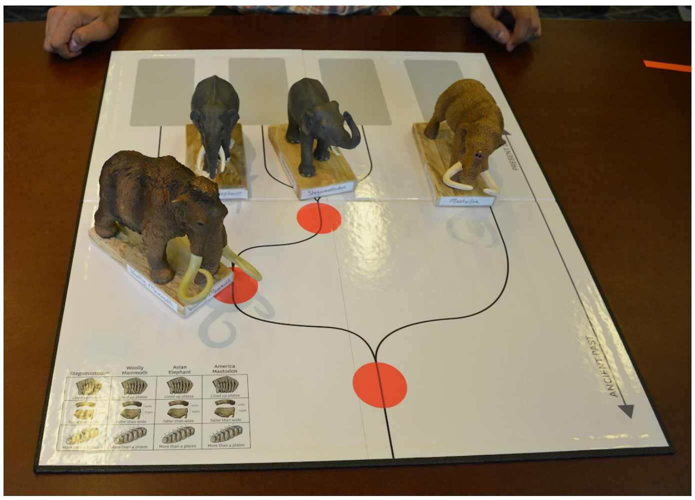
LINEAGE ACTIVITIES - Descriptions

January 24, 2020

NATIONAL MUSEUM *of* NATURAL HISTORY
Smithsonian

The activity content, including user guides, list of materials to purchase, documents and 3D models to print, will be available to download online for free.

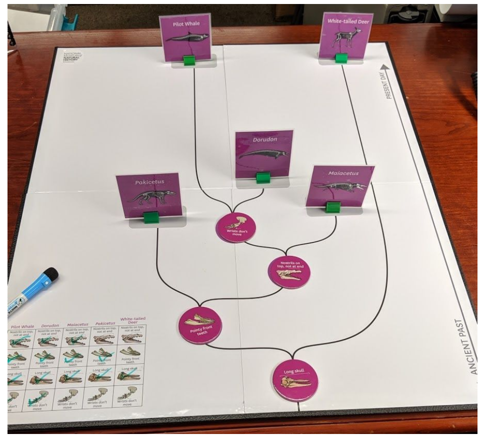
1. Elephant Evolution (includes models to 3D print)



Activity Goal	Visitors create an elephant evolutionary tree using teeth from 4 elephant relatives.
Activity Summary	Visitors are presented with 4 elephant relatives--an Asian elephant, a woolly mammoth, a *Stegomastodon*, and an American mastodon. They are asked to hypothesize which are most closely related. Roles are then assigned--field researchers, who report on evidence they "find in the field" (3 fossil teeth and a modern Asian elephant tooth), and a lead researcher, who is responsible for organizing data on the evolutionary tree. The team works together comparing key features and working out the evolutionary relationships. Then they revisit their hypothesis, see how their thinking has changed, and they are given a question--when on the tree did adaptations to eating grass arise?--that they use their tree to answer. A fuller elephant tree is then revealed, allowing visitors to explore the great diversity of the elephant lineage in more detail; with their new tree training, they are able to ask more questions and make new discoveries together.
Learning Objectives (what visitors think, feel	In the course of doing this activity, visitors will: -Make observations of, describe and compare the teeth of extinct and extant elephant relatives.

and do during the activity)	-Use an evolutionary tree to show hypotheses about evolutionary relationships -Use specific characteristics of the teeth to work out how closely the animals are related -Use the tree to answer questions about when different traits were acquired along the elephant lineage -Discuss, explain, and debate with family members to make hypotheses, and make decisions while building the tree -Feel like they are doing science
Learning Outcomes (new understandings or changes in perspective that result from activity)	We anticipate that visitors who participate in the activity are more likely to: -Begin to understand more about how scientists use shared derived characters to work out relatedness. -Better understand how to make and read evolutionary trees and why and how scientists use them to represent hypotheses about relatedness, to explore and generate questions about evolution of traits, and to represent shared features among living things. -Understand that certain skeletal features are more useful than external features for investigating relatedness between living things. -Think more critically about what the distant past was like. For example, if elephants were so much more diverse in the past, what else was different? And what can we expect for the future? -Feel more comfortable and confident engaging with science, independently and as a group or family.
Target Audience	Families with children 8-12, but adaptable for all.

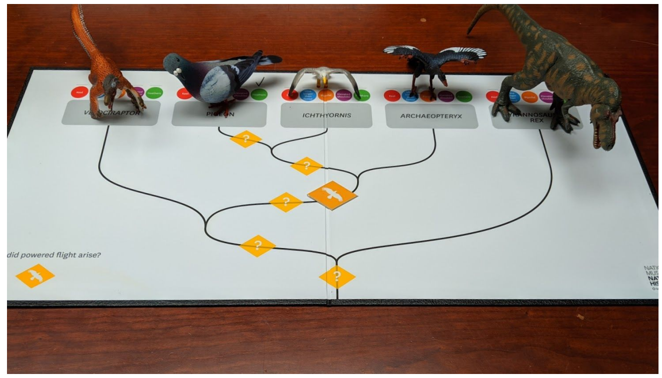
2. Whale Evolution (includes models to 3D print)



Activity Goal	Visitors find the closest living relatives among a set of animals using shared characteristics. Then they use fossils to investigate the whale lineage from the last common ancestor of whales and deer to today.
Activity Summary	In this two-part activity, visitors explore the idea of common ancestry by making hypotheses about relatedness among whales, deer, tigers, seals and sharks. They use an evolutionary tree to keep track of their hypotheses and observations about these animals. Upon learning that whales and deer are closely related, they move to Part 2, in which they compare traits visible in modern and fossil skeletons to understand more about whale ancestry. Visitors split into two paleontology roles - the lead researcher and the field paleontologists. They work together to build a whale evolutionary tree that tracks their observations and hypotheses about when and how shared derived traits evolved. Then they use the tree to pose and answer questions about the nature of change over time, looking particularly at how terrestrial mammals evolved to live in marine habitats.
Learning Objectives (what visitors think, feel and do during the activity)	In the course of doing this activity, visitors will: -Make observations of, describe and compare the traits of extinct and extant whale relatives -Use an evolutionary tree to make hypotheses about evolutionary relationships -Use specific characteristics of skulls and skeletons to work out how closely the animals are related -Use the tree to answer questions about when different traits emerged along the whale/artiodactyl lineage -Discuss, explain, and debate with family members to make hypotheses, and make decisions while building the tree -Feel like they are doing science

Learning Outcomes (new understandings or changes in perspective that result from activity)	We anticipate that visitors who participate in the activity are more likely to: -Begin to understand more about how scientists use shared derived characters to work out relatedness. -Better understand how to make and read evolutionary trees and why and how scientists use them to represent hypotheses about relatedness, to explore and generate questions about evolution of traits, and to represent shared features among living things. -Understand that certain skeletal features are more useful than external features for investigating relatedness between living things. -Think more critically about how much living things can change if given large enough spans of time--from mammals that walked on land to ocean creatures that could not survive outside of the water. -Feel more comfortable and confident engaging with science, independently and as a group or family.
Target Audience	Families with children 8-12, but adaptable for all.

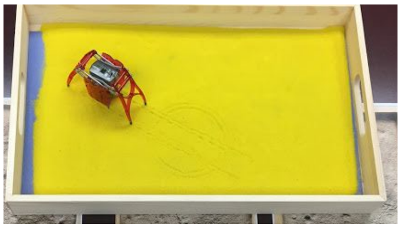
3. *Dinosaurs Take Flight* (includes models to 3D print)

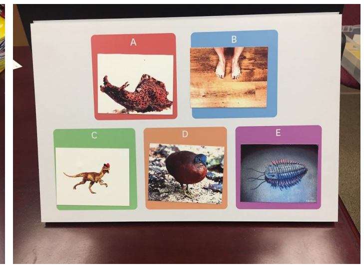


Activity Goal	Visitors examine fossil evidence from the bird/dinosaur lineage and hypothesize where along that lineage flight evolved.
Activity Summary	Visitors work together using fossil evidence to explore how features of powered flight evolved over time. They make observations of features across 5 different dinosaurs/birds and use those observations to make hypotheses about where on the lineage powered flight evolved. In the process they explore how features that served non-flight purposes when they first appeared, were co-opted to aid in flight (exaptations).
Learning Objectives (what visitors think, feel and do during the activity)	In the course of doing this activity, visitors will: -Make observations of, describe and compare flight features among theropod dinosaurs and their relatives -Use an evolutionary tree to make hypotheses about the origins of flight in dinosaurs -Discuss, explain, and debate with family members to make observations and explain their reasoning when making hypotheses -Feel like they are doing science
Learning Outcomes (new understandings or changes in perspective that result from activity)	We anticipate visitors who participate in this activity are more likely to: -Understand that paleontologists use modern examples to extrapolate from evidence they find in the past. -Better understand that evolutionary development of new traits and behavior among living things does not happen in a stepwise or intentional way, but is the result of nonlinear mechanisms like exaptation -Better understand that different types of unrelated animals develop similar traits to live in similar environments - convergent evolution -Better understand how to read evolutionary trees and why and how scientists use them to represent hypotheses about relatedness, to explore and generate

	questions about evolution of traits, and to represent shared features among living things. -Feel more comfortable and confident engaging with science, independently and as a group or family.
Target Audience	Families with children 8-12, but adaptable for all.

4. Fossil Trackways (includes models to 3D print)

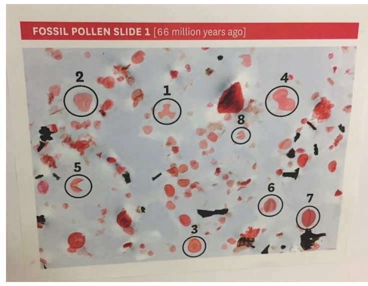





Activity Goal	Visitors learn how to identify traces left by animals in the past.
Activity Summary	Visitors observe three pre-made 'fossil trackways', which have been made using small robots and are asked to describe and hypothesize which organism (robot) made each trackway. They then operate the robots themselves in sand to see how each moves and leaves behind the different trackways. Once they have practiced how to look closely at tracks to understand the locomotive traits an animal that left those tracks would have had, visitors test their skills with fossil trackways, matching up fossils with images of possible organisms that could have made them.
Learning Objectives (what visitors think, feel and do during the activity)	Visitors will: -Understand that tracks left behind by animals can become fossilized. -Understand how ichnologists: 1) characterize the behavior responsible for fossil trackways; and 2) identify the organism that made them. -Practice using models of organisms to understand trace fossils. -Practice science skills, including close observation, comparing and contrasting, using models to develop hypotheses, making explanations, asking generative questions. -Feel like they're doing science.
Learning Outcomes (new understandings or changes in perspective that result from activity)	We anticipate that visitors who participate in the activity are more likely to: -Understand that paleontologists use modern examples and models to understand what they observe in the fossil record, and that they use all kinds of evidence--including traces left behind by organisms--to piece together what happened in the past, to know what organisms were present and when and even something about their behavior, which cannot be understood by bones alone.

	-Look for tracks in nature, ask questions about them, and try to decipher what made them and how. -Feel more comfortable and confident engaging with science, independently and as a group or family.
Target Audience	All ages.

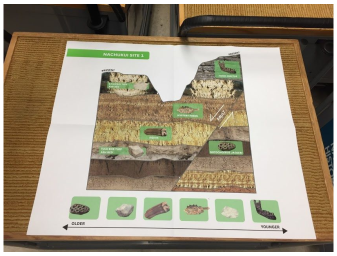
5. Tiny Fossils, Big Picture



Activity Goal	Visitors learn how to use microscopic fossil pollen--evidence of past plant life--to reconstruct a plant community that thrived millions of years ago.
Activity Summary	Visitors work together to help solve a mystery: What did the Hell Creek landscape look like during the time of the dinosaurs? Visitors are assigned roles of paleoartists and field scientists. The field scientists describe the fossil pollen they see in a microscope slide. The paleoartists match the description to a key of plants we know from modern pollen. Each time they identify a plant, they place it in the reconstructed landscape for the Cretaceous. Once they have completed the picture based on the evidence at hand, they are presented with reconstructions of other time periods for that same location. They observe what has changed, make hypotheses about the causes of those changes, and ask questions.
Learning Objectives (what visitors think, feel and do during the activity)	Visitors will -Understand that pollen is part of a plant and fossilizes, which means it can be used as evidence of the presence of plants in a past ecosystem -Understand that fossil evidence is laid down in layers, allowing you to compare evidence from one layer, or time period, with evidence from another layer, or time period, and infer change over time -Describe what they see, drawing on close observation, use of strong descriptive language, and comparison of features, patterns and detail -Compare the reconstructed ecosystems of the same location at different times and discuss and hypothesize why those changes occurred. -Feel like they're doing science
Learning Outcomes (new understandings or changes in perspective that result from activity)	We anticipate visitors who participate in this activity are more likely to: -Understand that paleontologists use modern examples--including pollen--to extrapolate from evidence they find in the past. -Understand that paleontologists use different kinds of evidence to compare ecosystems and infer changes in climate over time. -Look at modern ecosystems and think more critically about what they may have looked like in the past and will look like in the future

	-Value the role of artists in science -Feel more comfortable and confident engaging with science, independently and as a group or family.
Target Audience	Families with children 8-12, but adaptable for all.

6. It's a Date



Activity Goal	Visitors use relative and absolute dating techniques to estimate the age of a mystery fossil.
Activity Summary	Visitors are presented with a collection of fossils from the Turkana Basin in Kenya and asked to determine the age of a mystery fossil. They then see a hillside with stratigraphic layers where the fossils were found. With this reference, they arrange the fossils in relative order from youngest to oldest. They are then given absolute dates of ash layers that bracket the mystery fossil, so they are able to provide an age range. Finally, they are shown evidence from other hillsides in the area that show the earliest date for a fossil--*Equus*, an index fossil in Africa--that is found in a layer below the mystery fossil, enabling the visitor to narrow the age range even more.
Learning Objectives (what visitors think, feel and do during the activity)	Visitors will: -Understand how layers of rock form so that fossils found in lower layers are older than those found in higher layers -Understand that volcanic ash layers contain specific elements that can be analyzed to get absolute dates -Order fossils and rocks from different stratigraphic layers on a horizontal timeline from youngest to oldest -Use absolute dates and index fossils from layers surrounding a mystery fossil to narrow in on a date range for that fossil -Feel like they're doing science.
Learning Outcomes (new understandings or changes in perspective that result from activity)	We anticipate that visitors who participate in the activity are more likely to: -Begin to understand how scientists understand the history of the Earth, and how they estimate the age of rocks, fossils and the planet -Apply their experience when they see how old other rocks and fossils are throughout the museum and beyond. -Feel more comfortable and confident engaging with science, independently and as a group or family.
Target Audience	Families with children 8-12, but adaptable for all.