for example, set up four demonstration stations, each with 3 students working through the model on one side of the table and 3-4 peers observing and offering support (e.g., asking questions, offering trouble-shooting suggestions) from the opposite side.

25 minutes

Explain

Pass out **Unveiling The Digestive System** handout. Display **slide 14**. As a class, ask students to describe what happened in each step of the model. Display **slide 15**. For each step, ask them to describe what part of their body the process is occurring in. (*What organ does this part of the model represent? What process in digestion does this part of the model represent?*) Display **slide 16**. Next, ask students where they think chemical reactions are happening in the system. Have them justify their claims based on prior knowledge and what they observed in the model.

After the group discussion, provide students a formal explanation of the digestive system using **slides 17-19**. While it's important to cover the entire system, focus more heavily on the structures and processes students misunderstood or left out during the conversation. See the teacher's note below for more details about the structures.

Speaker Notes

Food starts in the **mouth** where we chew it up with our teeth. When we swallow the food, it travels down our **esophagus** into the stomach.

When food reaches the **stomach,** it is broken down into liquid with digestive juices. Next, food travels through the **small intestine** – a long and windy tube. The small intestine is very important because this is where many of the nutrients are absorbed by your body and travel via your bloodstream to all the body parts (like muscles, bones, eyes, skin, etc.) that need them.

Liver produces bile, removes toxins, stores some vitamins/minerals; Gallbladder stores bile; Pancreas releases enzymes to break food down and neutralize the acidity of stomach contents when they enter small intestine. Lipase, bile: breaks down fats. Protease: breaks down proteins. Amylase: breaks down starches and sugars.

Finally, food travels through the **large intestine** where water and some minerals are extracted and now that your body has taken everything it needs out of your food, the waste temporarily stored in the **rectum** then exits your body through the **anus** – like when you go to the bathroom.

If they already know part of the content, a brief overview is all that is necessary for those details. Include in the discussion:

- organs
- enzymes (students don't need to remember the specific names, just the purpose)
- processes
- places where chemical reactions occur

Display **slide 20**. Once students have a complete understanding of digestive processes, return to their observations from the Explore. Ask them to describe what they were able to identify in the "waste" products of the models. Help students connect this to their understanding of how fossils form. Some guiding questions to help facilitate this include:

- What types of materials are most/least likely to fossilize?
- Why are coprolites rare?
- When poop does fossilize, what sort of materials might be found inside? Why?

To further discussion, unhide **slide 21**, synthesizing content can be facilitated through student-generated questions. Student questions may include:

- Why can't we eat our poop?

Sample Student Responses

Bones are the most likely to fossilize and soft materials like plants are less likely. Coprolites are soft so they don't fossilize often. You might find bones or seeds inside, because these aren't easy to digest/can't be digested so they would stay in animal poop.

Display **slide 22**. Have students brainstorm the types of conclusions they might be able to draw about an animal based on what they might find in its poop (e.g., whole seeds would tell us that animals can't digest that food).

Teacher's Note: Reinforce and Support

To reinforce digestive system details, see the following YouTube video called "The Digestive System." A camera travels through the digestive system so students can watch the process in action from inside the human body. After watching the video, consider walking students through the process one more time to ensure they understand where the chemical processes occur. Have students answer their classmates' questions during discussion whenever possible.

30 minutes

Extend

Display **slide 23**. Remind students that scientists figured out how the "bone-crushing" dogs hunted based on their coprolites. Ask them to revise their explanation on the CER Explanations handout for how this is possible using what they now understand about digestion.

Display **slide 24**. Introduce to students the Jigsaw strategy. Students read a section about the scientific research on the "bone-crushing" dogs and teach their group about their section. Divide the article What can ancient dog poop reveal about an ecosystem? into four even sections. Group students into groups of four. Give students five minutes to read and discuss what they read.

Discuss the article as a class to help students determine why bones and other materials are left behind during digestion (e.g., lack of necessary enzymes, too dense for the body to break down physically, etc.).

Science Literacy Support

To meet the literacy needs and reading level of students there are two options to modify the reading in this lesson.

- NHMLA article titled The Proof Is in the Pooping is a shorter version of the article used in this lesson. The same activity can be done with this article.
- Dinosaur Poop Part 1: Who Dung It? is a 15 minute podcast that covers the same ideas as the reading. The podcast has the transcript available that students can follow along with while listening and make notes about what they learn.

Display **slide 25**. Provide students with the **Evidence and Conclusions** handout. It contains the evidence scientists found within the coprolites and the specific things they concluded about the "bone-crushing" dogs' ecosystem. Ask students to match the evidence and conclusions by deciding what evidence supports each conclusion and explain why using what they understand about digestion and fossils. *Note that pieces of evidence can be used to support more than one conclusion and conclusions may be supported by more than one piece of evidence.* Display **slide 26**. After students complete the task, have them compare their answers and reasoning with a partner. They should discuss why their ideas may be different by using the evidence and their learning so far.

Students may generate questions which provide an opportunity for a discussion connecting previous knowledge and the content learned during the lesson. The following questions may be particularly useful for reinforcing conceptual understanding of both the process of fossilization and chemical reactions during digestion, respectively:

- Why is poop less likely to fossilize?
- Why do poop and gas smell?

Sample Student Responses

Poop is less likely to fossilize because it is mostly soft material which doesn't fossilize as easily. Poop smells due to gas that gets released during chemical reactions in digestion.

15 minutes

Evaluate

Display **slide 27**. Have students explain how the process of digestion left bone fragments in the coprolites of "bone-crushing" dogs. Provide the students with the **Digestive System Model** handout for them to use as part of their explanation.

In addition, students should revise their Engage/Extend explanation one more time to describe why scientists can use materials found in coprolites to understand ancient ecosystems. They should structure their final explanation as a CER, using evidence from the lesson to support their claim.

Display **slide 28**. Use the Muddiest Point strategy to close the lesson. Ask the students "What is your muddiest point about how we can use fossils to learn about ancient organisms' diets and ecosystems?" Use student responses to address any remaining misconceptions or wonderings.

Resources

- Coprolites & Dinosaur Poop. (n.d.). Explore the Fascinating World of Coprolites & Dinosaur Poop. Poozeum. https://poozeum.com/coprolites
- Dinosaur Poop Part 1: Who Dung It? (2018, March 15). Tumble. http://www.sciencepodcastforkids.com/single-post/2018/03/09/Dinosaur-Poop-Part-1-Who-Dung-It
- Extinct Doggos' Bone-Crushing Diet Preserved in Fossil Poop. (n.d.). Live Science. https:///62666-extinct-doggos-munched-bones.html
- Fritts-Penniman, A. What can ancient dog poop reveal about an ecosystem? (2018, July 5). Massive Science. https://massivesci.com/articles/ancient-dog-fossils-bones/
- K20 Center. (n.d.). Claim, evidence, reasoning (CER). Strategies. https://learn.k20center.ou.edu/strategy/156
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- K20 Center. (n.d.). Muddiest point. Strategies. https://learn.k20center.ou.edu/strategy/109
- Lesson Idea: Digestive System Experiment: Reach Out Cpd. (2014). YouTube. https://www.youtube.com/watch?v=7av19YhNkhE
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- The Proof Is in the Pooping. (n.d.). National History Museum. https://nhm.org/stories/proof-pooping
- Wang, X., White, S. C., Balisi, M., Biewer, J., Sankey, J., Garber, D., & Tseng, J. First bone-cracking dog coprolites provide new insight into bone consumption in Borophagus and their unique ecological niche. (2018, May 22). eLife. https://elifesciences.org/articles/34773