

**PHYLUM: CHORDATA**

**SUBPHYLUM: VERTEBRATE (CRANIATA)**

**SUPERCLASIS: GNATHASTOMATA (JAWED FISHES)**

**CLASS II: ACTINOPTERYGII (RAY-FINNED FISHES)**

**CLASS III: SARCOPTERYGII (LOBE-FINNED FISHES)**

# GENERAL CHARACTERISTICS OF ACTINOPTERYGII

- **Caudal fin heterocercal (ancestral condition) or homocercal**
- **Paired fins (pectoral and pelvic) usually present, supported by bony rays**
- **Muscles** controlling fin movements within trunk
- **Skin with ganoid (ancestral condition), cycloid or ctenoid scales of dermal origin, or naked**
- **Skeleton of bone**
- **Notochord present, but reduced; Vertebrae distinct.**
- Jaws and spiral valve present
- Brain well-developed, but **small**. 10 pairs of cranial nerves.
- Three semicircular canal present.
- **Sexes usually separate; but many hermaphroditic; some of them reproduce asexually by parthenogenesis.**
- **Fertilization usually external. Oviparous or viviparous development**
- Excretory system of opisthonephric kidney; **ammonia usually main nitrogenous waste**
- **Gills covered by a bony operculum**
- **Swim bladder present**

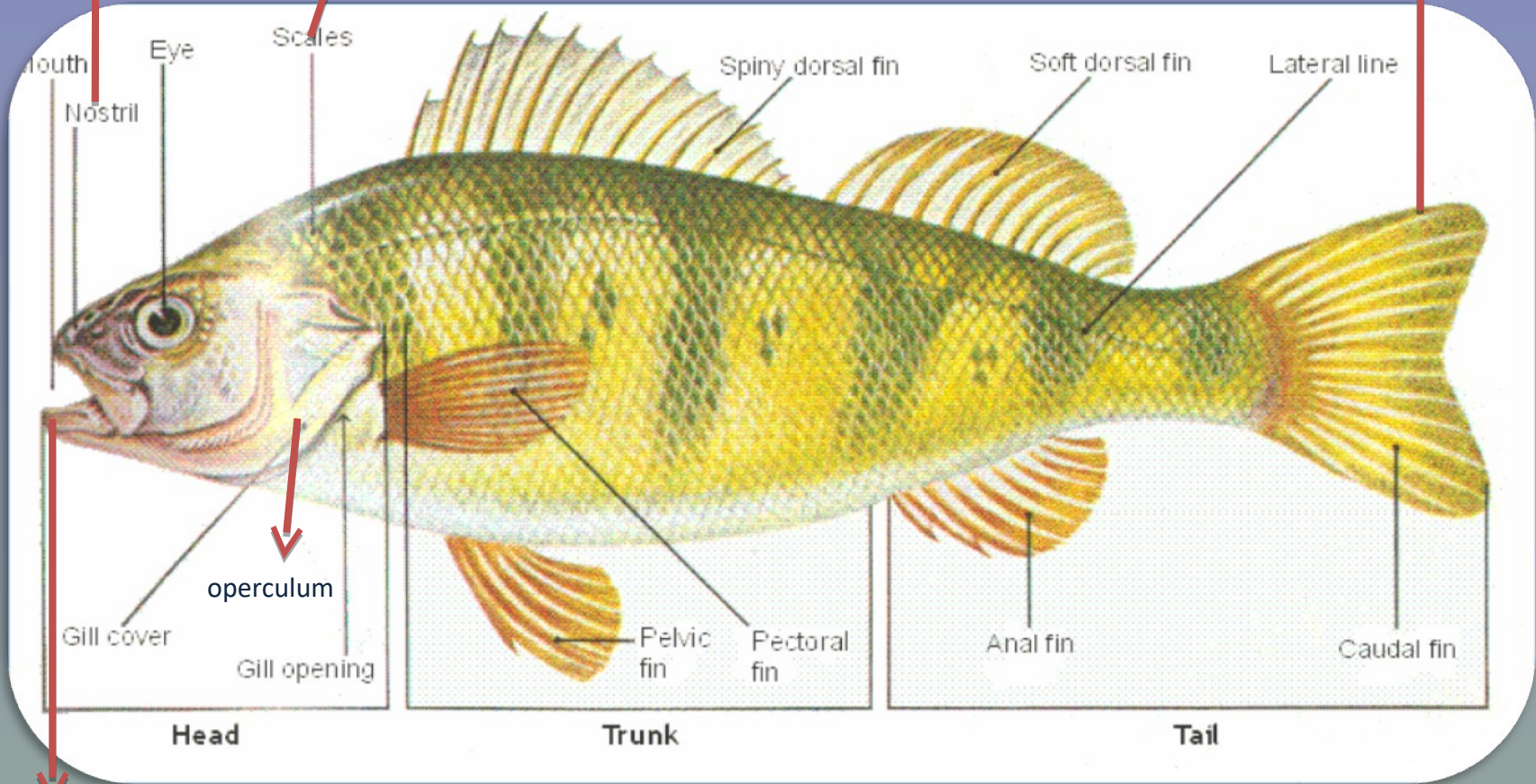
# GENERAL CHARACTERISTICS OF SARCOPTERYGIAN

- **Caudal fin heterocercal (fossil forms) or diphyrcercal in living**
- **Paired fins (pectoral and pelvic) usually present, supported by stout bones or bony rays**
- **Muscles** controlling fin movements within trunk
- **Skin with dermal scales composed of two layers of bone, a layer of cosmine (form of dentin) and a thin layer of enameled**
- **Skeleton of bone**
- **Vertebrae** distinct.
- Jaws and spiral valve present
- Brain well-developed, but **small**. 10 pairs of cranial nerves.
- Three semicircular canal present.
- **Sexes usually separate; fertilization external (lung-fishes) or internal (coelacant)**
- **Fertilization usually external. Oviparous development**
- Excretory system of opisthonephric kidney; **ammonia usually main nitrogenous waste**
- **Gills covered by a bony operculum**
- **Swim bladder present**

Two nostrils  
For olfaction

Cycloid; ctenoid; ganoid

Homocercal-Diphycercal



Mouth usually terminal state  
Jaws well-developed  
Mouth usually terminal

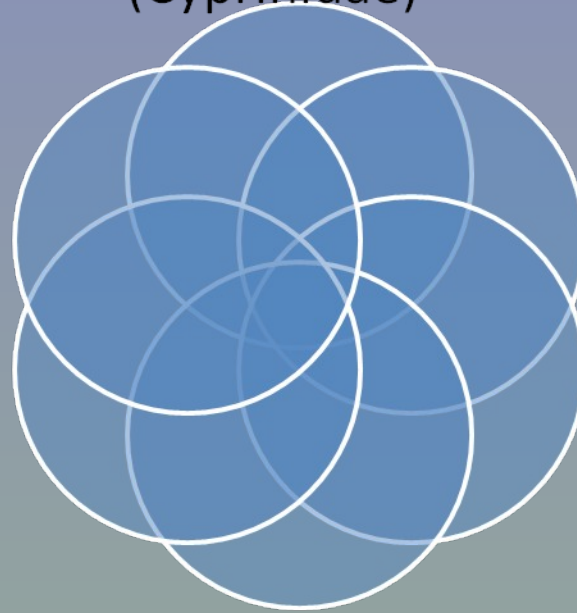
Swim-bladder

Bony skeleton

# TOOTH

## Pharyngeal Tooth

It is responsible for grinding of nutrients.  
(Cyprinidae)

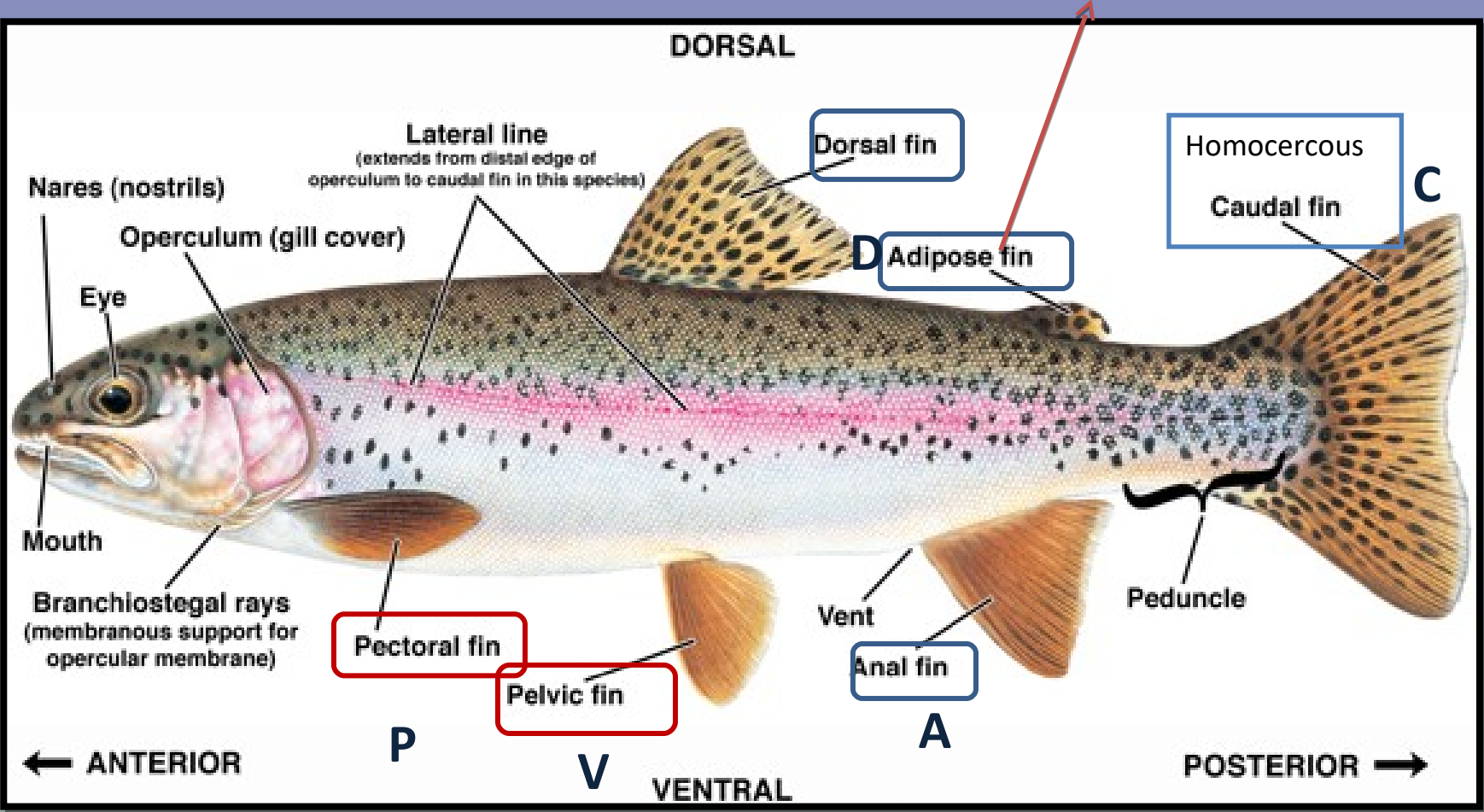


## Palate tooth

**Lingual Tooth**  
Characteristics  
feature of  
Salmonidae  
(Trout) family

## Maxilla Tooth

Salmonidae (Trout)  
Sisoridae (Sisorid cat-fish)



Scale: Cycloid; Ctenoid; Ganoid

## Covered with a durable skin

**SKIN:** 1. Epidermis

2. Dermis

- There are many glands that secrete mucus in the epidermis.  
Mucus;
  - \* Facilitates movement in water.
  - \* It makes it harder to get caught by your enemies.
  - \* It prevents the microorganisms that cause disease from entering the body.
- A layer is formed by keratinisation of the epidermis and its task helps in regulating osmotic pressure.
- Scales are dermal origin.



**Color** : Produced by chromatophores.

**Arranged by neurotic and hormonal**

- The color becomes **darker** if the cells are **dispersed**
- If pigments accumulate in the middle of the cell, **the color is transparent**

## **SKELETON SYSTEM**

**Axial Skeleton:** Head, Vertebrae, Notochord

**Appendicular Skeleton:** Median (dorsal; anal; caudal) and lateral (paired: pectoral and pelvic) fins

- The cranium is tightly attached to the vertebrae and does not move in any direction.

**Dorsal-Anal Fins:** Detection of direction

**Caudal Fin:** Left and right side movement

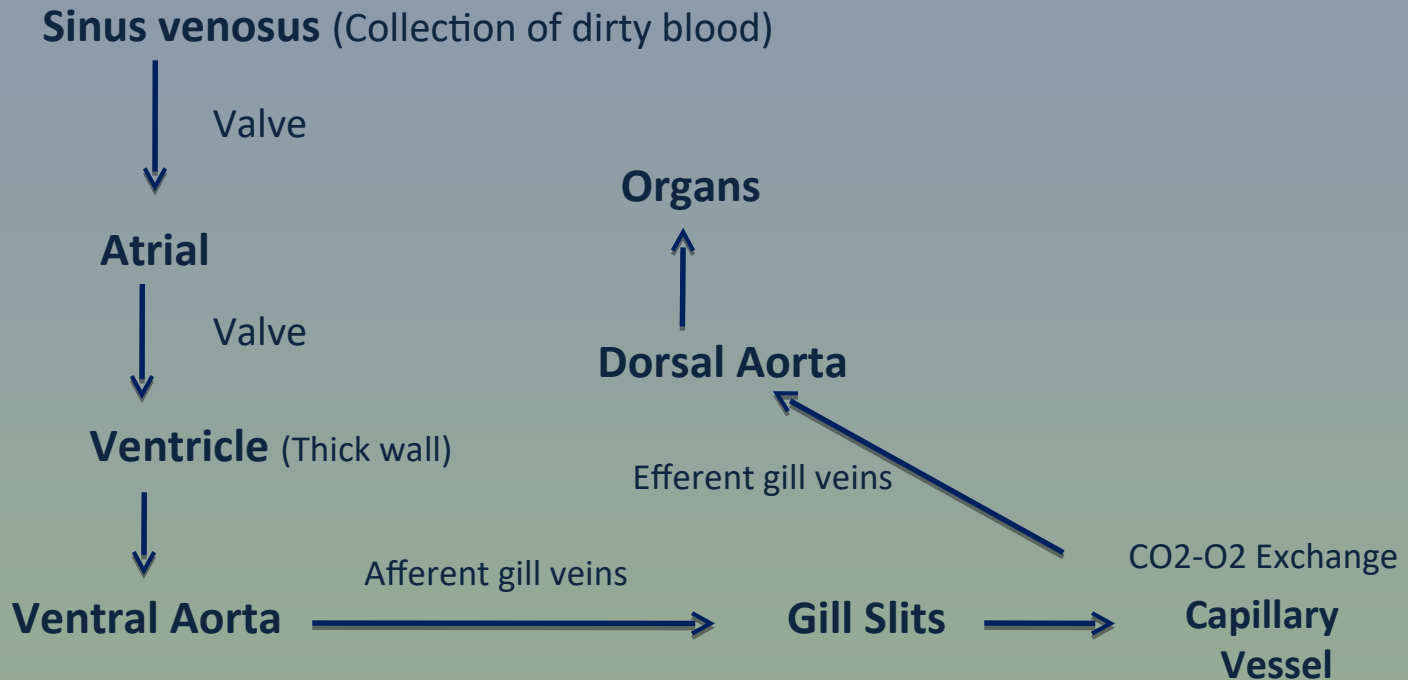
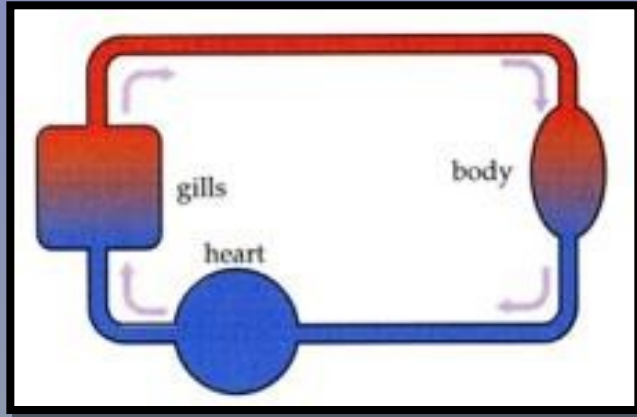


# DIGESTIVE SYSTEM



- Pancreas is not well-developed.
- Liver secrete digestive juices.
- Spleen is a part of circulatory system and task as blood production
- **Epiglottis is responsible for moving the respiratory water**
- **Muscular J-shaped stomach**
- **Liver Functions:** Storage of nutrients; degradation of red blood; hydrostatic organs

# CIRCULATORY SYSTEM



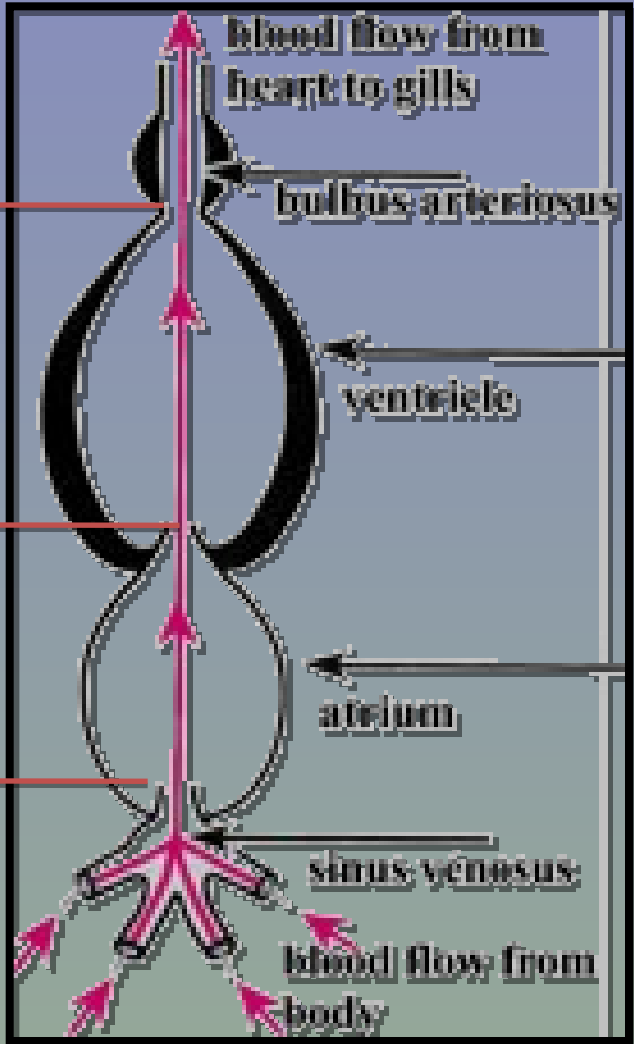
Their blood is dull color.  
Red blood cells are oval shape and nucleated

Blood and Lymphatic circulatory system

Valve

Valve

Valve

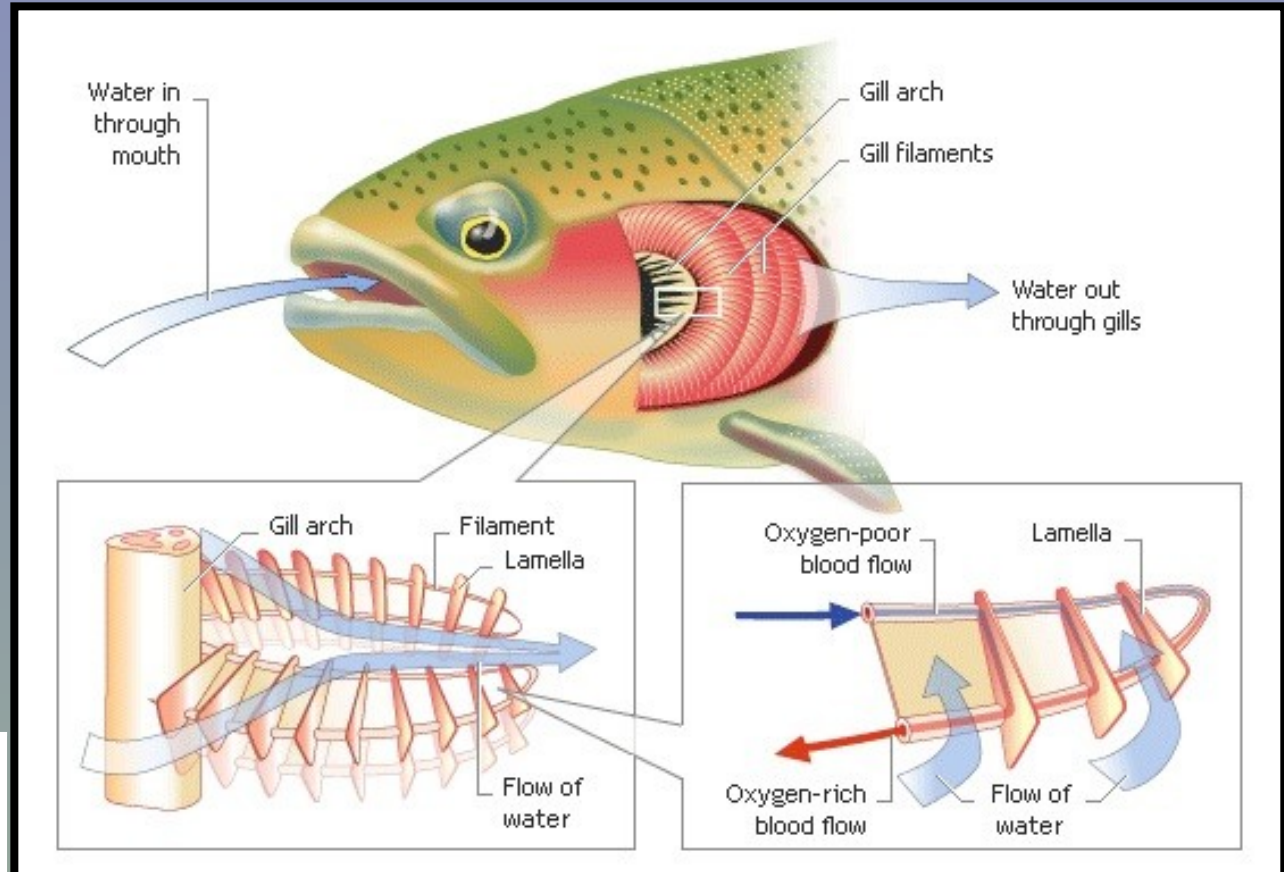
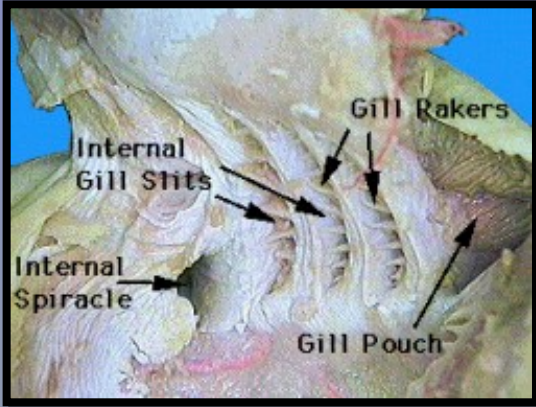


**conus arteriosus in Chondrichthyes**

Blood coming back from the venous system to sinus venosus is lower pressure than cartilaginous fish.

# RESPIRATORY SYSTEM

Gill respiration  
Swim-bladder present



There are numerous gill filaments surrounded by abundant capillaries on the gill.

The wall of the swim bladder has the same structure as the digestive system

It has got one or two chambers

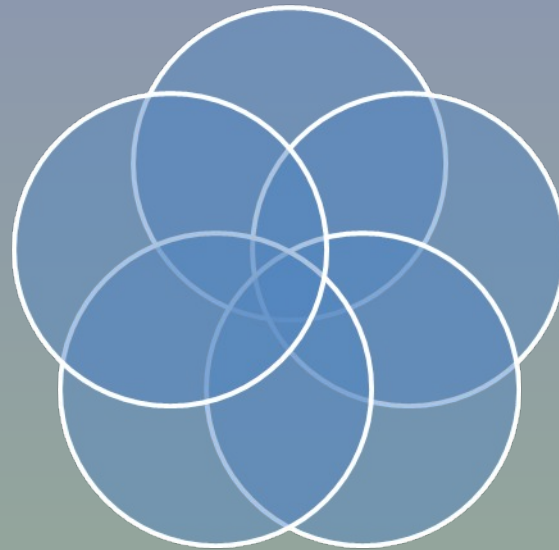
### Functions of Swim Bladder

Sound

Hydrostatic

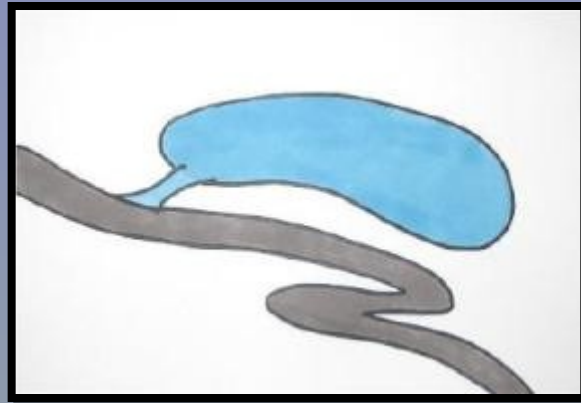
Audition

Respiration

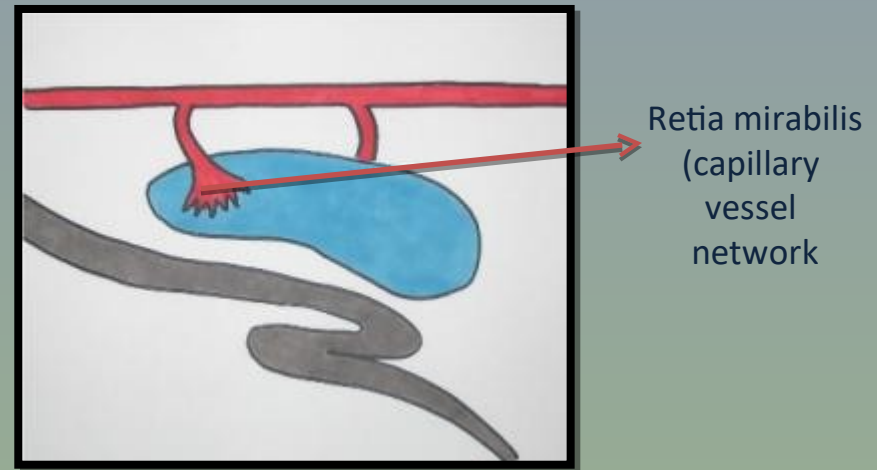


- In the primitive Teleostei samples, the swim bladder is associated with the pharynx. This is called **Physostomous Fish** (common in freshwater fishes)

Gas is absorbed from the external environment by the duct between the pharynx cavity and the swim bladder



**Physoclistous Fishes:** The swim bladder is not associated with the pharynx. The swim bladder closed (Common in marine fishes)



Retia mirabilis  
(capillary  
vessel  
network)

# NERVOUS SYSTEM AND SENSE ORGANS

Examined in three parts: Central, peripheral and autonomous

CNS: Brain and spinal cord

PNS: Brain and nerves affrenet from spinal cord

ANS: Sympathetic; Parasympathetic nerves

**Brain:** Forebrain, midbrain, hindbrain

➤ Unlike Cyclostomata forebrain and hindbrain divided into subregions.

Telencephalon (Cerebrum)

Diencephalon

**Forebrain**

**Mesencephalon (Midbrain)**

Metencephalon (Cerebellum)

Myelencephalon (Medulla oblongata)

**Hindbrain**



➤ **Lateral Line System:** It extends from the back of the head to the end of the tail on both sides of the body. It consists of a channel under the skin and the pores that open out at certain intervals. Channels contain bristles sensitive to vibrations.

➤ There are also many sensory channels (Lorenzini bulb) on the head.

**ACUSTICO-LATERALIS SYSTEM = Lateral line + Lorenzini Bulb + Semicircular canal and Ears**

➤ **Skin:** Sensations such as touch and pain

➤ **Olfactory Organ:** Nostrils are well-developed for smelling.

➤ There are both scattered taste buds and some chemical sensory organs on the **pharynx**.

➤ **Vision Organs:** Eyes are well developed for eyesight (prey and predator)

➤ **Vestibular Organ:** Ear is found inside of the cranium. Function is to identify the voices and determine the balance with the direction of the fish.

➤ Each internal ear contains 3 semicircular canal. Unlike other vertebrate animals, **there is no Lagena.**

# REPRODUCTIVE SYSTEM

Bisexual (Male and Female)

Hermaphroditic

Asexually by parthenogenesis

- Ovarian weight may reach up to 70% of body weight during the reproductive period
- The weight of the testicles may reach up to 12% of the body weight during the breeding period
- In bisexual reproduction, it is difficult to distinguish between male and female individuals in terms of external appearance.
- It can only be determined precisely by examination of sexual organs (**Primary Sexual Characteristics-Reproductive Organs**)
- In some fishes, male and female individuals can be easily distinguished in terms of appearance, especially in the breeding period (**Secondary Sexual Characteristics**)

**Hermaphroditic Organisms:** An organism has got both male and female functional reproductive organs, producing both eggs and sperm.

➤ Most of the hermaphroditic organisms require another individual to reproduce.

➤ Some hermaphroditic organisms change their sex through orderly hermaphroditism. **Protandry** is a change from male to female, whereas **Protogyny** is a change from female to male.

**Parthenogenetic Reproduction,** is a form of asexual reproduction. An embryo develops without fertilization by a male. **Gynogenesis** is a kind of parthenogenetic reproduction. Female needs a male to breed. However, spermatozoa do not fertilize eggs, but only stimulate them for segmentation. The offspring that occur as a result of this type of reproduction is completely female.

- Fish species living in tropical regions reproduce every season.
- Most of the inhabitants of the temperate regions breed in the first months of spring or summer.
- Salmonidae (trout) breed in autumn or winter.
- Balıkların çoğu yılda bir kere döl verirken, dişli sazancıklar (*Gambusia*) yılda 6 kadar döl verebilirler.
- While most of the fish reproduce once a year, the Toothcarp (*Gambusia*) can give up to 6 offspring per year.

## **BONY FISHES USUALLY OVIPAROUS and HAVE A GREAT NUMBER OF EGGS**

- The number of eggs depends on the species, age, and size of the fish.

*Syngnathus*: 200

Gadidae (Whiting): 6.000.000

Mollidae (Ocean Sunfish): 300.000.000

- If there are many mature and immature eggs in the ovary, it means that **the spawning time of this fish species is short.**
- If there is a gradation in size between the mature and immature eggs in the ovary, it means that the spawning time of this fish is long, and the eggs ripen out as they mature.

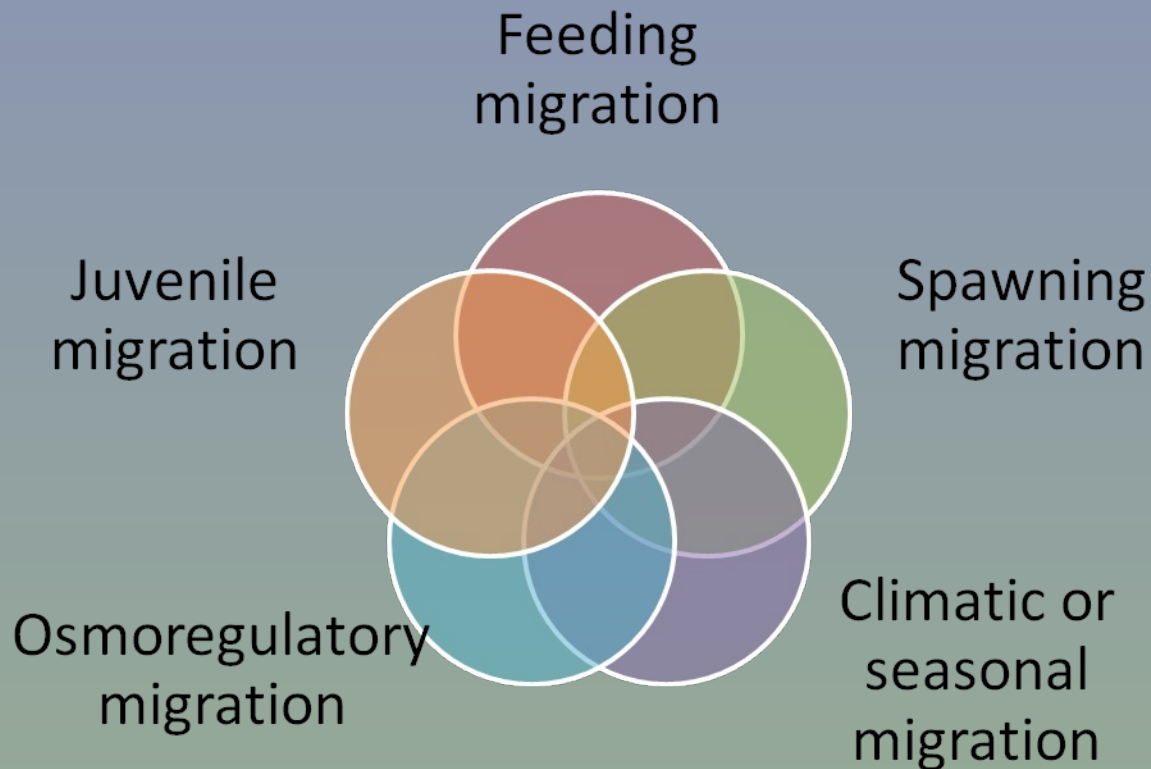
### **THE VIVIPAROUS AND OVOVIVIPAROUS FISHES BREED A FEW FRY IN EVERY TIME.**

- The eggs of the viviparous fishes develop in the ovary.
- The eggs in ovoviviparous fish fertilize in the ovary but develop in any part of the ovary.
- **Hatching time of the eggs varies depending on the fish species and the temperature of the water**
- Some fishes have metamorphosis after hatching. For example, *Solea* (Common Sole) has a bilateral symmetry in the larval stage but becomes asymmetric when becoming an adult (after metamorphosis).

# MIGRATION

Migratory behaviour of fish is a regular phenomenon.  
It is mainly for feeding and reproduction.

## Reasons for migration



# Types of Migration

**I. Diadromous migration:** The fishes migrate between sea and freshwater. Anadromous and catadromous migrations are the types of this migration

**Anadromous** is the migration of marine fishes from the sea to the river (freshwater) for spawning.

➤ Fishes spend most of their life living and feeding in sea and migrate to the freshwater during breeding season.

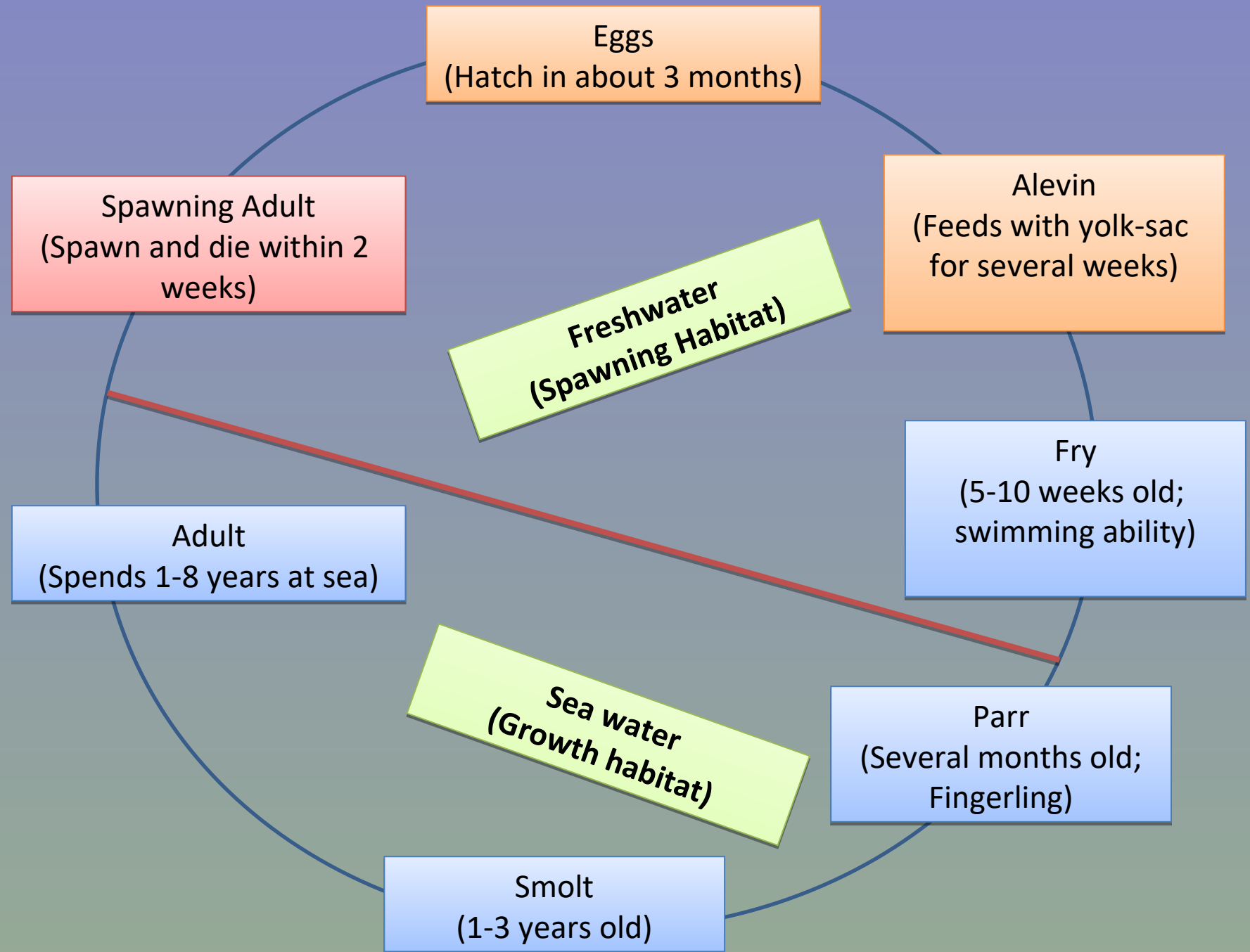
Forexample: *Salmon, Lamprey*

While Salmon migrate from the sea to the river for breeding;

➤ They stop feeding during the journey.

➤ Change their color from silver to dull reddish brown.



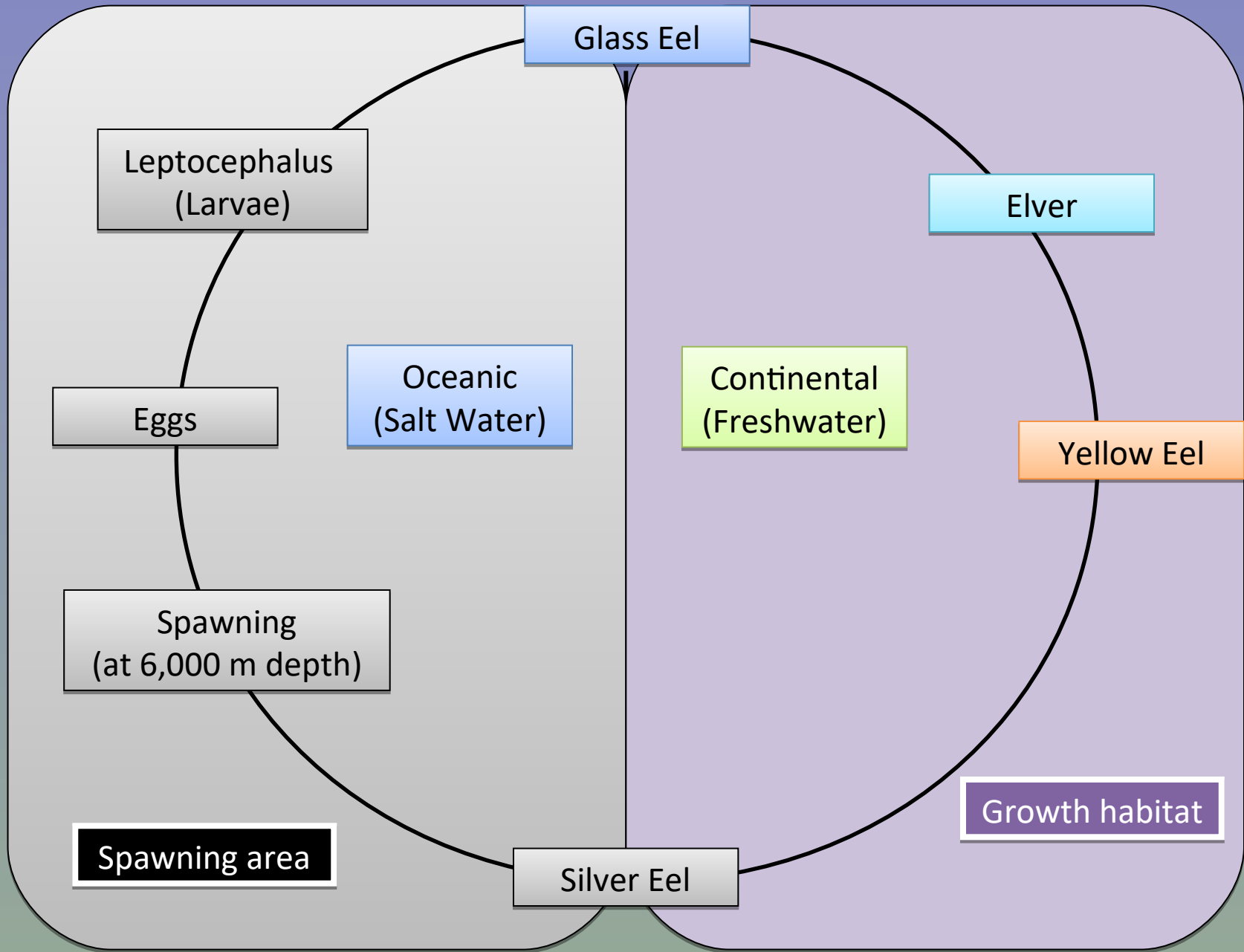


**Catadromous** is the migration of freshwater fishes from the river to the sea for spawning. Forexample: Eel (*Anguilla* sp)

- Both European eel (*Anguilla anguilla* or *Anguilla vulgaris*) and the American eel (*Anguilla rostrata*) migrate from the continental rivers to Sargasso Sea off Bermuda in south Atlantic for spawning, crossing Atlantic Ocean.

Before and during migration some physiological changes occur in their bodies:

- Deposit large amount of fat in their bodies (for provide food during the journey).
- Colour changes from yellow to metallic silvery grey.
- Digestive tract shrinks and stops feeding.
- Eyes get enlarged and vision sharpens. Other sensory organs also become sensitive.
- Skin serves as respiratory organ.
- Gonads get matured and enlarged.



**2. Potamodromous** is the migration of freshwater fishes from one freshwater habitat to another one for feeding or spawning. Fishes migrate to the upstream for spawning, then migrate downstream as juveniles to grow into adults. Ex: sicklefin redhorse, lake sturgeon, robust redhorse, flathead catfish

**3. Amphidromous** is a migration of fishes from freshwater to the sea or vice versa during certain periods of their lives for feeding or overwintering , except reproduction.  
Examples: Bigmouth sleeper, mountain mullet, river goby,

**4. Oceanodromous** is the migration of fish within the sea in search of suitable feeding and spawning ground.

# FISH DEFENCES AND ADAPTATIONS

**Spines and Venom Glands:** The spine and glands are surrounded by an enveloping sheath, known as the integument. The venomous spines are erected when the fish feels threatened. Such venomous spines are found in dorsal, pectoral, pelvic or anal fins of various venomous fishes. Some species have venomous spine processes on the gill cover (e.g. Weeverfishes, *Trachinus sp.*).

**Electric Organs:** Specialized for the production of an electric fields. Electric organs built up from a large number of electroplates.

**Light Organs:** Bioluminescence can occur two different ways:

- **Through symbiotic bacteria living on the fish**
- **Through self-luminous cells called photophores.**

They are absent in freshwater fishes. Their distribution on the body type and adaptive value may vary in different species of fishes.

**Functions:** to attract prey  
to attract mates

## Color Matching-Mimicry:

Many fish have color patterns that help them adapt to their environment.

**Functions:** to avoid being seen by a predator (Hide)

to catch prey

to scare the enemy

to attract and recognize potential mate