

Fish anatomy[]

Main article: [Fish anatomy](#)



Cutaway diagram showing various organs of a fish

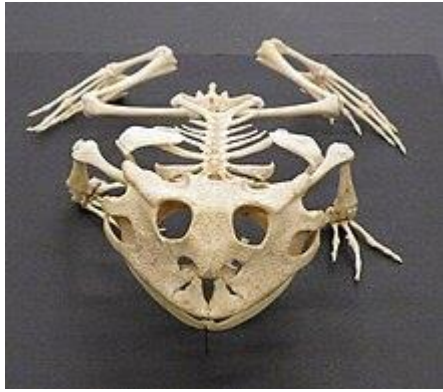
The body of a fish is divided into a head, trunk and tail, although the divisions between the three are not always externally visible. The skeleton, which forms the support structure inside the fish, is either made of cartilage, in [cartilaginous fish](#), or bone in [bony fish](#). The main skeletal element is the vertebral column, composed of articulating [vertebrae](#) which are lightweight yet strong. The ribs attach to the spine and there are no [limbs](#) or limb girdles. The main external features of the fish, the [fins](#), are composed of either bony or soft spines called rays, which with the exception of the [caudal fins](#), have no direct connection with the spine. They are supported by the muscles which compose the main part of the trunk.^[1] The heart has two chambers and pumps the blood through the respiratory surfaces of the [gills](#) and on round the body in a single circulatory loop.^[1] The eyes are adapted for seeing underwater and have only local vision. There is an inner ear but no external or [middle ear](#). Low frequency vibrations are detected by the [lateral line](#) system of sense organs that run along the length of the sides of fish, and these respond to nearby movements and to changes in water pressure.^[1]

Sharks and rays are [basal](#) fish with numerous [primitive](#) anatomical features similar to those of ancient fish, including skeletons composed of cartilage. Their bodies tend to be dorso-ventrally flattened, they usually have five pairs of gill slits and a large mouth set on the underside of the head. The dermis is covered with separate dermal [placoid scales](#). They have a [cloaca](#) into which the urinary and genital passages open, but not a [swim bladder](#). Cartilaginous fish produce a small number of large, [yolky](#) eggs. Some species are [ovoviviparous](#) and the young develop internally but others are [oviparous](#) and the larvae develop externally in egg cases.^[1]

The bony fish lineage shows more [derived](#) anatomical traits, often with major evolutionary changes from the features of ancient fish. They have a bony skeleton, are generally laterally flattened, have five pairs of gills protected by an [operculum](#), and a mouth at or near the tip of the snout. The dermis is covered with overlapping [scales](#). Bony fish have a swim bladder which helps them maintain a constant depth in the water column, but not a cloaca. They mostly [spawn](#) a large number of small eggs with little yolk which they broadcast into the water column.^[1]

Amphibian anatomy[]

Main article: [Amphibian anatomy](#)



Skeleton of Surinam horned frog (*Ceratophrys*



cornuta) Plastic model of a frog

Amphibians are a class of animals comprising frogs, salamanders and caecilians. They are tetrapods, but the caecilians and a few species of salamander have either no limbs or their limbs are much reduced in size. Their main bones are hollow and lightweight and are fully ossified and the vertebrae interlock with each other and have articular processes. Their ribs are usually short and may be fused to the vertebrae. Their skulls are mostly broad and short, and are often incompletely ossified. Their skin contains little keratin and lacks scales, but contains many mucous glands and in some species, poison glands. The hearts of amphibians have three chambers, two atria and one ventricle. They have a urinary bladder and nitrogenous waste products are excreted primarily as urea. Amphibians breathe by means of buccal pumping, a pump action in which air is first drawn into the buccopharyngeal region through the nostrils. These are then closed and the air is forced into the lungs by contraction of the throat.^[1] They supplement this with gas exchange through the skin which needs to be kept moist.^[1]

In frogs the pelvic girdle is robust and the hind legs are much longer and stronger than the forelimbs. The feet have four or five digits and the toes are often webbed for swimming or have suction pads for climbing. Frogs have large eyes and no tail. Salamanders resemble lizards in appearance; their short legs project sideways, the belly is close to or in contact with the ground and they have a long tail. Caecilians superficially resemble earthworms and are limbless. They burrow by means of zones of muscle contractions which move along the body and they swim by undulating their body from side to side.^[1]

Reptile anatomy[]

Main article: Reptile anatomy



Skeleton of a diamondback rattlesnake

Reptiles are a class of animals comprising turtles, tuataras, lizards, snakes and crocodiles. They are tetrapods, but the snakes and a few species of lizard either have no limbs or their limbs are much reduced in size. Their bones are better ossified and their skeletons stronger than those of amphibians. The teeth are conical and mostly uniform in size. The surface cells of the epidermis are modified into horny scales which create a waterproof layer. Reptiles are unable to use their skin for respiration as do amphibians and have a more efficient respiratory system drawing air into their lungs by expanding their chest walls. The heart resembles that of the amphibian but there is a septum which more completely separates the oxygenated and deoxygenated bloodstreams. The reproductive system has evolved for internal fertilization, with a copulatory organ present in most species. The eggs are surrounded by amniotic membranes which prevents them from drying out and are laid on land, or develop internally in some species. The bladder is small as nitrogenous waste is excreted as uric acid.^[1]

Turtles are notable for their protective shells. They have an inflexible trunk encased in a horny carapace above and a plastron below. These are formed from bony plates embedded in the dermis which are overlain by horny ones and are partially fused with the ribs and spine. The neck is long and flexible and the head and the legs can be drawn back inside the shell. Turtles are vegetarians and the typical reptile teeth have been replaced by sharp, horny plates. In aquatic species, the front legs are modified into flippers.^[1]

Tuataras superficially resemble lizards but the lineages diverged in the Triassic period. There is one living species, *Sphenodon punctatus*. The skull has two openings (fenestrae) on either side and the jaw is rigidly attached to the skull. There is one row of teeth in the lower jaw and this fits between the two rows in the upper jaw when the animal chews. The teeth are merely projections of bony material from the jaw and eventually wear down. The brain and heart are more primitive than those of other reptiles, and the lungs have a single chamber and lack bronchi. The tuatara has a well-developed parietal eye on its forehead.^[1]

Lizards have skulls with only one fenestra on each side, the lower bar of bone below the second fenestra having been lost. This results in the jaws being less rigidly attached which allows the mouth to open wider. Lizards are mostly quadrupeds, with the trunk held off the ground by short, sideways-facing legs, but a few species have no limbs and resemble snakes. Lizards have moveable eyelids, eardrums are present and some species have a central parietal eye.^[1]

Snakes are closely related to lizards, having branched off from a common ancestral lineage during the Cretaceous period, and they share many of the same features. The skeleton consists of a skull, a hyoid bone, spine and ribs though a few species retain a

vestige of the pelvis and rear limbs in the form of pelvic spurs. The bar under the second fenestra has also been lost and the jaws have extreme flexibility allowing the snake to swallow its prey whole. Snakes lack moveable eyelids, the eyes being covered by transparent "spectacle" scales. They do not have eardrums but can detect ground vibrations through the bones of their skull. Their forked tongues are used as organs of taste and smell and some species have sensory pits on their heads enabling them to locate warm-blooded prey.^[1]

Crocodylians are large, low-slung aquatic reptiles with long snouts and large numbers of teeth. The head and trunk are dorso-ventrally flattened and the tail is laterally compressed. It undulates from side to side to force the animal through the water when swimming. The tough keratinized scales provide body armour and some are fused to the skull. The nostrils, eyes and ears are elevated above the top of the flat head enabling them to remain above the surface of the water when the animal is floating. Valves seal the nostrils and ears when it is submerged. Unlike other reptiles, crocodylians have hearts with four chambers allowing complete separation of oxygenated and deoxygenated blood.^[1]