

Structure and Function in Raptors

Jaime Samour MVZ (Honours), PhD, Dip ECZM (Avian), FRSB

The knowledge of structure and function is essential for understanding raptors in health and diseases.

Integumentary system

Feathers are epidermal growths that form the distinctive outer covering, commonly called plumage, on birds. They are considered the most complex integumentary structures found in vertebrates and a primary example of a complex evolutionary novelty. There are two basic types of feather: vaned feathers which cover the exterior of the body, and down feathers which are underneath the vaned feathers. Flight feathers are the long, stiff, asymmetrically shaped, but symmetrically paired feathers on the wings and tail of a birds. Those on the wings are called remiges, while those on the tail are called rectrices. The primary function of the flight feathers is to aid in the generation of both thrust and lift, thereby enabling flight.

The beak of birds of prey includes the bones of the upper and lower jaws and their horny sheaths. The upper and lower horny sheaths are called the maxillary rhamphotheca or rhinotheca and the mandibular rhamphotheca or gnathotheca. Talons are the sharp, hooked claws at the end of the toe in birds of prey. Talons differ in shape and size depending on how the bird will use its talons.

Musculoskeletal system

The skeleton is a frame integrated by bones and joints supporting the body of a raptor. The skeleton of birds of prey is highly adapted for flight. It is extremely lightweight but, strong enough to withstand the stress of taking off, flying and landing. One key adaptation, in common with most bird species, is the fusing of certain bones into single ossified structures, including the notarium, the synsacrum and the pygostyle. Because of this, birds usually have a smaller number of bones than other terrestrial vertebrates.

Most birds have approximately 175 different muscles, mainly controlling the wings, skin and legs. The largest muscles in the bird are the pectorals, or the breast muscles, which control the wings and make up about 15 - 25% of the total body weight.

Respiratory system

Three distinct sets of organs perform respiration in birds in general, the anterior air sacs (cervicals, interclavicular, and anterior thoracics), the lungs and the posterior air sacs (posterior thoracics and abdominals). Typically, in most avian species, there are nine air sacs within the system.

Gastrointestinal system

The digestive system of raptors includes the cervical oesophagus, crop (absent in Strigiformes), thoracic oesophagus, proventriculus, ventriculus, pancreas, small intestine, large intestine, cloaca and vent. The proventriculus or true stomach is the glandular stomach where digestion primarily begins, while the ventriculus is the muscular stomach. This is not well developed in birds of prey. The liver is an accessory gland to the digestive system. A cast is the mass of undigested parts of food that some raptors throw up. The contents of a pellet depend on its diet, but can include bones, fur, feathers, bills, claws and teeth. In falconry terminology, the pellet is called a casting.

Female reproductive system

The female reproductive system consists of the ovary and the accompanying oviduct. While the female embryo in many species has two sets of reproductive organs, only one of these, the left survives and reaches maturity to produce eggs. The oviduct is integrated by five distinct anatomical structures including infundibulum, magnum, isthmus, uterus and vagina.

Male reproductive system

The male reproductive organs consist of two testes, each with a vas deferens or deferent duct that leads from the testes to the cloaca. The deferent duct transports the sperm from the testes, where they are formed, to the cloaca from which they enter the oviduct of the female when mating through the cloacal kiss.

Urinary system

Birds have paired kidneys, sub-divided into three lobes, connected to the lower gastrointestinal tract through the ureters. Unique to birds is the presence of two different types of nephrons both reptilian-like nephrons located in the cortex and mammalian-like nephrons located in the medulla. The urine collected by the kidney is emptied into the cloaca through the ureters and then to the colon by reverse peristalsis.

Cardiovascular system

Birds have a four-chambered heart, in common with mammals, and some reptiles (mainly the crocodilia). This adaptation allows for an efficient nutrient and oxygen transport throughout the body, providing birds with energy to fly and maintain high levels of activity.

Brain, intelligence

Birds in general use the medio-rostral neostriatum/hyperstriatum ventral, as the seat of their intelligence, and the brain-to-body size ratio of psittacines and corvids is actually comparable to that of higher primates.

Special senses

Hearing is the second most important sense and their ears are funnel shaped to focus sound. The ears are located slightly behind and below the eyes, and they are covered with soft feathers, the auriculars, for protection. The shape of a bird's head can also affect its hearing, such as owls, whose facial discs help direct sound toward their ears. The confusingly named “ear tufts” of many owls and other birds of prey, however, have nothing to do with hearing.

Birds of prey have a very high density of receptors and other adaptations that maximize visual acuity. The placement of their eyes gives them good binocular vision enabling accurate judgement of distances. Nocturnal species have tubular eyes, low numbers of colour detectors, but a high density of rod cells which function well in poor light.