HARVARD MUSEUM of NATURAL HISTORY

Evolution on Exhibit
Hints for Teachers

This gallery activity explores a variety of evolution themes that are well illustrated by gallery specimens and exhibits. Each activity is aligned with the NGSS as adopted by Massachusetts, as noted below. Teachers can assign all or a select few of the units, depending on curriculum alignment, time available, and student attention spans. For younger learners especially, choosing fewer activities will allow students to spend more time thinking, drawing, and discussing each topic, resulting in deeper learning.

PREPARING AN ACTIVITY

- Please make copies of the activity for your students. The museum will **NOT** have copies available.
- Please refrain from leaning on any glass cases. We recommend supplying students with clipboards or notebooks to lean on while writing and pencils for completing the activities.
- This activity has students observing specimens in various locations. We suggest having students start in different galleries to avoid crowding.
- When your students arrive at the museum, they will be given a brief greeting by a museum staff member. Following the greeting, it will be a good time for you to talk to your students and chaperones about the activity, if you have not already done so.

CORRESPONDING MA SCIENCE STANDARDS

A *Horse Family Tree: Adaptation and Evolutionary Change*; LS4-1, Fossil record
B *Skeletal Similarities: Homologous Structures and Evidence for Evolution*; LS4-2, Evolutionary relationships (homology)
C *Taking to the Skies: Investigating Convergent Evolution*; LS4-2, Evolutionary relationships (convergent evolution)
D *Fancy Pigeons: Humans and Artificial Selection*, LS4-5, Artificial selection

Pets to Produce: Humans and Artificial Selection

KEY TERMS FOR ACTIVITIES

For sections A–C it would be helpful to review the concepts of *common ancestor*, *adaptations*, *homology*, *convergent evolution*, and *forelimb* before completing the activity. **For section E** it would be helpful to review the concepts of *natural selection*, *common ancestor*, *adaptations*, *speciation*, and *artificial selection* before completing this activity.

IN THE CLASSROOM

Think, Pair, and Share

Some of the activities ask students to think about the answer to a question and discuss it with a partner or in a group. These are good questions for further discussion in the classroom.

Skeletal Similarities

After your visit, have students color code diagrams of homologous vertebrate forelimbs to better understand the similarities in their anatomy. Extend the learning by adding other examples easily found online.

Taking to the Skies

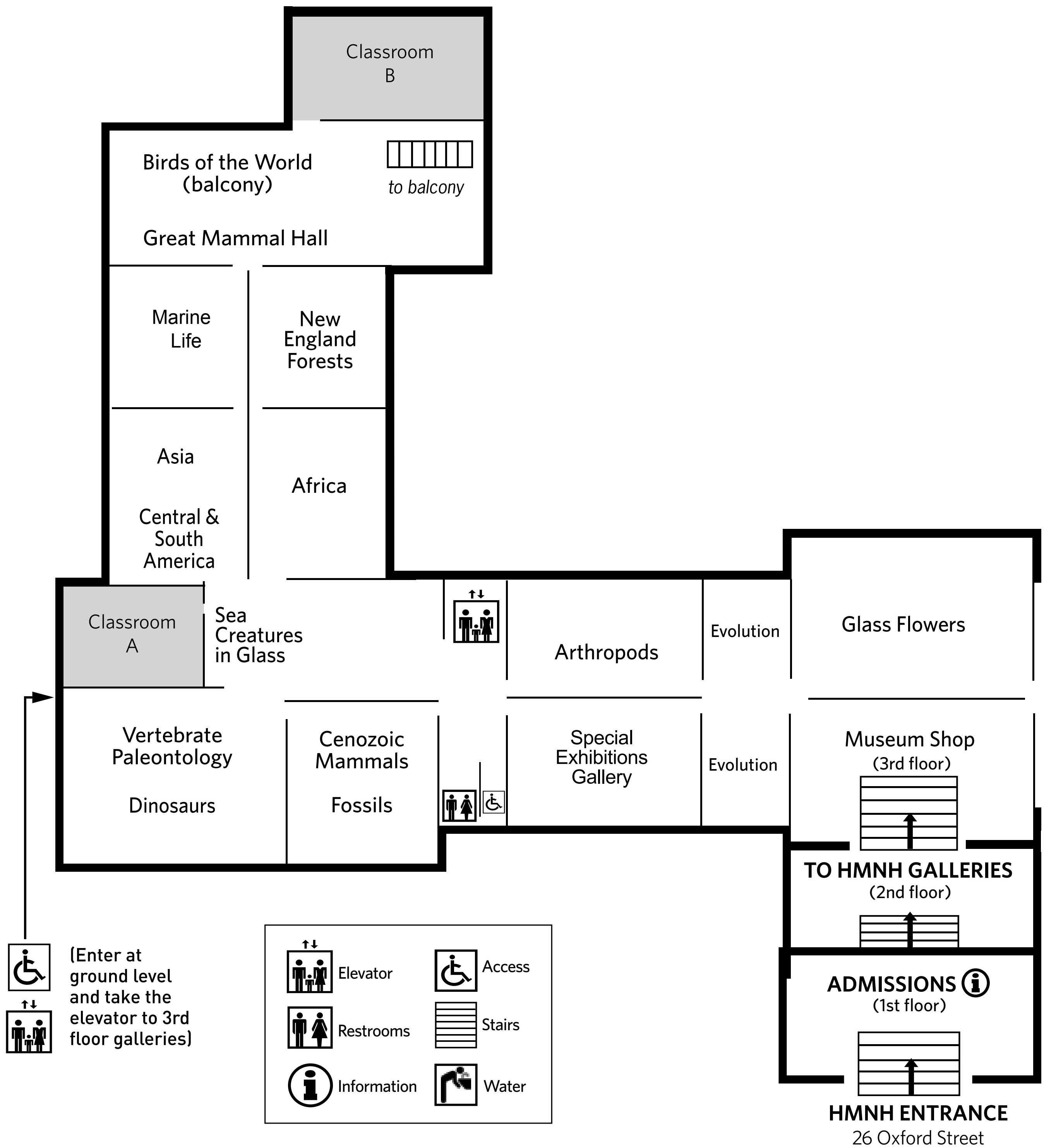
Utilizing the wings from *Taking to the Skies* as an example, explore the differences between *homologous* (evolved from common ancestor) and *analogous* (evolved independently) structures. Observe that while these three examples of *wings are analogous*, the *forelimb bones* of these animals are actually still *homologous* because they share an ancient common ancestor. *In contrast*: Take a look at various insect wings. While insect wings are analogous to the wings of birds and bats, they are in no way homologous.

RESOURCES:

For more information about evolution and teaching tips, we recommend UCMP's *Understanding Evolution*.

Evolution on Exhibit

The HMNH galleries contain thousands of specimens, many of them important in research and history. Visit each location in any order. See what Harvard's collections can reveal about evolution.



A

Horse Family Tree: Natural Selection and Evolutionary Change

☞ **THE EVOLVING HORSE, CENOZOIC MAMMALS GALLERY**

The horse as we know it today is very different from its early ancestors. Early horses like *Mesohippus* spent their time in damp forests, eating leaves among the underbrush. About 24 million years ago the climate changed and many forested areas became grassland savannas. Individuals with traits better suited to this new environment were more likely to survive and reproduce. This is an example of **natural selection**. As a result, modern horses (*Equus*) are highly adapted for living in open grasslands.

Compare the *Mesohippus*, *Parahippus*, and *Equus* skeletons—what differences do you notice among them? Use what you observe and the information on the labels to complete the table.

Skeleton	**Teeth/Diet** Browser (twigs & leaves) or Grazer (grass)	**Body size:** (small, medium, or large)	**Feet:** make a quick sketch of its toes	**Habitat:** Forest or grassland
Mesohippus ~30 mya 				
Parahippus ~17–23 mya 				
Equus ~3 mya 				

Think, Pair, and Share: Write down your thoughts. Discuss with a partner!

What adaptations does *Equus* have for living in a modern grassland environment that the early forest horse species do not have?

Why might individuals with these traits survive better than those without them?

B

Skeletal Similarities: Homologous Structures and Common Ancestry

☞ **PRIMATE SKELETONS, CASE C7, GREAT MAMMAL HALL**

Structures inherited from **common ancestors** are known as **homologous** structures. Look around the Great Mammal Hall and observe the many different kinds of mammals! Compare the moose skeleton behind you, the whale above you, and the human in front of you. While they may look different, you may notice their similar basic body structure. This is strong evidence that they evolved from a common ancestor.

Observe the arm, wrist, and hand bones that make up the **human forelimb (arm)**. Sketch the bones of the forelimb below.

Now choose two other mammal skeletons of different types from anywhere in the gallery. For each animal, sketch the bones in its **forelimb** (arm or front leg). Compare these sketches with your human sketch. Can you find bones that seem to be the same as those in humans? **Draw lines** between your drawings to connect the corresponding (**homologous**) bones.

Human	______________________	______________________

Think, Pair, and Share: Discuss with a partner

What is the human forelimb (arm and hand) adapted for? (Think about how you use your own arms and hands). How is each of your animals' forelimbs adapted for a certain lifestyle?

C

Taking to the Skies: Investigating Convergent Evolution

☞ **ROMER HALL OF PALEONTOLOGY**

The previous activity, **Skeletal Similarities**, looks at homologous structures that are the result of evolution from a common ancestor. However, similar traits can also evolve in organisms that are *distantly related*, but face similar *challenges*. These traits have evolved **independently** through **convergent evolution**.

Three distantly related vertebrate groups—**pterosaurs** (reptiles), **bats** (mammals), and **birds**—have independently evolved highly specialized forelimbs that allow them to **fly**. This is an example of **convergent evolution**. Although these wings may have the same function, they differ from each other in shape, support, and skeletal structure.

Here is a partial bird skeleton showing the forelimb bones

Compare the bird wing to the wings of the ***Pteranodon*** and bat. As you are sketching, note the fingers, the wing shape and structure, and how the wing is attached to the body.

Pteranodon **skeleton, Romer Hall of Paleontology**

Using the bird drawing as a model, sketch the forelimb and wing of the *Pteranodon*, one species of pterosaur (a group of extinct flying reptiles).

☞ BATS, CASES A6 AND A7, GREAT MAMMAL HALL

Using the bird drawing as a model, sketch the forelimb and wing of a bat, the only true flying mammal.

While you are in the **Great Mammal Hall**, head upstairs to ***Birds of the World***. Check out the **Peregrine Falcon** mount and skeleton in case C9. Observe the outstretched wings of the falcon and the fused fingers in the skeleton.

Share and compare!

What makes the wings of birds, *Pteranodons*, and bats different from each other? Discuss with your group and work together to complete the chart. For each trait, describe how it differs among the three groups.

Trait	Bird	*Pteranodon*	Bat
How do the fingers differ from each other?			
Where does the wing attach to the body?			
What is the wing made of?			
Other:			

D

Humans and Artificial Selection

In artificial selection, humans—not nature—determine which individuals will reproduce. Genetically determined traits can be "selected for" in parents and passed down to offspring. This can result in dramatic and rapid changes in plants and animals.

Fancy Pigeons

☞ **CHARLES DARWIN PIGEONS CASE, EVOLUTION GALLERY**

Breeding pigeons was a common hobby in Darwin's time. Pigeon "fanciers" in the 1800s did not know about genes and genetics, but they knew that mating two individuals with a certain trait such as long beaks could result in offspring with long—or even longer— beaks. Look at the "fancy" pigeons in this case. Their extreme physical characteristics are the result of artificial selection over generations. Darwin's pigeons in this case were not just for show; they also helped him develop the theory of natural selection.

Keep in mind: All of the pigeons in this case are the **same species**, *Columbia livia*. This is also the same species as the common pigeon you see outside!

Look closer

Sketch one of Darwin's pigeons, noting on your sketch which specific traits have been selected for.

If you were a pigeon fancier what trait would you select for?

Pets to Produce: Humans in Charge

☞ **CHARLES DARWIN PIGEONS CASE, EVOLUTION GALLERY**

From cows and cats to bananas and broccoli, domesticated animals and plants are the result of generations of artificial selection. Around the museum are some of the **wild ancestors** of more familiar domesticated animals. Find each animal and take a few moments to think. If you were domesticating this animal, what traits would you select for and why? Be specific! (A few possible purposes: appearance, usefulness, food). **Work with your group members to complete this table.**

Species	Trait(s) selected for	Purpose
Grey wolf *New England Forests* (Ancestor of dogs)		
Vicuña Great Mammal Hall case E3 (Ancestor of alpacas)		
Red junglefowl *Birds of the World* between cases B1 & B2 (Ancestor of chickens)		
African wildcat Africa Hall, case B3 (Ancestor of cats)		