Amherst College

Evolution, Speciation & Extinction

Hints for Teachers

MUSEUM INFORMATION:

This worksheet is designed to help students practice scientific observation skills in the Beneski Museum of Natural History in conjunction with the classroom curriculum; however, it can also be used independently.

- The Museum does NOT provide copies of *Evolution, Speciation & Extinction*. Please prepare copies for your students.
- While exploring the exhibitions, encourage your students to look above their heads to see specimens displayed at different levels of the Museum.
- The Beneski Museum of Natural History can accommodate up to 45 children and chaperones at a time. Please consider splitting into smaller groups when completing the *Evolution, Speciation & Extinction* activity.
- When your students arrive at the Museum, they will be given a brief greeting by a museum staff member. After this greeting is a good time for you to introduce the activity.

PREPARING AN ACTIVITY:

- *Evolution, Speciation & Extinction* asks students to look closely at specimens and make thoughtful observations. Please pay close attention to the written interpretive materials associated with each specimen.
- The Museum asks that students refrain from leaning on any of the glass cases while working. We recommend providing students with clipboards or notebooks.
- *Evolution, Speciation & Extinction* has a brief set of directions printed at the top for chaperones to use.

IN THE CLASSROOM:

Key vocabulary to review prior to your scheduled visit.

autotrophs	heterotrophs	symmetry	body segmentation
microphylls	megaphylls	sessile	motile
carnivores	herbivores	Pleistocene	genus species
desiccation prevention		Cretaceous/Tertiary boundary	

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Information for Chaperones

COMPLETING THIS ACTIVITY IN THE BENESKI MUSEUM OF NATURAL HISTORY:

- Please allow your students a few minutes to explore the main and bottom floors before beginning the *Evolution, Speciation & Extinction* activity.
- Consult with other chaperones and assign each group of students a question to begin with, so they start at different sections. This way, not all the students are looking for the same specimen at the same time.
- Remind your students to look all around them, even above their heads.
- Remind your students that the exhibits in the Museum are fragile. Please do not allow them to touch any of the exhibits.

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Tenets of the Nature of Science

Creativity

The sciences and humanities interact more than most people think. Science is not possible without imagination. In every stage of the process, from idea to experiment, creativity drives inspiration and innovation. Science is also often abstract and thinking outside the box helps us wrap our heads around complex concepts. When science and arts intersect, we achieve the most progress.

Curiosity

Derived from the concept "tentativeness," curiosity describes both the drive for and inherent skepticism of scientific discovery. Scientists are constantly building upon each other's work, using solutions derived by peers to ask new questions. Some generally accepted ideas have lasted for hundreds of years, so it is reasonable to have confidence in their validity, but new innovations are always approached with some apprehension. We are always learning, and there is always more out there. Curiosity keeps us going.

Observation and Inference

Observations involve the five senses. Using physical information, we draw conclusions we can all agree on. Inferences often rely on information not directly available to the senses; we find explanations for what we observe. Science is much more than just a collection of observations; it also requires inferred interpretations.

Scientific Laws and Theories

In science, laws are descriptions of observable phenomena. They are often expressed in empirical terms. Theories, conversely, refer to inferred explanations that have been widely accepted by the scientific community. Laws and theories are importantly distinct from one another and are not interchangeable. They both require substantial supporting evidence but can be adapted in light of new information or discoveries.

Objectivity and Subjectivity

There are infinite factors that can affect a scientist's biases. From institutional affiliation to religious belief, from race to gender, from societal values to personal ones, scientists must always be aware of external influences affecting their practices and conclusions. Though scientists are tentative of new developments and employ measures to hold themselves accountable and improve objectivity (like peer-review), subjectivity can never be fully disregarded.

Empirical Evidence

Empirical Evidence is evidence that can be directly observed and obtained using our senses or through experimental procedure. Some scientific concepts lean toward the theoretical, but they must be rooted in observational or experimental data to be accepted. Challenging existing conceptions is only possible when supported by qualitative or quantitative empirical evidence.

Scientific Methods

Though there are many ways scientists practice their work and develop bodies of information, observations and experiments must be replicable. Scientists must outline their methods so that another scientist could try the same thing and draw the same conclusions. This way, we check each other's work and have more faith in new developments. The scientific method is often viewed as an independent practice, but it is intrinsically collaborative.

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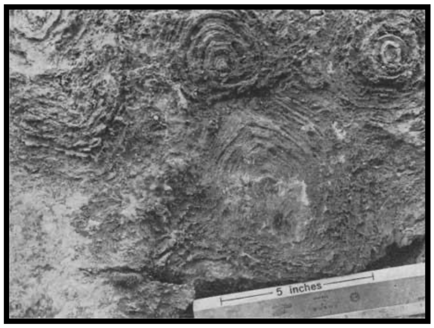
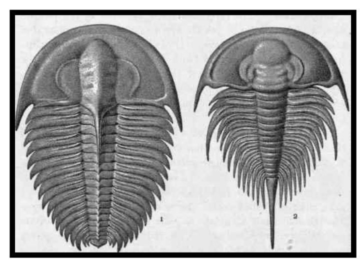
Evolution, Speciation, and Extinction

Name: ________________________

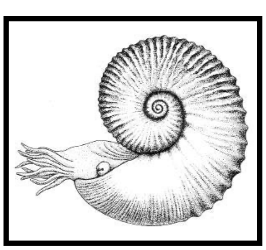
1. On the top floor, examine the large stromatolite. **What organisms were responsible for the formation of this large structure? Were these autotrophs or heterotrophs? What does that mean?**



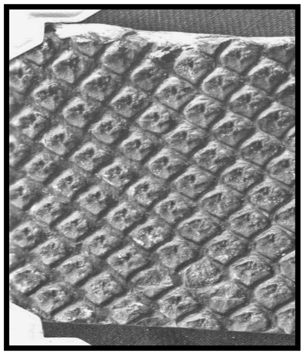
2. Along the back wall of the top floor, behind the Paleozoic Seas fossils, look for the display drawers housing Trilobites, Ammonites, and Nautiloids. **What type of symmetry do these organisms display? Even though these fossils are non-living, can you infer whether these animals were likely to be sessile (**immobile**) or motile (**mobile)? **What observations did you make to arrive at this conclusion?**



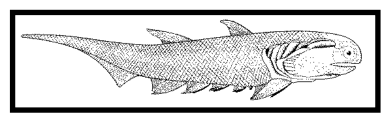
Do the trilobites and ammonites show evidence of body segmentation? What was the apparent function of the chambers inside the shell of the Nautiloides and Ammonites? Did the animal live inside these shell chambers?



3. Move to the display drawers along the wall at the top of the stairs. In the "Plant Fossils" drawers, locate the large Lepidodendron fossil. **Are the leaf-like structures coating the stem of this species microphylls or megaphylls? What structural feature preserved in the fossil leads you to this conclusion?**



4. On the main floor by the entrance door, examine the display drawers along the back wall of the Museum, starting at the main door. **In what organism did jaws first evolve? What are some of advantages of jaws?**



5. Along the back wall of display drawers on the main floor: **What evolutionary innovation allowed the Tetrapod lineage to become capable of completely terrestrial life—to reproduce on dry land?**

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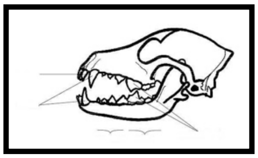
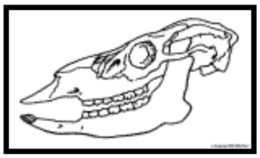
6. Review the definition of **observation and inference** provided at the beginning of this worksheet. Using the exhibit in the display case on the front side of the stairs on the main floor, **describe two observations paleontologists make to help them infer the diet of an animal. Explain how and why teeth differ between carnivores and herbivores.**

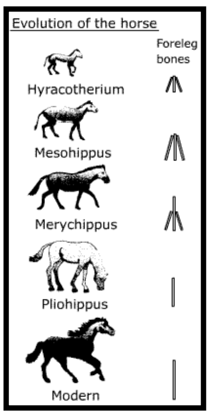




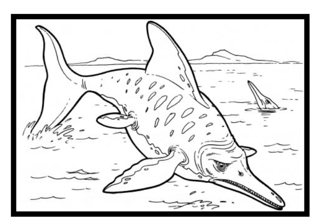
Review the definition of **empirical evidence** provided at the beginning of this worksheet. **Find one herbivore and one carnivore in the museum. List the genus and species and mention the specific observations and evidence you used to draw your conclusion about their eating habits.**

7. Examine the bird display on the main level. **In what geological period did all these birds go extinct? What general processes contributed to their extinction?** Check out the *Moa* (a recently extinct, flightless bird from New Zealand). **Do you see any similar feet represented elsewhere in the museum, and, if so, to whom do the feet belong? Do these similarities make sense evolutionarily?**

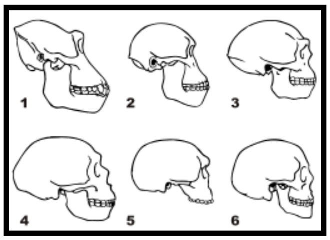
8. Horses are native to North America, although they had gone extinct in North America prior to the arrival of humans. Horses belong to a lineage that has seen an incredible sequence of evolution and adaptation over time. Look for the large display featuring horses in the case along the backside of the stairs leading to the second floor. The exhibit traces the evolution of horses from the ancestral forms, Hyracotherium, Mesohippus, and Merychippus, to the modern horse Equus. **Identify two evolutionary changes in the limb bones of these horses that are adaptations for a running lifestyle, and briefly explain the advantages conferred by each. How did the horses' habitat shift? How and why did teeth change with this shift in habitat? Split your answers into two columns: one for observations, and one for inferences.**



9. On the lower level of the museum, locate the Ichthyosaur (*Stenopterygius quadriscissus*) fossil. **How did this organism make a living (**i.e., where did it live and what did it eat) **and how can you tell? What was its likely ecological niche? What physical observations help you make this inference? What present day organism is convergent with this extinct creature?**



10. Examine the display on hominid evolution upstairs by the tables.
What are the three main evolutionary innovations that separate hominids from apes? Which of these characteristics is thought to have evolved first?



Compare the teeth of *Homo sapiens*, *Pan paniscus* (the pygmy chimpanzee or bonobo), and *Paranthropus boisei*. **Explain how these differences reflect how they procured and processed food.**

11. Essay: Consider the various major extinctions that have occurred in geological history. **Compare and contrast the causes and effects of the Pleistocene extinction with the mass extinctions at the Cretaceous/ Tertiary boundary** (when dinosaurs went extinct)**.**

12. Essay: **Compare and contrast the adaptations of vertebrates to land versus the adaptations of plants to land.** In your answer, you may want to consider gas exchange, desiccation prevention, reproduction, etc.

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https://www.amherst.edu/museums/naturalhistory