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## HOW DO BIRDS FLY?

How do birds fly? This is a common question from children and this fact sheet will help you learn all about the mechanics of flight. Look out for words in **bold** text and find out what they mean using the 'glossary' section. Finally, put your new knowledge to the test by answering the quiz questions at the end.

### Introduction

If you go outside and look up, you will probably see different birds flying around. They flap their wings to fly up high into the air, and then sometimes they spread their wings out wide in a straight line to continue soaring. They might twist and turn in the air as they fly. Different birds will fly in different ways; some might circle around, some fly in straight lines, and some will flit from place to place in seemingly random patterns.

Birds can fly because of their speed, strength, weight, feathers and the way their bodies work, especially because of their wings. These are all **adaptations**, or special features, that are designed to help birds fly. This fact sheet will help you explore how birds can actually fly and the ways in which different birds use this amazing ability.

### Birds' Bodies

Birds have a number of adaptations to help them fly, which is not just down to their wings. For starters, they have an extra-large breathing system. Like us, birds breathe in oxygen and breathe out carbon dioxide. They have special air sacs around their bodies, with hollow bones that allow these gasses to flow around their bodies easily. A birds' breathing system takes up about one-fifth of the space inside its body; in comparison, for most mammals like us, it is only around one-twentieth. As a result of this massive breathing system, birds also need a really strong heart to keep this system working.

Flapping wings to fly uses up a lot of energy, so birds need their blood to move around their bodies quickly to keep their flight muscles working properly. So, their hearts are very big and

strong compared to mammal's hearts. A small birds' heart will also beat much faster than a bigger birds' as they are often working much harder and flapping their smaller wings more often to get lift (see below for more information about wings and lift).

For example, a Human heart beats at around 60 to 80 beats per minute. A Sparrows' resting heartbeat is around 460 beats per minute, and a Hummingbirds' is 615. In flight, a small birds' heartbeat rises above 1,000 beats per minute – for a Hummingbird in flight, this can go up to around 1,300 beats per minute! A Buzzard has a flying heart rate of around 300 beats per minute. The heaviest flying bird, the Andean Condor, has a resting heartbeat of around 65 beats per minute.

A birds' skeleton is also very different to ours. It needs to be light enough to allow the bird to fly, but also strong enough to withstand the strain of flying. So, birds have a very special skeleton – their bones are hollow. This means that their skeletons are very light for their size. An owl, for example, has a skeleton that only makes up around 7 to 10% of its body weight. For some birds, their feathers altogether weigh more than their skeleton does! Birds also have lightweight beaks instead of heavy teeth and jawbones. Some other bones are very small or have disappeared completely – for example, mammals with tails, such as dogs, cats, and rodents, have bones in their tails. Birds' tails are made out of feathers and do not contain any bones.

Many of a birds' main limb bones (such as their wings and their legs) are still hollow but have special struts inside to support them. This makes their bones very strong without being heavy. Their bones are more rigid than those of a mammal. Birds' ribs are locked together with bones that stick out sideways, and their collarbones are joined together into one single bone, which is called a 'wishbone'. This stiff, rigid skeleton allows their bodies to cope with the stresses and strains of flying.

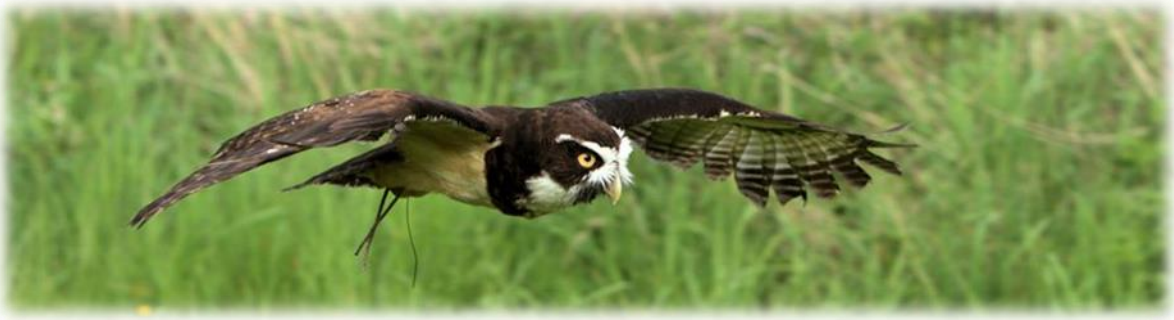
Another important bone is the huge breastbone, which is unique to birds. It sticks out, like the keel (or front) of a boat. It holds the huge, powerful breast muscles that a bird uses to flap its wings with the strength needed to fly. Most flightless birds, such as emus, do not have this breastbone as they do not need it.

**Wings**

One of the most important adaptations a bird has for flight is, of course, wings. A birds' arms, or front legs, have evolved into wings that no longer support its weight while on the ground, but instead allow it to take to the skies. The shape of a birds' wing has a direct effect on how the bird flies and is very important to achieve the lift necessary for flight.

Here is a simple experiment that you can do at home. Fill a sink or bath with water and try moving your hand through it, palm open and fingers together. Wide, flat objects, like your hand, are hard to move fast against water. It feels like the water is pushing back against you. Now try doing it with your fingers spread wide open – again, you can feel the drag of the water pushing back against you as it flows between your fingers. Now, turn your hand sideways, fingers together and palm flat; you can slip your hand through the water. This is because the water can flow much more easily around this flatter surface. Something similar applies to air and the shape of a bird's wing.

When a bird is flying, their wings are flat, so that air can flow easily around it in the direction the bird is flying – much like your sideways hand cutting through the water. However, something really special happens as a result of the shape of the wing. A wing is slightly curved on the top. As the air flows over and under the wing, it flows faster over the top than under the bottom, because of this curved shape. This means that there is more air under the wing because the air is moving slower here. When there is more air under the wing, this pushes against the wing. As the wing is wide and flat on the underside, this push lifts the bird up. So, the bird's wing slices through the air in a forward direction, and gets pushed up from below, and this how a bird can fly up into the sky and stay up.



Flapping the wing up and down also creates the same pushing effect against the underside of the wing, which allows the bird to take off from the ground or a perch, or to gain more lift while in flight.

**Feathers**

Feathers are an amazing adaptation that cover the bodies of all birds. However, they are not just for flying; they help to keep a bird warm and dry, which is why even flightless birds like ostriches have them.

Feathers are made of the same lightweight material as our hair and fingernails – a substance called keratin. Tiny muscles attached to the base of each feather allow the bird to move its feathers; this is useful for steering when in flight, or for **preening**, and to help the bird keep warm or cool off. Feathers also have to deal with a lot of wear and tear; they can get damaged or break off, so each year birds grow a new set of feathers to replace any that are old or damaged. This is called **moulting** and this is why you will sometimes find lost feathers on the ground. Many birds will moult once per year, some twice.

Each feather has a central, hollow shaft. Either side of this is a flat area, called the vane. A vane is made up of many small, side branches, all linked together with smaller branches with hooks, known as **barbules**. A bird keeps its feathers neat and tidy by preening them, effectively 'zipping up' the barbules by using its beak. Birds also secrete oil from a gland at the base of their tail; when a bird preens, it gently squeezes this gland with its beak to release the oil, and then rubs the oil through its feathers. This keeps the feathers clean, shiny and in good condition; it also helps the bird to stay waterproof, which is especially useful for ducks and sea birds.

The bare part at the end of the shaft is called the **quill** – before the invention of pens, feathers were cut and dipped in ink to use as writing tools, which were known as quills.

Feathers come in lots of different colours; some colours come from pigments produced by the bird's bodies, such as greys, reds, browns and yellows. Other colours can come from their food – for example, the pink colour of a flamingo's feathers comes from the tiny plankton that it eats. Other colours, such as green and blue, come from the way light shines off the surface of the feather, which is known as refraction.

There are also names for the different feathers that a bird has. For example:

- The big, stiff feathers on a bird's wings and tail are called **flight feathers**.
- The longest flight feathers are called **primaries**
- The shorter flight feathers are called **secondaries**

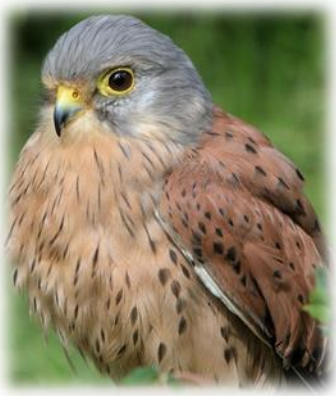
- The small feathers that cover the bases of the primary and secondary feathers are called **coverts**
- The small feathers which sometimes sticks out like a thumb at the joint of a birds' wing is called the **alula**
- The smaller feathers that cover a bird's body are called **contour** feathers, which lie flat against the body to protect it from wind and weather, and give the body a smooth, aerodynamic shape for flying
- Under the contour feathers are tiny, soft feathers, called **down**. These lie against the skin and help the bird to keep warm.


In cold weather, a bird will fluff out its feathers. This traps a layer of air against the skin. The bird's body heat will warm up this layer of air, and the feathers keep the warm air trapped, which helps the bird to stay warm – much like you putting on a thick jumper or a coat to keep warm when it is cold outside.

Birds can also use their feathers to hide – known as **camouflage**. This long-eared owl, for example, can use the tufts of feathers on top of its head to break up its outline, which, along with the mottled brown colouring of its feathers, helps it to blend in with the trunk of a tree, so it cannot be easily seen.

Other birds might use their feather colours to impress a potential mate – for example, the magnificent display a peacock puts on when he fans out his long, decorative tail feathers.

With some birds, looking at the colour of their feathers can help tell if you are looking at a girl or a boy. This is known scientifically as **sexual dimorphism**, which is just a posh way of saying that the girls look different to the boys! For example, here are two photos of Common Kestrels:



The male has blue grey on his head and tail, while the female is brown all over. They are the same species but the two genders have different feather colours so it is easy to tell them apart – but not all birds have this difference, so it is not always easy to tell apart the boys and girls!

Some feathers can even be used to help the bird protect itself. This Bateleur Eagle, for example, has a big crest of thick, stiff feathers it can fluff out on its head and around the face, as shown in the photo. This is because this species of eagle will sometimes hunt snakes – the eagle will puff out these feathers when hunting snakes, so if the snake tries to bite the eagle, it will only get a mouthful of feathers instead of being able to pierce the eagles' skin.

**Wing Shapes and Flying Styles**

Wings come in lots of shapes and sizes, so birds fly in lots of different ways; these varying flight styles allow birds to find food in different ways, depending on what they need to eat.

Some birds have very long wings, so that they can glide for a long time without having to flap their wings very often. This means that they can cover long distances in flight without using up very much energy. The wandering albatross, for example, has a **wingspan** of over three metres, the longest of any bird. Its wings are also quite narrow, which is a perfect shape for gliding low over the sea, using the wind moving over the surface of the water for lift.

Eagles, buzzards and vultures also have long wings but they are also very broad, with a large surface area. This helps them to catch warm, rising air currents, called **thermals**. By gliding around in these thermals, birds with big broad wings can get lots of lift and gain height without needing to flap their wings very much. Again, this means that they can fly long distances without using up much energy, which is very useful when hunting for food.

Owls have very broad wings as well, but with a much more rounded shape. Their feathers are also much softer and rougher at the edges compared to other birds. This means that the air moving over their wing does so more gently, which is what allows an owl to fly silently – they do not disturb the air as much as other birds when they flap their wings, so with their silent flight they can sneak up on their prey.

A kestrel has long, pointed wings which, when combined with a long tail, allow them to **hover** perfectly in the sky, using their keen eyesight to look for food while hanging in the air. Similarly, Hummingbirds can flap their tiny, pointed wings more than 40 times in one second. This allows them to hover perfectly still while they drink nectar from flowers, and the humming noise made by their wings as they do so is where they get their name from.

A sparrowhawk, on the other hand, hunts mostly in woodlands; it has broader, more rounded wings to allow it to twist and turn when chasing smaller birds around tree branches.

Not all birds can fly, but they still use their wings – penguins, for example, cannot 'fly' through the air at all. But their wings have **evolved** into something that looks more like the flippers of a seal, which makes them powerful swimmers – effectively 'flying' underwater. Puffins are sea birds that have small wings and although they can fly short distances, it takes a lot of effort and uses up a lot of energy. But, when they dive into water to catch fish, they can flap their wings underwater to dive deeper in pursuit of their food.

## GLOSSARY

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| **Adaptation** | An 'adaptation' is a feature or process that an animal has to help it survive better in its environment. The process of adaptation takes place over many generations, which is also known as 'evolution'. When we talk about adaptation, we mean a 'feature' which helps the animal to survive. |
| **Alula** | This is the name given to the group of small feathers near the joint of a birds' wing, which look a bit like a thumb. |
| **Barbules** | The little hooks on the vanes of a feather which hold them together to give the feather its shape. |
| **Camouflage** | This is the word given for the way in which an animal helps itself to hide in the wild – this is usually through skin, fur or feather markings that help it blend in. |
| **Contour** | The small feathers that cover a bird's body to give it a streamlined shape. |
| **Coverts** | The smaller feathers on a birds' wing, which cover the shafts of the primary and secondary flight feathers. |
| **Down** | The tiny, soft feathers on a birds' body, under the contour feathers, which help to keep it warm. |
| **Evolved** | 'Evolving' or 'evolution' is the name given to the process a living thing goes through over a long period of time to adapt to its environment so that it can survive. |
| **Flight Feathers** | The name given to the long, stiff feathers of a birds' wings and tail. Flightless birds, such as Ostriches, have limp, soft feathers as they cannot use them to fly. |
| **Hover** | Hovering is a hunting technique used by some birds to help them find their food, by flapping their wings in such a way that they can stay in one position in the air. |
| **Moulting** | The process a bird goes through when it loses any old or broken feathers and grows new ones to replace them. |
| **Preening** | The act of a bird cleaning and tidying its feathers, using its beak to rub them clean and zip them back together. |
| **Primaries** | The longest, leading flight feathers of a birds' wing. |
| **Quill** | The bare part of the shaft at the end of the feather. Also the name given to an old-fashioned writing tool made from a feather that was dipped in ink then used as a pen. |
| **Secondaries** | The shorter flight feathers of a birds' wing. |
| **Sexual Dimorphism** | This is a posh scientific way of saying that the males and females of the same species have different markings or characteristics that makes it easy to tell them apart. For example, some birds have different feather colours or patterns depending on whether they are a boy or a girl. |

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| **Thermals** | Warm, circling, rising air currents that some birds with big, broad wings can use to gain lift without having to flap their wings. |
| **Wingspan** | The length of a birds' wings, measured from the tip of the first primary feather on one wing all the way across the birds' back to the tip of the first primary feather of the other wing. |

# HOW BIRDS FLY: QUIZ

Test your new-found knowledge about how birds fly by answering the quiz questions below. When you are finished with the quiz, why not try and write a short story or a poem about a bird using the facts you have learned, or perhaps draw a picture of one?

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| 1 | How much faster does a hummingbird heart beat when at rest compared to a human heart? | |
| 2 | How much of its body weight does an owl's skeleton take up? | |
| 3 | What makes birds' bones stronger without making them heavier? | |
| 4 | What bone is unique to flying birds and what makes it special? | |
| 5 | What is special about the shape of a birds' wing and how does this affect air moving around it? | |

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| 6 | What is moulting, and why do birds do it? | |
| 7 | What is preening, and why do birds do it? | |
| 8 | Can you name three different types of feathers, and explain what each of them is for? | 1)<br><br>2)<br><br>3) |
| 9 | How do birds keep warm in cold weather? | |
| 10 | Can you give an example of how a bird uses feathers to protect itself? | |
| 11 | What is a thermal and why is it useful to some birds? | |