

Super class (1): **Agnatha (jawless fish)**

- 1- Jaws absent (there is mouth, but it lacks internal cartilaginous or bony supports).
- 2- Paired limbs absent (a single pair may be present in fossil forms).
- 3- Fibrous and cartilaginous skeleton are present; notochord persist throughout life, vertebra un-ossified.
- 4- Larval forms resemble lancelets.
- 5- Living forms are elongate, scale less, slimy parasites and scavengers.
- 6- Heart with one atrium and one ventricle.
- 7- Dorsal nerve cord with differentiated brain and Sense organs of taste, smell and hearing.
- 8- Digestive systems without stomach
- 9- External fertilization.

Class 1: **Myxini (50 sp. Hagfish)**

- 1- Buccal funnel is absent and terminal mouth with four pairs of tentacles; the teeth –like processes on their tongues; olfactory sacs open to mouth cavity.
- 2- There is 5 to 15 pairs of gill slit and has only one pair of external (gill openings).
- 3- Eel-like, cylindrical animals; the skin is naked, slimy and bears large number of mucous glands and only vertebrates in which the body fluid is isotonic with sea-water.
- 4- Is a specialized scavenger.
- 5- Anterior nasal opening; pineal eye not exposed.
- 6- Single semicircular canal.
- 7- Poorly developed eyes (lens-less), the dorsal and ventral roots of spinal nerves are fused.
- 8- No vertebrae.
- 9- Dorsal fin is continuous with caudal fin, and unsupported with fin rays.
- 10- Partially developed cartilaginous braincase and gill supports.

Class 2: **Cephalaspidomorphi (41 sp. Lamprey)**

- 1- The lampreys has funnel-like sucking, a round mouth without skeletal supports, a rasping tongue with horny teeth, and oral funnel sub terminal in position and bear oral papillae, and are ectoparasite.
- 2- A single, dorsally located nostril. Dorsal fin is divided into two portions,
- 3- The 7 pair's gill slits, gill pouches are lined with gill filaments that serve as a surface for the exchange of respiratory gases.
- 4- Blind olfactory sacs and Two semicircular canals
- 5- Pineal eye present, the dorsal and ventral roots of spinal nerves remain separate.
- 6- Branchial skeleton, vertebrae (neural arches) and there is no true fin ray.
- 7- Developed cartilaginous braincase

Super class (2): **Gnathostomata**

Class 1: **Chondrichthyes (cartilaginous fish)** (830 sp.)

Subclass: **Holocephali (30) the chimaeras, or rat-fishes**

Subclass: **Elasmobranchii (the sharks, skates, and rays).**

Order (1): **Selachii (Squalidae)**

- 1- The body is cylindrical in shape; consist of head, trunk and tail.
- 2- Has a cartilaginous skeleton.
- 3- The anterior part of the head extends to form rostrum.
- 4- Pair of nostril is ventral in position.
- 5- The eyes are laterally in position with two lids.
- 6- The body covers by placoid scales.
- 7- Has ventral or sub terminal mouth and teeth are similar in both the jaw.
- 8- Has heterocercal type tail, in which the dorsal flange is larger than the ventral, has paired pectoral, pelvic and dorsal fins supported by fin-rays.
- 9- Gill slits open separately to the outside and without operculum.
- 10- No air sacs.
- 11- The anus is in the same groove with the urogenital system (cloaca) and male has claspers (modified pelvic fins).
- 12- Internal fertilization and lay large eggs, in a few sp. The eggs are hatched within the body.
- 13- Heart has two chambers.
- 14- Intestine with spiral valve.



Order (2): **Batoidea (Rajomorphii) (Skates and rays, 476 sp)**

- 1- Most diverse elasmobranches.
- 2- Dorsoventrally-flattened bottom dwellers.
- 3- Large pectoral fins; dorsal fins reduced to absent; caudal fin reduced.
- 4- Large dorsal spiracle.
- 5- External gill openings are on the ventral side of the body; water (for breathing) is taken through the large spiracle on the dorsal side.
- 6- Teeth usually flattened and united to form pavement for crushing mollusks; also feed on crustaceans, and occasionally fish.

Subclass Holocephali: Chimaeras

The approximately 30 species of chimaeras, distinguished by such suggestive names as ratfish, rabbit fish, spook fish, and ghost fish, are remnants of a group that diverged from the earliest shark lineage, which originated at least 360 million years ago.

- Anatomically they present an odd mixture of shark like and bony fishlike features.
- Their food is a mixed diet of seaweed, mollusca, echinoderms, crustaceans, and fishes.
- Chimaeras are not commercial species and are seldom caught.
- Despite their grotesque (ugly) shape, they are beautifully colored with a pearly iridescence.



Class 2: Osteichthyes (bony fish)

- 1- They have bony skeletons. Most bony fishes have fusiform (rounded and tapering at both ends) body shape. This body shape reduces drag and requires a minimum amount of energy to swim. Most fish species have pigmentation contained in cells called **chromatophores** which allows the fishes to change color. This coloration may serve as camouflage.
- 2- Has homocercal type tail fin. Fins help stabilize or propel the fish in the water. Fins generally present on bony fishes are dorsal fins, the caudal fin, the anal fin, pectoral fins and pelvic fins.
- 3- On the head are the lateral eyes, without lids, which vary in size depending on the particular habitat.
- 4- The single gill openings are covered by a flexible plate called an operculum that protects the gills.
- 5- Pair of nostril is dorsal in position. The nostrils of most bony fishes have no internal connections with the oral cavity.
- 6- Mouth shape and size are good indication of a bony fish's feeding habits and terminal in position.
- 7- The body of most bony fish species are covered with and protected by a layer of dermal plates called scales. Some bony fishes may have scales and some species have no scales. The scales lay head to tail which helps reduce drag. The most common types of scales are ctenoid, ganoids, and cycloid.
- 8- Bony fishes secrete a layer of mucus that covers the entire body and protects a fish from infection.
- 9- Although there are no external ear openings, sounds are transmitted through the soft tissue to the inner ear.
- 10- The lateral line (a mid body line running from head to tail) senses distance and low frequency vibrations and water direction flow.
- 11- The anus is separated from urogenital system.
- 12- External fertilization and lay small eggs.
- 13- Heart has two chambers.
- 14- Have swim bladder or air sac (That helps regulate buoyancy because bones and muscles are heavier than water).

Subclass 1: Actinopterygii (27000 sp)

The ray-finned fishes have paired fins supported by dermal rays; basal portions of paired fins not especially muscular and blind olfactory sacs.

From these earliest ray-finned fishes, two major groups emerged.

- Those bearing the most primitive characteristics are **chondrosteans** (Gr. *chondros*, cartilage, + *osteon*, bone), represented today by Sturgeons, Paddlefishes, Bichir, and *Polypterus* of African rivers.

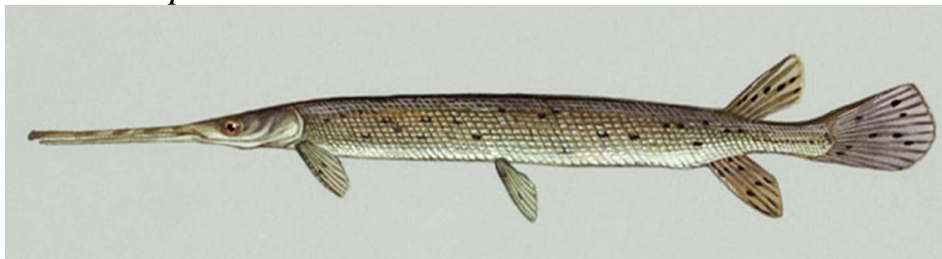


- The second major group to emerge from the early ray finned stock was **neopterygians** (non teleosts & Teleosts).

1- The two surviving genera of non-teleost neopterygians are the bowfin *Amia calva* of shallow water.



- Gars *Lepisosteus*



Subclass 2: Sarcopterygii.

The flashy-finned fish include the lobe-finned fish (or. **crossopterygii**) (paired fins are supported by musculature lobe and a bony skeleton). These lobes are employed for walking upon the bottom of bodies of water.

- 1- Have large cycloid scales; the tail is diphyccercal with a median lobe; two dorsal fins and all fins have fleshy lobes.
- 2- Presence of an internal nostril; respiration is performed by gills
- 3- Swim-bladder is reduced.

The lung fish members (**Dipnoi**) who never lost their lungs; pneumatic sacs function as lungs.

- 1- Have large cycloid scales; protocercal or isocercal type of caudal fin; single dorsal fin which is continuous with caudal fin; paired fins with basal fleshy structures
- 2- Presence of two internal nostrils
- 3- Swim-bladder is modified into lung (used for respiration)

Relationship with amphibia

- 1- The presence of vomerine teeth.
- 2- The presence of lung, pulmonary artery and pulmonary vein are present.
- 3- The skin glands are multicellular.
- 4- The brain has cerebrum and cerebellum
- 5- Egg and development are similar.
- 6- The larvae possess the external gills and sucker.
- 7- The spermatozoa are carried through the excretory part of the mesonephros

Did descendants of the lobe-finned fishes or lungfishes move onto the land?

The coelacanths (lobe-finned fish) were surely the living fossil representatives of the group that gave rise to the land vertebrates. This was the prevailing hypothesis until the 1980s.

The external nasal openings, tooth enamel and the presence of four similarly sized limbs that have a similar structure, position of fossil and living lungfish suggested that they, rather than the coelacanths, might be the ancestors of the land vertebrates.

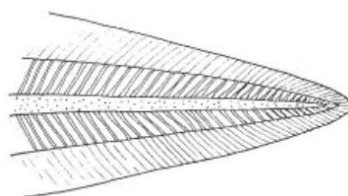
Diphycercal



Homocercal



Protocercal



Heterocercal

