Where Nature Meets Learning

BIRDS: WINGED WONDERS

Unit 3:
Birds: Winged Wonders

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Table of Contents

UNIT 3

BIRDS: WINGED WONDERS

"Hope is the thing with feathers" - Emily Dickenson

Deep in the forest, in the fork of two thin branches, a nest made of dry leaves and palm fibers holds two small eggs. Early one morning, above the chirping of insects and the soft plinking of an unexpected drizzle, the female **blue-crowned manakin** hears a quiet cracking. She stands and peers into her nest. The eggs are moving and one is **pipping**! It has a tiny crack near its tip. As she watches her nest closely, wary of any signs of predators, she can see the tiny beak of one of her nestlings slowly breaking its way out of the egg. Above her, she hears a loud commotion. Leaves are shaking, and branches are bending. Her small eyes search the trees above her. Then, suddenly, a loud howl echoes through the forest, followed by several more. There is a troop of **howler monkeys** traveling through the trees. She watches as they use their **prehensile** tails to grip onto branches as they search for just the right leaves to feed upon. These monkeys are not a threat to her young.

World of Birds

Bird Basics

If you were to throw a dart at the map of the world, chances are it would land in a place where birds of one kind or another can be found. From the searing, arid sands of the Sahara Desert in northern Africa, to the ice and snow-covered terrain of Antarctica - the coldest place on Earth; from Cherrapunji, India which receives over 1,150 meters of rainfall annually, to the desert grasslands of North America, our feathered friends are surviving and thriving in diverse climates on EVERY continent of the world.

Birds can also be found soaring, migrating, and foraging above the world's oceans and seas. From remote jungles to the most populous cities these sometimes rugged, sometimes fragile avian wonders continue to go about their daily lives while managing to inspire artists, poets and nature lovers who are captivated by their beauty, their song, and their powers of flight.

This unit is intended to stir your curiosity and wonder about these amazing creatures. One could (and many have) fill volumes of books about the habits and biolo-

gy of birds. To learn more, check the online references at the end of this unit, visit your local library, or even better, get out there and watch birds. Until then, happy reading!

Scientists believe that birds descended from dinosaurs, and specifically, the **theropods**, which included the well-known *Velociraptor* and *Tyrannusaurus rex*. The first known bird, *Archaeopteryx*, lived in what is now Europe between 213 and 144 million years ago. Since then, birds have continued to **evolve** and now they have many important characteristics such as feathers, toothless beaks, hollow bones, and the ability to fly. Today, there are around 10,000 species of birds worldwide and some scientists believe that between 50 billion and 428 billion individual birds are alive at any given time. That's a lot of birds!

You might be wondering how all of these individuals manage to survive, find enough food, and mate. While birds share many common characteristics, each species has adapted to fit into its own niche, or habitat.

For example, the **wandering albatross**, a **pelagic** species, meaning it spends all or most of its life at sea, can spend hours or even days soaring above vast, watery landscapes. In fact, this bird spends most of its life in flight and only lands to feed on fish, squid, and other small marine life, and to breed. Other species of birds, like the kiwis of New Zealand, are not able to fly at all. They are **nocturnal** (or active at night) and use their long beaks, equipped with nostrils at the tip, to locate and feed on small insects and worms.

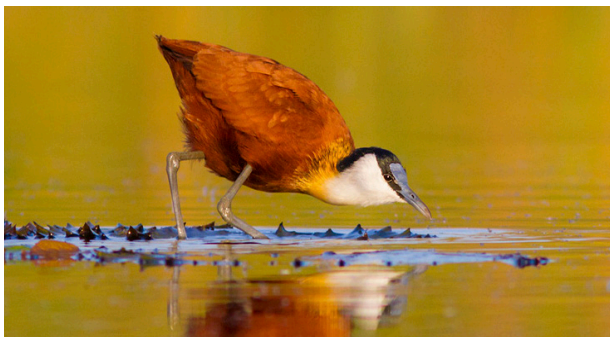
Some birds have formed **mutualistic relationships** with other wildlife or plants. The oxpeckers are a good illustration of this. These small birds, found in sub-Saharan Africa, survive by gleaning insects, namely ticks and other parasites, from the grateful

backs of cape buffalo, giraffes and other large mammals.

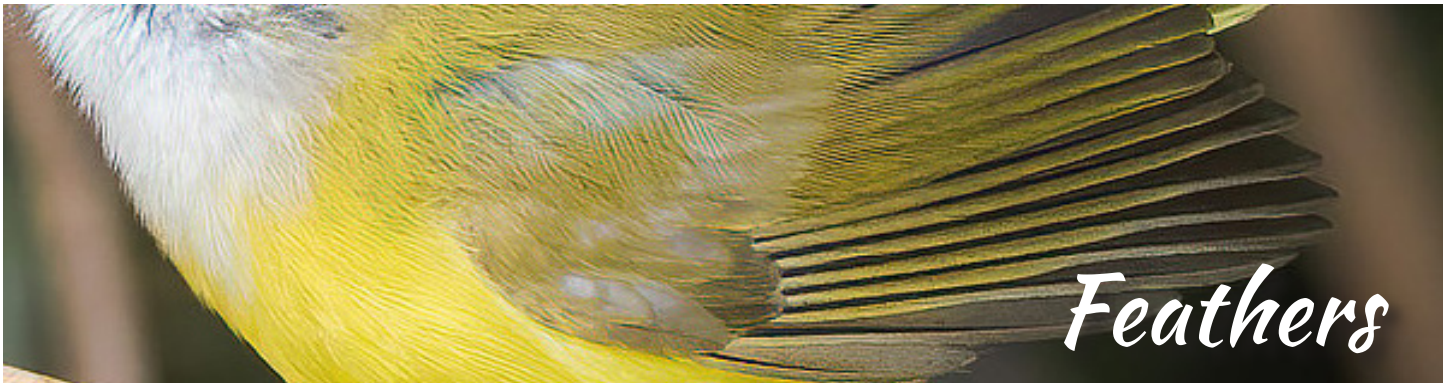
Variation in diet, size, wing shape, beaks, and feet all help birds survive in their own unique way within a variety of environments. Despite these differences, birds have many features in common which help to make them one of the most fascinating and interesting groups of wildlife on the planet.

Sum of Their Parts

Close your eyes and imagine a bird - any bird. What are the first things that come to mind? Perhaps you thought first of its soft feathers or bright colors, or you imagined it soaring through the skies in graceful flight. Did you imagine it perched on a branch beliting out a melodious call? Maybe you even pictured it hopping through the grass in search of insects. Perhaps the image of a nest popped into your head.



Though those might have been the first images in your mind, there are other fascinating parts of a bird that we don't see. Their light skeletons, unique digestive system, or even their heart and lungs all have special **adaptations**. Bird anatomy is fascinating! We are going to take a closer look at the inner and outer workings of birds - those physical adaptations that have helped them survive for millions of years. Let's start with the one thing all birds have in common.



Feathers

Feathers are the only feature that every bird in the world shares and that no other living animal has. When you first think of a feather, what comes to mind? Of course, you likely know that it is feathers that help birds fly. But, there are other animals that can fly, including insects and bats. However, they lack this special feature that helps make birds so unique. Feathers are strong, light, warm, and flexible. In addition to aiding in flight, they also provide insulation, protective coloration (such as **camouflage**), and play a part in mating and other behavioral rituals.

Feathers are made up of **keratin** (the same material as reptile's scales and our hair and fingernails). They grow from tiny follicles of a bird's skin and cover most of its body. Though some dinosaurs also had feathers, today, birds are the only living animals that have them. While feather might appear simple at first, they are actually quite complex and are made up of over 1 million parts.

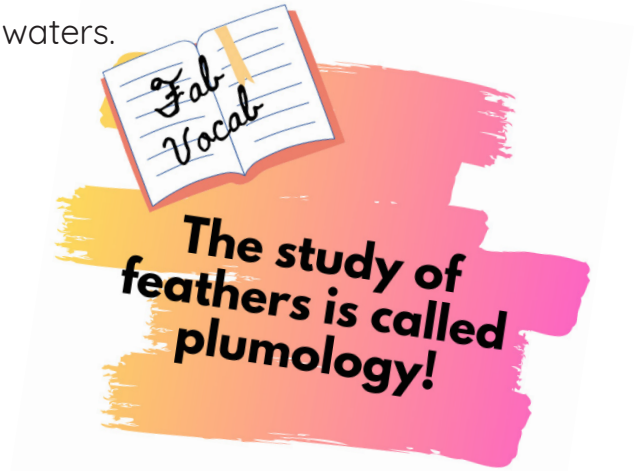
However, the basic design is as follows: feathers have a hollow central tube called the shaft (or **rachis**) which helps give the feather its shape and form. On either side of the shaft are small projections called **barbs**, which together form **vanes** - or the surface of the feather. If you were to examine these barbs even closer, you would see they are made up of smaller, interlocking **barbules** that have tiny hooks on one side. When a bird **preens** its feathers, these barbules hook together, similar to how Velcro works. This helps the feather keep its shape. Owl flight feathers lack barbules along the edges. This gives their feathers a fringed appearance and allows them to fly silently.

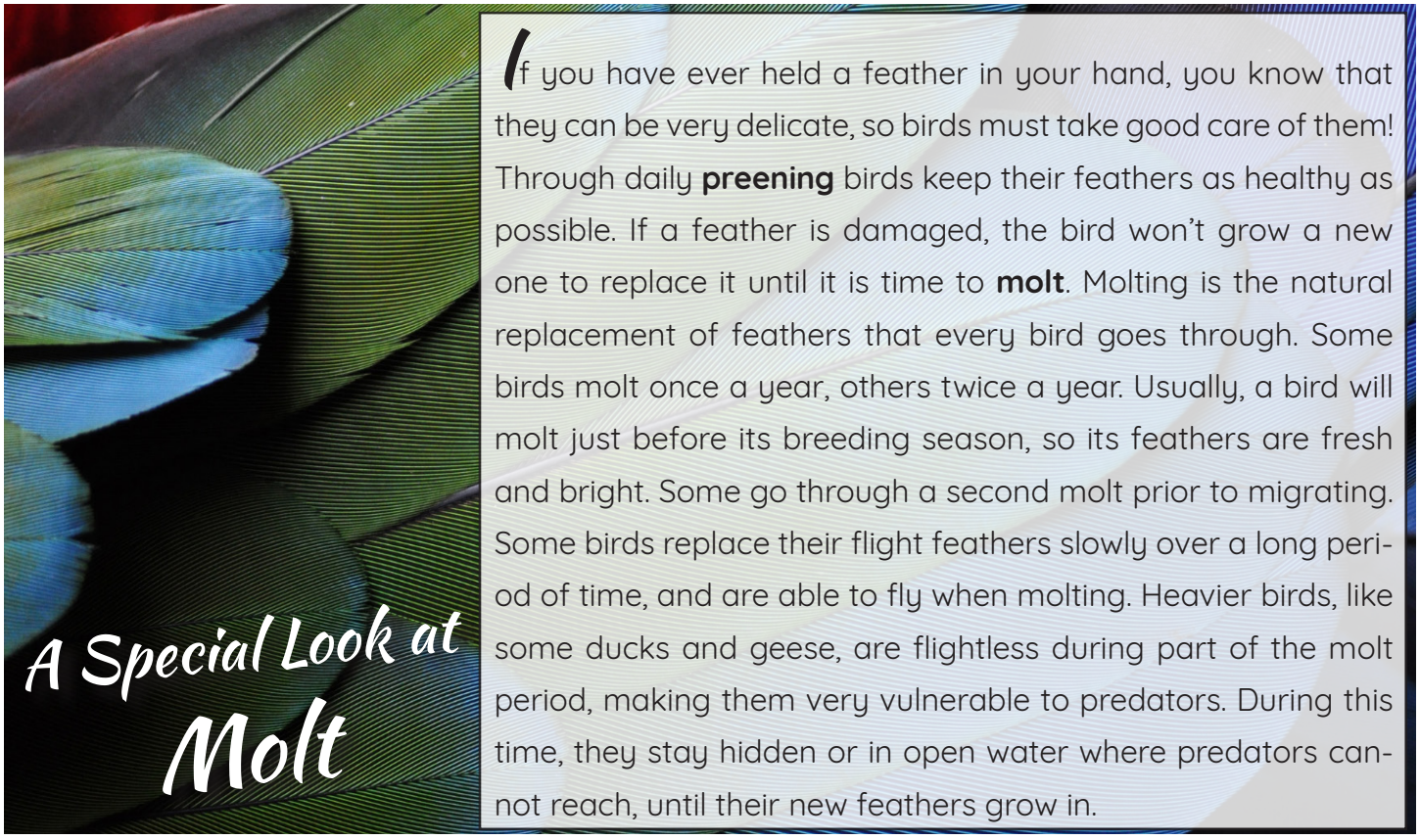
There are several different types of feathers. **Contour feathers** are visible and cover the bird's body, and include the flight feathers found on the wings and tail. **Down feathers** and **semiplumes** are smaller feathers which are found beneath the contour feathers and help insulate the bird. **Bristle feathers** are hairlike and are usually found around the bird's eyes, beaks, or nostrils. They sometimes serve as sensory elements, and filters for assisting with feeding. **Filoplumes** are whiskery feathers that are mixed in with the contour and down feathers all over a bird's

body. These feathers help the bird sense touch, position the flight feathers, and possibly even determine airspeed!

Feathers help birds in flight, in **thermoregulation**, and waterproofing (which we'll learn more about in a bit). Feathers also help birds communicate and evade danger. Some species have a crest of feathers on their heads, including **harpy eagle**, **royal flycatcher**, **Steller's jay**, and **sulphur-crested cockatoo**. Many birds with crests can raise and lower them to help them communicate. Feathers contain **pigments** and structural features that give birds their colors, making them among the most colorful of all vertebrates.

So, if all birds have feathers, and contour feathers help birds in flight, why is it that some birds can fly and others can't. What is the difference? Many flightless birds, such as **emus** and **penguins** can't fly because, simply put, they are just too heavy. But they too have feathers. Feathers in flightless birds are even more modified to meet the demands of life on land or in water. For example, a penguin's feathers are short and densely packed over its body, helping the penguin to swim efficiently and be well-insulated in frigid Antarctic waters.





If you have ever held a feather in your hand, you know that they can be very delicate, so birds must take good care of them! Through daily **preening** birds keep their feathers as healthy as possible. If a feather is damaged, the bird won't grow a new one to replace it until it is time to **molt**. Molting is the natural replacement of feathers that every bird goes through. Some birds molt once a year, others twice a year. Usually, a bird will molt just before its breeding season, so its feathers are fresh and bright. Some go through a second molt prior to migrating. Some birds replace their flight feathers slowly over a long period of time, and are able to fly when molting. Heavier birds, like some ducks and geese, are flightless during part of the molt period, making them very vulnerable to predators. During this time, they stay hidden or in open water where predators cannot reach, until their new feathers grow in.

Beaks

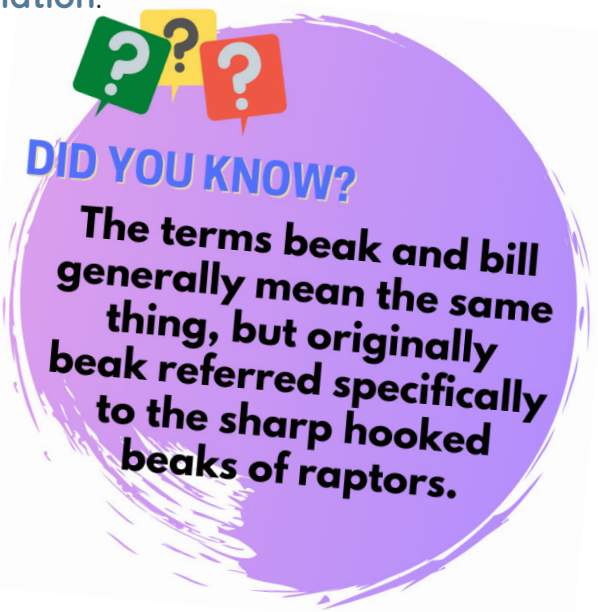
Birds do not have teeth. Their upper and lower mandibles (or jaws) are called beaks or bills. By observing a bird's beak, it is often possible to tell what a bird eats. The hooked, curved beaks of raptors indicate that they eat meat. Large, strong beaks of toucans, hornbills, and parrots are designed for eating fruit, seeds, and nuts. The long, thin bills of hummingbirds, honeycreepers, and sunbirds are designed perfectly for feeding on flower nectar. Read on to learn more about the incredible form and function of birds' beaks.

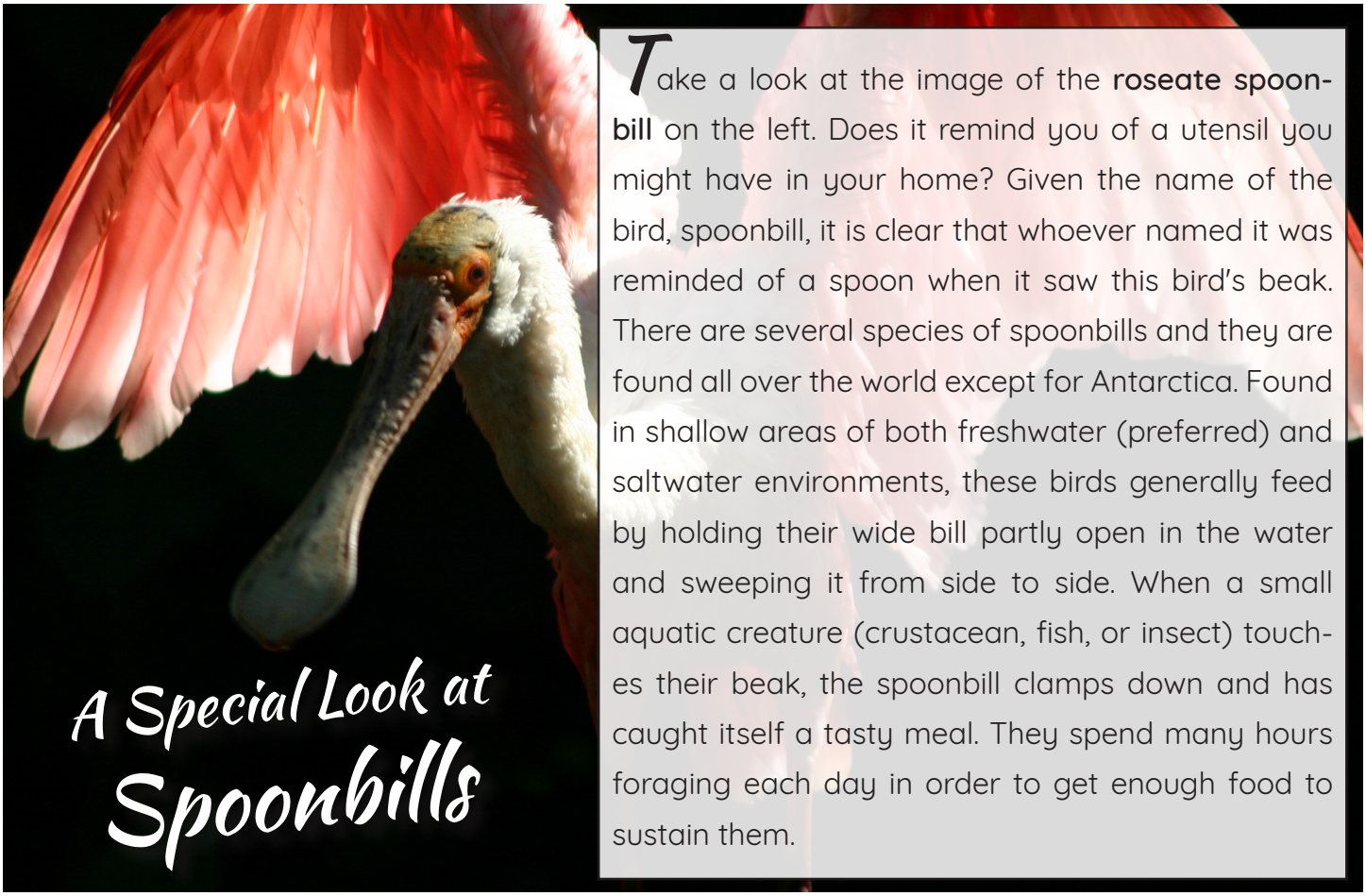
Think about it - a vast majority of animals on Earth that have teeth do not fly. Teeth, and the heavy jaw structure needed to support them, add significant weight to an animal. Beaks, on the other hand, are lightweight yet strong, effectively reducing the overall body weight of the bird. Having a beak is actually one of the main characteristics of a bird that contributes to its ability to fly. Since birds do not have teeth, they use their muscular gizzard to essentially "chew" their food. We'll learn more about this further into this unit.

Birds can do pretty amazing things with their beaks. Right from hatching, a baby bird uses its beak, along with a special "egg tooth" that forms on the upper surface of the beak, to crack and hatch out of the tough egg shell. As we already noted, a bird's beak is used primarily in feeding, and each bird's beak is amazingly adapted to feed in different ways and to eat different things. Some birds, such as woodcocks and snipes, have rather flexible beak tips for probing into mudflats and foraging for invertebrates. Some birds

are adapted to eat a wide variety of items, while others, like the **snail kite**, with its long, thin, deeply curved bill, has adapted to eat the apple snails almost exclusively. Whether skimming, seining, scooping, drilling, digging or diving, each bird's beak is adapted specifically to fit its own feeding and habitat needs.

A bird's nostrils are also found on its beak. The nostrils of some birds, such as gannets and pelicans, are adapted for diving into water at high speeds. Some birds, such as ducks and hornbills, have unusual knobs or casques on their upper mandibles. These odd bill structures, which are most developed in adult males of those species, are thought to signal sexual maturity. During breeding season, a fibrous plate forms on the top of the bills of **American white pelicans**. This plate is shed after the mating season is over. Some birds, such as toucans, use their bills and its network of capillaries found inside for **thermoregulation**.

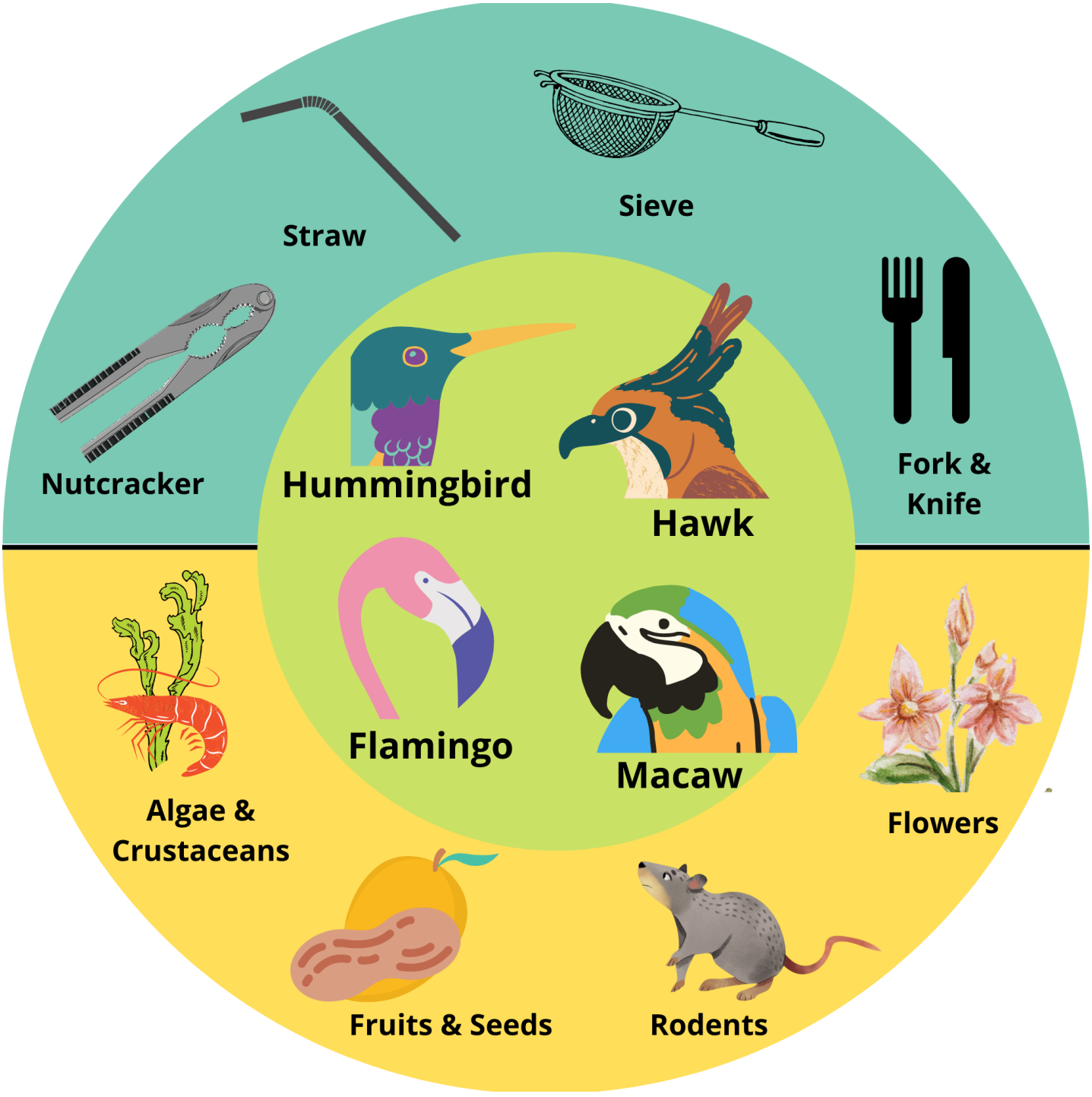




Take a look at the image of the **roseate spoonbill** on the left. Does it remind you of a utensil you might have in your home? Given the name of the bird, spoonbill, it is clear that whoever named it was reminded of a spoon when it saw this bird's beak. There are several species of spoonbills and they are found all over the world except for Antarctica. Found in shallow areas of both freshwater (preferred) and saltwater environments, these birds generally feed by holding their wide bill partly open in the water and sweeping it from side to side. When a small aquatic creature (crustacean, fish, or insect) touches their beak, the spoonbill clamps down and has caught itself a tasty meal. They spend many hours foraging each day in order to get enough food to sustain them.

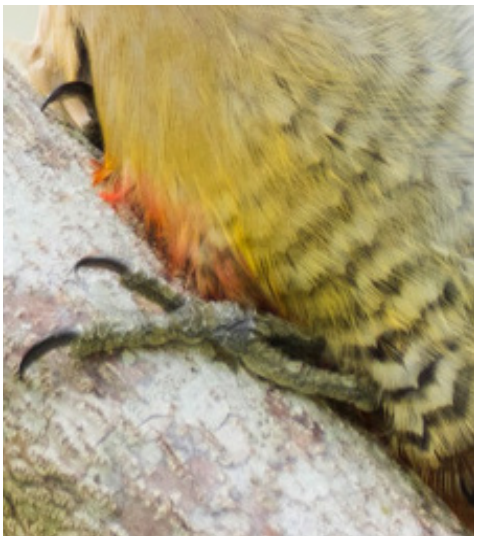
Brain BUSTER

Many bird beaks have the same function as many of the utensiles we use in our homes. We use sieves to drain water from pasta, a knife and fork to cut meat, a nutcracker to break open hard nut shells, and straws to drink from. Take a look at the bird beaks below. Can you match the beak to the utensil that works in a similar way, and identify what each bird eats?

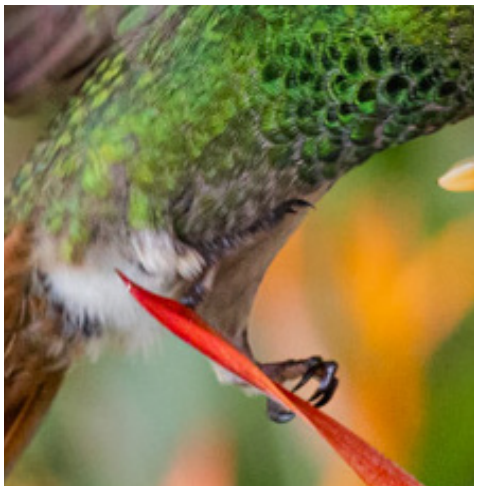


Feet

All birds have front limbs, or wings, and hind limbs - legs and feet. A bird's legs and feet, combined with their beaks, are very important features necessary for survival and they differ greatly among species and types of birds. Long or short, curved talons or straight nails, toes that face forward or backward, feet that are wide or narrow, toes that are webbed, lobed, or unwebbed, are all differences that help each bird to successfully live within its niche. Legs and feet may be designed and used for swimming, perching, hunting, or walking, and much more!



As you now know, raptors, or birds of prey, have hooked beaks with sharp edges that allow them to cut their food. However, they also have strong toes and sharp, curved talons adapted to swiftly capture and kill their prey. This combination allows them to efficiently hunt as top predators in their ecosystem. Ducks, on the other hand, have webbed feet that help them glide seemingly effortlessly through the water and flat bills for feeding on aquatic plants and insects. Woodpeckers have long, strong bills designed to drill holes in wood and search for insects hiding within and feet designed for climbing and clinging vertically to trees.



Think about how you walk. Humans have a broad foot with a flat bottom ideal for walking and running, and they support us standing upright. But take a closer look at a bird's foot: a bird actually walks on its toes! Can you imagine walking on your toes all the time? The way we get around might look a little different, and our toes might look a little different as well.

A bird's toes, foot, and lower leg are covered in scales made up of **keratin** (just like feathers and fingernails). These hard scales, similar to those of lizards and crocodiles, protect the bird's legs and feet. Most birds have four toes, but many have only three, and ostriches have only two.

Depending on how a bird uses its feet (walking, perching, clinging, or swimming), the toe arrangement can vary from bird to bird. For example, most songbirds that perch on small branches have three toes pointing forward and one toe pointing backward. Woodpeckers and parrots use their feet for clinging and climbing, and have two toes pointing forward and two toes pointing backward. Birds that swim often have skin (webbing) between each of their toes that act as a paddle to help them move in water.

Owls and osprey are actually able to change the positon of their toes, depending on what they are doing. They will sometimes have three toes in front and one facing backward. Other times, they move their outer toe so that two are facing forward and the other two are facing backward.

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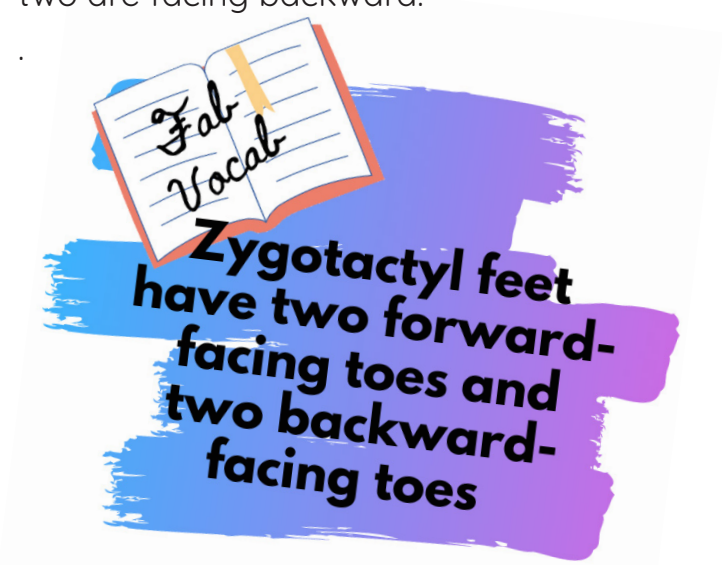
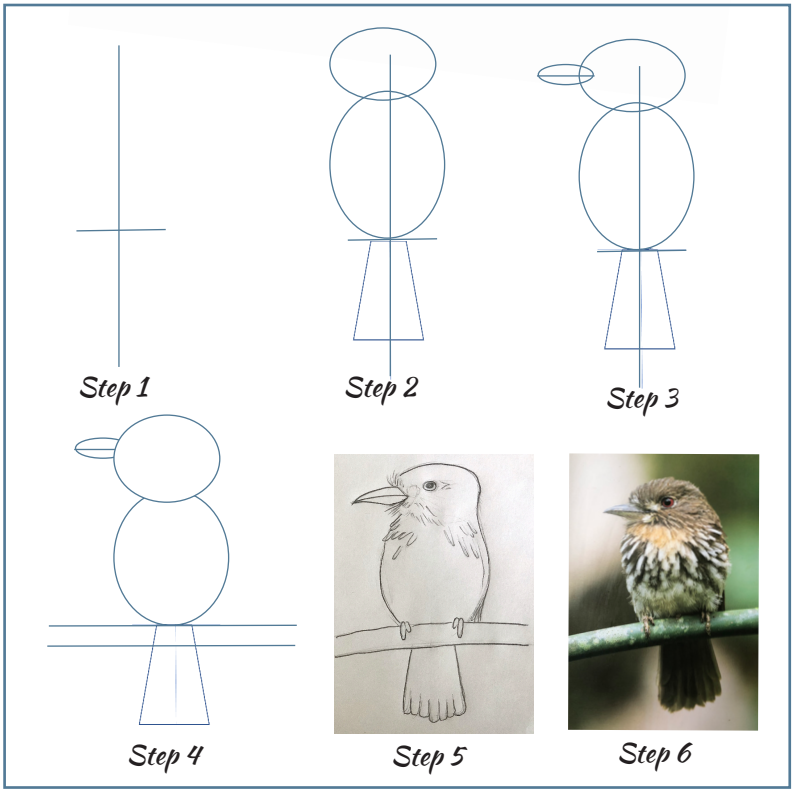


You are starting to understand how birds have adapted to live in some challenging environments. We can find them living in very dry deserts, extremely high altitudes, dark caves, even in icy conditions and large cities. But, birds are absent from many other "extreme" habitats on Earth. Can you think of any? What about inside a volcano? Or deep on the ocean floor? Take a moment to imagine a bird living in one of those places - or any other you can think of. How would it adapt to survive? What would it eat? What would it look like? Draw your unique bird in a notebook or on a piece of paper. You can practice drawing a bird by following the directions in the box to the right.



Wings

Wide or narrow, tapered or rectangular, wings are one of the most important features of a bird. Of course, birds aren't the only animals with wings, but they are some of the best fliers around! But remember, wings aren't just used for flight. They can be used for swimming, for balance, to keep their young cool or dry, to hide their food from scavengers, or even to scare away potential predators. Some birds even make noises with their wngs to attract a mate or for elaborate courtship displays.

When we think about wings, we often think about their size and shape. But did you know that when it comes to flght, even the color of a bird's wings matters! For a long time, scientists and bird watchers have known that many birds that spend a lot of time soaring, especially those that do so over water, tend to have dark wings, or dark wing tips. Recent research has shown that darker feathers absorb more heat. This helps the birds fly more efficiently - longer and faster! The **melanin** found in darker feathers also makes them more resilient, allowing them to withstand wear and tear so they don't break as easily.

Some bird species have some unique behavioral and physical adaptations relating to their wings. Hoatzins are the only living birds in which the young have claws on their wings, much like that of *Archaeopteryx*. Because these birds spend a lot of time near water and can be quite clumsy, these claws

come in handy should they fall in. The young birds can use the claws to quickly climb onto low branches as a quick way to get away from aquatic predators.

Birds-of-paradise, found in parts of Papua New Guinea and Australia, are masters at using their wings while performing elaborate courtship dances. They are able to almost completely transform their bodies into different shapes and flashes of colors just by moving their wings. They also make otherworldly sounds - snaps, whooshes, and whistles - all by maneuvering their wing feathers.

Some herons, including the **black heron**, which is also known as an "umbrella-making bird" have learned to use their wings to help them hunt food. These herons open their wings, spread and curl them around over the water to create shade. The shade created by the heron's wings attracts fish and other critters, which all make a tasty meal for this clever bird.

A bird's wingspan is the length of its oustretched wings from one tip to the other. The bird with the longest wingspan is the **wandering albatross**, at 3.7 m (12 feet)! The record for the shortest wingspan goes to the **bee hummingbird**, at only 5.5 cm (2.1 inches). This is just slightly longer than an adult human's thumb!

Inner Workings of Birds

Some of the most fascinating things about birds pertain to parts of them we cannot even see. Birds are warm-blooded vertebrates with unique adaptations that help them fly, swim, breathe, forage, ingest water, and digest food more efficiently. Read on to learn more about some of the amazing adaptations our feathered friends around the world have in order to survive and thrive in all types of habitats.

Skeleton

The fundamental characteristic of all **vertebrates** is a backbone or spinal column. In fact, we can learn a lot by looking at the entire skeleton of any animal. You may recall that birds are **endotherms** like mammals. However, the skeletons of these two groups of animals are quite different from each other. You can imagine that the skeleton of a bird must have some unique characteristics and modifications. Birds have developed a strong yet lightweight skeleton essential to withstand the forces of flight through the reduction and fusion of various bones.

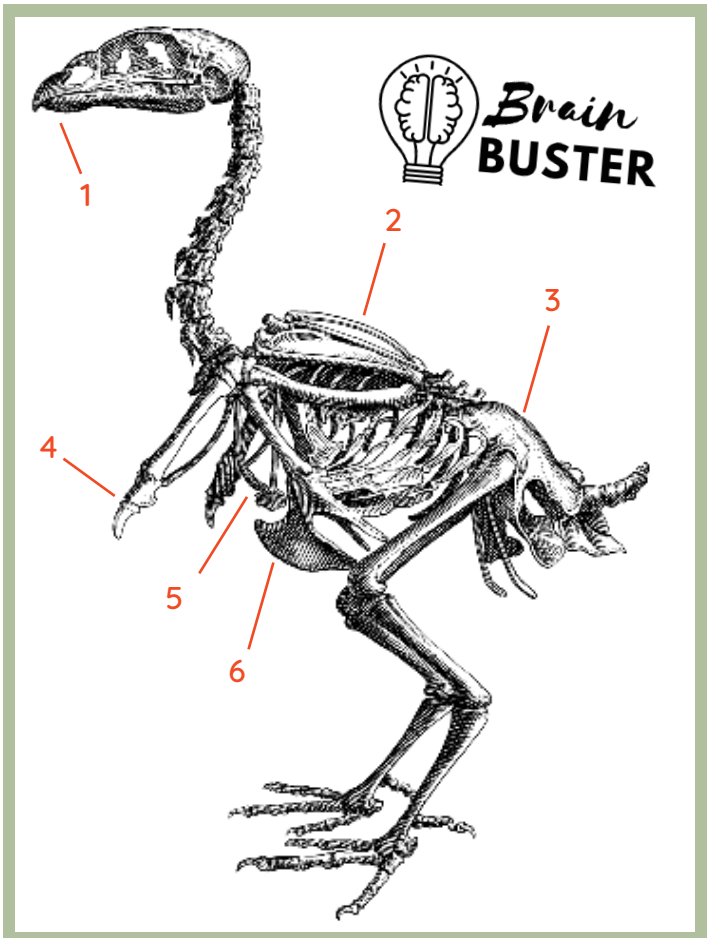
Furthermore, many bird bones are hollow and filled with air spaces to work in conjunction with their respiratory system. When looking at a bird skeleton, you may notice how it bears a resemblance to the upright **theropod** dinosaurs. You may recall that they had hollow bones, just like our modern birds.

All the major bones of a bird's pelvis have fused to create an efficient platform for muscle attachment, called a **synsacrum**. Some of their **vertebrae** are fused to form a rigid structure. The forelimbs of a bird are heavily modified as wings. As birds evolved, the bones in the hand area fused to support the primary flight feathers, called the **carpometacarpus**. The first three digits (fingers) have been fused and reduced and the fourth and fifth lost entirely. The humerus (upper arm bone) is shortened to withstand the forces of the flight muscles. Likewise, we see

the fusion and reduction of bones in a bird's skull, vertebrae, and in some of the leg and foot bones.

A bird's huge **sternum** (or breastbone) is perhaps the most obvious modification they have as an adaptation for flight. This rigid platform supports the flight muscles. Their shoulder bones have been further modified by fusing the clavicles into what is called the **furcula** or "wishbone." It allows for flexion (bending) during flight.

As we have mentioned, one of the main defining features of a bird, and one that helps keep it lightweight, is the loss of teeth. Teeth require heavy jaw bones to support them, and by evolving a **beak**, there is no longer a need for a heavy jaw structure. Birds have also lost the long bony tail of their ancestors, reducing their weight even more. But birds are highly diverse, and come in all different shapes and sizes. Well, a bird's skeleton does, too! Depending on the bird and its lifestyle, the skeleton of different birds have further modifications. Some flightless birds, such as ostriches, have reduced sternums and their wing bones are almost non-existent! Obviously they do not need these important skeletal components necessary for flight. On the other hand, their leg bones are long and strong, as they are fast runners. A bird skeleton's form is intrinsically linked with its function and gives every species of bird the interior support they need to fill their niche.



Take a look at the image of the bird skeleton above. Can you identify the main features that help make a bird skeleton lightweight? Match the terms bolded in black in this section, with the numbered arrows in the diagram. Fill them in here or in a notebook. Can you find any others?

1. _____ 4. _____

2. _____ 5. _____

3. _____ 6. _____

Others: _____

_____

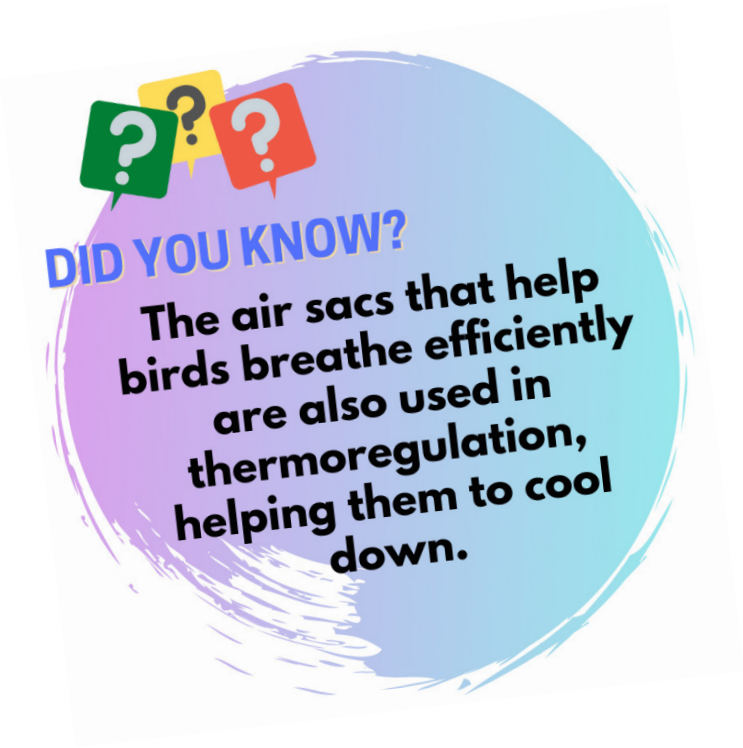
_____

_____

Respiratory System

Think about it: birds are very active animals. They are almost always on the move in order to forage for food, fly, swim, and migrate. You probably won't be surprised to learn that birds have the most efficient respiratory system of all animals. They have very high oxygen intake to meet their metabolic demands. How do they do it? In addition to having lungs, birds are equipped with **air sacs**, another feature that is unique to birds and that no other animals have.

The air sacs are considered extensions of a bird's lungs. They allow for continuous airflow, helping birds breathe more efficiently. This can come in handy, especially during long flights. If you take a mouse and a sparrow and expose them to the air at about 5,700 meters elevation, the mouse would be unconscious, but the sparrow would appear unaffected by the lack of oxygen at this altitude, and even be able to fly!

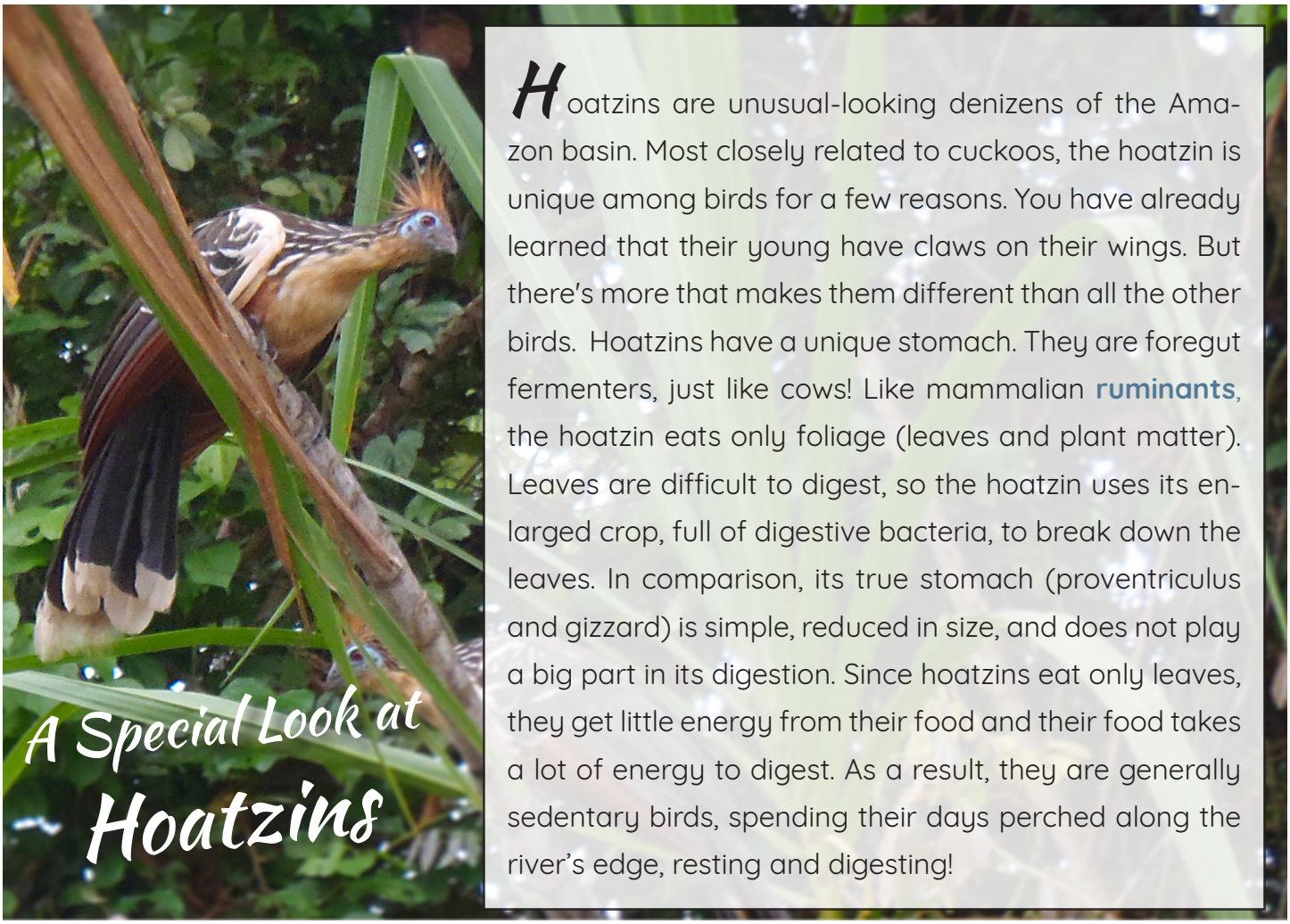


Digestive System

If you have ever watched a songbird forage, you probably noted that it ate A LOT and OFTEN! Birds have very high demands when it comes to their **metabolism**, and they need to fuel their high energy bodies day in and day out. A bird's digestive system is quite distinct compared to that of a mammal, for example. It is, as you can imagine, faster and more efficient!

When a bird eats, the food enters its mouth and travels down the bird's **esophagus**, more or less the same way as in humans and other mammals. But here's where the similarities end. Generally, when a bird eats, the food will often make a first stop in its **crop**, where food is temporarily stored. This allows it to eat a lot of food quickly. The bird will then fly off and digest its food in a safe place. Some birds, such as owls, do not have crops.

A bird's stomach is quite advanced and divided into two sections: the **proventriculus**, where digestive enzymes start to break down the food, and the **gizzard**, a muscular stomach for grinding food. Since birds don't



A Special Look at Hoatzins

Hoatzins are unusual-looking denizens of the Amazon basin. Most closely related to cuckoos, the hoatzin is unique among birds for a few reasons. You have already learned that their young have claws on their wings. But there's more that makes them different than all the other birds. Hoatzins have a unique stomach. They are foregut fermenters, just like cows! Like mammalian **ruminants**, the hoatzin eats only foliage (leaves and plant matter). Leaves are difficult to digest, so the hoatzin uses its enlarged crop, full of digestive bacteria, to break down the leaves. In comparison, its true stomach (proventriculus and gizzard) is simple, reduced in size, and does not play a big part in its digestion. Since hoatzins eat only leaves, they get little energy from their food and their food takes a lot of energy to digest. As a result, they are generally sedentary birds, spending their days perched along the river's edge, resting and digesting!

have teeth, the gizzard is where food is broken down into smaller parts.

After being broken down, the food will continue into the bird's simple **small intestine** where it will be digested and absorbed. Depending on what the bird is eating (seeds, meat), the small intestine can be long or short. The **large intestine** is quite reduced compared to mammals.

One of the most obvious differences between mammals and birds has to do with their poop! Almost anyone who has ever seen a bird, has also seen bird poop! Though we call it poop, it is actually something very different. All of a bird's wastes (uric acid, feces) gather in the **cloaca** where they are often dried out and packaged into a compact excretion with a paste-like texture. This waste then exits through the **vent**.

Oil Gland

Since we already learned about feathers, it is important that we also learn about a bird's oil gland. You might be wondering what oil has to do with feathers and why birds would have a gland that secretes oils. The oil gland is found right above their tail. It is called a **uropygial gland** or preen gland. It secretes oils, fatty acids, and waxes, everything a bird needs for cleaning, arranging, and waterproofing its feathers. The bird is able to reach this spot with its beak, take up a bit of oil and spread it through their feathers. This helps keep the feathers clean and dry.

If you have heard the expression "like water off a duck's back" you will know what we are talking about. Having oil on a bird's feathers helps to repel water - just like a raincoat. Some birds, including the flightless emu and ostriches, as well as some pigeons, doves, and parrots, lack an oil gland, and instead use special powder down feathers and take dust baths to keep themselves in tip-top condition.

Try it yourself

As you just learned, birds waterproof their feather with oil. Do this simple experiment below to see for yourself that water doesn't mix with oil. Write your observations in a notebook.

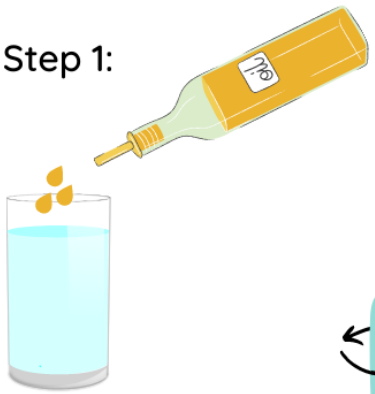
What You'll Need

a cup of water 5-10 drops of oil

mixing spoon

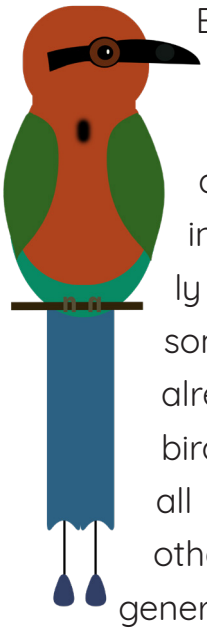
What You'll Do

Step 1:



Step 2:

Amazing Physical Adaptations



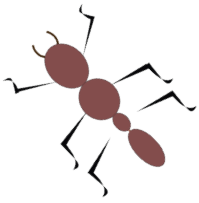
By studying bird anatomy and behavior, we can see that birds have many general adaptations both externally and internally, shared among nearly all species. But think about some of the birds you may know already - sparrows, hummingbirds, condors, and kookaburras, all are very different from each other! While they all share the general characteristics that make a bird a bird, they each have their own set of unique adaptations for filling their niche.

Here we will take a look at some groups of birds that have rather unique adaptations to suit their lifestyle. We will also look at some special adaptations that some birds have to enhance their efficiency, whether that be adaptations to where they live, managing feeding, or physical features for courtship and territory defense.

As you can imagine, the number of amazing adaptations that birds have can seem endless! In addition to those you will learn about here, what other adaptations can you think of? Perhaps by looking at the birds in your backyard or at a local park, and by watching their behavior, you will be able to observe and note some of these adaptations in action.

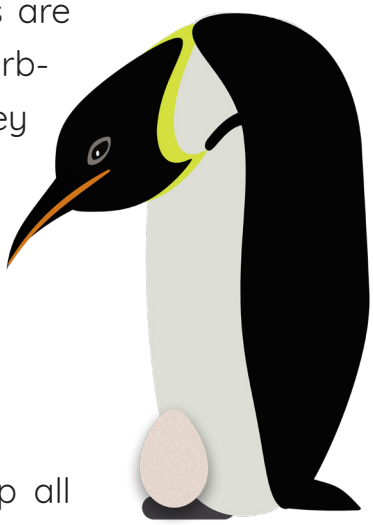
Woodpeckers

Woodpeckers are well-known for their amazing ability to drum into trees with their bill at great force without giving themselves a headache! They feed on ants, grubs and other insects, found under tree bark. To get to this food source, they use their highly modified bill to drill into the tough bark. They are also cavity nesters, and are responsible for creating their own cavities in tree trunks. They even use their bill to communicate and announce their territory. To handle the seemingly constant drumming that woodpeckers do, their skulls are thick and padded with shock-absorbing tissue to protect the brain. They have strong necks, a stiff tail to prop them against the tree, and strong grabbing toes for clinging to tree trunks. If that isn't enough, woodpeckers have an unusually long tongue, controlled by muscles and bones that wrap all around the woodpecker's skull. Their tongue is flexible yet hard at the tip. It is covered in a sticky fluid, and often has backward-pointing barbs to be best equipped to handle whatever arthropod prey they may encounter!



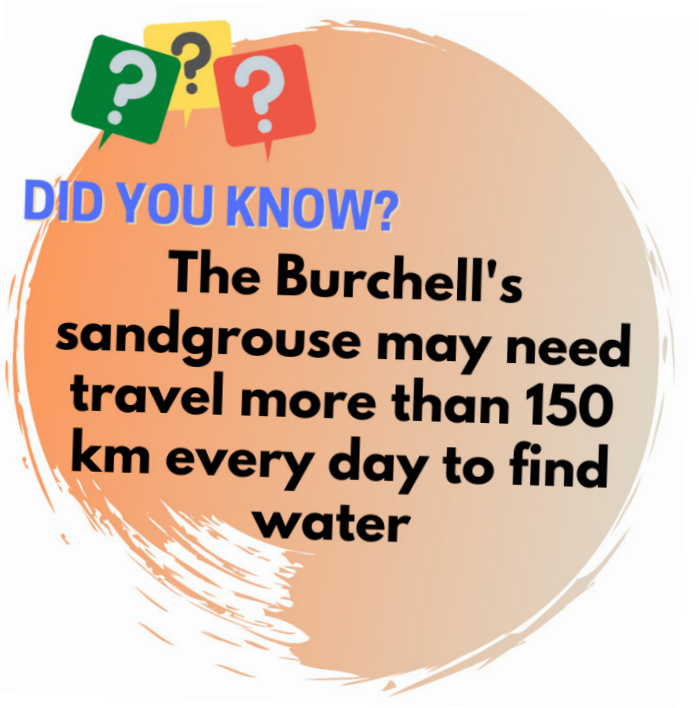
Penguins

Penguins are truly unique birds. All 18 species are flightless and have taken to the sea and the frigid waters of the southern hemisphere. While many birds swim and dive, penguins have taken swimming to the next level. Of all the birds on our planet, penguins swim the fastest, dive the deepest, and stay underwater the longest. In order to do so, they have **evolved** special adaptations for this extreme aquatic lifestyle. They are very streamlined, with modified feathers arranged in three layers, which help keep them warm, dry and bouyant. Their wings have been modified as flippers. They have short legs and are rather awkward walkers on land, often preferring to slide around on their bellies instead! The **emperor penguin**, the largest species, is capable of holding its breath underwater for up to 18 minutes, and has been recorded at depths beyond 500 meters under the surface! Penguins will often partake in 'porpoising' when swimming, that is, jumping out of the water and in again, like some fish and dolphins. This is thought to help them gain speed (among other reasons), and penguins have been clocked at swimming speeds of up to 14 km/h!



Sandgrouse

Sandgrouse are a small family of birds found in the open, semi-arid regions of Asia, Africa, and parts of Europe. These sandy-brown-colored birds frequent water holes where they drink and bathe. They also have an amazing adaptation of being able to soak up and carry water in their belly feathers. Their lower abdominal feathers can hold up to 40 ml of water. In the dry regions where they live, where water may be scarce, it is important for them to be able to provide water to their young in the nest. The males, in particular, are in charge of this task. When a male returns to the nest, the thirsty nestlings drink the water he has carried from his sponge-like feathers!



Salt Glands

Birds that live at sea, such as albatrosses, petrels, gulls, and sea ducks, must be able to adapt to the high quantity of salt in the ocean water. There is no freshwater around for them to drink, so they must get their water from their salty surroundings. To deal with this, seabirds have specialized salt glands located above their eyes. These glands function similar to the kidney, removing salt from the bird's bloodstream. The salt that is removed drips from its beak and nostrils. These glands are efficient, removing 90% of saltwater intake within three hours!

Spurs

Some birds, like some amphibians, reptiles, and mammals, have developed spurs. Spurs are bony extensions that, in birds, can be present on the legs and wings of some species. Think about a domestic rooster, or a **wild turkey**. If you look closely, you will notice a long pointy bone sticking off the back of their legs above the foot. This spur is well-developed in fowl (chickens, turkeys, pheasants), and especially in the males. These spurs are thought to be used in competing for females and territory defense. Other birds, such as lapwings, jacanas, screamers and some ducks and geese sport one or two sharp spurs on the leading edge of their wings. Both males and females have wing spurs. Scientists believe they are used primarily in defense. The wing spurs of a male **horned screamer** reach over 6 cm in length!

Owl Pellets

Birds are masters at managing somewhat inconceivable diets, including directly swallowing bones and other indigestible parts. In fact, one unique bird, the **bearded vulture**, has a diet of primarily bone marrow alone! Some birds, like vultures and other raptors, have highly acidic, strong stomachs to deal with eating bones, but owls do not. So what is an owl to do?

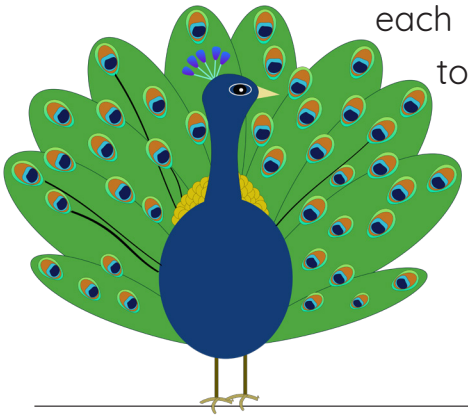
Owls prefer to swallow their prey whole when possible. This means that they regularly ingest bones and all other animal parts such as claws, fur, beetle wings, and more. When an owl swallows a mouse, for example, its stomach digests the muscles, organs and tissues of its prey. And the indigestible matter is neatly packed into a pellet - a small package containing all the bones, fur and other parts not digested. The owl then regurgitates the pellet out of its mouth!

By pulling apart or "dissecting" an owl pellet with tweezers, you can find the bones and animal parts that made up its meal. By studying owl pellets, we can learn a lot about what owls eat. Have you ever found an owl pellet? If you find a pile of pellets at the base of a tree, look up! You might see an owl looking down at you.

Bird Behavior

If you watch a bird in your backyard, at a local park, or on your travels, you will probably notice that it is doing something! Birds are very active vertebrates, and while some prefer to perch silently, most are up and moving around, whether that be flying, walking, swimming, foraging, or even burrowing.

Birds in general have developed behaviors as a group that help them to survive and thrive in environments all over the world. While we could probably write an entire book on bird behavior alone, we narrowed it down to a few behaviors that you will likely be at least a little familiar with. So the next time you watch a bird, try to think about what makes each behavior unique to that species.



Nesting

All birds lay eggs, though not all build their own nests. Some, like most falcons, will lay their eggs in abandoned nest sites of other large raptors or corvids (crows, ravens). Others nest in cliff walls or directly on the ground. In many bird species, both the male and the female incubate and otherwise tend to the eggs. The pair will often only stay together during the breeding and nesting season. Some species of birds, like **California condors**, are believed to mate for life.

Birds use camouflage, defensive and distraction behaviors to protect their eggs and their young once they hatch. For example, the **killdeer**, a small shorebird, will spread its wings and call as if it were injured in order to lure potential predators away from its brood.

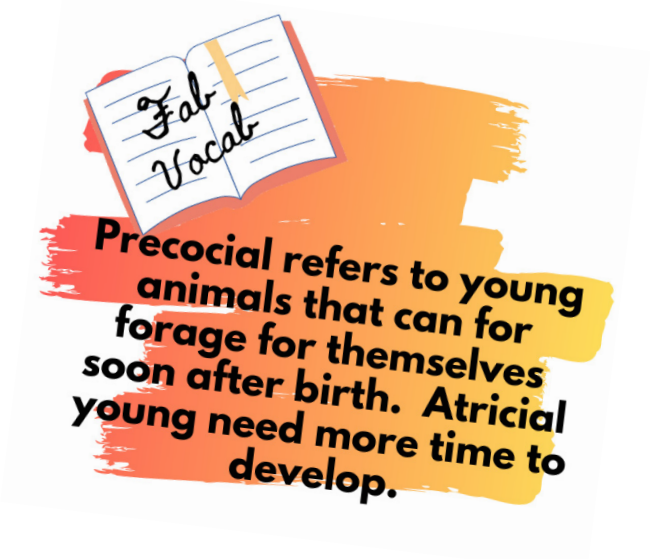
Some birds, such as the **brown-headed cowbird,** are **brood parasites.** This tricky species lays its eggs in the nests of other birds. When all the eggs hatch, the cowbird nestlings are usually larger and end up out-competing or killing the nest's original inhabitants.

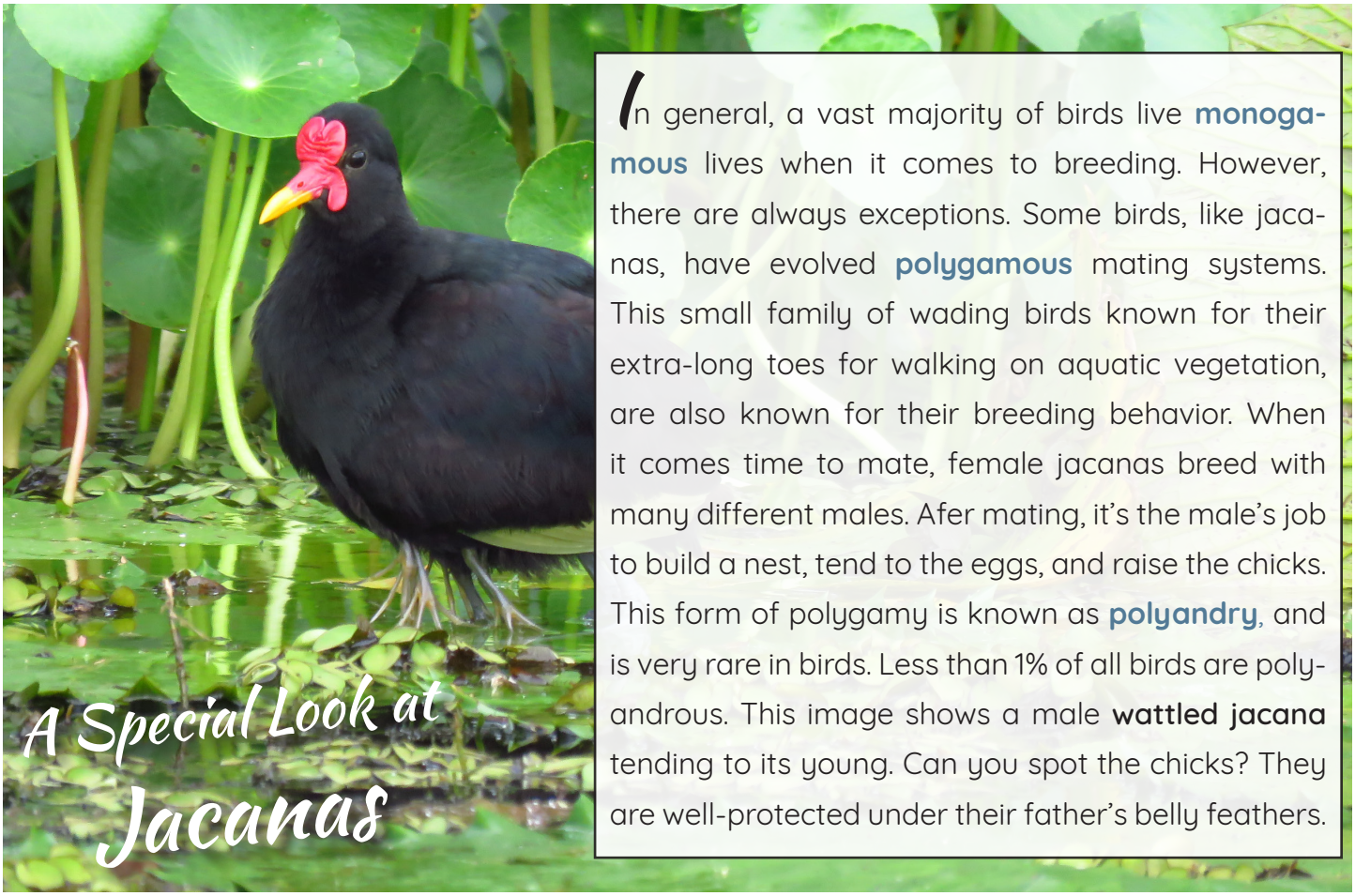
Depending on the species, a bird may nest only once a year, once every few years, or two or three times in one season! Birds lay clutches, or groups of eggs, that may con-

tain one egg, or, like a certain **northern bobwhite**, 28. However, the average clutch size is around 3-5 eggs.

The shape and color of eggs differ greatly among species. An egg laid by the **common murre** is more oblong shaped than oval. Since hundreds of murres nest side by side on high cliff ledges above the roaring sea, an oblong-shaped egg will allow it to spin back on itself and not roll off the cliff's edge if it is accidently kicked. Scientists believe that Common murre parents are able to identify their own egg among a literal plethora of oblong, blue eggs by the color and pattern of dark speckles that cover it.

Once they hatch, some chicks require weeks or even months of parental care before they are able to fledge, or fly from the nest for the first time. Others, like shorebirds, ducks, and pheasants, are up and running, swimming, and eating within a matter of hours or days.





A Special Look at Jacanas

In general, a vast majority of birds live **monogamous** lives when it comes to breeding. However, there are always exceptions. Some birds, like jacanas, have evolved **polygamous** mating systems. This small family of wading birds known for their extra-long toes for walking on aquatic vegetation, are also known for their breeding behavior. When it comes time to mate, female jacanas breed with many different males. Afer mating, it's the male's job to build a nest, tend to the eggs, and raise the chicks. This form of polygamy is known as **polyandry**, and is very rare in birds. Less than 1% of all birds are polyandrous. This image shows a male **wattled jacana** tending to its young. Can you spot the chicks? They are well-protected under their father's belly feathers.

Flight

Flight is what sets birds apart from most other animals. Feathers, light bones, air sacs, no teeth and more, combine perfectly in birds allowing a vast majority of bird species to take to the air. But what came first, feathers or flight? To answer this, we need to look back in time. The **fossil record** gives a glimpse of what was happening when birds started to fly, around 125 million years ago.

Archaeopteryx, the famous fossil of a feathered dinosaur, has fascinated scientists for more than a century. However, the origin of feathers and their functions are still unclear. Feathers evolved from reptile scales. The earliest feather forms are found in the fossil record dating back to 190 million years ago, and fully formed feathers around 135 million years ago. So it appears that feathers are older than flight, and many early birds still retained some reptilian characteristics that indicate they probably didn't fly. In fact, it is now thought that the feathers that covered the bodies of early birds primarily functioned to keep them warm. Then, as time went on, birds slowly took to the air, and feathers gave them the boost they needed to fly.

There are a couple of theories that scientists have come up with regarding the origins of flight. The **top-down theory** hypothesizes that **arboreal** dinosaurs would climb to the top of a tree and with a big jump they would glide using the assistance of their wings and

To fly or not to fly – flightless vs. flying birds

While a vast majority of birds fly, there are around 60 species of birds living today that are truly flightless. Ostriches, emus, kiwis and penguins are probably the first ones that come to mind, but did you know that there are flightless ducks, grebes, cormorants, rails, and even parrots? Tens of thousands of years ago, there were far more flightless birds that lived on Earth. Are you familiar with any flightless birds that lived many, many years ago? The **dodo** is one of them. It lived on the island of Mauritius and is famous for its unusual appearance and tameness. Its closest relatives living today are pigeons and doves. Flightless birds evolved from their flighted ancestors. Birds lost their ability to fly for a number of reasons. Around 65 million years ago, when dinosaurs and other predators went extinct, birds were left with few natural predators and thus no need to fly. On many islands, where there are no natural predators, you may also find some flightless birds. As vegetation changed, a number of species that fed on low-lying plants also no longer had a need to fly. As some birds became flightless, they developed their ability to run and many grew quite large, like our modern day ostriches and emus.

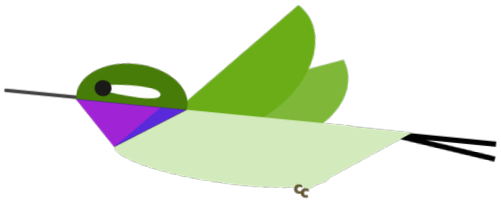
feathers, eventually evolving into powered true flight. The **ground-up theory** suggests that **terrestrial** dinosaurs and early birds would run along the ground and take big leaps, flapping their feathered wings to get airborne. No matter how it happened, over time flight in birds came to be.

Birds are the only animals that have feathers and, with few exceptions (insects and bats), the only animals that truly fly. But flying isn't just about flapping wings and becoming airborne. There is some pretty complex physics that comes with flight and the principle of aerodynamics, but birds don't think about that when they're flying, nor do we! We'll save the "how" of flight for Unit 5.

Almost everyone knows that birds can fly. But do you know why? Of course birds fly to get from one place to the other. Some fly long distances to migrate; others fly only when needed, often in short burst flights. Birds fly to evade danger quickly and efficiently, as many of their predators are not capable of flight. Birds also fly to find food and have developed different styles of flight for feeding. Harriers glide on **dihedral** wings, while they scan the ground below for prey. Flycatchers sally from perches to catch insects in mid-flight. Hummingbirds have fast-beating wings and can hover at flowers to sip nectar, and falcons tuck in their wings and stoop or dive to hit their prey out of the air at great speeds.

Birds also fly in order to attract mates and some perform elaborate **courtship** displays in the air. Courtship flights are performed by male birds or by both males and females prior to mating. Early in the breeding season, the male **American woodcock** performs a "sky dance" at dawn and dusk. His courtship flight involves bursting upward in a wide spiral, then twittering his wings as he descends back to the ground in a zig-zag pattern through the air. **Bald eagles** also perform a courtship flight in which both male and female engage in a "cartwheel spin" by locking talons and tumbling downwards toward the ground, breaking free at the last moment. The male **marvelous spatuletail**, a hummingbird endemic to Peru, hovers in front of a female and waves elaborate ornamental discs on two wiry tail feathers to impress the female. Talk about a lot of work! And flight can make it all happen.

There are three main types of flight - **flapping**, **gliding**, and **bounding**. They are distinguished by the motion of the wings. When a bird flaps, its muscles move its wings up and down, providing the bird the thrust and power it needs to move forward and upward, as well as increase speed. In gliding flight, the birds do not flap their wings and thus are not working with thrust and propulsion. When a bird glides, it is able to maximize its efficiency in flight and minimize the energy used to fly. Many raptors, especially during migration, will use **thermals** - rising pockets of hot air - to gain altitude then glide to the next thermal. This allows them to save so much energy during their migration and reduce their need to hunt along the way. Bounding flight is when a bird gives short bursts of flapping flight followed by tucking in its wings to its body. This is repeated and gives the bird a wave-type flight pattern. Small birds often do this to fly long distances. This type of flight is thought to increase the efficiency of the muscles and decrease the energy required for flight.



You have now learned a little bit about birds and some of their amazing powers of flight. But there is always more to learn. Using books, the internet, local experts, your own observations, fill in the chart below. Think about how each type of flight is dfferent from the other and the characterstics some birds need to utilize these flight styles. The next time you're outside, remember to pay attention to how different birds fly.

	Flapping	*Gliding*	*Bounding*
Size of bird			
Wing shape			
Types of bird			
Uses			
Benefits			

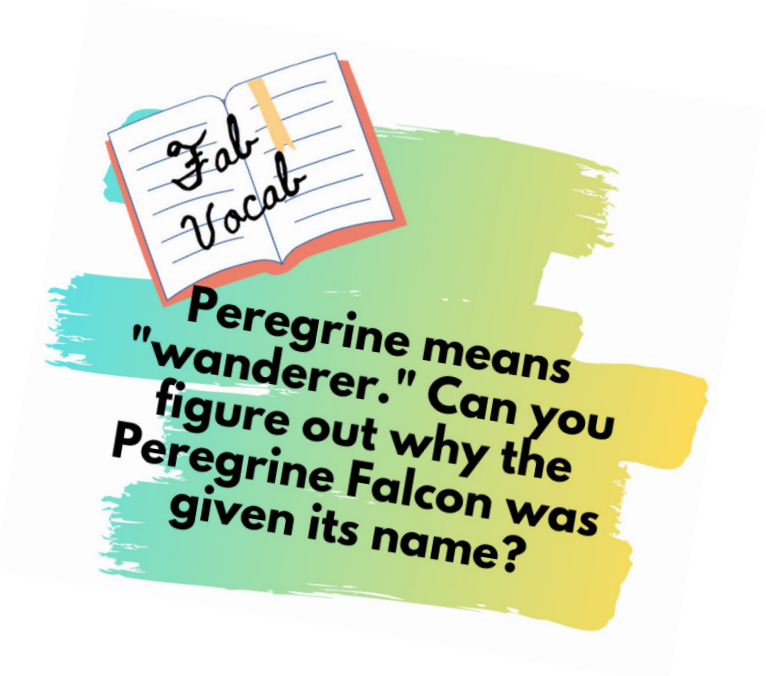
Migration

Evidence of man's fascination with flight and birds can be found all around the globe. Flight is depicted in ancient petroglyphs carved into the red stone of New Mexico that depict the **sandhill crane** that migrates to the Rio Grande Valley each winter. Leonardo Da Vinci's sketched flying machines, inspired by soaring birds and the basic biology of bird and bat wings. The Wright brothers' determination created one of the first true airplanes. The technology that allows us to fly has changed the way the world functions but we have still not achieved the ability to soar as freely and majestically as birds do. Birds, as you have learned, have air sacs, light, hollow bones, and use thermals to achieve their aerial acrobatics that humans continue to look at with awe. Perhaps even more confounding to us is their ability to migrate vast distances in an inconceivable amount of time.

The **Arctic tern** travels 30,000 km each year from the Arctic to Antarctica and back again. Most migrating birds fly 160-320 km in a single flight, averaging 30-80 km per hour. Some birds can fly over 4,000 meters in altitude, while some have been reported flying as high as 11,000 meters (about the maximum cruising altitude for a Boeing 747). Many migratory birds travel short flights and stop, although some birds can fly nonstop for up to 60 hours.

Bird migration has been of interest to scientists, naturalists, and the generally curious for years. Biologists believe that length of day, sudden change in temperature and food supply may be instigators for these annual migrations. Scientists believe that birds follow geographic features and some may even navigate by the stars! Birds must be ready to meet the energy requirements for migrating flight. They do so by eating excess food and storing it as fat.

Not all birds are migratory. Some are permanent residents and never leave the area in which they were hatched. It is clear that migration is a fascinating subject and there is so much to talk about. That is why we have dedicated a whole unit - unit 5 - to the study of migration.



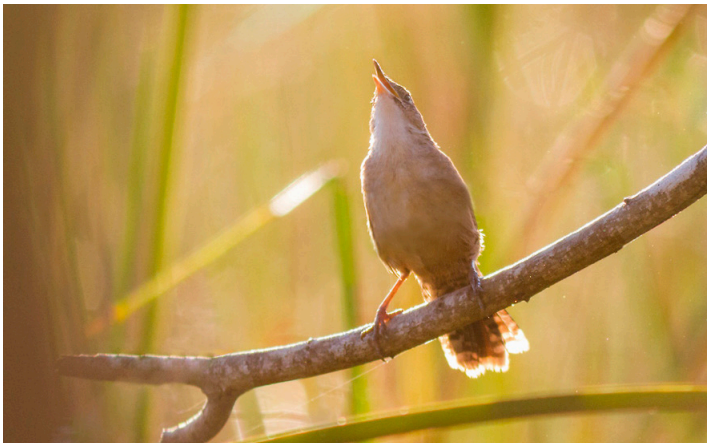
Bird Communication

Close your eyes and imagine yourself standing in a tropical rainforest, an open grassland, or even an urban park. Your ears will pick up the songs and calls of birds in the area. What do they sound like? Can you describe them? Do you know what birds are making those sounds?

Melodic or discordant, soft or shrill, or no matter how they sound to the human ear, bird calls and songs play an important part in the daily lives of avian species. Birds may use vocalizations during **courtship**, to alert others to danger, to locate members of their flock, to indicate that food has been found, or to warn others who have strayed into their territory, and much more.

Bird calls also help biologists and bird watchers who often don't get to see the bird but can identify it solely by its unique call or song. With a little practice, we can learn the songs and calls of each species of bird and be able to identify them too! By learning the sweet "birdie-birdie-birdie" song of the **northern cardinal**, or the deep, resounding hoot of the **crested owl,** we know that those birds are near without even seeing them. Bird songs and calls are quite complex and fascinating, and by studying them in good detail we can learn a lot about the birds themselves.

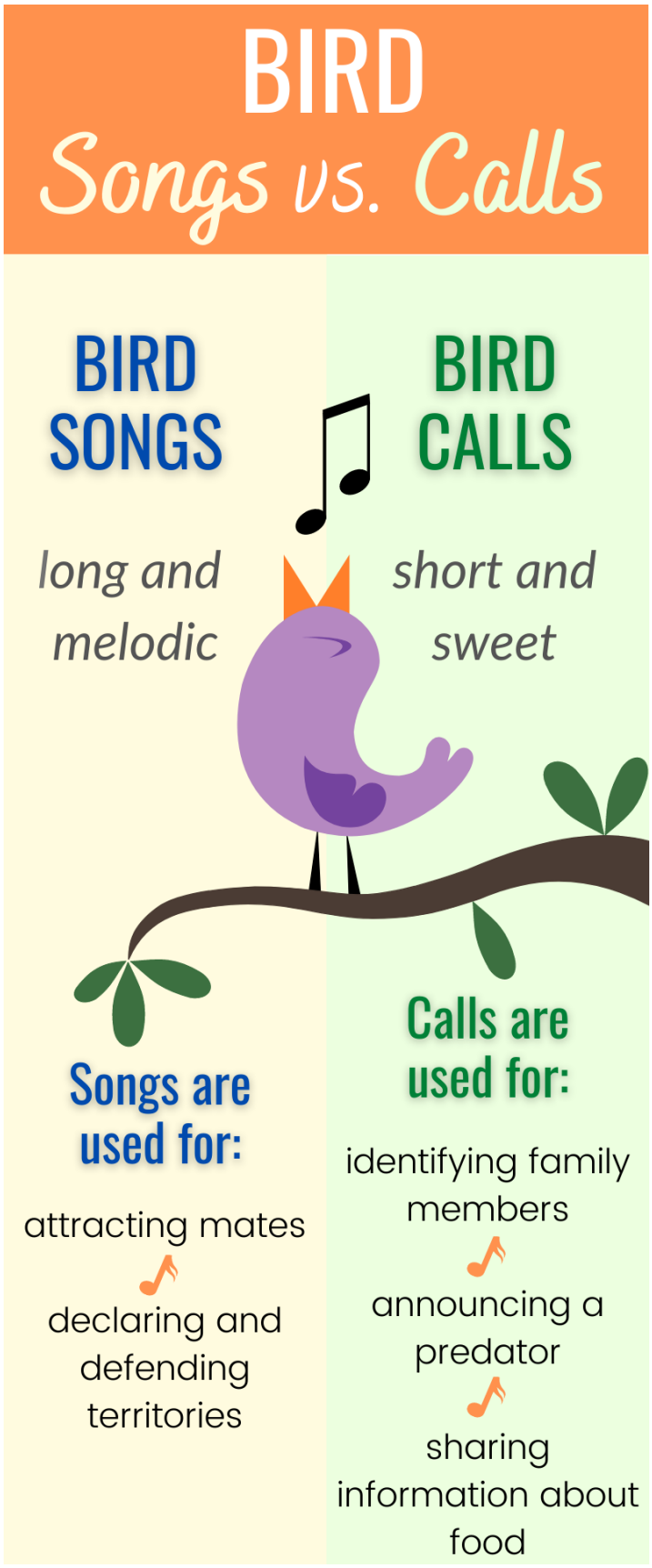
As we are learning, birds make a wide variety of different vocalizations. And some bird species also use their wings, beaks and other body parts to make non-vocal sounds as well. Each call means something different. Let's take a look at some of the ways that birds communicate.



Songs

Have you ever heard of a songbird? A songbird is not one species of bird, but a general term used for a group of birds called “passerines.” This large group is characterized by having well-developed vocal organs. Passerines are generally known for their ‘singing’ capabilities. Thrushes, warblers, sparrows, orioles, and cardinals are all part of this group.

A bird song is one form of avian vocalization. Songs are generally longer and are used to attract mates and to declare and defend territories. Dawn songs are given by many birds at daybreak. Some birds sing year round, while others sing predominantly during the breeding season, and remain fairly quiet throughout the rest of the year. For birdwatchers and ornithologists, songs are easier to learn than other vocalizations since they are usually more melodic and distinctive.



Calls

Calls are different from songs. They are typically shorter or more abrupt, as is the case with alert calls. Calls are used for identifying family members, announcing a predator nearby, or to share information about food. Birds will also give flight calls, often when migrating, which can sometimes be heard at night. Nestling birds use begging calls to let their parents know they are hungry. Bird calls are a little more challenging to learn, but with a careful ear, you may start to recognize some of the bird calls in your area and distinguish which species is making each call.

Each bird species has its own unique series of songs and calls. Amazingly, sometimes, their vocalizations are structured depending on where they live. For example, in a tropical rainforest, birds that live in the canopy often have loud, high-pitched songs and calls that can travel through the open air. On the other hand, antbirds, wrens, and other birds that live in the rainforest understory have lower-pitched songs. Vocalizations at lower frequencies travel better in the dense forest understory.

Non-vocal Communication

Some birds are not overly vocal, have very limited songs and calls or no songs at all, but of course, they still need to communicate. Thus, they have developed different behaviors that involve sounds to help them do just that. Even birds that do have strong vocalizations have added to their repertoire by including non-vocal sounds. Have you watched a woodpecker drum its strong beak on the trunk of a tree? It is sending a message to others!

Some birds, such as grouse, will beat their wings on a log or the ground to produce a drumming noise during breeding season as a means of attracting females. Many species of manakins engage in elaborate wing snapping and rolling in their breeding displays at leks. A unique bird called a **pheasant cuckoo**, found in the rainforests of Central and South America, rattles its wings and produces an unusual sound (much like a baby rattle) as a part of a feeding ritual. And ground-cuckoos will clack their bills, making a sharp, loud sound, to alert others of their presence or perhaps the presence of a predator. The **palm cockatoo** has an unique behavior of holding a large stick and banging it against a branch or snag to send its message out, proclaiming its territory. This sound can be heard up to 100 meters away.

Many birds can produce sounds with their wings when in flight. Hummingbirds are an excellent example, and aside from the typical buzzing sounds they make when flying (giving them their name), some species produce a whistle sound with their wings to defend their breeding territories. **Common nighthawks** rush wind through their wings when doing their courtship diving displays which makes a loud "booming" sound. These are just a few examples of how birds use non-vocal sounds for communication. Can you think of any others?

Take a look at some of these birds you may know. How would you desribe the sounds they make? Match each bird to the description. If you're not sure, you can look in a bird guide or visit some online resources, such as eBird or xeno-canto.

Tapping

Harsh squawks

Humming or buzzing

Melodious, sweet song

Short whistles

Croaking

Ecosystem Services

How are songbirds, ducks, sea birds, raptors and all the other species of avian critters beneficial to humans, plants, and all other organisms on Earth? The truth is, birds play a large part in maintaining the health and biodiversity of an ecosystem. Some birds, like hummingbirds and sunbirds, help to pollinate many species of plants. Other species help to disperse seeds which pass through the bird's digestive system unharmed, and are left to germinate far from their parent tree. Birds may serve as a prey base for other species, or may be predators themselves helping to control the delicate balance of nature. Birds also attract tourists and birdwatchers, many of whom travel hundreds of miles for the chance to catch a glimpse of just one representative of a rare or little seen species. Wetlands, forests, islands, and savannahs have been protected in order to save bird habitat. Have you ever heard the term, "ecosystem services?" These are the benefits wildlife bring to humans. In the case of birds, they help us in countless ways. Here are just a few examples of all the amazing things birds do to keep our plant and us healthy.

Seed Dispersal

Let's face it, the world needs more trees and plants. It is one of the major solutions to our current climate change crisis and seed dispersal helps plants avoid overcrowding and competing with each other for resources. Many species of birds play a major role in seed dispersal and do so in a number of ways. When a **frugivorous** bird eats, it will often pluck small fruits from branches and fly off to a different perch to eat. Once it has eaten the sweet, fleshy fruit matter, it will drop the seed to the ground where it can germinate far from the parent plant or tree. Seeds gathered from grasses are done so in mass, and birds will drop seeds as they fly away. There are even plants and trees that

require their seeds to pass through the gut of a bird in order to germinate! As they do so, nitrogen in a bird's poop will fertilize the seed. Birds such as waxwings, manakins, and hornbills, which swallow fruits whole, play a major role in this form of germination and seed dispersal. Birds, such as jays and nutcrackers, will **cache** food (seeds, nuts) for the winter. Though they are good at remembering where they stored their food, they don't always return to every cache, so not all seeds get eaten. These will often germinate and grow the following spring. This important service not only shapes our global landscapes, but is essential to ecosystem health, and the health and well-being of humans.

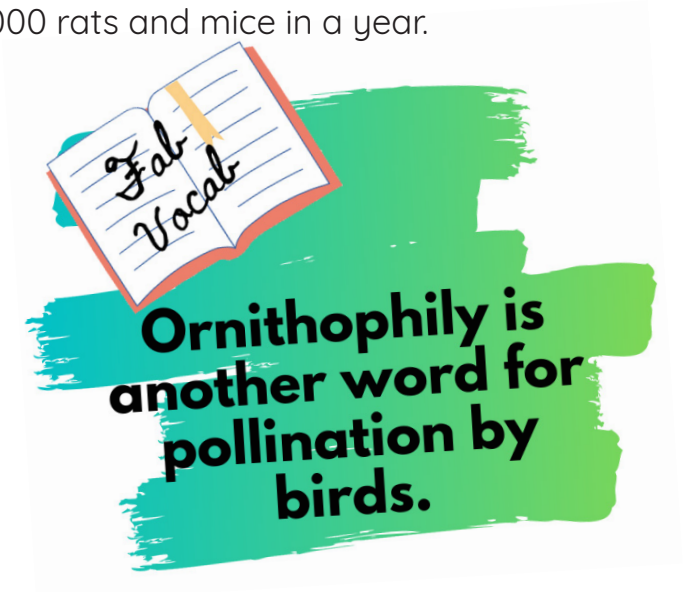
Pollination

Without birds, many of the flowers, fruits, trees, and other plants we need simply wouldn't be here. We are going to learn more about **pollination** in Unit 6, and you probably know a bit about it already. But did you know that along with some insects and bats, birds help fertilize plants when they pass pollen from one flower to another during feeding? While bees, of course, are the world's most important pollinators, birds do their fair share of helping plants, especially wild flowers, reproduce. Scientists estimate that there are nearly 2,000 different bird species that act as pollinators. If you like bananas, nutmeg, or papaya, thank a bird! In the tropical regions of the world several avian species help fertilize these food crops.

Wildlife Management

Birds of all kinds help control populations of animals that, in large numbers, can negatively affect humans. Even though mosquitoes are an integral part of the ecosystem, they can also cause a lot of health issues for humans and wildlife. They can transmit several diseases including malaria. Other insects can be damaging to forests and agriculture. So, it is a good thing that we have birds. like flycatchers, swallows and swifts, that love to consume mosquitoes and other insects. In fact, **insectivorous** birds around the world are known to cumulitavely eat as many as 400 to 500 million tons of insects each year.

Raptors, especially owls and some hawks that feed mainly on rodents, help control rats and mice. This is important because these rodents can damage crops, destroy homes, and spread disease. So, having an owl around is a good thing. A family of **barn owls**, for example, have been known to eat 1,000 rats and mice in a year.



Nature's Clean-up Crew

We are going to learn more about vultures in Unit 4, but these scavenging birds play a very important role in keeping our environment clean and disease-free. Imagine what it would be like if there was nothing around to consume large animals that have died - such as cows, or elephants. Though other scavenging animals would eat the carcasses, no other scavengers come close to the efficiency that vultures have in stripping a carcass down to its bones. In just a few hours, a feeding flock of vultures can completely clean a dead animal as large as a water buffalo. Vultures are essential to this clean-up job. They have strong acidic stomachs to digest rotting flesh and prevent the spread of potentiall harmful bacteria into the environment.

Tourism

In the U.S. alone there are 45 million birders and birdwatchers. Globally, this number is much higher. While some like to watch birds from home, others seek out birds all around the world. No matter where people are watching birds, they are contributing to the economy. In one year, birders spend around 39 billion U.S. dollars between travel, guides, and equipment. Birding also helps conservation! When birders travel, they often employ local guides, stay at family-run hotels, and eat at local restaurants. This helps people see the value of protecting birds and their habitats, and it helps them make a living. Directly or indirectly, birding tourism has many benefits.

Human Health

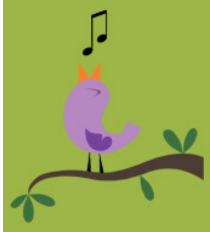
Did you know that watching birds is not only enjoyable as a hobby, but is actually very good for you? Recently, more and more studies show how watching birds benefits our physical and mental health. Naturally, watching birds pulls you outdoors, away from screens and devices, where you can immerse yourself in nature, breathe fresh air, soak up vitamin D from the sun, relieve stress and promote relaxation. It just feels so good to be outdoors! Even a few minutes in a forest, at a park, a beach, or in the mountains can help improve mood and the ability to focus on tasks. Birdwatching gets us active, helps our cardiovascular health, improves blood pressure and heart rate, and can lead to longer lifespans overall. It also helps our cognitive thinking and the ability to problem solve. In fact, many doctors give

their patients “nature prescriptions” as a complementary treatment for a number of different diseases and ailments.

Has there ever been a moment in your life where a bird has caught your attention and instantly changed your current mood or outlook on something? Birdwatching is a very meditative activity. In the quiet surroundings of nature, It gives us the opportunity to reflect on life and think calming thoughts, giving us peace of mind. It promotes patience, as birdwatching takes time and does not often give you instant gratification. Searching for a rare bird, or observing the breeding cycle of a cardinal in your yard are good examples of this. Since birds often move quickly, watching them can improve our reflexes and increase mental alertness. Watching birds and being out in nature can help us battle depression and anxiety. Furthermore, birdwatching promotes a sense of community. Through birding with others and social outings that involve birdwatching, or through travel and joining the global birding community, we can reap the benefits of social health and maintaining friendships.

The term ornitherapy – the healing power of birding in nature – used for the first time by Robin A.F. Cox in a letter he wrote for the British Medical Journal in 1974, stems from this principle. As we live in a changing world complicated with stresses on many levels, we can turn to ornitherapy as a means of maintaining our physical and mental health and happiness.

Do you want to try some fun and new ways to spend time in nature? Try some of these activitites below.



ENJOY NATURE'S MUSIC

Listen to birds and insects singing, the sounds of wind through the leaves, a babbling brook, or any other nature sounds.

SKETCH OR WRITE

Find a quiet spot to put your observations on paper.

SOLVE A MYSTERY

Search for animal tracks, scat, or other clues of what might live here.

FIND PATTERNS

Take a closer look at leaves, bark, flowers, and feathers.

OBSERVE BEHAVIOR

Find a bird, insect, or other animal. Spend time watching what it does.

Read and reflect...

Wow! Give yourself a pat on the back! You just learned a lot about some of the amazing bird life we share our planet with. From flightless birds, to long-distant migrants, from strong predators to agile pollinators, birds are truly fascinating. And there is always more to learn!

In this chapter, we learned about some of the most important characteristics that make a bird a bird. But we only touched the surface of all the fascinating bird adaptations, characteristics, and behaviors. We also learned about just a handful of the more than 10,000 different species we share this planet with. Whether studying the breeding biology of a particular species, finding more connections between birds and dinosaurs, or seeking to understand how and why toucans and hornbills share a similar niche, there is still so much for us to learn about our amazing feathered friends.

While we hope this chapter helped answer some questions you might have had about some wonderful and fascinating birds, we also hope it left you with a curiosity to learn more. If so, we invite you to make a list of questions you would like the answers to in a journal or other place you can easily access your questions and make notes. Now, work on your own, with family members, friends, or your teacher to discover the answers to some of these questions. Using scientific resources, talking with an expert, and making your own observations are just some of the ways you can go about this.

Finally, take a moment to think about the quote at the beginning of this chapter. *"Hope is the thing with feathers."* What does this quote mean to you? Does it mean something different now that you have learned a little more about these amazing creatures? Can you give an example, using something you just learned, to illustrate what this quote might mean? Is the author speaking metaphorically? Is she being literal? Do you agree with her statement? Why or why not?

explorer's corner

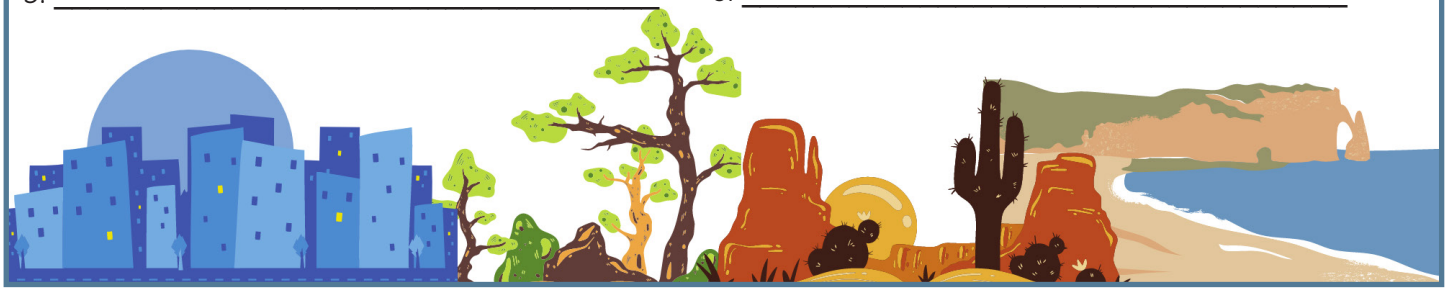
my backyard

It's time to do some birdwatching!

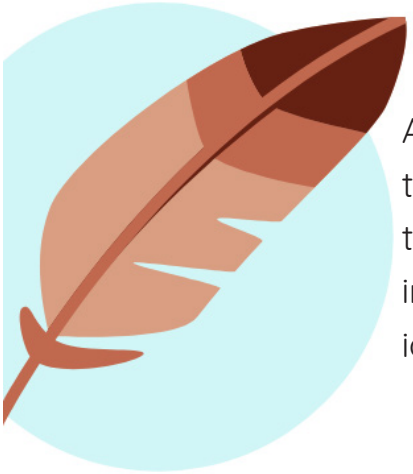
Take a walk around your neighborhood identifying areas where you think birds might be. Whether at a local park, a nearby lake or beach, or even in a tree or bush right in your backyard. Spend a week observing birds in your area. Can you determine what time of the day birds are more active? How many species can you recognize? Can you find other clues that birds are nearby, such as old nests, feathers, even bird droppings? Make a list of your observations below.

MY OBSERVATIONS:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____



Before you go, be sure to review a few characteristics that make a bird a bird.

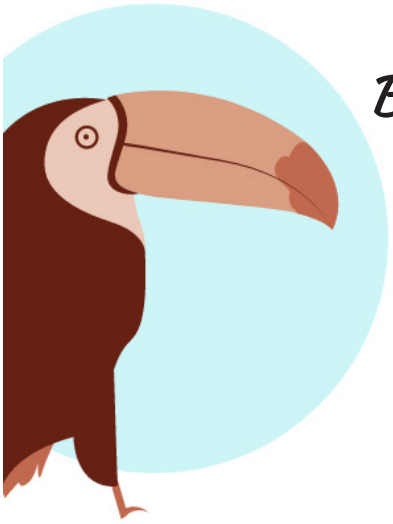


Feathers

All birds have feathers. Feathers are made of beta-keratin, similar to what makes up our fingernails. They help birds to fly, as well as to stay warm, cool and dry. Feathers contain pigments and come in many different colors and shapes, which helps with the visual identification of each different species of bird.

Wings

All birds have wings, which are primarily used for flight. Different wing shapes reflect different styles of flight. Birds also use their wings for courtship displays and other behaviors. Some birds are not able to fly, but still have wings that are modified for other uses, such as swimming.

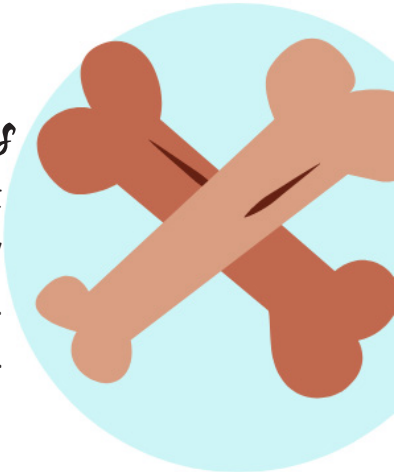


Beaks

Though not unique to birds (fun fact: octopuses and some fish have beaks!), beaks are an important characteristic of birds. Beaks come in all different shapes and sizes, including straight, down-curved, up-curved, flat, and hooked. They are a useful tool to help birds grab and eat their food.

Hollow Bones

Most birds have hollow bones, which helps make them lightweight and able to fly (fun fact! Penguins, loons and puffins lack hollow bones, perhaps making it easier for them to dive underwater). This is a characteristic that our modern birds share with dinosaurs.



Glossary

Adaptation - a change in structure, function or behavior of an organism which improves its chances of survival in a specific environment or condition

Arboreal - relating to an animal that spends most or all of its time in trees

Brood parasite - an animal that relies on others to raise its young

Cache - the storing or hoarding of food by an animal

Camouflage - a physical or behavioral adaptation in which an animal or plant disguises itself to become less obvious and blend in with its surroundings

Courtship - a behavioral display of an animal that leads to attracting and selecting a mate in order to reproduce

Dihedral - when two intersecting planes meet at an upward angle; in birds, when a bird holds its wings in a slight upward “V” shape

Ecosystem services - the benefits wildlife brings to humans

Endotherm - an animal that is able to produce and regulate body temperature internally

Evolve - the process of gradual development, typically from a simple to more complex form

Fossil record - the record of the history of living organisms through geological time, documented by fossils

Frugivorous - when an animal eats primarily fruits

Insectivorous - when an animal eats primarily insects

Keratin - a fibrous protein that forms the main substance of hair, fingernails, claws, beaks, feathers, horns, scales, and other skin derivatives

Melanin - a black or brown-toned pigment found in skin, hair, feathers, and eyes of humans and animals

Metabolism - a series of chemical reactions that occur in living organisms to sustain life, specifically to change food into energy

Molt - loss of feathers, hair or skin as a part of an animal's natural cycle

Monogamous - having one mate at a time, often forming strong pair bonds

Mutualistic relationship - a symbiotic interaction in which both organisms benefit from each other

Niche - the role that an animal, plant or organism plays in its environment

Nocturnal - active at night

Ornitherapy - the healing power of birding in nature

Pelagic - relating to the open ocean or sea

Pigment - substances produced by a living organisms that give them their colors

Pipping - the initial cracking of an eggshell when a bird hatches

Pollination - when pollen from the male part of a plant is transferred to the female part of a plant, which allows for seed production
Preen - when a bird cleans and arranges its feathers using its beak

Prehensile - having the ability to grasp, for example the tails of some mammals or an octopus' arms

Polyandry - a polygamous mating system in which females mate with multiple males

Polygamous - having multiple mates at a time

Ruminant - an animal that eats grass and leaves, pre-digesting its food in a specialized chambered stomach prior to digestion

Terrestrial - relating to an animal that spends most or all of its life on land

Thermals - rising columns of warm air that birds use to gain height when flying

Thermoregulation - the process carried out by an animal to maintain or regulate its internal body temperature

Theropod - a group of primarily carnivorous, bipedal dinosaurs, characterized by having hollow bones and three-toed limbs

Thrust - the force that moves an object or animal (airplane, bird) in the direction of the motion. In the case of a bird, thrust is created by flapping its wings using its breast muscles

Vertebrate - an animal with a backbone or spinal column

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PAGE 6 - Rainbow Bee-eater, Australia © Jonathan Munro

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Top left: Shining Honeycreeper, Panama © Angel Muela
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Bottom: Tibetan Partridge, India © Marta Curti

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Bottom right: African Jacana, Senegal © Yeray Seminario

PAGE 11 - Yellow-bellied Warbler, Bhutan © Yeray Seminario

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PAGE 20 - Header: Feathers image courtesy of Canva

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Bottom: Bearded Vulture, Nepal © Yeray Seminario

PAGE 23 - A Special Look at Hoatzins, Hoatzin, Ecuador © Jenn Sinasac

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PAGE 25 - Pelican illustratcion © Marta Curti
Oil and Water Experiment graphic created with Canva

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Broad-billed Motmot illustration © Marta Curti
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PAGE 30 - Spectacled Owl illustration © Marta Curti
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PAGE 43 - Fab Vocab graphic created with Canva

PAGE 44 - Black Vulture illustration © Marta Curti

PAGE 45 - Spending Time in Nature graphic created with Canva

PAGE 46 - Header: Red-legged Honeycreeper, Belize © Yeray Seminario

PAGE 47 - Explorer's Corner graphic created with Canva
Bottom: Crab-Plover, India © Yeray Seminario

PAGE 48 - Bird Characteristics graphics created with Canva

PAGE 49 - Header: Blue-gray Tanager, Panama © Yeray Seminario

PAGE 51 - Montezuma Oropendola, Costa Rica © Yeray Seminario

PAGE 55 - Green Bee-eater, India © Yeray Seminario

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