The Cornell Lab of Ornithology
BirdSleuth K–12

Jump, Glide, or Fly?

Exploring Bird Evolution

Activities to accompany the *Flap to the Future* game

The *Exploring Bird Evolution* activities are part of BirdSleuth K-12 suite of education resources from the Cornell Lab of Ornithology.

If you have questions about the BirdSleuth K-12 curriculum, please contact us.

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For additional information, useful resources, and direct links to the resources described within this unit, please visit www.birdsleuth.org/flap-to-the-future.

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The Cornell Lab of Ornithology is a nonprofit membership institution whose mission is to interpret and conserve the earth's biological diversity through research, education, and citizen science focused on birds.

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Welcome to BirdSleuth!

The Cornell Lab of Ornithology's BirdSleuth K-12 program provides resources and training to educators. Our curriculum kits and free resources focus on learning to identify birds, participating in the Lab's citizen-science projects, getting outdoors, and doing science investigations. Through these activities, we hope to motivate students and encourage their interest in science.

Please visit www.birdsleuth.org to learn more about our K-12 resources, connect with us via our social networks, and access our free downloads and easy-to-use curriculum kits.

Introduction to *Exploring Bird Evolution*

Flap to the Future: The Flight Adaptations Game by the Cornell Lab of Ornithology's Bird Academy allows students to explore and understand the adaptations birds have evolved that help them fly. BirdSleuth K-12 has developed this activity resource to help educators scaffold Flap to the Future for middle school students, grades 6-8. *Jump, Glide, or Fly? Exploring Bird Evolution* addresses key concepts such as adaptation, anatomy, evolution, and structure and function. As your students enjoy playing *Flap to the Future*, these activities will help ensure students learn the most from this fun online game.

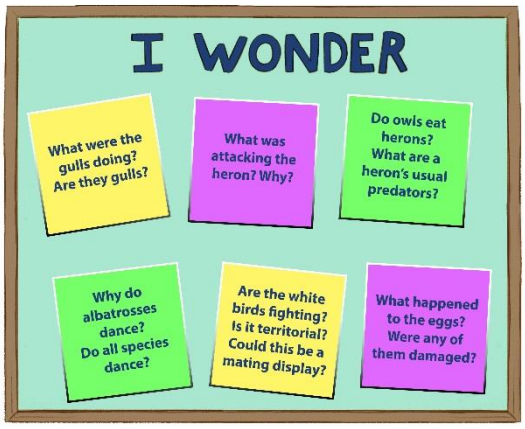
Activity	Key Science Content
1. What makes a dinosaur a bird?	Anatomical features of modern birds and their dinosaur ancestors
2. Bird flight game	Benefits and costs of flight adaptations
3. Create your own bird	Flight adaptations

Meeting Standards

Exploring Bird Evolution is aligned with the Next Generation Science Standards and English Language Arts Common Core State Standards. A Framework for K–12 Science Education (NRC, 2012) lays out the vision that students will learn about science by integrating content knowledge with experience in the practices of scientific investigation. Students should be engaged with fundamental questions about the natural world and how scientists investigate and seek answers to these questions.

Exploring Bird Evolution challenges students to analyze characteristics of modern birds and their dinosaur ancestors. Through this process, students meet science practices by constructing explanations and engaging in arguments that use developed knowledge to design a futuristic bird. Students also address crosscutting concepts like patterns, structure and function, and cause and effect as they meet disciplinary core ideas in Life Sciences. Along the way, students will also meeting the ELA Common Core State Standards. You can find specific NGSS and ELA Standards at www.birdsleuth.org/flap-to-the-future.

"I Wonder" Board



You might be surprised by how many questions will arise as students navigate *Flap to the Future*! Observation and questioning are important science practices. We want to empower kids to plan and carry out their own investigations and encourage their curiosity.

Keep track of student questions by creating an "I Wonder" board. We recommend that you make sticky notes available so kids can write their questions as they think of them and then easily affix the notes to the board. The questions can later be sorted by topic or type, creating another opportunity for learning.

The "I Wonder" Board will grow to provide a wealth of ideas that can form the basis of independent research. Students can return to questions in which they have a genuine interest. *Investigating Evidence*, also available as a free curriculum on the BirdSleuth website, will help you lead students through their scientific investigations.

Activity 1: What makes a dinosaur a bird?

Goal: Learn the defining features and structures of modern birds. Compare and contrast modern birds and their dinosaur ancestors.

Learning Objectives
Students will be able to...

- identify common characteristics of modern birds.
- compare and contrast modern birds and their prehistoric ancestors.

Time and Location: 90 minutes, indoors

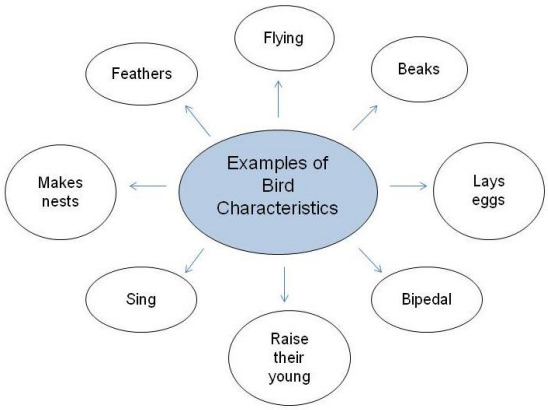
Resources Needed

- Paper and pencil
- Whiteboard and markers
- Computer lab with internet access
- Projector

Background Information
While today's birds are extremely diverse, all share characteristics such as feathers, laying eggs, and beaks. These characteristics are adaptations, physical and behavioral characteristics that improve a species' ability to survive and reproduce in its specific environment. This activity will introduce students to adaptations of modern birds and their ancestors.

Conducting the Activity

1. In groups of two or three, have students brainstorm characteristics that are common among modern birds for five minutes.
2. Regroup as a class and have students share their answers. Write the characteristics on the board. With each characteristic listed, challenge students to provide evidence that supports or rejects the characteristic as being common. On the board, write a final list of characteristics most birds have and characteristics some birds have. Ask students what single characteristic ALL birds have that makes birds unique. *(Feathers)*.



   a. Example characteristics:
      i. All birds and only birds have feathers. All birds also lay eggs, have beaks, are bipedal, and have wings, though these characteristics are not unique to only birds.
      ii. Most birds have hollow bones, can fly, make nests, raise their young, and sing. Size may also be listed as a characteristic. If it is, have students discuss how to judge the size of a bird. Is there a standard for a small bird versus a large bird?

3. Show pictures of birds that are 'different.' Examples include ostriches, kiwis, penguins, Burrowing Owls, and Toco Toucans. You can find images at www.birdsleuth.org/flap-to-the-future.
   a. Ask why these birds are different than a 'typical' modern bird. Using the class-generated list of bird characteristics, which characteristics do these birds exhibit? What characteristics do they lack? If students are unfamiliar with certain birds, have them research the unknown birds. Example responses:
      i. All of these birds have wings, but ostriches, kiwis, and penguins cannot fly.
         1. Ostriches cannot fly and are large. They have long, powerful legs that allow them to run very fast.
         2. Kiwis can't fly. Their wings and flight muscles are small and weak.
         3. Penguins cannot fly. They are powerful swimmers and dive to catch prey.
      ii. Burrowing Owls burrow in the ground rather than build a 'typical' nest in trees.
      iii. Toco Toucans have very large and colorful beaks.
   b. Discuss how these birds evolved such characteristics. For example, scientists hypothesize that a Toco Toucan's colorful beak could be a desirable trait in sexual selection, that it helps the toucan to cut fruit and prey, and that beaks play an important role in internal temperature regulation. Specifically focus on why some birds are flightless.

Lindsay Story/Macaulay Library

4. Show the students the Wall of Birds, a digital interactive based on the Cornell Lab of Ornithology mural representing the diversity of modern birds, as well as some bird ancestors. Point out that the extinct animals are gray-scaled.
5. Allow students to explore the Wall of Birds individually or in small groups for five to ten minutes. While students are browsing the wall, write the names of prehistoric animals on the board: Archaeopteryx, Tawa, Microraptor, Gastornis, Yutyrannus, Caudipteryx, Hesperornis, Ornimegalonyx, Elephant Bird, Pelagornis, Ichthyornis.
    a. Assign each group to a different prehistoric animals.
    b. Tell students to use the information and illustrations from the Wall of Birds to identify the species' defining characteristics. Students can also do additional research on other websites.
    c. Ask students to compare and contrast their prehistoric animal's defining characteristics with the class list of modern bird characteristics in a Venn diagram. Have them consider the following questions:
        i. What features does your animal share with modern birds?
        ii. If they both have a certain feature (like wings or feathers), how does that feature differ between them? *(For example, like modern birds, the Caudipteryx had wing-like appendages and feathers. However, the feathers and wings were not used for flying. Scientists believe the feathers could have been used for camouflage, warmth, or display.)* Can characteristics have multiple purposes? *(Yes! Penguins may not use their feathers to fly, but feathers are used for insulation to keep warm.)*
        iii. What features does your prehistoric animal have that modern birds do not? Why might it have these features?
        iv. Are there any behaviors, such as movements or diet, the prehistoric animals have in common with modern birds? Which behaviors are different?
    d. Using evidence from their research and discussions, have students develop an argument for why their prehistoric animal is or is not a bird. Use the following guiding questions.
        i. Does your animal have or lack key characteristics of a modern bird? Which features?
        ii. How similar is your animal to a modern bird? On a scale of 1 to 10, rank your prehistoric animal where 1 = not at all like a bird, and 10 = exactly like a bird. Justify your rating.
        iii. Call on groups to describe their prehistoric animal and explain their rating. Put an image of the animal on the board. Have the students write the name of and rating for their animal on the board.
        iv. Once all the groups have presented, have the class look at the ratings and as a class discuss the following questions:
            1. Which prehistoric animals were rated highly?
            2. What characteristics do they have in common?
            3. Do these characteristics match the class list of common characteristics?

Activity 2: Bird flight game

Goal: Learn the pros and cons of flight adaptations by playing the interactive game *Flap to the Future*.

Learning Objectives

Students will be able to...

- relate locomotion mechanisms from the game to flight adaptations.
- demonstrate understanding of the costs and benefits of certain adaptations.

Time and Location: 60 minutes, indoors

Resources Needed

- Computer lab with internet access
- Paper and pencil

Background Information

Scientists theorize that modern birds evolved from a group of dinosaurs known as theropods. These dinosaurs walked and ran on two feet, and many had feathers. The two dinosaurs in the game, Tawa and Microraptor, were theropods. It is important to remember that evolution is rarely linear. Tawa and Microraptor are likely not in modern birds' direct line of ancestry, but *were* contemporaries of very similar creatures that are. Also remember that evolution occurs gradually over many generations and millions of years, and there were many steps where certain beneficial features were passed down to offspring, thereby making those offspring more likely to survive in their environment and pass on their genes to their offspring. This process is called natural selection. Tawa, Microraptor, and indeed the American Robin are just snapshots at particular moments in the history of evolution. While the game levels may not accurately represent the gradual and subtle process of evolution, we see that the species have adaptations that help them to survive in their environment and fulfill certain functions, such as flight or pre-flight abilities.

Conducting the Activity

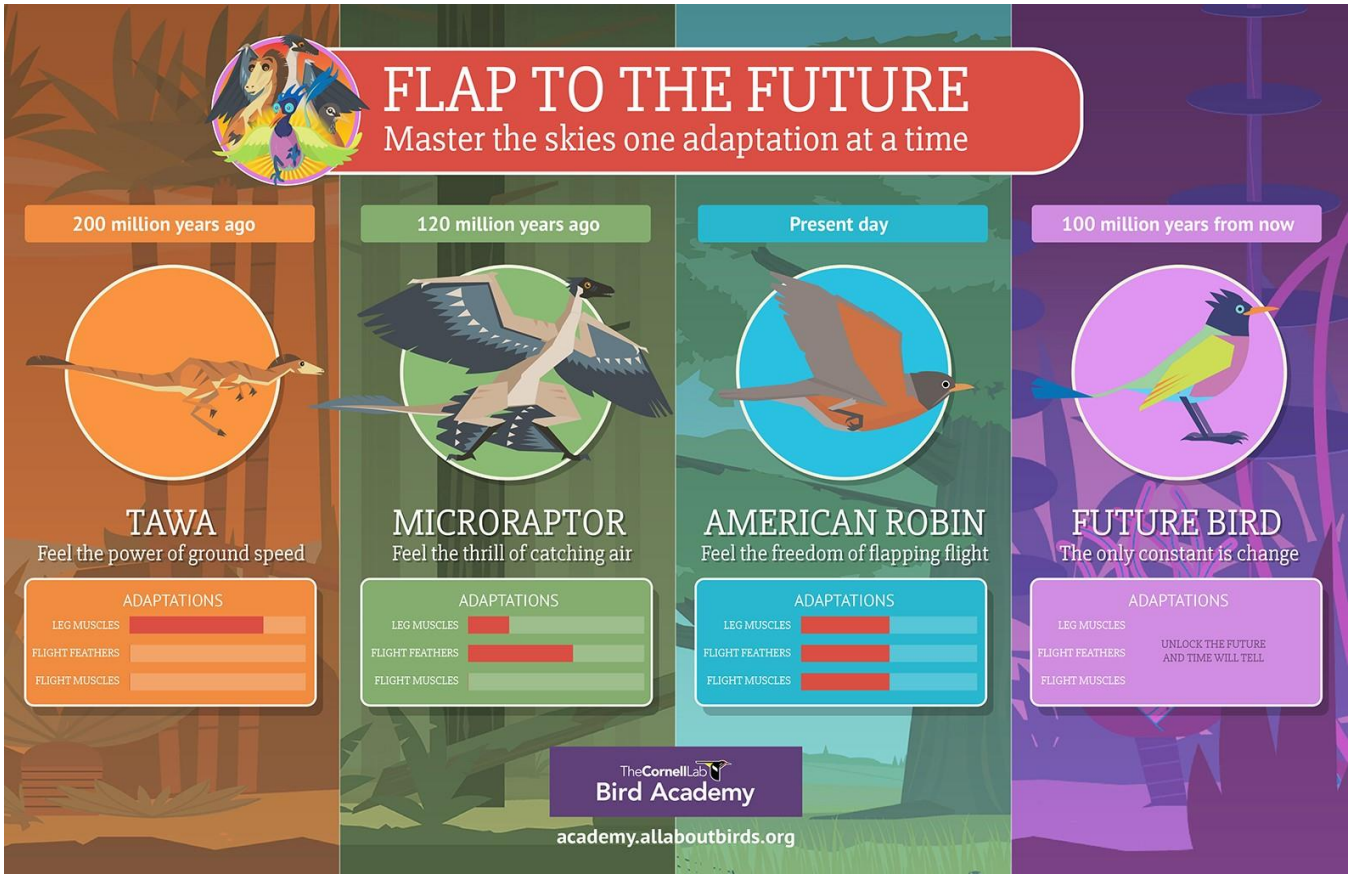
1. Let students play the *Flap to the Future* levels one through three (around twenty minutes).
2. Separate students into groups of three to read the informational paragraphs that appear on the launch page. Then tell them to launch the game and look at each of the adaptation strength charts on the Level Select pages. Students should take notes on the following questions.
    a. How did the species' anatomical adaptations (muscles, size, feathers, appendages, etc.) affect their skill types and levels? Example answers:
        i. The small size of the American Robin and its strong flight muscles (relative to its body) allow it to fly.

   ii. The leg muscles in the Tawa help it to run quickly.
   iii. The feathers of the Microraptor help it to glide, but it does not have the flight muscles to actually fly.

b. How are anatomical structures similar between the three species? How are they different?
   i. All the animals are bipedal, so they run/walk on two feet.
   ii. The Microraptor and American Robin have wings and flight feathers, while the Tawa has small arms and 'dino fuzz.'
   iii. The Microraptor has feathers on all its appendages, but robins do not.

c. What are the advantages and disadvantages of each of their features?
   i. The wings of the Microraptor allow it to glide around the branches of tall trees, but its inability to fly makes it hard to navigate dense areas.
   ii. The flying or gliding ability of the Microraptor and American Robin allows them to escape predators/dangerous structures and find food in trees.

3. In preparation for activity three, allow students to play the final level of the game and experiment with creating different futuristic birds. Have students brainstorm and discuss how certain features and adaptations affect the futuristic bird.



[Download this poster by Bird Academy.]

Activity 3: Create your own bird

Goal: Use and apply knowledge of adaptations to create a future bird that is well-suited for a specific habitat.

Learning Objectives

Students will be able to...

- think critically about the functional advantages and disadvantages of certain anatomical structures.
- apply knowledge of adaptations, functionality, and fitness by creating a futuristic bird.
- explain how certain adaptations increase an organism's fitness in a specific environment.

Time and Location: 40 minutes, indoors

Resources Needed

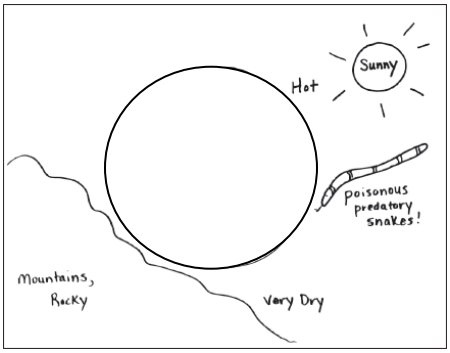
- Paper
- Colored pencils

Background Information

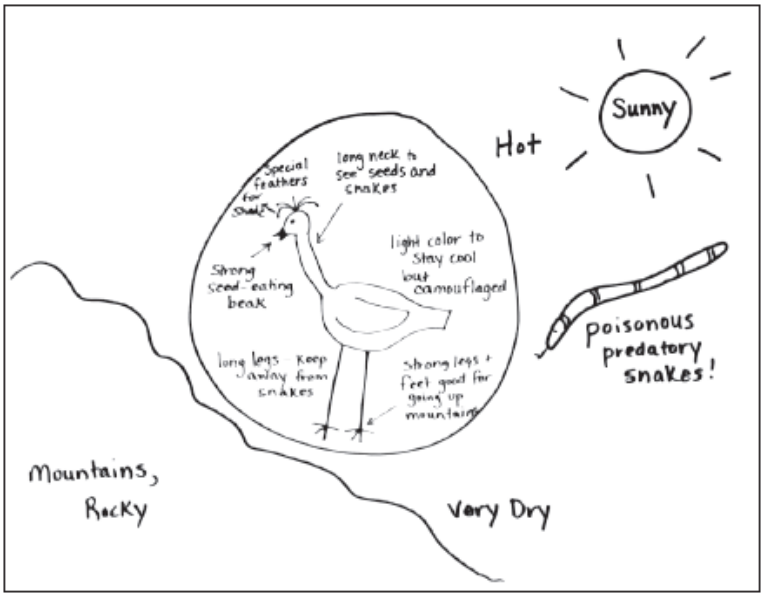
The Earth's surface and climate have always been changing. Plants and animals continuously evolve over time or go extinct in response to changing habitats. In millions of years, our planet and its lifeforms will be very different from today's world. In this activity, students will create a future habitat and a bird that is adapted to that environment.

Conducting the Activity

1. In groups of three, give students 15 minutes to create a habitat that they think will exist in 10,000, 20,000, or even 100,000 years. The habitat may be drastically or subtly different from today's habitats.
    a. When creating the habitat, students should consider climate (temperature, precipitation, humidity, seasonality, availability of light etc.), plant types, predators, food sources, places for shelter, and landforms (mountains, bodies of water).
    b. Students should make a list of the habitat characteristics.
2. On a sheet of white paper, have students draw a circle with a diameter of 6 inches in the middle. Around the circle, students will draw and label the features of their futuristic habitat and write any information that cannot explicitly be illustrated.



3. Once the students are finished, collect and randomly redistribute the futuristic habitats. Have students assess the new habitat and design a bird, or bird-like animal, which would be able to successfully survive in this environment. Have them reflect on the types of adaptations from the second activity, as well as the common bird characteristics from the first activity. Encourage them to consider the following questions:
    a. What does the bird need to survive in your habitat? (Food, water, cover, etc.)
    b. What adaptations would allow the bird to survive?
4. Once students are finished brainstorming, have them draw the bird in the circle and label its adaptations.
5. Have students present their work by describing the environment and their bird. Students should explain why the bird's adaptations allow it to survive in its environment.
    a. Students can take questions or suggestions from their classmates about how to improve the bird.
    b. Go further and have students write a story describing the life of their futuristic bird in its habitat.



Glossary

- **Adaptation**: a functional physical or behavioral trait that allows an organism to better survive and reproduce in its habitat, and that also can be passed on from parent to offspring.
- **Fitness**: an organism's ability to survive and pass on its genes in its environment.
- **Functionality**: the beneficial purpose of a physical or behavioral trait.
- **Microraptor**: a theropod dinosaur from the Early Cretaceous with wings, feathers, and the ability to glide, but not the necessary flight muscles to lift its body.
- **Natural selection**: an evolutionary theory stating organisms that are best adapted to their environment are able to pass on their genes to future generations. This gradually changes the gene pool of the population, therefore changing species over time.
- **Theropods**: a group of carnivorous, bipedal dinosaurs that are ancestors of modern birds.
- **Tawa**: a small, flightless theropod from the Late Triassic period.