

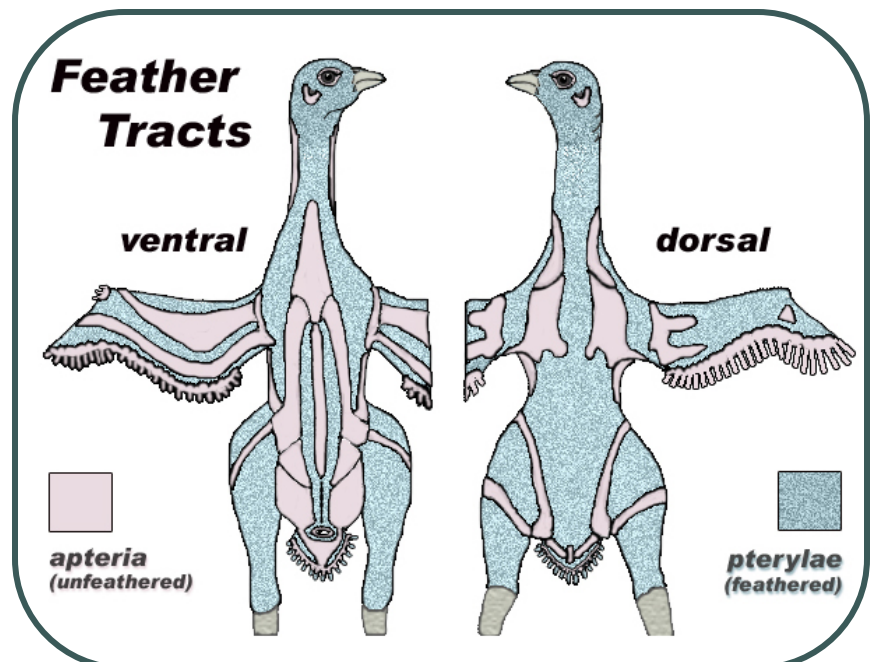
Skin and Feathers

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Many species of animals and insects can fly, but birds are the largest and best fliers of all. They have many special adaptations that make flight possible, such as an extremely light skeleton, a large keel bone for the attachment of powerful flight muscles, and flexible aerodynamic wings. Perhaps the most interesting adaptation for flight is the feathers. Birds are the only creatures on earth that have feathers.

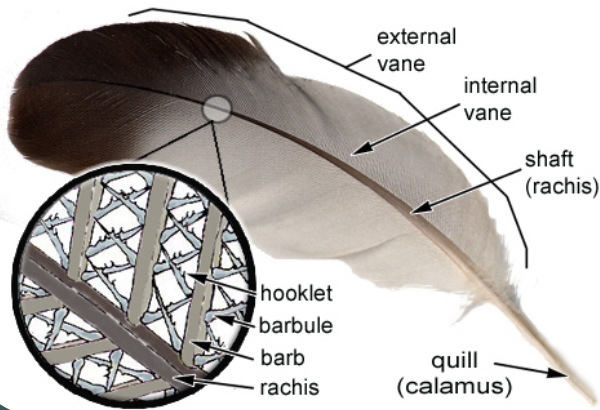
The bird's skin is very thin and often transparent when compared to that of a mammal. Bird skin lacks sweat glands and so birds must control body heat in ways other than sweating. Heat loss is controlled mainly through the respiratory tract (panting) but heat can also be lost through the non-feathered portions of the skin by convection.

Feathers develop from feather follicles in the skin much like the hair of mammals. However, feathers are far more complex than hair. Feather follicles are arranged in groups or feather tracts called pterylae. The non-feathered areas of skin between the feather tracts are called apterylae.



ABOVE: Pigeon showing feather tracts. Shaded area are feathered areas; un-shaded areas are non-feathered areas.

Rock Dove Feather Anatomy

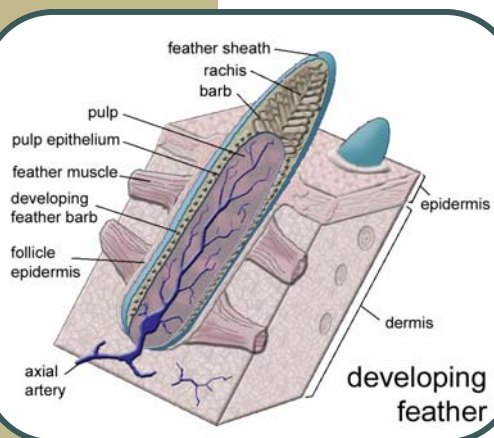


The basic structure of a feather is shown on the left. All feathers have a central shaft known as the rachis or quill that attaches to the feather follicle in the skin. Coming off the feather shaft at slanted angles are the barbs, and off of the barbs are thousands of tiny barbules. Each of these barbules have tiny hooklets that lock together, creating a solid surface for air to flow over.

ABOVE: Schematic of feather structure. Feather integrity is critical for flight, water proofing and temperature control.

Over the course of a year, the feathers take quite a beating, and birds must spend a lot of time grooming and caring for their feathers so they do not become frayed or damaged. Broken feathers that impair the ability to fly would mean death for the bird. The grooming process is called preening. During this behaviour, the bird picks dirt and parasites from the feathers, realigns any barbs and barbules that have come unhooked and spreads a special oily substance over each feather. This oily secretion is produced by a small gland called the uropygeal gland or preen gland located near the base of the tail. This secretion lubricates the feathers, keeping them soft and pliable much like using conditioner on human hair.

Birds shed their feathers once each year in a process called molting. During this process, all of the feathers are lost and new feathers grow to replace them. The factors initiating a molt are complex and include photoperiod, thyroid gland function, reproductive hormone levels, nutritional status etc. Birds of prey molt in a slow and controlled fashion over the course of a summer so they never lose the ability to fly and hunt. Waterfowl molt all at once, and the molt period coincides with the hatching of their young. The new waterfowl babies are taken to a pond or lake where they have relative safety and the adults molt over the space of the next few weeks.



Newly growing feathers develop from a feather papilla in the dermis of the skin. As the feather grows it needs nutrients that are supplied by a network of blood vessels in the shaft of the growing feather. The shaft of a developing feather looks blue because the blood supply can be seen through the shaft. Pigments that impart color are put in the feather during this development phase. As the feather approaches its full size, it stops growing and the blood supply retracts. The feather is now a dead structure, but remains firmly attached in the feather follicle.

Feathers have many functions other than just helping birds fly. Feathers are critical for controlling body temperature. When birds are cold they fluff up their feathers and create an air pocket between the body and the feathers. This cushion of warm air helps to insulate the bird from the cold. Feathers are important in water proofing birds that live on or near water or those that dive for food such as ducks and penguins. The colourful feathers of male birds attract the attention of females and are important in courtship. Male birds generally have more brightly coloured feathers than do females. The males often show elaborate courtship behaviour, strutting and dancing to display their beautiful feathers. The females often are drab and have feather coloration similar to the environment where they live, providing camouflage so their nest sites are not discovered and helping them hide from predators. Some species of birds like the Willow ptarmigan (*Lagopus lagopus*) found throughout the arctic tundra, have white plumage in the winter and mottled gray/brown plumage in the summer so they have efficient camouflage year round.

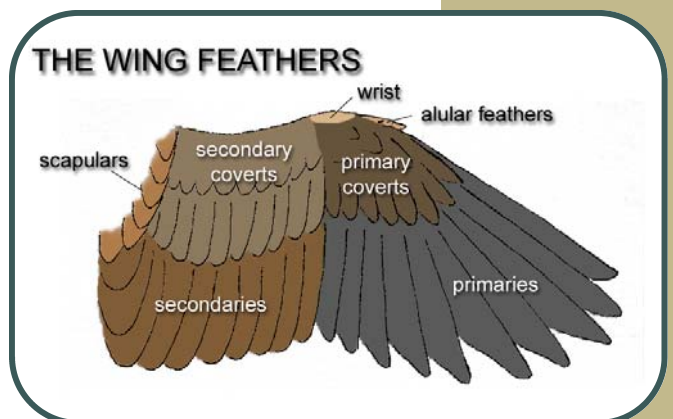
With all of these special and important functions, it is not surprising that there are many types of feathers. There are special soft down feathers located close to the skin for insulation and warmth. There are bristle feathers located around the eyes and mouth. These feathers attach to the skin close to nerve endings and are important in helping the birds feel things close to their face.

The largest feathers on the wing are called the flight feathers. These attach deep in the skin and actually touch the bones of the wing. The first 10 of these are called the primary feathers. The primaries attach to the wrist and hand of the wing. The next 10 or so feathers attached to the ulna are called the secondary feathers. The smaller feathers that cover the primaries and secondary feathers are called covert feathers, as shown in the diagram below. The feathers that cover most of the body giving it shape are called the contour feathers.

All of these feather types have slightly different anatomical structures that facilitate their particular functions. Feathers are so specialized, that even the structure of the primary feathers differs among bird species. For example the primary feathers of a Great horned owl have a central shaft and the leading edge has many small hair-like projections called “fluting”. This wide, soft feather along with the fluted edge allows the owl to fly slowly and with complete silence as



BELOW: Different feather types on the wing of a bird.





they search for their prey at night. The Peregrine falcon flies and dives through the air at high speed. The peregrine needs a strong inflexible primary feather that will cut through the wind cleanly at high speeds so the bird doesn't lose control during a dive.

Modified skin

In addition to the thin, almost transparent skin with feather tracts that covers most of the body of the bird, there are a number of modified areas of skin. These include the beak, the scaly legs, talons or claws and secondary sexual characteristics like spurs, wattles and combs.

Bird beaks or bills come in many shapes and sizes depending on the needs of that particular species of bird. Game birds, chickens and turkeys have beaks adapted for picking up seeds and insects. Birds of prey have strong, sharply curved beaks for killing and tearing prey. Waterfowl have broad flat beaks with serrated edges efficient in filtering plant and invertebrate material from the bottom of ponds.

The legs of birds have modified skin. The skin of the legs and feet of many bird species is thick and the surface is a series of overlapping scales. Waterfowl have soft, leathery skin over the legs and the feet are modified with soft webbing for paddling and swimming.

Many species of birds have skin modifications that attract females during the breeding season. For example roosters have large bright combs on their

head and wattles under their beaks that enlarge during the breeding season. Male members of the order Galliformes that includes chickens, turkeys, pheasants and grouse have large spurs on their legs that are used as weapons during fights over territory.



LEFT: Some of the special bird bill adaptations in different species.



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