**ORNITHOLOGY AND HERPETOLOGY**

**Class:- B.Sc (Forestry) IInd year**

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**Introduction to Birds**

We watch them, feed them, identify them, list them, [count them](https://www.thespruce.com/how-to-count-birds-386687), protect them, and more, but what is a bird? With roughly 10,000 unique bird species in the world, it can be difficult to identify exactly what makes a bird a bird, but these remarkable creatures share a number of characteristics that help classify them as "birds."

Birds, also known as Aves or avian dinosaurs, are a group of [endothermic](https://en.wikipedia.org/wiki/Endotherm) [vertebrates](https://en.wikipedia.org/wiki/Vertebrate), characterised by [feathers](https://en.wikipedia.org/wiki/Feather), [toothless](https://en.wikipedia.org/wiki/Tooth) [beaked](https://en.wikipedia.org/wiki/Beak) jaws, the [laying](https://en.wikipedia.org/wiki/Oviparity) of [hard-shelled](https://en.wikipedia.org/wiki/Eggshell) eggs, a high [metabolic](https://en.wikipedia.org/wiki/Metabolism) rate, a four-chambered [heart](https://en.wikipedia.org/wiki/Heart), and a strong yet light weight [skeleton](https://en.wikipedia.org/wiki/Bird_skeleton). Birds live worldwide and range in size from the 5 cm (2 in) [bee hummingbird](https://en.wikipedia.org/wiki/Bee_hummingbird) to the 2.75 m (9 ft) [ostrich](https://en.wikipedia.org/wiki/Common_ostrich). They rank as the world's most numerically-successful [class](https://en.wikipedia.org/wiki/Class_%28biology%29) of [tetrapods](https://en.wikipedia.org/wiki/Tetrapod%22%20%5Co%20%22Tetrapod), with approximately ten thousand living species.

**Taxonomy of birds:**

The first [classification](https://en.wikipedia.org/wiki/Biological_classification) of birds was developed by [Francis Willughby](https://en.wikipedia.org/wiki/Francis_Willughby) and [John Ray](https://en.wikipedia.org/wiki/John_Ray) in their 1676 volume *Ornithologiae*. [Carl Linnaeus](https://en.wikipedia.org/wiki/Carl_Linnaeus) modified that work in 1758 to devise the [taxonomic classification](https://en.wikipedia.org/wiki/Taxonomic_classification) system currently in use. Birds are categorised as the [biological class](https://en.wikipedia.org/wiki/Class_%28biology%29) Aves in [Linnaean taxonomy](https://en.wikipedia.org/wiki/Linnaean_taxonomy). [Phylogenetic taxonomy](https://en.wikipedia.org/wiki/Phylogenetic_taxonomy%22%20%5Co%20%22Phylogenetic%20taxonomy) places Aves in the dinosaur [clade](https://en.wikipedia.org/wiki/Clade%22%20%5Co%20%22Clade) [Theropoda](https://en.wikipedia.org/wiki/Theropoda%22%20%5Co%20%22Theropoda). The Linnaean classification of birds is as follows:

**Kingdom:** Animalia

**Phylum:** Chordata

**Clade:** Ornithurae

**Class:** Aves

**Origin And Evolution Of Birds:**

1. **Dinosaurs and the origin of birds**

Based on fossil and biological evidence, most scientists accept that birds are a specialised subgroup of [theropod](https://en.wikipedia.org/wiki/Theropod%22%20%5Co%20%22Theropod) [dinosaurs](https://en.wikipedia.org/wiki/Dinosaur), and more specifically, they are members of [Maniraptora](https://en.wikipedia.org/wiki/Maniraptora%22%20%5Co%20%22Maniraptora), a group of theropods which includes [dromaeosaurs](https://en.wikipedia.org/wiki/Dromaeosaur%22%20%5Co%20%22Dromaeosaur) and [oviraptorids](https://en.wikipedia.org/wiki/Oviraptorid%22%20%5Co%20%22Oviraptorid), among others. The consensus view in contemporary [palaeontology](https://en.wikipedia.org/wiki/Paleontology%22%20%5Co%20%22Paleontology) is that the flying theropods, or [avialans](https://en.wikipedia.org/wiki/Avialae%22%20%5Co%20%22Avialae), are the closest relatives of the [deinonychosaurs](https://en.wikipedia.org/wiki/Deinonychosaur%22%20%5Co%20%22Deinonychosaur), which include dromaeosaurids and [troodontids](https://en.wikipedia.org/wiki/Troodontid%22%20%5Co%20%22Troodontid). Together, these form a group called [Paraves](https://en.wikipedia.org/wiki/Paraves%22%20%5Co%20%22Paraves). Some [basal](https://en.wikipedia.org/wiki/Basal_%28phylogenetics%29) members of this group, such as *[Microraptor](https://en.wikipedia.org/wiki/Microraptor%22%20%5Co%20%22Microraptor)*, have features which may have enabled them to glide or fly.

The [Late Jurassic](https://en.wikipedia.org/wiki/Late_Jurassic) *Archaeopteryx* is well known as one of the first [transitional fossils](https://en.wikipedia.org/wiki/Transitional_fossil) to be found, and it provided support for the [theory of evolution](https://en.wikipedia.org/wiki/Theory_of_evolution) in the late 19th century. *Archaeopteryx* was the first fossil to display both clearly traditional reptilian characteristics: teeth, clawed fingers, and a long, lizard-like tail, as well as wings with flight feathers similar to those of modern birds. It is not considered a direct ancestor of birds, though it is possibly closely related to the true ancestor.

1. **Early evolution**

The earliest known avialan fossils come from China, which has been dated to the late [Jurassic](https://en.wikipedia.org/wiki/Jurassic) period, about 160 million years ago. The avialan species from this time period include *[Anchiornis huxleyi](https://en.wikipedia.org/wiki/Anchiornis_huxleyi%22%20%5Co%20%22Anchiornis%20huxleyi)*, *[Xiaotingia zhengi](https://en.wikipedia.org/wiki/Xiaotingia_zhengi%22%20%5Co%20%22Xiaotingia%20zhengi)*, and *[Aurornis xui](https://en.wikipedia.org/wiki/Aurornis_xui%22%20%5Co%20%22Aurornis%20xui)*.

Avialans diversified into a wide variety of forms during the [Cretaceous Period](https://en.wikipedia.org/wiki/Cretaceous_Period). Many groups retained [primitive characteristics](https://en.wikipedia.org/wiki/Symplesiomorphy), such as clawed wings and teeth, though the latter were lost independently in a number of avialan groups, including modern birds (Aves). While the earliest forms, such as *Archaeopteryx* and *[Jeholornis](https://en.wikipedia.org/wiki/Jeholornis%22%20%5Co%20%22Jeholornis)*, retained the long bony tails of their ancestors, the tails of more advanced avialans were shortened with the advent of the [pygostyle](https://en.wikipedia.org/wiki/Pygostyle%22%20%5Co%20%22Pygostyle) bone in the group [Pygostylia](https://en.wikipedia.org/wiki/Pygostylia%22%20%5Co%20%22Pygostylia). In the late Cretaceous, about 100 million years ago, the ancestors of all modern birds evolved a more open pelvis, allowing them to lay larger eggs compared to body size. Around 95 million years ago, they evolved a better sense of smell.

1. **Early diversity of bird ancestors**

The early birds were categorized into two parts:

* 1. Enantioornithes
	2. Euornithes

 **i. Enantioornithes:**

They were also called the “opposite birds” because the construction of their shoulder bones was reverse of that in the modern birds. They were short tailed avialans and occupied a wide array of ecological niches from shore birds and fish eaters to tree dwellers and seed eaters.

While they were the dominant group of avialans during the Cretaceous period, enantioornithes became extinct along with many other dinosaur groups at the end of Mesozoic era.

**ii. Euornithes:**

They were also called “true birds” because they include the ancestors of modern birds. They were semi-aquatic and specialized in eating fish and other small aquatic organisms. Unlike the enantioornithes, which dominated land and arboreal habitats, early euornithes lacked perching adaptation and included shorebirds, swimmind and diving species.

The early euornithes also saw the development of many traits associated with modern birds, like strongly keeled breastbones, toothless, beaked portions of their jaws (though most non-avian euornithes retained teeth in other parts of the jaws). Euornithes also included the first avialans to develop true [pygostyle](https://en.wikipedia.org/wiki/Pygostyle%22%20%5Co%20%22Pygostyle) and a fully mobile fan of tail feathers, which may have replaced the "hind wing" as the primary mode of aerial maneuverability and braking in flight.

It also included ichthyornis and hesperornithiformes which became so well adapted to hunting fish and the marine environment that they lost their ability to fly and became primarily aquatic.

1. **Diversification of modern birds:**

All modern birds lie within the [crown group](https://en.wikipedia.org/wiki/Crown_group) Aves, which has two subdivisions:

* the**[Palaeognathae](https://en.wikipedia.org/wiki/Palaeognathae%22%20%5Co%20%22Palaeognathae),** which includes the flightless [ratites](https://en.wikipedia.org/wiki/Ratite) (such as the [ostriches](https://en.wikipedia.org/wiki/Ostrich)) and the weak-flying [tinamous](https://en.wikipedia.org/wiki/Tinamou%22%20%5Co%20%22Tinamou), and
* the extremely diverse **[Neognathae](https://en.wikipedia.org/wiki/Neognathae%22%20%5Co%20%22Neognathae)**, containing all other birds.

Depending on the [taxonomic](https://en.wikipedia.org/wiki/Alpha_taxonomy) viewpoint, the number of known living bird species varies anywhere from 9,800 to 10,050.

The discovery of *[Vegavis](https://en.wikipedia.org/wiki/Vegavis%22%20%5Co%20%22Vegavis)*, a late Cretaceous member of the [Anatidae](https://en.wikipedia.org/wiki/Anatidae%22%20%5Co%20%22Anatidae), proved that the diversification of modern birds started before the [Cenozoic](https://en.wikipedia.org/wiki/Cenozoic). The affinities of an earlier fossil, the possible galliform *Austinornis lentus*, dated to about 85 million years ago, are still too controversial to provide a fossil evidence of modern bird diversification.

Most studies agree on a [Cretaceous](https://en.wikipedia.org/wiki/Cretaceous) age for the most recent common ancestor of modern birds but estimates range from the [Middle Cretaceous](https://en.wikipedia.org/wiki/Middle_Cretaceous) to the latest [Late Cretaceous](https://en.wikipedia.org/wiki/Late_Cretaceous). Similarly, there is no agreement on whether most of the early diversification of modern birds occurred before or after the [Cretaceous–Palaeogene extinction event](https://en.wikipedia.org/wiki/Cretaceous%E2%80%93Paleogene_extinction_event).

**Ornithology:**

The science of ornithology has a long history and studies on birds have helped develop several key concepts in evolution, behaviour and ecology such as the definition of [species](https://en.wikipedia.org/wiki/Species), the process of [speciation](https://en.wikipedia.org/wiki/Speciation), [instinct](https://en.wikipedia.org/wiki/Instinct), [learning](https://en.wikipedia.org/wiki/Learning), [ecological niches](https://en.wikipedia.org/wiki/Ecological_niche), [guilds](https://en.wikipedia.org/wiki/Guild_%28ecology%29), [island biogeography](https://en.wikipedia.org/wiki/Island_biogeography), [phylogeography](https://en.wikipedia.org/wiki/Phylogeography%22%20%5Co%20%22Phylogeography), and [conservation](https://en.wikipedia.org/wiki/Bird_conservation). While early ornithology was principally concerned with descriptions and distributions of species, ornithologists today seek answers to very specific questions, often using birds as models to test hypotheses or predictions based on theories. Most modern biological theories apply across taxonomic groups, and the number of professional scientists who identify themselves as "ornithologists" has therefore declined. A wide range of tools and techniques is used in ornithology, both inside the laboratory and out in the field, and innovations are constantly made.

The word "ornithology" comes from the late 16th-century Latin *ornithologia* meaning "bird science" and from the [Greek](https://en.wikipedia.org/wiki/Greek_language) *ornis* meaning "bird" and *logos* meaning "theory, science, thought". Thus, Ornithology is a branch of [zoology](https://en.wikipedia.org/wiki/Zoology) that concerns the study of [birds](https://en.wikipedia.org/wiki/Birds). Several aspects of ornithology differ from related disciplines, due partly to the high visibility and the aesthetic appeal of birds.

**History of ornithology:**

The history of ornithology largely reflects the trends in the [history of biology](https://en.wikipedia.org/wiki/History_of_biology), as well as many other scientific disciplines, including [ecology](https://en.wikipedia.org/wiki/Ecology), [anatomy](https://en.wikipedia.org/wiki/Anatomy), [physiology](https://en.wikipedia.org/wiki/Physiology), [paleontology](https://en.wikipedia.org/wiki/Paleontology), and more recently, molecular biology. Trends include the move from mere descriptions to the identification of patterns, thus towards elucidating the processes that produce these patterns.

1. **Early Knowledge and Study**

Humans have had an observational relationship with birds since [prehistory](https://en.wikipedia.org/wiki/Prehistory), with some stone-age drawings being amongst the oldest indications of an interest in birds. Birds were perhaps important as food sources, and bones of as many as 80 species have been found in excavations of early [Stone Age](https://en.wikipedia.org/wiki/Stone_Age) settlements. [Waterbird](https://en.wikipedia.org/wiki/Waterbird%22%20%5Co%20%22Waterbird) and [seabird](https://en.wikipedia.org/wiki/Seabird) remains have also been found in [shell mounds](https://en.wikipedia.org/wiki/Shell_mound) on the island of [Oronsay](https://en.wikipedia.org/wiki/Oronsay%2C_Inner_Hebrides%22%20%5Co%20%22Oronsay%2C%20Inner%20Hebrides) off the coast of [Scotland](https://en.wikipedia.org/wiki/Scotland).

[Poultry](https://en.wikipedia.org/wiki/Poultry) farming and [falconry](https://en.wikipedia.org/wiki/Falconry) were practised from early times in many parts of the world. Artificial incubation of poultry was practised in China around 246 BC and around at least 400 BC in Egypt. The Egyptians also made use of birds in their hieroglyphic scripts, many of which, though stylized, are still identifiable to species. Early written records provide valuable information on the past distributions of species. For instance, [Xenophon](https://en.wikipedia.org/wiki/Xenophon) records the abundance of the [ostrich](https://en.wikipedia.org/wiki/Ostrich) in [Assyria](https://en.wikipedia.org/wiki/Assyria). Other old writings such as the [Vedas](https://en.wikipedia.org/wiki/Vedas) (1500–800 BC) demonstrate the careful observation of avian life histories and include the earliest reference to the habit of [brood parasitism](https://en.wikipedia.org/wiki/Brood_parasite) by the [Asian koel](https://en.wikipedia.org/wiki/Asian_koel) (*Eudynamys scolopacea*).

[Aristotle](https://en.wikipedia.org/wiki/Aristotle) in 350 BC in his *[Historia Animalium](https://en.wikipedia.org/wiki/History_of_animals%22%20%5Co%20%22History%20of%20animals)* noted the habit of [bird migration](https://en.wikipedia.org/wiki/Bird_migration), moulting, egg laying, and lifespans, as well as compiling a list of 170 different bird species. However, he also introduced and propagated several myths, such as the idea that [swallows](https://en.wikipedia.org/wiki/Swallow) [hibernated](https://en.wikipedia.org/wiki/Hibernated) in winter**.** The earliest record of falconry comes from the reign of Sargon II (722–705 BC) in [Assyria](https://en.wikipedia.org/wiki/Assyria). Falconry is thought to have made its entry to Europe only after AD 400, brought in from the east after invasions by the [Huns](https://en.wikipedia.org/wiki/Huns) and [Alans](https://en.wikipedia.org/wiki/Alans%22%20%5Co%20%22Alans).

[Volcher Coiter](https://en.wikipedia.org/wiki/Volcher_Coiter) (1534–1576), a Dutch anatomist, made detailed studies of the internal structures of birds and produced a classification of birds that was based on structure and habits. [Pierre Belon](https://en.wikipedia.org/wiki/Pierre_Belon) described the fish and birds that he had seen in France and the Levant. Belon's *Book of Birds* (1555) is a folio volume with descriptions of some 200 species. His comparison of the skeleton of humans and birds is considered as a landmark in [comparative anatomy](https://en.wikipedia.org/wiki/Comparative_anatomy). [Ulisse Aldrovandi](https://en.wikipedia.org/wiki/Ulisse_Aldrovandi), an encyclopedic naturalist, began a 14-volume natural history with three volumes on birds which was published from 1599 to 1603. His *Ornithology* covers 2000 pages and included such aspects as the [chicken](https://en.wikipedia.org/wiki/Chicken) and poultry techniques. He used a number of traits including behaviour, particularly bathing and dusting, to classify bird groups.

In the 17th century, [Francis Willughby](https://en.wikipedia.org/wiki/Francis_Willughby) (1635–1672) and [John Ray](https://en.wikipedia.org/wiki/John_Ray) (1627–1705) came up with the first major system of bird classification that was based on function and morphology rather than on form or behaviour. Willughby's *Ornithologiae libri tres* (1676) completed by John Ray is sometimes considered to mark the beginning of scientific ornithology. The earliest list of British birds, *Pinax Rerum Naturalium Britannicarum*, was written by [Christopher Merrett](https://en.wikipedia.org/wiki/Christopher_Merrett) in 1667. Naturalist [Sir Thomas Browne](https://en.wikipedia.org/wiki/Sir_Thomas_Browne) (1605–82) introduced the words "incubation" and "oviparous" into the English language.

[Louis Jean Pierre Vieillot](https://en.wikipedia.org/wiki/Louis_Jean_Pierre_Vieillot) (1748–1831) spent 10 years studying North American birds and pioneered in the use of life histories and habits in classification. Alexander Wilson composed a nine-volume work, *American Ornithology*, published 1808-14 was the first such record of North American birds. From 1827 to 1838, Audubon published [*The Birds of America*](https://en.wikipedia.org/wiki/Birds_of_America_%28book%29), which is often regarded as the greatest ornithological work in history.

1. **Scientific studies**

The emergence of ornithology as a scientific discipline began in the 18th century, when [Mark Catesby](https://en.wikipedia.org/wiki/Mark_Catesby) published his two-volume *Natural History of Carolina, Florida, and the Bahama Islands*, a landmark work which included 220 hand-painted engravings. However, ornithology did not emerge as a specialised science until the Victorian era—with the concept of natural history, and the collection of natural objects such as bird eggs and skins. This specialization led to the formation in Britain of the [British Ornithologists' Union](https://en.wikipedia.org/wiki/British_Ornithologists%27_Union) in 1858. In 1859, the members founded its journal [*The Ibis*](https://en.wikipedia.org/wiki/The_Ibis). The bird collectors of the Victorian era observed the variations in bird forms and habits across geographic regions, noting local specialization and variation in widespread species. The naming of species with binomials and the organization of birds into groups based on their similarities became the main work of museum specialists.

The search for patterns in the variations of birds was attempted by many. [Friedrich Wilhelm Joseph Schelling](https://en.wikipedia.org/wiki/Friedrich_Wilhelm_Joseph_Schelling) (1775–1854), his student [Johann Baptist von Spix](https://en.wikipedia.org/wiki/Johann_Baptist_von_Spix) (1781–1826), and several others believed that a hidden and innate mathematical order existed in the forms of birds. A particularly popular idea was the [Quinarian system](https://en.wikipedia.org/wiki/Quinarian_system%22%20%5Co%20%22Quinarian%20system) popularised by [Nicholas Aylward Vigors](https://en.wikipedia.org/wiki/Nicholas_Aylward_Vigors) (1785–1840), [William Sharp Macleay](https://en.wikipedia.org/wiki/William_Sharp_Macleay) (1792–1865), [William Swainson](https://en.wikipedia.org/wiki/William_John_Swainson), and others. The idea was that nature followed a "rule of five" with five groups nested hierarchically. He followed this idea and demonstrated his view of the order within the crow family. Where he failed to find five genera, he left a blank insisting that a new genus would be found to fill these gaps. These ideas were replaced by more complex "maps" of affinities in works by [Hugh Edwin Strickland](https://en.wikipedia.org/wiki/Hugh_Edwin_Strickland) and [Alfred Russel Wallace](https://en.wikipedia.org/wiki/Alfred_Russel_Wallace). A major advance was made by [Max Fürbringer](https://en.wikipedia.org/wiki/Max_F%C3%BCrbringer) in 1888, who established a comprehensive phylogeny of birds based on anatomy, morphology, distribution, and biology. This was developed further by [Hans Gadow](https://en.wikipedia.org/wiki/Hans_Gadow) and others.

The study of birds in their habitats was particularly advanced in Germany with [bird ringing](https://en.wikipedia.org/wiki/Bird_ringing) stations established as early as 1903. Work on resource partitioning and the structuring of bird communities through competition were made by [Robert MacArthur](https://en.wikipedia.org/wiki/Robert_MacArthur). Principles from economics were introduced to the study of biology by Jerram L. Brown in his work on explaining territorial behaviour. This led to more studies of behaviour that made use of cost-benefit analyses.

The new tools of molecular biology changed the study of bird systematics, which changed from being based on [phenotype](https://en.wikipedia.org/wiki/Phenotype) to the underlying [genotype](https://en.wikipedia.org/wiki/Genotype). The use of techniques such as [DNA-DNA hybridization](https://en.wikipedia.org/wiki/DNA-DNA_hybridization) to study evolutionary relationships was pioneered by [Charles Sibley](https://en.wikipedia.org/wiki/Charles_Sibley) and [Jon Edward Ahlquist](https://en.wikipedia.org/wiki/Jon_Edward_Ahlquist), resulting in what is called the [Sibley-Ahlquist taxonomy](https://en.wikipedia.org/wiki/Sibley-Ahlquist_taxonomy). These early techniques have been replaced by newer ones based on [mitochondrial DNA](https://en.wikipedia.org/wiki/Mitochondrial_DNA) sequences and [molecular phylogenetics](https://en.wikipedia.org/wiki/Molecular_phylogenetics) approaches that make use of computational procedures for [sequence alignment](https://en.wikipedia.org/wiki/Sequence_alignment), construction of [phylogenetic trees](https://en.wikipedia.org/wiki/Phylogenetic_tree%22%20%5Co%20%22Phylogenetic%20tree), and calibration of [molecular clocks](https://en.wikipedia.org/wiki/Molecular_clock) to infer evolutionary relationships. Molecular techniques are also widely used in studies of avian [population biology](https://en.wikipedia.org/wiki/Population_biology) and ecology.

**History of Ornithology In India:**

The sages of ancient India were great lover of nature. They had a very acute sense of observation and had a fairly objective knowledge of animals, both domestic as well as wild. It seems that ancient people in India closely watched and studied the animal behavior with special attention to birds.

The history of bird study in India can be better understood if we divide it into categories based on time period as follows-

1. Pre-Vedic Period
2. Vedic period (2000 BC-400 BC)
3. Post-Vedic period (1-1200 AD)
4. Moghul period (1525-1757)
5. Colonial period (1800-1947)
6. Post –Independence period (1947 onwards)
7. **Pre-Vedic Period (10,000-2000 BC)**

*Bhela Samhita* is one of the oldest treatises belonging to the pre-Vedic period (3000 BC) which prescribes the flesh of various birds for treatment of various human diseases. Besides this work there is no other work of repute from this period. But many artifacts belonging this period are available. Clay animals, sculptures, paintings, engravings on rock, pottery, clay tablets, figurines and seals etc. have been found at various excavations sites from Harappa to Inamgaon near Pune. These artifacts belong to various time periods ranging from 3rd millennium BC to 1000 AD. Though various different kinds of birds were represented, parrots and peacock were the most common. The rock cave paintings from the central India, which are more than 10,000 years old also, depict a few birds.

1. **Vedic Period (2000 BC – 400 BC)**

The epics Ramayana and Mahabharata, the Puranas and the Smriti works have several references to animals including birds. Maharishi Valmiki is not only India’s first poet, but is also regarded as the first bird watcher of India.

The Chandogya Upanishad has classified animals into three groups, one of which is that of birds. It further classifies animals into eight classes on the basis of habitats and feeding habits, the birds are put in the last two classes. The well-known treatise of Ayurveda, the Charaksamhita and the Sushrut Samhita (1st cent.BC) have many references to birds. The former divides the birds into four groups as the peckers, scratchers, water birds and birds of prey. The treatise further describes the properties of their flesh for the use as medicines.

The Rig Veda mentions about 20 birds. The Vishnu Purana mentions returning of geese during winter. The Indo-Aryan were familiar with many birds and kept hill myna and parrots as pet. They also knew parasiting habit of koel.

Panchatantra (3rd cent BC) is another treatise on political science and human moral conduct. It is recognized as the book of Indian folk wisdom. Most of the stories are told using various animals and birds as the actors in the stories. Several *Smriti* works mention prohibitive rules against killing many birds.

The ‘Arthashastra’ by Kautilya (4th cent BC) is a treatise on political science and governance. It recommends the protection of auspicious, pleasure and pet birds. It also mentions the use of royal homing pigeons for carrying news and messages. The work also discusses the use of flesh of various birds.

1. **Post-Vedic Period (300 BC-1200 AD)**

One of the greatest littérateurs, Kalidasa belongs to this period. He was an ardent nature lover and master of geography. His literature contains frequent references of birds including peacock, parrots, pigeons, swans, geese and many other water and garden birds. His ‘*Raghuvansh*’ mentions flocks of ‘kadamb’ (geese) visiting India from Manasarovar in Tibet across the Himalayas. In the Jaina work, Tattvarthadhigama Umasvasti (40 AD) has attempted a classification of the animal kingdom on the basis of number of senses. Prasnavyakran (5th AD) mentions over 50 different kinds of birds.

The Jataka tales (5th AD) are a series of books and many of them have bird titles like Tittiri (partridge) Jataka, Hansa (swan) Jataka, Baka (heron) Jataka etc. Many Jataka stories mention birds of various kinds. This is also the period of the Sangam literature (4th to 7th cent AD). The treatises were produced in the Tamil country (present day Tamil Nadu).The work mentions a large variety of animals, both wild and domestic, including birds. There is a detailed discussion on birds with respect to their habits and ecological distribution. This is probably the first time that the distributional aspects are mentioned.

Two important works of the later part of this period are the Sandes Rasaka and Mriga Pakshi shashtra, both belonging to the 13th century. The former mentions changing birds as per the changing seasons. The latter written by Hamsadeva, a Jain sage, is the science of animals and birds. The work has two volumes; the first describes 27 mammals and the second 97 bird species.

1. **Mughal period (12-17th century)**

Many Mughal emperors were keen naturalists. They were fond of hunting and maintained menageries .Their works include the memories of Babur (1494-1529), Akbar (1556-1605) and Jahangir (1605-1627). These were written either by them or by writers appointed by them. Most prominent among them is the ‘*Baburnama’*- memories of Babur. *Baburnama* mentions a large variety of game, garden and town birds as well those seen in the nearby jungles. The unique aspect of the memories is the Moghul paintings, which were quite realistic and depicted various animals and birds. These painting have made the memories more authentic.

The Marathi saints period (12-17th centuries) coincides with the Mughal period. Maharashtra has a very long and rich saints (sant) tradition ranging from Sant Dyaneshwar (13th century) to Sant Ramdas (17th century).Their treatise include references to animals and birds, with anecdotes describing their greatness and usefulness.

1. **Colonial Period (1800-1947)**

This was the era when the Britain had started establishing their empire in every corner of the world. This was also the period when British biologists, scientists, civil and military officers and traders had undertaken the task of collecting the information about natural resources including biological resources, because there were many gaps in the knowledge and collection that became inevitable.Collection was one of the chief ways of gathering information about India’s little known flora and fauna. Most of the earlier works on India’s natural and wildlife wealth have been contributed not by experts but amateur naturalists. The information thus collected was compiled by many experts to produce first fauna books.

The first ever account of birds of the region dates back to 1830’s when Lt.Col.Sykes of the Bombay Army wrote a catalogue of birds observed in the ‘Dukhun’ (Deccan). The overall beginning of the ornithological study in the country is credited to T.C.Jerdon. His pioneer work on the Indian birds-“The Birds of India” was published in 1862-64.Allan Octavian Hume (who also happened to be the founder of the Indian National Congress) edited the “Stray Feathers” (SF) – a periodical dedicated to bird study. Ten volumes of the “SF” were published between 1872 and 1888.The first bird list for any part of the present day Maharashtra appeared in the “SF” in 1876.It was contributed by S.B.Fairbank and covered the Sahyadri Mountains including Matheran & Mahabaleshwar. The Deccan list included birds from the grass & scrub country from the eastern margin of the present study area.

The Journal of the Bombay Natural History Society, which started in 1886, has been regularly publishing ornithological papers, notes and checklists for different parts of India. The earlier issues of the journal contained Barne’s articles on nesting birds of western India, followed by Stuart-Baker’s Ducks and Betham’s nesting accounts of the Deccan birds.

1. **Post-Independent Period:**

Decades following 1940’s were dominated by one man-Dr.Salim Ali, the Doyen of modern Indian ornithology. He started his real forays for birds while a resident of the Pali hill, in Mumbai in late twenties. Dr.Ali along with Prater, McCann and Abdulali made most of his earlier collections here. He also collected birds from nearby Western Ghats country.Though his bird study started during the early part of the twentieth century and his land mark book ‘The Book of Indian Birds’ first appeared in 1944 ,his classic bird books appeared only during the post –Independent era.

Another keen naturalist and ornithologist of the contemporary era- Humayun Abdulali, Salim Ali’s cousin and one time companion, had also started natural history studies around the same time. In the early thirties he collected birds for St.Xavier’s college museum from Mumbai neighborhoods. This collection helped him in producing a series of papers jointly with Salim Ali, titled “Birds of Bombay and Salsette” which appeared in the journal of the BNHS in 1936-37.Since then Mr. Abdulali contributed on regular basis to the ‘Journal’ on birds of the oriental region in general and western India in particular. His notes dealt with every aspect of bird – nidification, nesting, molting, local movements, mortality, new occurrences, range extension and description of new races from Konkan and Western Ghats country. His two checklists, one for the state as a whole (1973) and another for the Sanjay Gandhi (Borivli) National Park (1981) have been widely acclaimed and used. V. C. Ambedkar, the first research student of Dr.Salim Ali, produced a landmark study on Baya weaver bird most of which was based in Pune. He also contributed a chapter on birds, along with D. N. Mathew to the FAUNA Gazetteer of Maharashtra State (1974).

Another Pune-based naturalist, Prakash Gole initially wrote about common birds around Pune.(1972,1973). The first ever bird list for the city was contributed by P.Gole in 1972.His ‘March Bird Count for Poona’ (1981) was the first ever bird count not only for the city of Pune but for any city in Maharashtra. The bird census covered about 120 km2 of the city area, enumerated about 55000 birds belonging to 130 species. He (1985) also studied the avifauna of the polluted stretches of the Mula-Mutha Rivers and identified some indicator species. He afterwards shifted his attention to Konkan and Western Ghats birds. His ‘Birds of Western Ghats’ is the only bird study for the region with some geographical bias.

Purandare K. (1984) did a systematic year-long study of the breeding biology of Black-shouldered kite from a riverside grove along river Mutha. Nalavade (1981) analyzed the birds of Pune area from geographer’s point of view. Dr.Bharucha’s (1986, 1987, 1988, and 1990) work mostly deals with wetlands and wetland birds around Pune. Ingalhallikar & T. Gole (1987) recorded 290 species for a slightly larger area. Dr Anil Mahabal of the Zoological Survey of India has extensively worked on population, roosting behavior and social biology of communally roosting birds - mynas, parakeets, kites and crows. Purandare K.(1994) conducted another landmark study on the breeding biology of Whit-browed Wagtail along a stretch of Mutha river. He also provides a checklist of water birds found in the wagtail habitat.

The first decade of the 21st century saw many landmark studies by Dr. S. Pande. His work deals with various aspects of birds around Pune, Sahyadri and western coast. He is also the lead author of “The Birds of Western Ghats, Kokan and Malabar” (2003) and his pocket guide on birds of Khandala, as a co-author (2008) has become quite popular within a short period of time. The Asian Waterfowl Census, which has been taking place on regular basis since 1987 covers many water bodies from Pune, Satara and Raigad districts.

**Characteristics of birds:**

All birds are classified as members of the Kingdom Animalia, Phylum Chordata and Class Aves. While this may seem to be an arbitrary, artificial classification, this general grouping emphasizes that birds are related through many of the characteristics they share, including:

1. **Vertebrates**:

All birds have a backbone, which places them in the Phylum Chordata. Unlike most other vertebrates, however, birds have a lighter skeletal structure filled with hollows, gaps, and air sacs to keep birds lightweight so they can fly more efficiently.

1. **Feathers**:

All birds have evolved feathers, composed of keratin and other proteins and light-reflecting pigments, to serve as body insulation. Different types of feathers may also be ornamental, such as plumes, [crests](https://www.thespruce.com/meaning-of-crest-385208), or streamers. Other feather types help birds [control their flight](https://www.thespruce.com/how-do-birds-fly-4165822), while some feathers, such as down, are strictly for insulation.

1. **Wings**:

Wings are one of the most defining characteristics of birds. Even [flightless birds](https://www.thespruce.com/why-some-birds-dont-fly-385428) have vestigial or adapted wings or [flippers](https://www.thespruce.com/flipper-definition-penguin-wings-385251) they may use for swimming, threat displays, or [courtship dances](https://www.thespruce.com/bird-courtship-behavior-386714). The size and shape of wings vary between species based on how the bird flies and [wing markings are useful to identify bird species](https://www.thespruce.com/bird-wing-parts-387365).

1. **Bill**:

All birds have a bony, keratin-covered projection forming their mouth. This [bill](https://www.thespruce.com/bird-bill-parts-387362) is frequently evolved for specific [bird diet types](https://www.thespruce.com/bird-diet-types-386612), and many birds also use their bills as tools for carrying, [drumming](https://www.thespruce.com/why-woodpeckers-drum-386708), drilling, [preening](https://www.thespruce.com/why-birds-preen-386448), and other tasks. Some birds even use their bills as weapons or to help regulate body temperature.

1. **Warm-blooded**:

All birds are endothermic, which means they generate their own internal body heat and do not rely exclusively on their environment to maintain their temperature. While many birds will sun themselves to help regulate their temperature, [sunning](https://www.thespruce.com/bird-sunning-386442) has more than one purpose and is not solely for body temperature maintenance.

1. **High metabolism**:

Birds have a high, efficient metabolism that quickly turns food into usable energy. They have a four-chambered heart and high respiratory rate as well, which helps them be efficient and agile fliers as well as maintain their high body temperatures.

1. **Bipedal**:
2. All birds have two legs used for perching, walking, hopping, or running. Different types of birds have evolved different leg shapes and lengths to suit their needs. For example, [wading birds](https://www.thespruce.com/what-is-a-wading-bird-387103) have thin, long legs suitable for moving through deeper water, while [raptors](https://www.thespruce.com/types-of-birds-of-prey-387307) have thicker, more powerful legs for capturing prey.
3. **Furcula**:

Though not visible to birders, every bird has a [furcula, or wishbone](https://www.thespruce.com/wishbone-bird-anatomy-385409), that protects the chest cavity during wing beats. This keeps the bird's chest organs safe from excessive pressure as the wings move and birds change altitude.

1. **Egg-laying**:

All birds lay amniotic eggs as part of their reproductive cycle. The eggs have a hard shell and require incubation to continue development until hatching. [Egg size, shape, and markings vary](https://www.thespruce.com/how-to-identify-bird-eggs-387352) for each species, as does the number of eggs laid, necessary incubation time, and the condition of the chicks at hatching.

1. **Communication**:

Birds have highly developed communication skills, and many bird species communicate vocally through elaborate songs and calls. [Nonverbal bird sounds](https://www.thespruce.com/nonverbal-bird-sounds-387324) are also part of their communication abilities. For many species, extensive communication is part of courtship behavior, [territorial defense](https://www.thespruce.com/how-birds-claim-territory-386444), parent-chick recognition, and community cooperation.

1. **Navigation**:

Migratory and non-migratory birds alike have keen navigational skills. For [migrating species](https://www.thespruce.com/types-of-bird-migration-386055), those skills allow them to make journeys of hundreds or thousands of miles through highly variable climate and geographical conditions, yet arrive at the same places year after year. [Non-migratory birds](https://www.thespruce.com/why-birds-dont-migrate-4151247) also use their navigation skills to visit the same food sources or nesting sites without difficulty.

**External Morphology of a Bird:**

The first step toward successful bird identification is knowing the basic parts of a bird. Thrushes have the most common, classic bird "shape" that is easily broken into all the key parts, each of which can be examined closely to help identify birds.

1. **Head**:

The bird's head is one of the best places to look for field marks such as eye color, malar stripes, eyebrows, eye rings, eye lines and auricular patches. The [crown](https://www.thespruce.com/crown-bird-anatomy-385211) (top) and [nape](https://www.thespruce.com/glossary-definition-nape-385319) (back) are also key parts of the head that can help identify a bird. The head of a bird consists of the following parts:

1. **Forehead:** The forehead extends from the base of the upper mandible to a line drawn across the top of head approximately over the middle of the eyes.
2. **Crown:** The crown extends from just posterior to the forehead to the beginning of the cervical vertebrae of the neck.
3. **Lore:** The lore is the lateral area of the head between the front of the eyes and the base of the bill.
4. **Supercilium and superciliary line**: The supercilium is a line of feathers immediately above the eye. It is distinctly colored in many birds (especially sparrows, family Emberizidae) and is called the superciliary line.
5. **Eye ring:** The eye ring is a group of feathers surrounding the eye at the edge of the eyelids. These feathers often contrast with those immediately surrounding them, forming a distinct eye ring that can be a useful field mark.
6. **Eyeline**: The eyeline extends back along the side of the head from the posterior angle of the eye. Another potentially useful field mark.
7. **Narial feathers:** Narial feathers are dense, stiff feathers that extend forward along the upper mandible to partially cover the nostrils. These feathers are particularly evident on the crows (family Corvidae).
8. **Auriculars or ear coverts**. The auriculars are a patch of feathers just behind and below the eye that cover the external ear. They are often loosely webbed.
9. **Malar region or mustache feathers**. The malar feathers lie between the eye and the throat, extending back from a point where the upper and lower jaw meet (the commisure). They are distinct on the male Northern Flicker (family Picidae).
10. **Bill:**

The size, shape and color of a bird's bill is critical for identification. Also check for any curvature in the bill or unique markings such as differently colored tips or bands. For instance, seedeating birds tend to have heavy, conical bills (sparrows, family Emberizidae), insect-gleaning birds have slender, sharply pointed bills (warblers, family Parulidae), sallying birds tend to have broad, flattened bills (flycatchers, family Tyrannidae), aerial insectivores have small external bills with a large gape (nightjars, family Caprimulgidae), and piscivorous birds tend to have long, heavy, sharply pointed bills (loons, family Gaviidae).

1. **Nostrils**. The external nostrils are located on the top of the bill. The shape of the nostril occasionally serves as a taxonomic character. For example, albatrosses and other members of the order Procellariiformes have tubular nostrils that extend down the bill (and are associated with salt glands that remove salt from seawater) while superficially similar gulls (family Laridae) have linear nostrils. Accipiter hawks (family Accipitridae) have oval nostrils, while falcons (family Falconidae) have circular nostrils.
2. **Operculum**. The operculum is a soft, fleshy structure at the base of the upper bill that covers the external nostrils. It is especially evident in pigeons (family Columbidae).
3. **Tomia**. The tomia (singular, tomium) is the cutting edges of either the upper or lower mandible. The tomia are notched in some birds (falcons, family Falconidae), and serrate in others (mergansers, family Anatidae).
4. **Chin**: The chin, directly below the bill, is often hard to see on many birds, but when it is a different color it can be an exceptional body part to check for identification.
5. **Throat**: A bird's throat may be a different color from its surrounding [plumage](https://www.thespruce.com/bird-plumages-387315), or it may be marked with spots, streaks or lines. [Malar stripes](https://www.thespruce.com/malar-stripe-bird-field-marks-385301) may frame the throat as well, helping set it off from the rest of a bird's body. For many birds, the chin and throat have similar colors and markings.
6. **Neck**: The neck of a bird is hard to see on many species, since it can be relatively short and insignificant. On [wading birds](https://www.thespruce.com/what-is-a-wading-bird-387103), however, the neck is much more prominent and can be a good place to look for field marks. The length of the neck can also help distinguish different bird species.
7. **Back**: A bird's back is often broad and easy to see in the right posture. Look for different colors and markings along the back that distinguish it from the neck, rump and wings.
8. **Chest**: The chest (also called the breast) is the upright part of the bird's body between the throat and the abdomen. A bird's chest may be differently colored or marked with stripes, streaks or spots that can help with identification.
9. **Abdomen**: The abdomen or belly of a bird extends from the bottom of the chest to the undertail coverts. The colors and markings on the abdomen may vary from the chest and flanks, making it a good feature to check for identification.
10. **Flanks**: The flanks (sides) of a bird are located between the underside of the wings and the abdomen. In many bird species, the flanks have unique colors or markings, though depending on how the birds carry their wings, the flanks may be difficult to see.
11. **Wings**: [Birds' wings](https://www.thespruce.com/bird-wing-parts-387365) are their upper limbs used for flight. [Wing bars](https://www.thespruce.com/wing-bar-bird-field-marks-385420) or patches are useful field marks, as are the lengths of the wings compared to the length of the tail when the bird is perched. In flight, wing shape is also a great field mark.
12. **Rump**: A bird's rump is the patch above the tail and low on the back. For many birds, the rump does not stand out, but some species show unique rump color patches that are useful for identification.
13. **Tail**: The length, shape and colors of a bird's tail are important for proper identification. The tail can be held in different positions when the bird is perched or flying, however, and watching for different markings can help distinguish different birds.
14. **Undertail Coverts**: The short feathers beneath the tail are the undertail coverts, and these feathers often show unique colors or markings that can distinguish bird species.
15. **Legs**: Birds' legs vary in length and color, both of which can be useful field marks for proper identification. The thickness of the leg, while difficult to see on many species, can also be a clue, as can any feathering. Some raptors, for example, have heavily feathered legs that can be used to identify the birds.
16. **Feet**: Many birds' feet are the same color as their legs, but not always. The orientation of the toes, the size of the [talons](https://www.thespruce.com/bird-talons-385394) and how a bird uses its feet are also useful identification characteristics.

**Internal Anatomy of The bird:**

Birds are just as different from us on the inside as they are on the outside. Read on to learn about the different parts that keep your pet going.

1. **Brain:**

Being called a bird brain isn't necessarily a bad thing--in fact, some may take it as a compliment! Birds are extremely intelligent creatures, and as any bird owner knows, they never fail to surprise us with their [capacity for learning](https://www.thesprucepets.com/cool-tricks-to-teach-pet-bird-390474).

1. **Spinal Column:**

Like all vertebrates, birds have a spinal column that runs the length of their bodies, and encases the delicate spinal cord. The spinal cord is part of the central nervous system and, in essence, acts as the brain's "messenger." When the bird decides that he wants to move, the spinal cord relays the message from the brain to the muscles that correspond to the desired body part, causing movement.

1. **Trachea:**

The trachea is a long tube that runs from the bird's throat to its lungs, and transports fresh air for the bird to breathe.

1. **Esophagus:**

The bird's esophagus is a narrow tube that transports food from the mouth to the crop, where it will be stored until it is digested.

1. **Lung:**

Much like human lungs, avian lungs serve to diffuse air throughout the bird's bloodstream. They are unique, however, in the fact that they have small air sacs that allow air to flow through the lung in only one direction, ensuring a constant supply of fresh oxygen.

1. **Crop:**

In the same way that a chipmunk stores food in its cheeks, birds store food in their crops. The crop is composed of layers of muscle tissue and holds and softens the food until it's ready to be passed on to the gizzard.

1. **Gizzard:**

A gizzard is a structure composed of tough muscle tissue which contains roughage that is used to grind the bird's food into a pulp. When the food is sufficiently ground, it is passed into the bird's intestine.

1. **Kidney:**

Liquids that the bird ingests are passed into the kidneys, which filter out any waste to be expelled from the bird later.

1. **Heart:**

Much like our human hearts, a bird's heart is divided into four chambers and serves to pump oxygen-rich blood throughout the body. Because birds are such high-energy animals, their hearts beat much faster than those of mammals. Some bird species have a resting heart rate of over 500 beats per minute.

1. **Liver:**

A bird's liver acts much like a large filter, and rids the bird of any toxins in its body.

1. **Ureter:**

The ureter is a tube that extends from the kidney to the cloaca, and allows liquid waste to be expelled from the bird's body.

1. **Intestines:**

A bird's intestines work to digest the food that is pumped into them from the gizzard, absorbing the nutrients that the bird needs to function. After the food is digested, the waste is pushed into the rectum.

1. **Rectum:**
2. The rectum allows waste to be expelled from the bird's body.

**Bird physiology:**

Bird physiology is unique and closely linked to the energetic demands of [flying](https://www.basicbiology.net/animal/birds/flying/). Birds have high metabolisms and body temperatures. Their respiratory system is highly adapted to allow efficient oxygen delivery into the body during flight. A large heart pumps the circulation system to deliver oxygen and important compound around the body.

Birds are heated by the heat generated through their metabolism. Their high body temperature gives birds faster reflexes and muscle contractions which are important attributes for flying. Many birds have specialized digestive systems depending on their specific diets and the toxins they are required to digest.

There are various physiological reactions in a birds body. These are:

1. **Respiration:**

The respiratory system of birds is significantly different to mammals, mostly to account for the physical demands of flying. A bird’s respiratory system is made up of the nostrils, windpipe, bronchi, two small lungs and a network of interconnected air sacs.

1. **Circulation:**

The circulatory system of birds must be very efficient in order to keep up with demands from the respiratory system and the bird’s metabolism. The blood is responsible for transporting important compounds (such as [glucose](https://www.basicbiology.net/micro/biochemistry/carbohydrates/), [fats](https://www.basicbiology.net/micro/biochemistry/lipids/) and waste products) through the body. Large volumes of [blood](https://www.basicbiology.net/micro/cells/blood/) are pumped around the body of birds in order to maintain the delivery of such compounds.

The blood is also responsible for transporting oxygen and CO2 around the body and must keep up with the respiratory system in order to do so. Because the demand for blood is higher in birds than it is in [mammals](https://www.basicbiology.net/animal/mammals/), birds typically have larger hearts than mammals of similar sizes.

1. **Metabolism:**

The metabolism is the set of chemical reactions that keep an organism alive and is an important part of a bird’s physiology. These reactions require energy and an individual’s metabolism is the total amount of energy required to sustain this complete set of chemical reactions. If we consider all organisms and more specifically just animals, birds have high metabolisms relative to most living things. They are active, warm-blooded animals so they require large amounts of energy to maintain their active lifestyle and their body temperatures.

Their metabolisms are highest whilst flying when they require the most energy and lowest while they are sleeping. Metabolism in birds is closely linked to temperature regulation. Small birds have the highest metabolisms relative to their size because their small bodies lose heat faster than larger birds so their metabolisms must work harder in order to maintain their internal body temperatures.

1. **Digestion:**

Bird physiology of the digestive system in birds can be very specialized. Birds can have specialized digestive systems for different diets and they can change significantly with changes in seasons. They have sacs on the sides of their large intestines called ‘ceca’ which helps birds to digest plant material. Some birds are able to digest waxes and parrots eat clay to help them digest toxic compounds in [fruits](https://www.basicbiology.net/plants/angiosperms/fruit/) and seeds. Hummingbirds are able to extract 99% of the energy from the nectar they feed on.

1. **Temperature regulation:**

Birds maintain their body temperatures by producing heat through their metabolism rather than relying on heat from the environment. Their feathers also play an important role in regulating their temperatures by controlling how much heat leaves the body.

A bird’s body temperature is usually maintained within the high range of 40-42°C and this allows birds to be very active but means they are required to eat a lot of food. A bird will consume around 20 times as much food as a reptile of a similar size. Birds also regulate their body temperatures by shivering when they are cold, panting or fluttering when they are hot, and increasing or reducing blood flow to their feet. Temperatures over 46°C are fatal.

**Skeletal System of a Bird:**

The [anatomical](https://en.wikipedia.org/wiki/Anatomy) specializations have earned birds their own [class](https://en.wikipedia.org/wiki/Scientific_classification) in the [vertebrate](https://en.wikipedia.org/wiki/Vertebrate) [phylum](https://en.wikipedia.org/wiki/Phylum).

All the vertebrate animals possess skeletons as it helps them in providing support and plays a vital role in protecting both interior organs and their tissues. The Birds skeletal system resembles related to that of other animals but it too light weighed which is required them to fly while having necessary body support.

Birds are creatures gifted with the flying ability and their body structure also made up so. Even though the avian skull and limb structure resemble human system, their skeletal systems are different. Avian skeletal systems have modified according to their usage.

As compared to mammals [skeletal system](https://byjus.com/biology/skeletal-system/) of birds is light weighted. But they are sufficiently strong to overcome the stresses they face during flight and landing. Also, the numbers of bones are far lesser than reptiles and mammals.

Bones of birds are hollow which makes them light-weighted while internal struts or cross walls make them strong. But penguin-like birds have solid bones, hence, they can’t fly.  Hollow bones contain air spaces in them. These allow more oxygen absorption and provide the extra energy needed for flight. Numerous bones fused together to reduce the count and make the bird’s skeleton rigid.  Breastbone (keel-shaped sternum) its large surface area provides the attachment for muscles for flight. Breast bones are fused collarbones (furcula or wishbone).

Here are some unique features of Birds – Skeletal System.

* The vertebral sections of the bird’s backbone are fused together to provide the rigidity which is required for them to flight.
* The skull size of the birds is proportionally smaller compared to the other species and this helps birds to fly easily.
* The Skeletal System of birds includes various hollow bones with crisscrossing reinforcements for structural strength.
* Birds lack teeth and have a beak which is more lightweight.
* Birds have a fused collarbone, attached to the site of the muscles used for flight.

**Digestive system of birds:**

The digestive system of any animal is of vital importance for the processing of the food that the animal consumes. Through the digestive tract birds can absorb all the nutrients their bodies need to grow, maintain and reproduce.

As the birds do not have teeth, the foods digested by them are decomposed mechanically and chemically in the digestive system. That is, different digestive enzymes and acids are released to be able to digest the food and the organs involved in the process are crushed and mixed, ensuring maximum absorption of nutrients during the process.

**Parts of the digestive system:**

1. **Beak or Mouth:**

Birds use their beak to feed themselves. All food entering the bird's body first passes through the beak. Birds have no teeth, so they can not chew food. However, salivary glands can be found inside the beak, which serves to moisten food, allowing them to be swallowed easily.

The saliva that is inside the beak contains digestive enzymes as [amylase](https://es.wikipedia.org/wiki/Amilasa)Which serve to initiate the process of digestion of food. Birds also use their tongue to push the food to the back of the beak to swallow it.

### Esophagus

The esophagus is a flexible tube that connects the beak to the rest of the bird's digestive tract. It is responsible for bringing food from the mouth to the crop and from the crop to the proventriculus.

1. **Crop:**

The crop is a protrusion of the esophagus located in the region of the neck of the bird. Swallowed food and water are stored in this bag until they can pass to the rest of the digestive tract. When the crop is empty or almost empty, it sends signals of hunger to the brain for the bird to eat more food.

Although the digestive enzymes secreted in the beak begin the process of digestion, in the crop this process is quite slow, since this organ serves as a temporary storage place for food. This storage mechanism was developed in birds that are typically hunted by other animals, but need to move in the open to find food. In this way, birds can consume a considerable amount of food quickly and then move to a safer place to digest such food.

1. **Proventricle:**

The esophagus continues after the crop and connects it with the proventriculus. This organ is known as the glandular stomach of birds where the primary digestion begins.

Hydrochloric acid and digestive enzymes such as pepsin are mixed with ingested food and begin to break down more efficiently. At this time, the food has not yet been ground.

1. **Ventricle or gizzard:**

The ventricle or gizzard is an organ of the digestive system of both birds and reptiles, earthworms and fish. It is usually referred to as the mechanical stomach, because it is composed of a pair of strong muscles with a protective membrane that act as if they were the teeth of the bird. The food consumed by the bird and the digestive juices from the salivary glands and the proventriculus pass to the gizzard where everything will be ground and mixed.

1. **Small Intestine:**

The next step of digestion occurs in the duodenum and the nutrients released by the food are mainly absorbed in the lower part of the small intestine. The duodenum receives the digestive enzymes and bicarbonate from the pancreas and bile of the liver to counteract the effect of [Hydrochloric acid](https://es.wikipedia.org/wiki/%C3%81cido_clorh%C3%ADdrico)from the proventriculus. The digestive juices produced by the pancreas are mainly related to the digestion of proteins. Bile is a major cleansing agent in lipid digestion and absorption of fat-soluble vitamins such as A, D, E, and K. The lower part of the small intestine is composed of two parts, which [jejunum](https://es.wikipedia.org/wiki/Yeyuno)and the [ileum](https://es.wikipedia.org/wiki/%C3%8Dleon). The [Meckel's diverticulum](https://es.wikipedia.org/wiki/Divert%C3%ADculo_de_Meckel%22%20%5Ct%20%22_blank)marks the end of the jejunum and the beginning of the ileum. This diverticulum is formed during the embryonic stage of the birds.

1. **Ceca:**

The ceca consists of two blind pockets where the small and large intestine are attached. Some traces of water contained in the digested food are reabsorbed at this point. The ceca is located very close to the end of the digestive tract, however, it still absorbs some nutrients available in the food.

Another important function of the ceca is the fermentation of the food remains that have not yet finished being digested. During the fermentation process, the mint produces fatty acids and the eight Vitamins B (Thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, biotin, folic acid and vitamin B12).

### Large Intestine or Colon

Although the name suggests that the large intestine is larger than the small intestine, it is actually shorter. The main function of the large intestine is to absorb the remaining remains of water present in the digested material.

### Cloaca

In the cloaca, residues of digestion are mixed with waste from the urinary system (urea). Birds usually expel fecal matter from the digestive system along with uric acid crystals resulting from the process of the excretory system. As birds do not urinate, they expel debris from uric acid in the form of a whitish, creamy paste. The feces of the birds can indicate in which state of health they are. The color and texture of the fecal material indicates the conditions under which the digestive tract is located.

In the cloaca also converge the reproductive system of the birds. When a female lays an egg, the vagina is folded over the surface of the egg, so that the cloaca can be opened without contact with faeces or urine.

Because of their high metabolic requirements, birds should consume more food than other vertebrates in proportion to their size. The digestive process makes possible the release of nutrients contained in food. Likewise, it makes possible the absorption and uniform distribution of these nutrients in the body of the bird.

**Respiratory System of the bird:**

The **Respiratory system of birds**is in charge of oxygenating the tissues and organs and of expelling the carbon dioxide of the body of the same. Birds have relatively small lungs and up to nine air sacs that help them with the gas exchange process. This allows their respiratory system to be unique among vertebrates. The air sacs located around the lungs allow a unidirectional flow of air through the lungs, providing more oxygen to the body of the birds.

The unidirectional flow of air moving into the lungs of birds has a high oxygen content, higher than that found in the lungs of any mammal, including humans. Being able to store more oxygen in the lungs allows birds to better oxygenate their body, thus maintaining regulated body temperature while in flight. In birds' lungs, oxygen is distributed from the air capillaries to the blood, and carbon dioxide passes from the blood to the capillaries themselves. Gaseous exchange is, in this sense, very efficient.

**Process of Breathing in birds:**

The process of breathing in birds requires two cycles to move the air through the entire respiratory system. Birds can breathe through the mouth or nostrils. The air entering through these openings during the inhalation process passes through the pharynx and then through the windpipe or tube.

The trachea usually has the same length as the bird's neck, however, some birds, such as the cranes, have an exceptionally long neck and their windpipe that coils within an extension of the sternum known as a keel. This condition gives birds the possibility of producing sounds with high resonance.

1. **Inhalation**

During the first inhalation, the air passes through the nostrils or nostrils located at the junction between the top of the beak and the head. The fleshy tissue surrounding the nostrils is known as wax in some birds.

Air in birds, as in mammals, moves through the nostrils, into the nasal cavity, and then into the larynx and trachea.

Once in the trachea, the air passes through the syrinx (organ responsible for the production of sounds in birds) and its current is divided in two, since the trachea of ​​the birds has two channels.

The air in the process of breathing of the birds does not go directly to the lungs, first it goes to the caudal air sacs, from where it will pass to the lungs and during the second inhalation it will pass to the craneal air sacs. During this process, all air sacs expand as the air enters the body of the bird.

1. **Exhalation**

During the first exhalation, the air moves from the posterior air sacs to the bronchi (ventrobronchios and dorsobronchios) and then to the lungs. The bronchi are divided into small capillary branches through which the blood flows, it is in these aerial capillaries where the exchange of oxygen by carbon dioxide takes place.

At the second exhalation, air exits the air sacs through the syrinx and then into the trachea, larynx, and finally into the nasal cavity and out of the nostrils. During this process, the volume of the sacks decreases as the air exits the bird's body.

**Structure and elements of a bird respiratory system:**

**Structure:**

Birds have larynx, however and unlike mammals, do not use it to produce sounds. There is an organ called syrinx that is in charge of acting as a"voice box"and allows birds to produce highly resonant sounds.

On the other hand, birds have lungs, but they also have air sacs. Depending on the species, the bird will have seven or nine air sacs.

Birds do not have a diaphragm, so air is displaced into and out of the respiratory system by changes in the pressure of the air sacs. The chest muscles cause the sternum to be pressed outward, creating a negative pressure in the sacs that allows air to enter the respiratory system.

The exhalation process is not passive, but requires the contraction of certain muscles to increase the pressure in the air sacs and propel the air out.

**Elements:**

1. **Air sacs:**

Birds have a lot of"empty space"inside them, which allows them to be apt to fly. This empty space is occupied by air sacs that inflate and deflate during the breathing process of the bird. The air sacs allow a one-way flow of air through the lungs. This means that the air that reaches the lungs is mostly"fresh air"with a higher oxygen content.

Birds have at least nine air sacs that allow them to deliver oxygen to body tissues and remove remaining carbon dioxide. They also play the role of regulating body temperature during the flight phase.

The nine air sacs of birds can be described as follows:

* An interclavicular air sac
* Two cervical air sacs
* Two anterior thoracic air sacs
* Two posterior thoracic air sacs
* Two abdominal air sacs
* The function of these nine sacs can be divided into anterior sacs (interclavicular, cervical and anterior thoracic) and posterior sacs (posterior thoracic and abdominal).

All sacks have very thin walls with some capillaries so they do not play an important role in the gaseous exchange process. However, its duty is to keep the lungs ventilated where the gas exchange takes place.

1. **Windpipe/Trachea:**

The work of the trachea of ​​the birds is the same of the one of the mammals, consists in resisting the flow of the air. However, in birds the volume of air that the trachea must withstand is 4.5 times greater than the volume of air present in the trachea of ​​mammals. The trachea forks or divides into two primary bronchi in the syrinx. The syrinx is an organ that is only found in birds, since in mammals the sounds occur in the larynx.

The main entrance to the lungs is given by the bronchi and is known as mesobronchial. The mesobronquio divides in smaller tubes called dorsobronquios that in turn take to the smaller parabronquios. The parabronchios contain hundreds of small branches and aerial capillaries surrounded by a profuse network of blood capillaries. Gaseous exchange between the lungs and blood takes place within these aerial capillaries.

1. **Lungs:**

The structure of the birds' lungs may vary slightly depending on the ramifications of parabronchia. Most birds have a pair of parabronchia, composed of an"old"(paleopulmonic) lung and a"new"(neopulmonic) lung. In the case of birds, the lungs do not expand or contract as they do in mammals, because the gas exchange does not occur in the alveoli but in the aerial capillaries and the air sacs are responsible for ventilation of the lungs.

**Excretory syetem of birds:**

The **Excretory system of birds**Is composed of kidneys, ureters and cloaca. All three are responsible for eliminating waste from the blood of these animals. The excretory system of the birds retains some similarities with that of the reptiles, in that both have cloaca and the urine is deposited in a semi-solid state creamy. However, the location, shape, and color of the organs composing both systems differs widely.

Apart from mammals, birds are the only vertebrates that can hold water in their bodies through an osmotic process of urine production. However, the ability of birds to concentrate urine is limited compared to that of mammals.

**Elements of the excretory system:**

### ****The Kidneys****

The most important organs of the excretory system of birds are the kidneys. These are two reddish brown organs, each generally consisting of three lobes. They are found behind the lungs and on each side of the spine of the birds. The kidneys have two thin, straight tubes connected in their mid-lateral part known as ureters.

A kidney is made up of the renal cortex and the renal medulla. A microscopic examination of a dissected kidney shows how it is composed of a large number of renal tubules or [Nephrons](https://es.wikipedia.org/wiki/Nefrona%22%20%5Ct%20%22_blank), each of them divided into cortical and medullary parts.

Birds have two types of nephrons, similar to those found in mammals with a [Henlewing](https://es.wikipedia.org/wiki/Asa_de_Henle%22%20%5Ct%20%22_blank)(used to help concentrate urine) found in the renal medulla, and other reptilian nephrons located in the renal cortex. Nephrons have a duty to extract components of the urine from the blood that flows through the kidneys.

A nephron is composed of a complex network of capillaries contained by a capsule, called [Bowman's capsule](https://es.wikipedia.org/wiki/C%C3%A1psula_de_Bowman), in which the blood is directly filtered. It also has a spiral segment ranging from the Bowman Capsule to the Henna Asa (in the mammalian nephrons) and finally have a [Distal tubule](https://es.wikipedia.org/wiki/T%C3%BAbulo_contorneado_distal)Which directs the urine to the ureters for subsequent removal of the body.

### ****The Ureters****

The ureters open and connect to the cloaca, located adjacent to the vas deferens of the male or female oviduct. The ureters are connected internally to the kidneys through funnel-shaped structures in each of the lobes of the kidney.

They are conduits that are used to transport the urine directly to the cloaca/sewer. Since birds do not have a bladder, the ureters must deposit the filtrate through the kidneys into the sewer chamber intended for storage.

### ****The Cloaca****

The cloaca is an organ located at the bottom of the digestive, excretory and reproductive systems of birds. It is used to expel faeces and lay eggs. It is located at the back of the body, below the base of the tail of the birds and is covered by feathers at the lower end of the abdomen.

Birds have a single hole to expel faeces, urine and lay eggs. The cloaca is the organ that allows the execution of all these functions to the extent that bird needs it. Within it are multiple folds of skin and muscle that subdivide it into cameras suitable for different uses.

Bird feces are usually stored in one or several chambers of the cloaca. Within it, the absorption of nutrients continues and solid and liquid wastes are mixed and excreted simultaneously once the bird's digestion concludes.

### ****Urine****

Unlike mammals and amphibians, birds generally do not have a bladder. Urine passes directly from the kidneys to the sewer through the ureters, from where it is transported by a Peristaltic movement to the intestine. There the excess water is reabsorbed before the disposal of the waste.

This process of water reabsorption in birds is similar to that in mammals. However, birds lack the ability to concentrate urine as efficiently as mammals can.

The urine of the birds in a thick paste with a low water content and a high content of uric acid, product of the nitrogen metabolism. After being mixed in the cloaca with solid waste, it is expelled from the bird's body in the form of white or creamy paste on the solid stool.

**Functions of the excretory system:**

The main functions of the bird excretory system are:

* to maintain the electrolyte balance,
* to maintain the water balance and
* to eliminate residues of the metabolic process, in particular nitrogenous products such as uric acid.