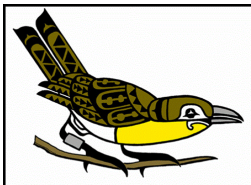

Evolution of Birds

Oregon State Standards

OR Science
7.1, 7.2, 7.3, 7.3S.1, 7.3S.2
8.1, 8.2, 8.2L.1, 8.3, 8.3S.1, 8.3S.2
H.1, H.2, H.2L.4, H.2L.5, H.3, H.3S.1, H.3S.2, H.3S.3

Vocabulary

- Evolution
- Extinction
- Adaptation
- Natural Selection
- Phylogenetic Tree
- Clade
- Node

Summary:

Students create phylogenetic trees to learn about the evolution of birds, from the first bird-like dinosaurs to modern birds specialized for foraging in present-day landscapes. This lesson also teaches students about how natural selection shapes evolution through an activity exploring bird beaks and an activity exploring flight, wings, and bird morphology.

Prep Time: 1 hr

Time: 90 min

Grade Level: 7th-12th

Goals

- Learn about the evolutionary history of modern birds
- Explore phylogenetic trees and classification
- Teach students about natural selection and the factors driving evolution

Learner Objectives

Students will…

- Describe how natural selection drives evolution
- Predict how natural selection and food availability work together to determine the evolution of beak morphology
- Create a phylogenetic tree for selected bird species, and describe how they chose to group their birds

Materials

- "*Phylogenetic Tree*" worksheet
- Instructions and worksheet for "*Bird Beak Evolution*"
- Marshmallows, black beans, tweezers, clothespins and spoons for "*Bird Beak Evolution*"
- (Optional) Instructions, worksheets, straws and paper for "*Variation and Selection in the Egyptian Origami Bird (Aves papyrus)*"

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Evolution of Birds

Background information:

Birds are descendants of dinosaurs. This claim, which originated in the 16th century, has been contested for several centuries. Over time, thanks to the discovery of fossils containing feathers, such as the *Archeoptryx,* this idea has become accepted by not only scientists, but society in general. *Archeoptryx* is an example of an early species in the saga of bird evolution. In recent years, scientists have discovered at least two other species of dinosaur that evolved into birds, but their lineages went extinct! Additional evidence has strengthened the connection between dinosaurs and birds, such as the discovery of feathers preserved in amber from the Cretaceous Period, other fossils containing feathers, and "feather pores" in the forelimbs of velociraptors.

Modern birds have evolved many traits and characteristics that distinguish them from dinosaurs. **Evolution** is the process by which species change over time, typically creating new species. **Extinction** is the dying out of a species. Extinction can occur when a species is no longer able to survive in a changed environment. Overharvesting by humans can also cause extinction. Evolution generally proceeds in two ways. Either a species changes over time, in response to a change in the environment (e.g., change in available food, predators or nesting habitat), or a population becomes split into two or more isolated populations and these populations slowly diverge from each other until each becomes a separate species, exhibiting traits suited to survival in its particular environment. The driving factor in both evolution and extinction is **natural selection**, the selection for or against certain traits in a population typically based on environmental conditions. An **adaptation** is any trait that helps an organism survive and reproduce in its environment, under present conditions. Natural selection gradually (over many generations) causes populations to change over time as environments change, and organisms best adapted to current conditions are more likely to reproduce and pass on their adaptive traits to their offspring.

Bird Ancestors

Fun Fact:

Scientists believe that more than one species, and lineage, of dinosaur evolved into species that resemble birds. For some unknown reason, none of the other groups of birds survived extinction!

Photo of Archeoptryx fossil by Jejune Ennui at: http://www.flickr.com/photos/handozo/6341106187/

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Evolution of Birds

Background continued

The process by which natural selection shapes the evolution of a species is fairly straightforward. Variations in physical appearance occur as a natural part of wild populations. These variations can increase or decrease an individual's ability to survive, or have no effect on survivability. If survivability is increased, that individual will be more likely to pass on its genes. Thus, the offspring will have the same beneficial traits. After many generations, the entire population will have the beneficial traits. It is important to note that whether a trait is beneficial (adaptive) or not **depends on the environment**. If a species is already well-adapted to its environment and its environment is stable, then the species will not change much because there will not be pressure to adapt to a new environment.

A **niche** is a way a species lives, forages, and breeds. In relatively stable environments, such as on the continental mainland, there are few "available" niches because there are already species feeding on insects, on plants, on seeds, etc. In unstable, isolated or changing environments, such as offshore islands, there are not that many different species so the few species that arrive to these islands can evolve into separate species that specialize in different niches.

The evolutionary path of bird species can be traced by scientists and this information is displayed in a phylogenetic tree. A **phylogenetic tree** is a diagram of how species are related. Two species that share a lot of similarities, such as the Bullock's Oriole and Red-winged Blackbird, are located near each other on the phylogenetic tree and they likely branched off from a common ancestor more recently. Species that are more different from each other, such as the Red-tailed Hawk and Wood Duck, have a common ancestor that goes back further in time and thus these species have been on separate evolutionary paths for a greater amount of time.

Science Connection:
Bullock's Orioles (right) and Red-winged Blackbirds (left) are in the same taxonomic family, Icteridae. Even though these birds do not necessarily look like family members, scientists have been able to use genetics to determine and support their inclusion in the same taxonomic family!

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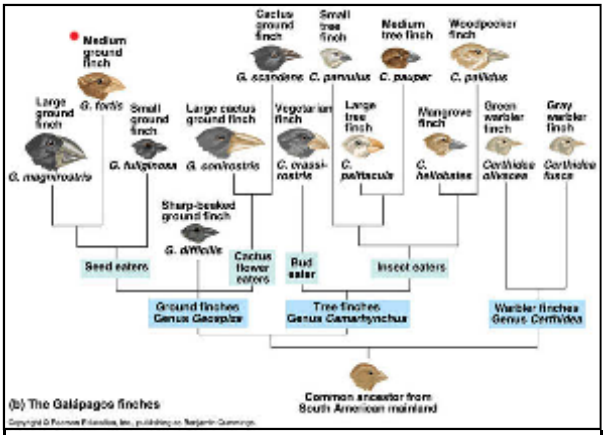
Evolution of Birds

The Evolution of Galapagos Finches



Phylogenetic tree depicting the evolution of Galapagos Finches.

A clear example of evolution can be found in the finches of the Galapagos Islands. The 13, or so, species of finches found on the Galapagos Islands today all originated from one species. The original finch traveled to the Galapagos a few million years ago from Central or South America. Over time, this one species evolved into the approximately 13 species found today. Different populations of the original species began to develop adaptations for capturing specific food resources on the islands. Now, the various species include three species of ground-dwelling seed-eaters, three species that live on cactuses and eat seeds, and seven species that dwell in trees and eat insects. Because few organisms made it all the way out to the Galapagos Islands, there was ample opportunity for the original finch species, once it arrived in the Galapagos, to evolve to take advantage of unused or underutilized food resources. Evolution is still at work on the Galapagos and climatic changes in recent years have altered food supplies (for example, changes in moisture have altered the size of seeds that are available to birds) and beak sizes in ground-dwelling finches have been changing to keep pace with the changes in the size of seeds.

Getting ready

- Read background information
- Have students research an extinct species of bird, such as the Dodo, Great Auk, Passenger Pigeon, Bachman's Warbler, Ivory-billed Woodpecker, or Carolina Parakeet, among other examples. Use the following questions to help guide the students' research:

  How long ago did this species live?
  Where was it found? Or, where are its fossils found?
  What kind of habitat did it use?
  What did it eat?
  What did it look like? (Include a picture if possible.)
  What special adaptations did it have?
  What other birds, extinct or alive today, are its closest relatives?
- Copy worksheets and instructions for activities.

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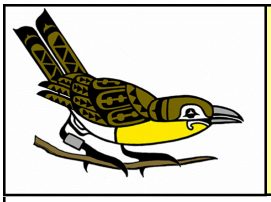

Evolution of Birds

Discuss:

- Ask students: What is evolution? Why does evolution happen? How does evolution happen? Why do species go extinct? What are some ways that scientists use evolution to understand birds?
- Have students share their answers with a partner, then ask partner groups to share their answers with the class.
- Discuss Darwin's finches and how adaptation and evolution are linked.
- Talk with students about phylogenetic trees and how scientists use them to demonstrate how birds are related, and how we can use them to get an idea of how birds evolved.

Investigate:

- Divide students into groups and provide groups with the materials for the "*Bird Beak Evolution*" activity.
- Ask students to create a hypothesis about the outcome of this activity.
- After student groups have completed the activity, have them share their results with the class.
- Now, discuss how they, as scientists, could group the birds, the marshmallow eaters and M&Ms eaters, that evolved from their activity. Could these birds have common ancestors?
- Pass out sample phylogenetic tree and explain how scientists use them. This phylogenetic tree shows how birds, reptiles and dinosaurs are related. Emphasize that branching points, or nodes, represent common ancestors. The more recent a common ancestor between two species, the more closely those species are related. Also, note to students that phylogenetic trees can be used to create clades, groups of organisms that are descended from a common ancestor. The creation of clades and phylogenetic trees is one of the ways to show how closely related birds and dinosaurs are.
- Have students do the *Bird Phylogeny* worksheet.

Conclusion

- Have students construct their own phylogenetic trees using the *Create a Phylogenetic Tree* cards.
- Have students share and explain their phylogenetic trees.

Classroom extension

- University of Indiana has a great activity that shows natural selection called "*Variation and Selection in the Egyptian Origami Bird (Avis papyrus).*" The activity is available here: http://www.indiana.edu/~ensiweb/lessons/origam.pdf

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Evolution of Birds

Outdoor extension

- Take students on a field trip to the playground, playing field or other natural area and have them look for birds, plants, rocks, etc that they can use to create a phylogenetic tree.
- Have students create "fossils" with plaster-of-paris and leaves, feathers or other natural items. Then have students write a story about the evolutionary history of their fossil.

Link to KBO lessons:

- **Bird Beak Buffet:** Students will learn about bird beak adaptations and bird habitats through scientific inquiry, hands-on experiments, and class discussions.

Literature cited:

- "Are Birds Really Dinosaurs?" *DinoBuzz*. UCMP UC Berkeley. 22 January, 1998. Web. 24 January, 2013. Available at: http://www.ucmp.berkeley.edu/diapsids/avians.html
- "Using the Tree for Classification." *Evolution 101*. UCMP UC Berkeley. 2013. Web. 25 January, 2013. Available at: http://evolution.berkeley.edu/evosite/evo101/IIDClassification.shtml

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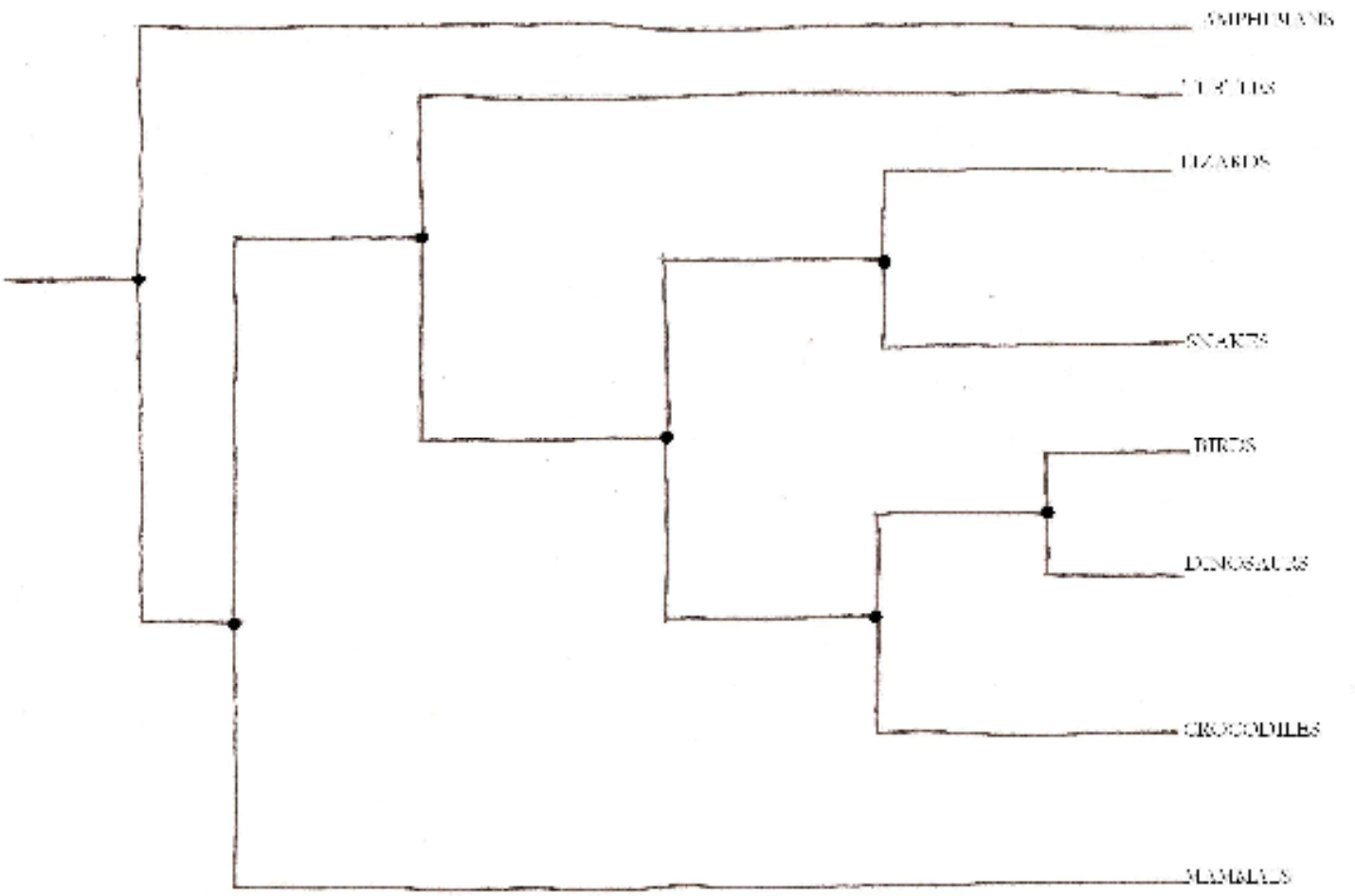
Bird Phylogenetic Tree



The image above is of a **phylogenetic tree**. Phylogenetic trees are diagrams of how species are related. Scientists use these diagrams to discover and demonstrate distant and recent ancestors for species. This phylogenetic tree shows how birds, reptiles and dinosaurs are related. Branching points, or **nodes**, represent common ancestors. The more recent a common ancestor between two species, the more closely those species are related. Phylogenetic trees can be used to create **clades**, groups of organisms that are descended from a common ancestor. In this phylogenetic tree, there are six clades. These clades are grouped as follows: Amphibians, Turtles, Lizards and Snakes, Birds and Dinosaurs, Crocodiles, and Mammals. The creation of clades and phylogenetic trees is one of the ways to show how closely related birds and dinosaurs are.

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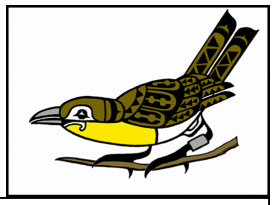

Bird Phylogeny

Using the sample phylogenetic tree, answer the following questions.

1) Which species are most closely related to birds?

2) Which species are most closely related to mammals?

3) Are Crocodiles more closely related to lizards or birds?

4) Do birds share a common relative with lizards that is earlier or later than their common ancestor with snakes?

5) Which group is most closely related to the group that includes snakes?

6) Who the most recent common ancestor of snakes?

7) Which species is most distantly related to all the others?

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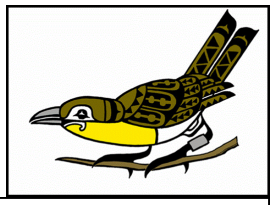

Bird Beak Evolution

Introduction:
On a distant planet, there exists 3 species of birds. Each species is similar except there are variations with regard to their beaks…

1) Clothespin-mouthed Bird
2) Tweezer-mouthed Bird
3) Needle-mouthed Bird

One year, an extremely rare new species of bird was discovered… the Spoon-mouthed Bird!

Lab:
You will simulate NATURAL SELECTION with these 4 species of birds. They will feed in two different environments…

Marshmallow environment
M&Ms environment

As a group of 4, each student will represent each species of bird. You will have 15 seconds to gain as much food as possible. At the end of the 15-second round, count the pieces of food that you have collected and record in the data tables below. REPEAT EACH PROCEDURE FOUR TIMES!

Hypothesis:
I think that the _____ bird will be able to capture more MARSHMALLOWS than the other birds because

_____.

I think that the _____ bird will be able to capture more M&Ms than the other birds because

_____.

Data Table:

	MARSHMALLOW				BLACK BEAN			
	Time = 15 seconds				Time = 15 seconds			
	Trials				Trials			
Bird Species	**#1**	**#2**	**#3**	**#4**	**#1**	**#2**	**#3**	**#4**
Clothespin								
Tweezer								
Needle								
Spoon	**X**	**X**			**X**	**X**		

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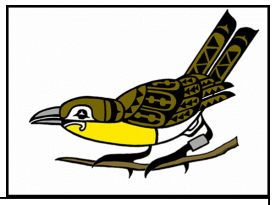

Bird Beak Evolution

Conclusion:

Rank the fitness of the bird species (from least fit to most fit) in the…

Marshmallow habitat

M&Ms habitat

Conclusion Questions:

1) What happens to animals that cannot compete as well with other animals in the wild for food?

2) List a real-life example of competition, where one species has a definite advantage over another species in the wild. Explain in detail!

3) Sometimes, animals that are newly introduced into an environment that they have never lived before out-compete and endanger the "natural" resident animals. Why do you think this happens?

4) If only one species is considered to be the "fittest", then why do we continue to have so many other species surviving in an area?

5) How do you think disease, natural disasters, or destruction of habitats by humans can impact the process of natural selection?

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