FISH

CLASSIFICATION

Characteristics

Fish – presence of paired fins

A flexible backbone. This allows them to move and twist their body.

Cold blood. Their body is usually the same temperature as the water in which they live. Ectothermic

Fins. Fish use fins to control their movement through the water.

Most fish have single fins along their top and/or bottom, and pairsof fins that work together on their sides.

A fish's tail fin is its largest and most important fin it acts as a rudder.

Gills. to breathe. Clusters of tiny blood vessels in an opening at the back of the mouth absorb oxygen from the water and give off carbon dioxide. .

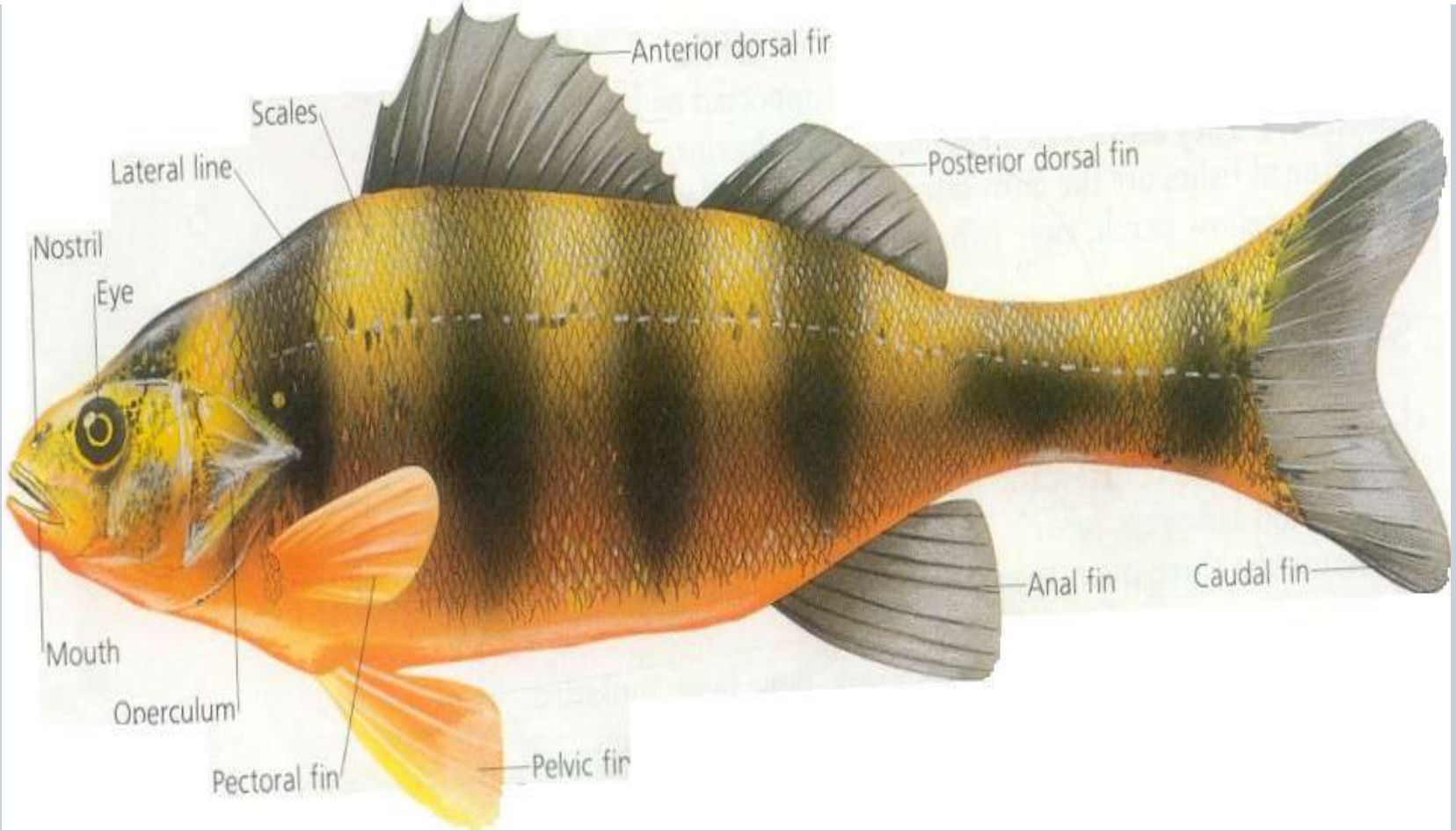
- Operculum: covers and protects the gills
- Caudal fin: moves from side to side for swimming
- Anterior dorsal fin (spines), posterior dorsal fin (rays), & anal fin: keep fish upright and moving in a straight line
- Pelvic fins & pectoral fins: used to steer, brake, move up and down, and move backwards

Fins are richly supplied with blood and, as such, help the fish to

regulate body temperature when they are moved up or down

- Integument (skin): covered with round scales of modified bone
  - Grow throughout life, creating growth rings that allow the age of the fish to be determined

- Chromatophores: pigmented cells that give the fish color pattern


Anterior dorsal fin
Scales
Lateral line
Posterior dorsal fin
Nostril
Eye
Anal fin
Caudal fin
Mouth
Operculum
Pectoral fin
Pelvic fin

- **Digestive System**
  - Carnivores with sharp teeth pointing inward
  - Anchored tongue lined with nerve cells for chemical detection
  - Much digestion occurs in outpockets of the stomach called pyloric ceca
  - Liver and pancreas secrete digestive enzymes
  - Intestine has fingerlike extensions called villi to increase surface area available for digestion

- **Circulatory System**
  - Adapted for rapid swimming
  - Two-chambered heart, blood vessels, and blood with red and white blood cells
  - Oxygenated blood is carried by arteries and capillaries from gills to rest of the body
  - Deoxygenated blood is carried by veins from the body to the gills

- Respiratory and Excretory System
  - Gills consist of four sets of curved pieces of bone
  - Each gill has a double row of gill filaments richly supplied with capillaries for rapid gas exchange
  - Gills help kidneys in excretion of nitrogenous wastes from the body; both organs function in osmoregulation (maintaining proper salt balance)
    - freshwater fish need salt and, therefore, must excrete excess water in order to maintain internal homeostasis

Gills

- Most fish exchange gases using gills on either side of the pharynx
- Gills consist of thread like structures called filaments.
- Each filament contains a capillary network that provides a large surface area for exchanging oxygen and carbon dioxide.
- Fish exchange gases by pulling oxygen-rich water through their mouths and pumping it over their gills.
- In some fish, capillary blood flows in the opposite direction to the water, causing countercurrent exchange.
- The gills push the oxygen-poor water out through openings in the sides of the pharynx.
- Some fish, like sharks and lampreys, possess multiple gill openings. However, bony fish have a single gill opening on each side. This opening is hidden beneath a protective bony cover called an operculum.

- **Gas Bladder**
  - Contains a mixture of oxygen, carbon dioxide, and nitrogen obtained from the bloodstream
  - By regulating the amount of gas in the sac, fish adjust overall density and, thus, move up or down in water or hover at a given depth

- **Brain, spinal cord, and nerves**
- **Brain consists of five paired lobes**
  - **Optic lobes** (largest part of brain): sight
  - **Olfactory lobes**: respond to smells
  - **Cerebrum:** respond to smells
  - **Cerebellum:** coordinates the muscles
  - **Medulla oblongata:** regulates internal organs

- **Reproduction**
  - **Separate sexes (dioecious)**
  - **Perch: external fertilization (eggs hatch within a few hours in warm water, many weeks in cold)**
    - **Sperm from male is contained in a fluid called milt**
    - **80 to 3 million eggs may be laid, depending upon species**
  - **Some fishes bear live young after internal fertilization, e.g., guppies and mollies**

Adaptations

- Buoyancy: trap gas inside body in order to control vertical position in water
- Streamlined shape
- Muscular tail
- Paired fins
- Mucus secretions
- Highly developed senses of smell and touch
- **Lateral line system**: detects vibrations

Superclass Gnathostomata, **Jawed fishes**

- Class Placodermi , (plate-skinned) extinct
- Class Chondrichthys, living
- Subclass Elasmobranchii
- Subclass Holocephali
- Class Osteichthys, bony fish
- Subclass Acanthodii, (spiny sharks) extinct
- Subclass Actinopterygii , living
- Subclass Sarcopterygii, living

CLASS PLACODERMI (placoderms)

- **Placo- plate and derm- skin .**
- **These are the plate-skinned fishes.**
- **Fish with jaws and armor plating.**
- ***Geologic range*: Late Silurian to Late Devonian. Extinct.**
- ***Mode of life*: Swimmers. carnivorous predators,**
- ***Dunkleosteus* - about 9 meters long**

Class Chondrichthys, Cartilaginous Fish

notochord is present in young, but is replaced by cartilage in adults

red blood cells are produced in the spleen, not in bone marrow

paired appendages

tooth-like scales, called denticles cartilaginous skeleton , placoid scales

male intromittent organs (claspers)

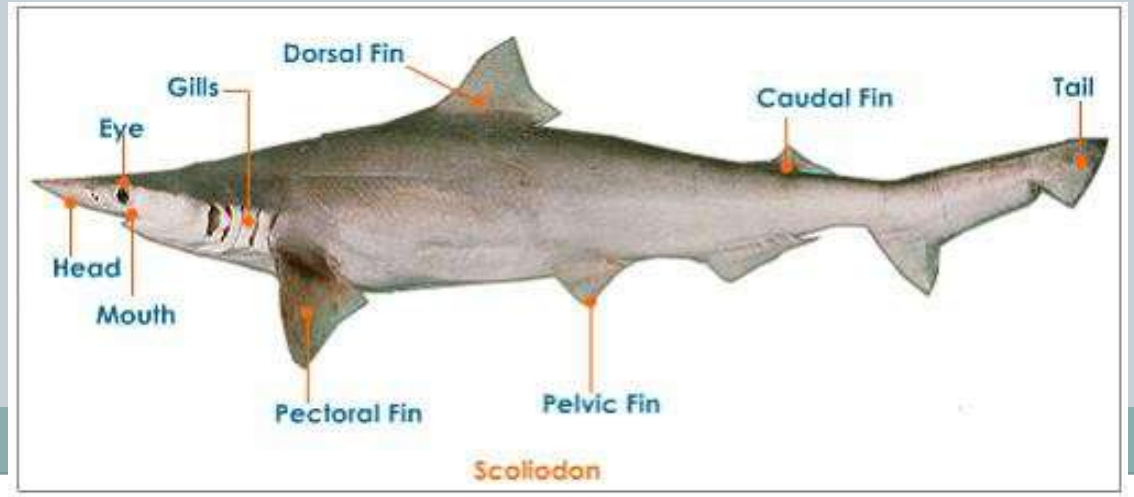
teeth not fused to jaws (only to connective tissue)

lipid (squalene) filled livers

fin rays soft and unsegmented (ceratotrichia)

swim bladder and lung absent

high concentrations of urea and trimethylamine oxide (TMAO) in blood (for osmoregulation)



Class Chondrichthys

- **Subclass Elasmobranchii**
- **Order Selachi ,Sharks**
- **Order Batoidea , Rays**

Sharks

- Swim , side-to-side motion of asymmetric tail fins
- Paired pectoral fins behind head jut out from the body like wings of an airplane
- Mouth has 6 to 20 rows of backward-pointing teeth that can be replaced ~ one shark may use more than 20,000 teethAcute ability to detect chemicals ~ blood from an injured animal can be detected up to 500 m away!
- Well-developed lateral line system
- Must swim continuously for gas exchange to occur (Water Mouth Gills Gill slits)
- Eggs are fertilized internally and pups are born alive
  - Male grasps female with modified fins called claspers
  - Sperm runs from male into female through grooves in the claspers

Subclass Holocephali

Holocephali **(complete heads)**

extinct species cartilaginous fish.

A single gill opening in each side gives the head a undivided appearance,

in contrast to the sharks and rays (class *Elasmobranchii*) which have two or more gill openings.

large eyes for deep sea adaptation

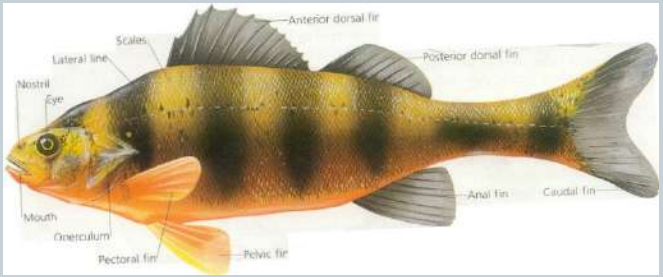
large head

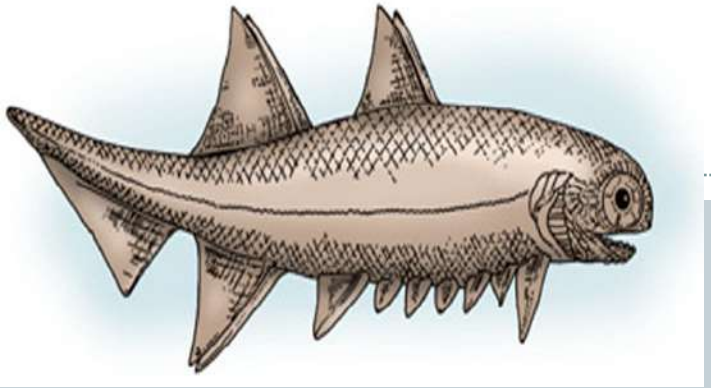
long tail.

Ratfish, rabbit fish, chimera

Bony Fish
(Class Osteichthyes)

1. endochondral bone replaces cartilage
2. calcified bones
3. circulatory system in the bones creates osteoblasts, which continually replace and strengthen the bones
4. sclerotic ring supports the eyeball





Subclass Acanthodi

first fishes to have jaws.

"Acanthos" means "spiny".

Primitive spiny fishes with jaws.

***Geologic range*: Late Silurian to Permian.**

Most numerous during the Devonian. Extinct.

Swimmers.

Nonmarine.

Subclass **Sarcopterygii**

lobe-finned fish (Greek, flesh fin)

The living sarcopterygians are the coelacanths,lungfish, and the tetrapods.

Crossopterygii (fringe-finned fish, bony fish, though a strict cladistic view includes the terrestrial vertebrates.

The living Sarcopterygians are

- Suborder , Rhipidistia **were lobe-finned fishes that are the ancestors of the tetrapods.**
- **a subgroup of Crossopterygii , lived during the Devonian**
- **Porolepiformes and Osteolepiformes.**
- **cladistic understanding of the vertebrates has improved over the last few decades a monophyletic Rhipidistia is an ancestor for the Tetrapoda and extant lungfishe**

Subclass Actinopterygii, ray-finned fishes infraclass Teleostei

- This diverse group, arose in the Triassic period,- includes 26,840 extant species in about 40 orders and 448 families; most living fishes are members of this group.
- The other two infraclasses, Holostei and Chondrostei, may be paraphyletic.
- Teleosts have a movable maxilla and premaxilla and corresponding modifications in the jaw musculature.
- These modifications make it possible for teleosts to protrude their jaws outwards from the mouth.
- The caudal fin is homocercal, meaning the upper and lower lobes are about equal in size.
- The spine ends at the caudal peduncle, distinguishing this group from those in which the spine extends into the upper lobe of the caudal fin, such as most fish from the Paleozoic

Teleostei

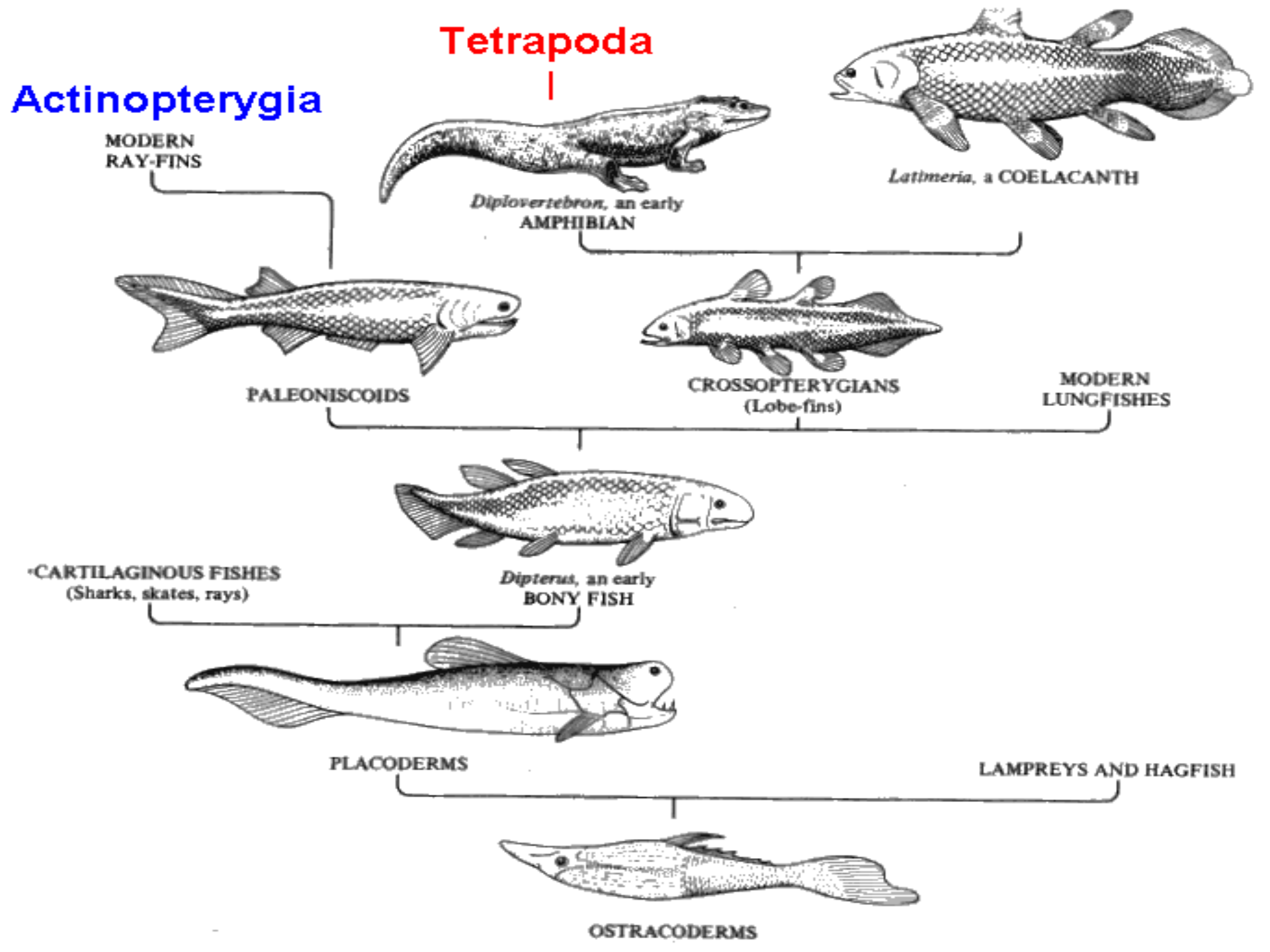
- The skeleton is composed of both cartilage and bone.
  Most of the fins on the body are paired.
  Most freshwater fish are covered with scales.
  Ray-finned fishes (half of all vertebrate species known.)
- They are found in every aquatic habitat from the abyssal depths of the ocean to freshwater streams and ponds; a few can even crawl on land for short periods of time.
- Ray-finned fishes constitute a major source of food

Evolution

- All classes of fishes appear to have arisen from the jawless ostracoderms (small fish covered with bony plates) 500 million years ago – only vertebrates for 50 million years
- By ~350 mya, most became extinct
- survivors became ancestors of jawless fishes.

- First fishes to have paired fins and jaws were the acanthodians (spiny fishes) – became extinct 270 mya.

- Relatives of modern jawed, bony and cartilaginous fishes began to appear in the fossil record 400 million years ago.


Tetrapoda
Actinopterygia
MODERN RAY-FINS
Diplovertebron, an early AMPHIBIAN
Latimeria, a COELACANTH
PALEONISCOIDS
CROSSOPTERYGIANS (Lobe-fins)
MODERN LUNGFISHES
Dipterus, an early BONY FISH
CARTILAGINOUS FISHES (Sharks, skates, rays)
PLACODERMS
LAMPREYS AND HAGFISH
OSTRACODERMS