-2022
2023

# Fish Biology &Special Environments

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**For / Fourth Chemistry and Zoology students**

Faculty of Science
[Type the company name]
2022-2023

# How to identify a fish?

## How to preserve specimen:-

**Formalin** is generally a reliable representative after which they can be transferred to **alcohol** for lengthy preservation .

Commercial formaldehyde [trade- name formalin] is concentrated [about 40%] and **must be diluted before use 1 part formalin to 9 parts water [about 10%]**

Large fish need [up to 20%] but small fishes can be fixed in a more dilute solution[down to 5%formalin].

## Containers:-

well-galvanized or heavily-tinned cans make good temporary storage for use in the field, as do large plastic containers .

wide mouth bottles and glass or polyethylene plastic tubes are also required.

# ****The Key to identification a fish****

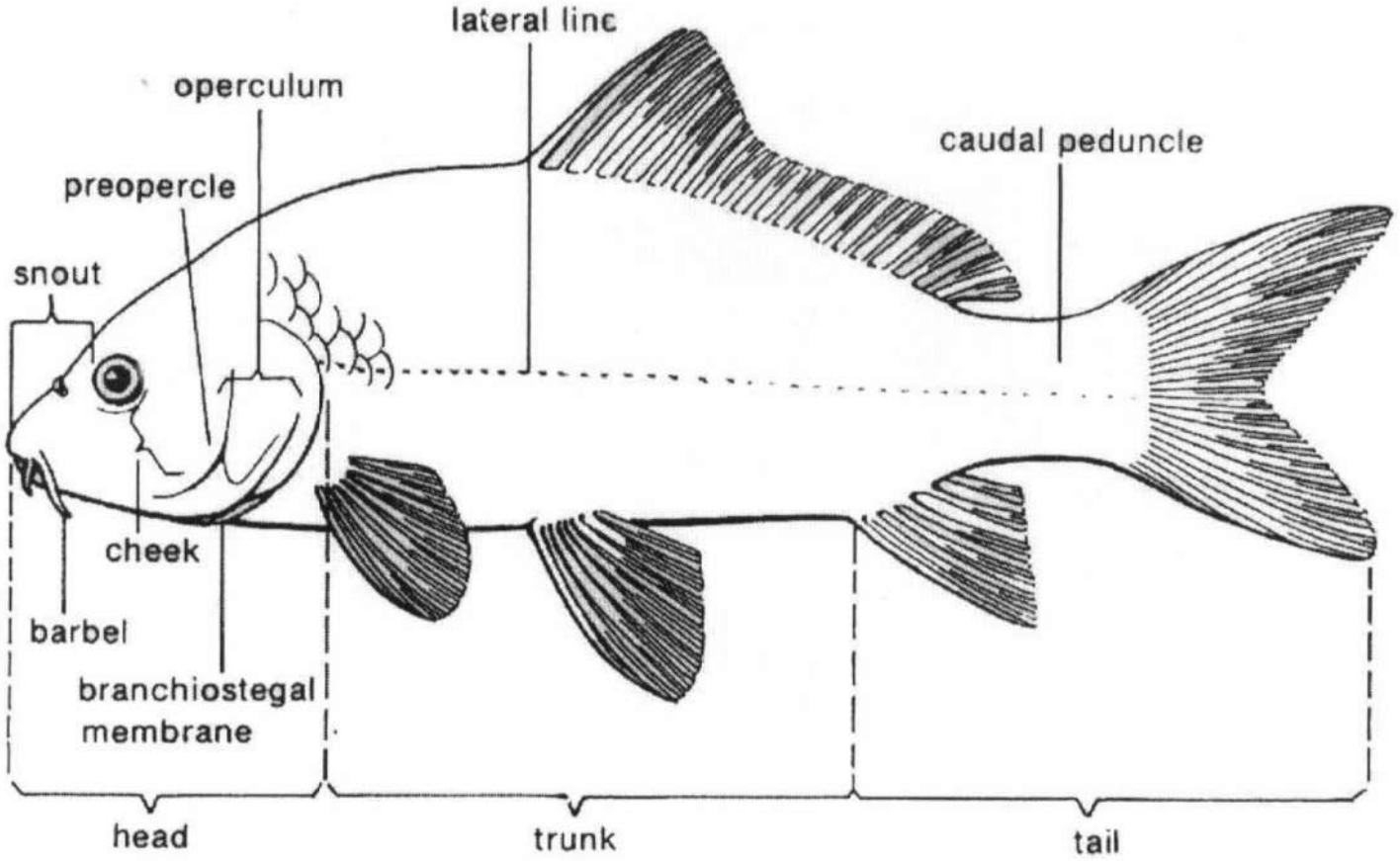



**FIGURE 2–1.** Diagram of bony fish, showing external features.

**1- Body shapes in fishes:**

Fusiform, Compressiform, Depressiform, Anguilliform, Filiform, Taeniform, Sagittiform or globiform.

**2- General outline of the body: (Head & Trunk):**

compressed or Depressed

- Dorsoventrally depressed (head of *catfish)*
- Bilaterally compressed (rest of *catfish)*

**3- Cross section of the body:** [cylindrical, ovoid, global, triangular ]

**4- Color: of lateral and ventral side + with** [spots, patches, lines, bars…etc.]

**5- Skin :** Scaless (naked) **or** Scales present

**6- Kind of scales**: placoid, cycloid, ctenoid, ciliated, ganoid. …etc.

**Scale Formula = No. of scales along lateral line** $\frac{\text{No. of scales above lateral line}}{\text{No. of scales below lateral line}}$

# Body shapes in fishes

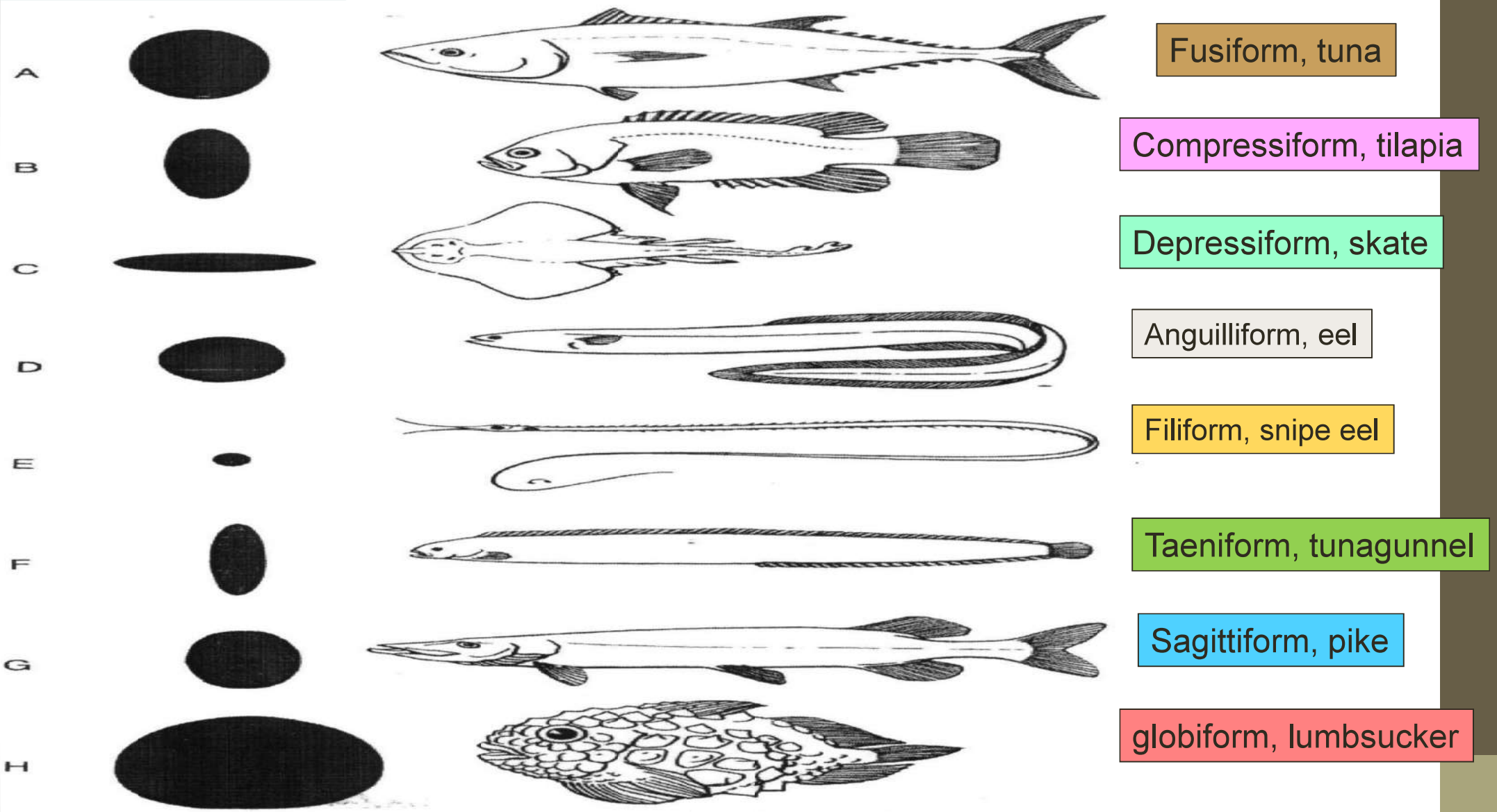



**FIGURE 2–8.** Representative body shapes in fishes, with typical cross sections. *A*, Fusiform (tuna, Scombridae); *B*, compressiform (sunfish, Centrarchidae); *C*, depressiform (skate, Rajidae), dorsal view; *D*, anguilliform (eel, Anguillidae); *E*, filiform (snipe eel, Nemichthyidae); *F*, taeniform (gunnel, Pholidae); *G*, sagittiform (pike, Esocidae); *H*, globiform (lumpsucker, Cyclopteridae). (*H* based on Jordan and Evermann, 1900.)

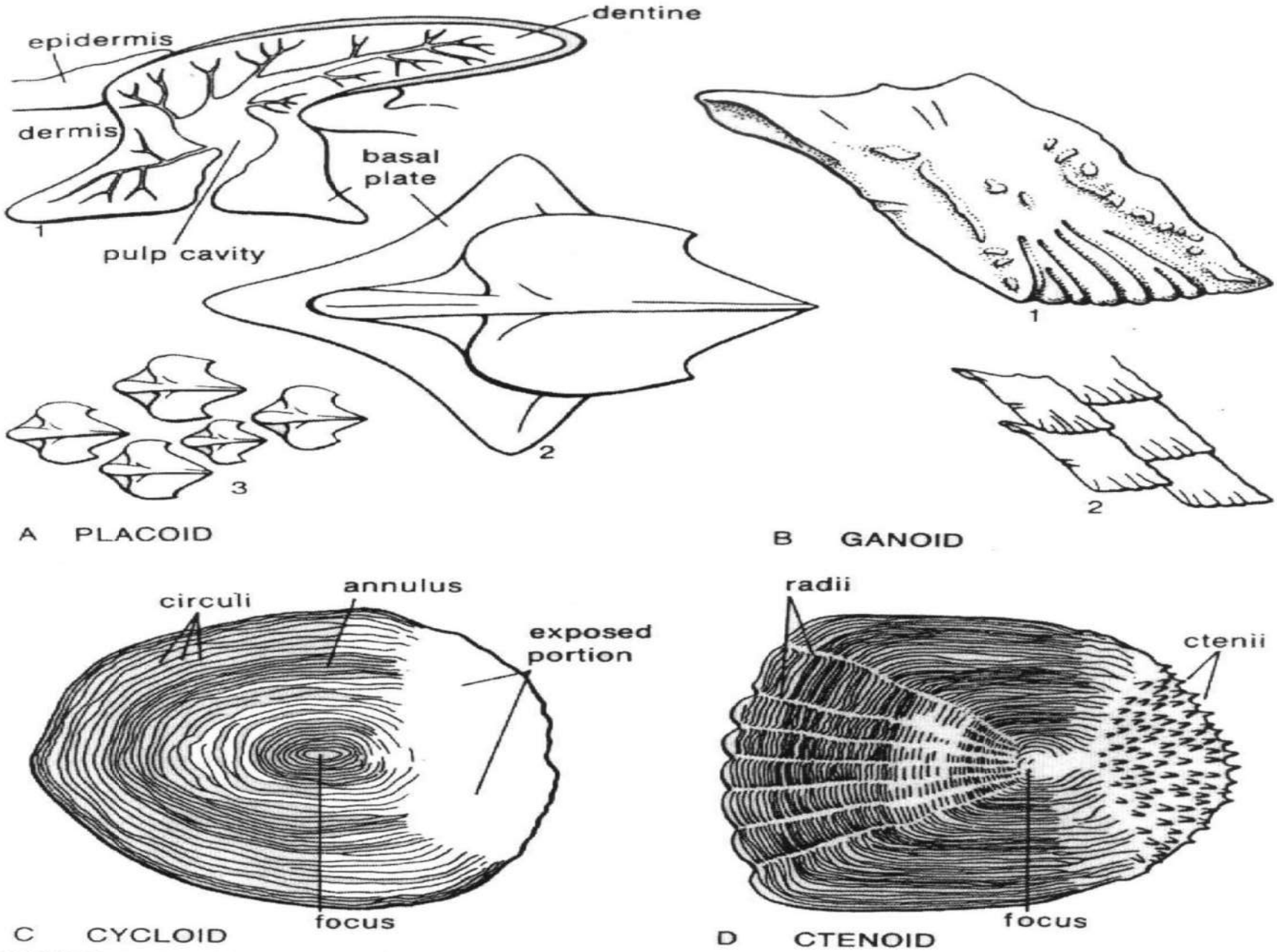
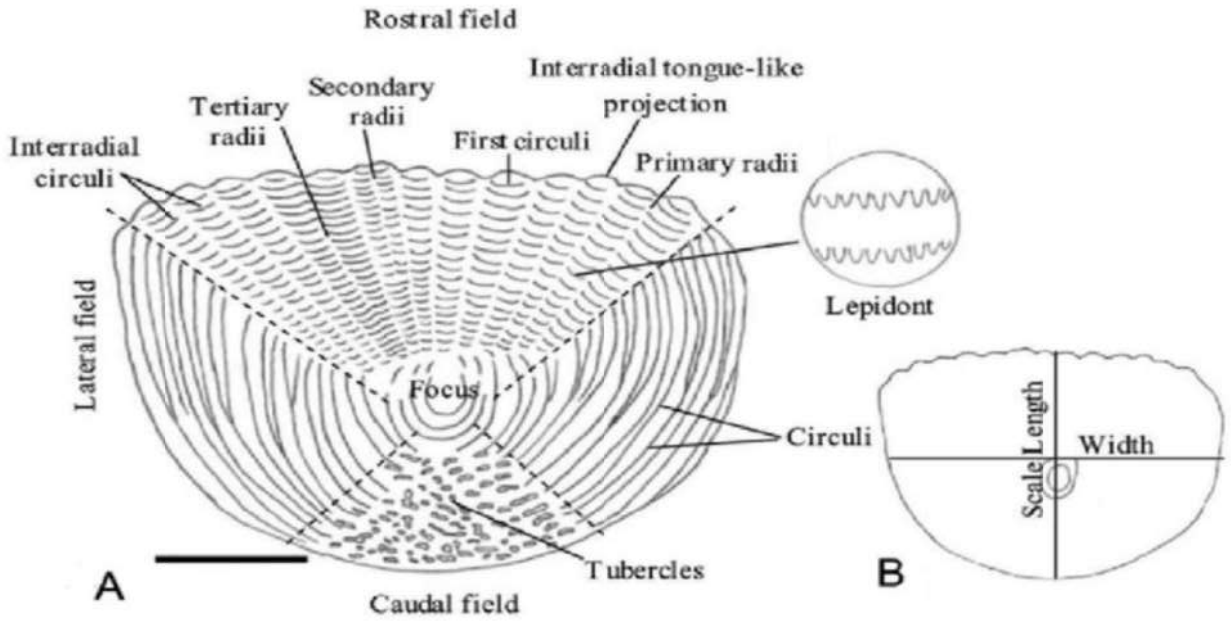
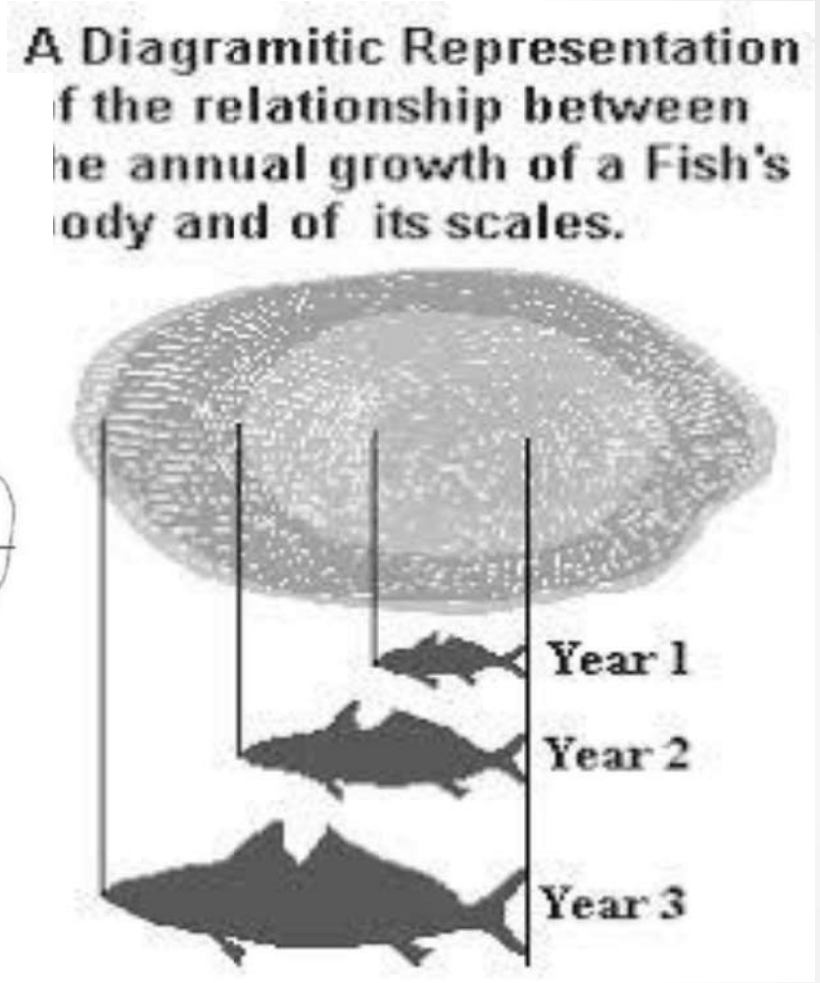



**FIGURE 2–20.** Examples of types of scales (anterior to left). *A*, Placoid— *1*, sagittal section, *2*, top view, *3*, disposition on skin; *B*, ganoid—*1*, single scale, *2*, disposition on fish; *C*, cycloid; *D*, ctenoid


Rostral field
Interradial tongue-like projection
Tertiary radii
Secondary radii
First circuli
Primary radii
Interradial circuli
Lateral field
Lepidont
Focus
Circuli
Tubercles
A
Caudal field
B
Scale Length
Width


A Diagramitic Representation
f the relationship between
he annual growth of a Fish's
ody and of its scales.
Year 1
Year 2
Year 3

7- **Lateral line** → absent
→ Present [pores ]

Complete line, **incomplete**, **interrupted** [**two lateral lines**]

**Dorsal , ventral**

8- **Head** : large , small, any other form

9- **mouth:** → terminal
→ inferior (ventral)
→ superior (dorsal)
→ subterminal

Protractile **OR** Non-protractile

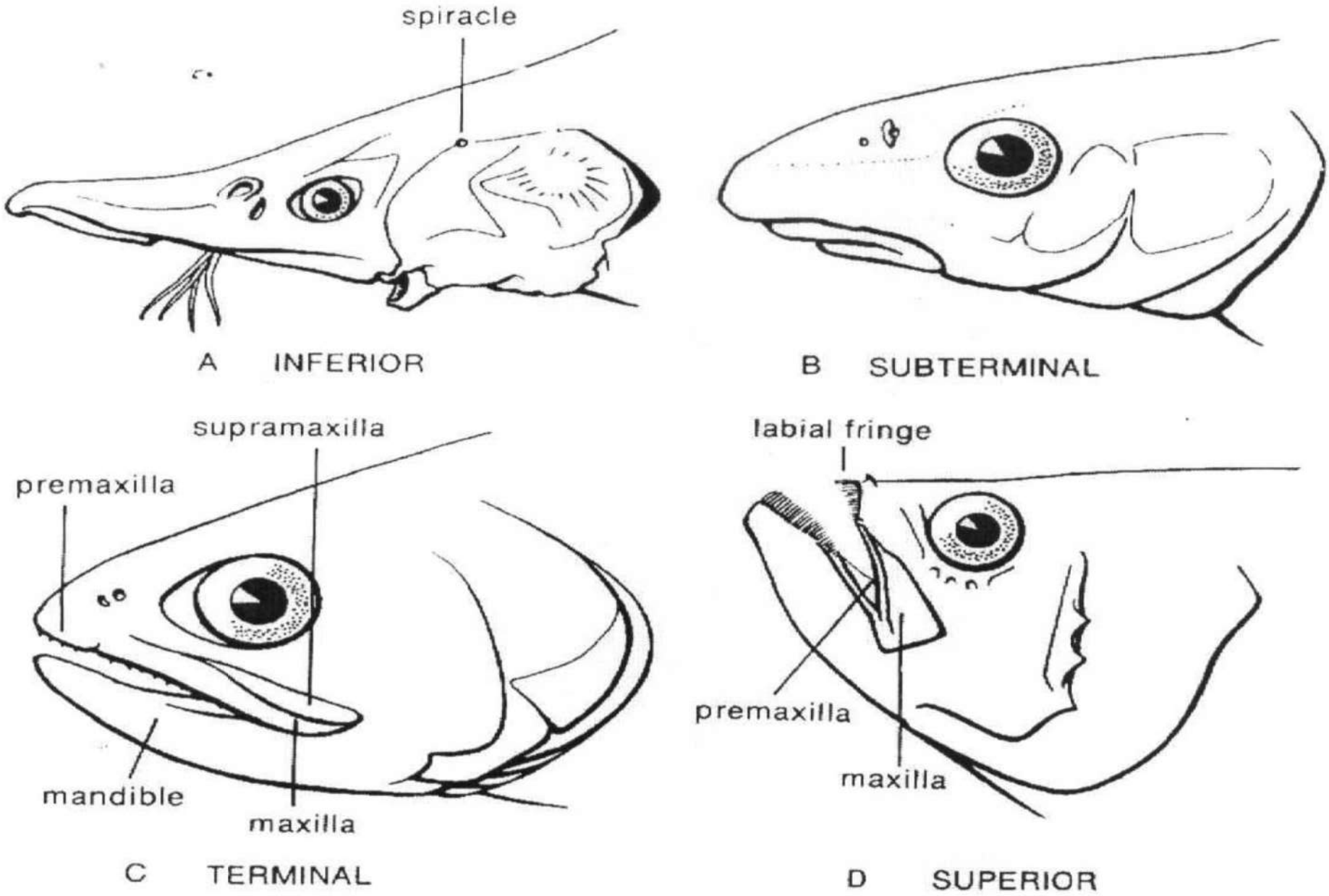




**FIGURE 2–2.** Examples of mouth positions in fishes. *A*, Inferior (sturgeon); *B*, subterminal (dace); *C*, terminal (trout); *D*, superior (sandfish). (*D*, based on Jordan and Evermann, 1900.)


Bluegill

**10- lips**

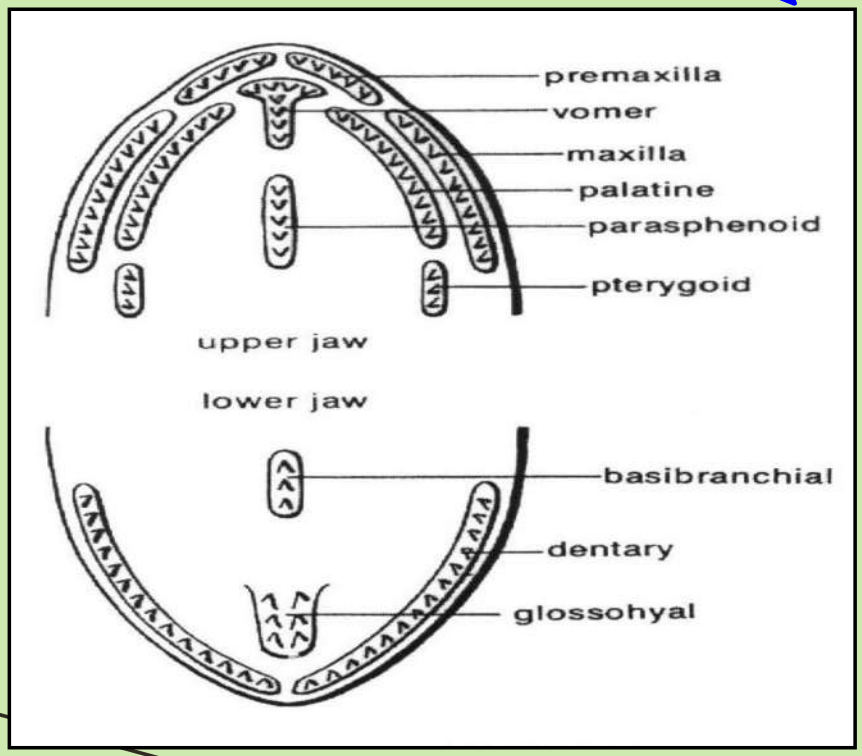
- small
- large
- fleshy

**11- buccal cavity:** with **or** with out teeth

**12- teeth**

- pointed,
- rounded

Diagram of positions of bones that can bear teeth in bony fishes.




Shape: truncate, unicusped ,bicuspid, tricuspid, polycusped

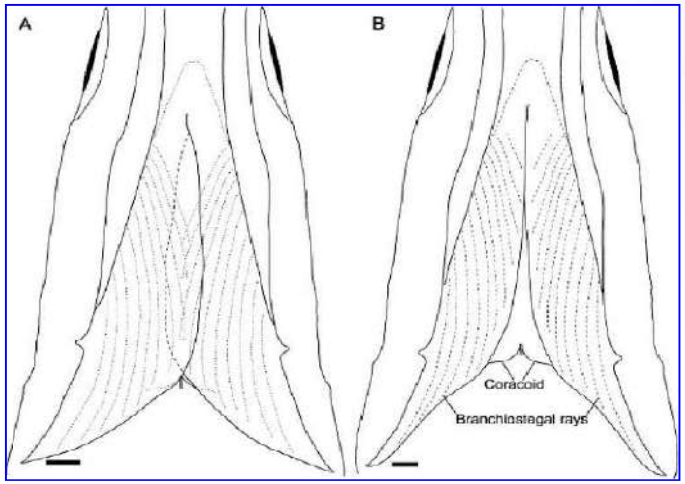
Position: premaxillary, maxillary, Vomerin, palatal teeth ….etc

## 12- Barbles : absent OR present

If present: Nasal, maxillary OR mandibular (relative length of each ).
long, short OR barbules

## 13- Eyes: small OR large

dorsal, ventral OR lateral
oval OR rounded




## 14- Operculum: absent [No. of gill slits]

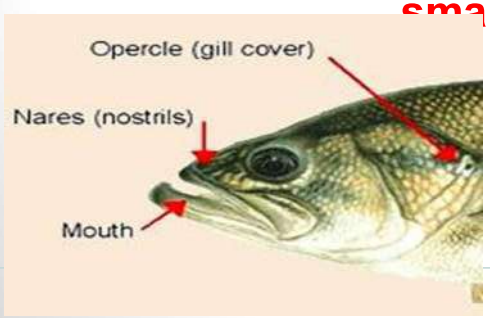
OR
present

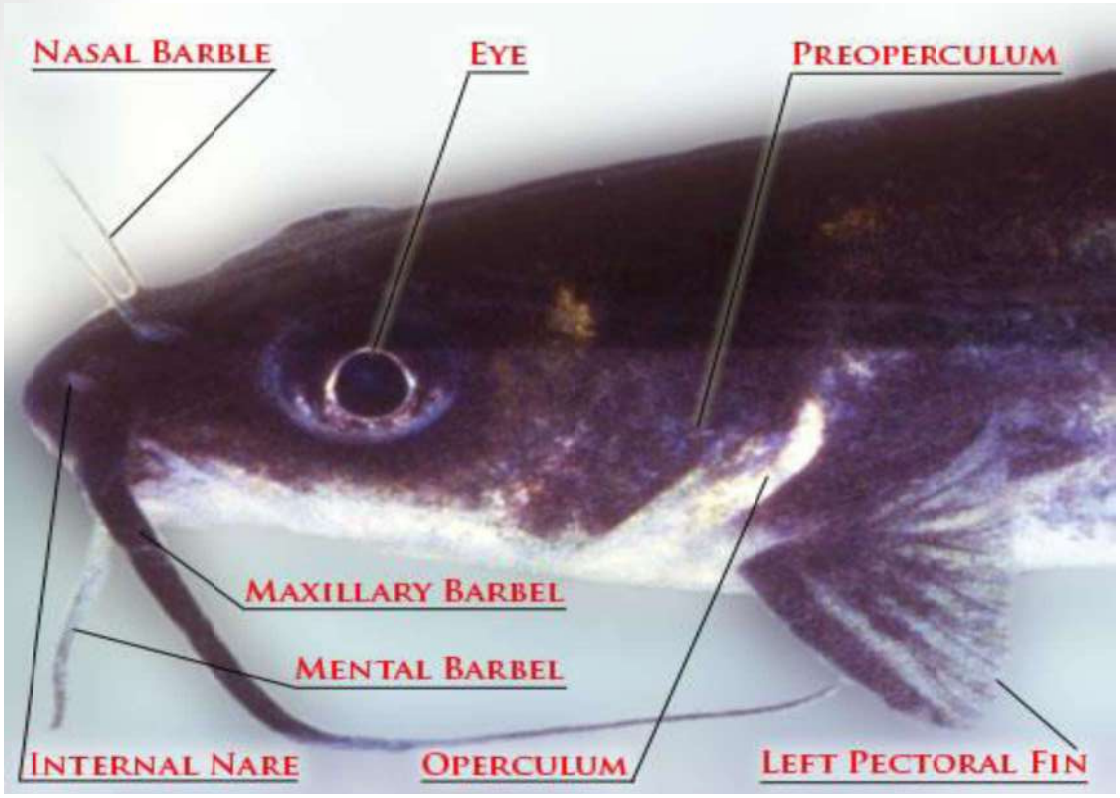
If present:

Lateral OR ventral
Branchiostegal membrane Free OR attached at the isthmus.
Overlapped OR Non-overlapped.

## 15- Nostril (Nares): Paired OR single

dorsal, ventral OR lateral …….
small OR large





NASAL BARBLE
EYE
PREOPERCULUM
MAXILLARY BARBEL
MENTAL BARBEL
INTERNAL NARE
OPERCULUM
LEFT PECTORAL FIN

# 16- gill rakers:

**No. of gill rakers on the 1st right gill arch, (on upper limb & on lower limb)**

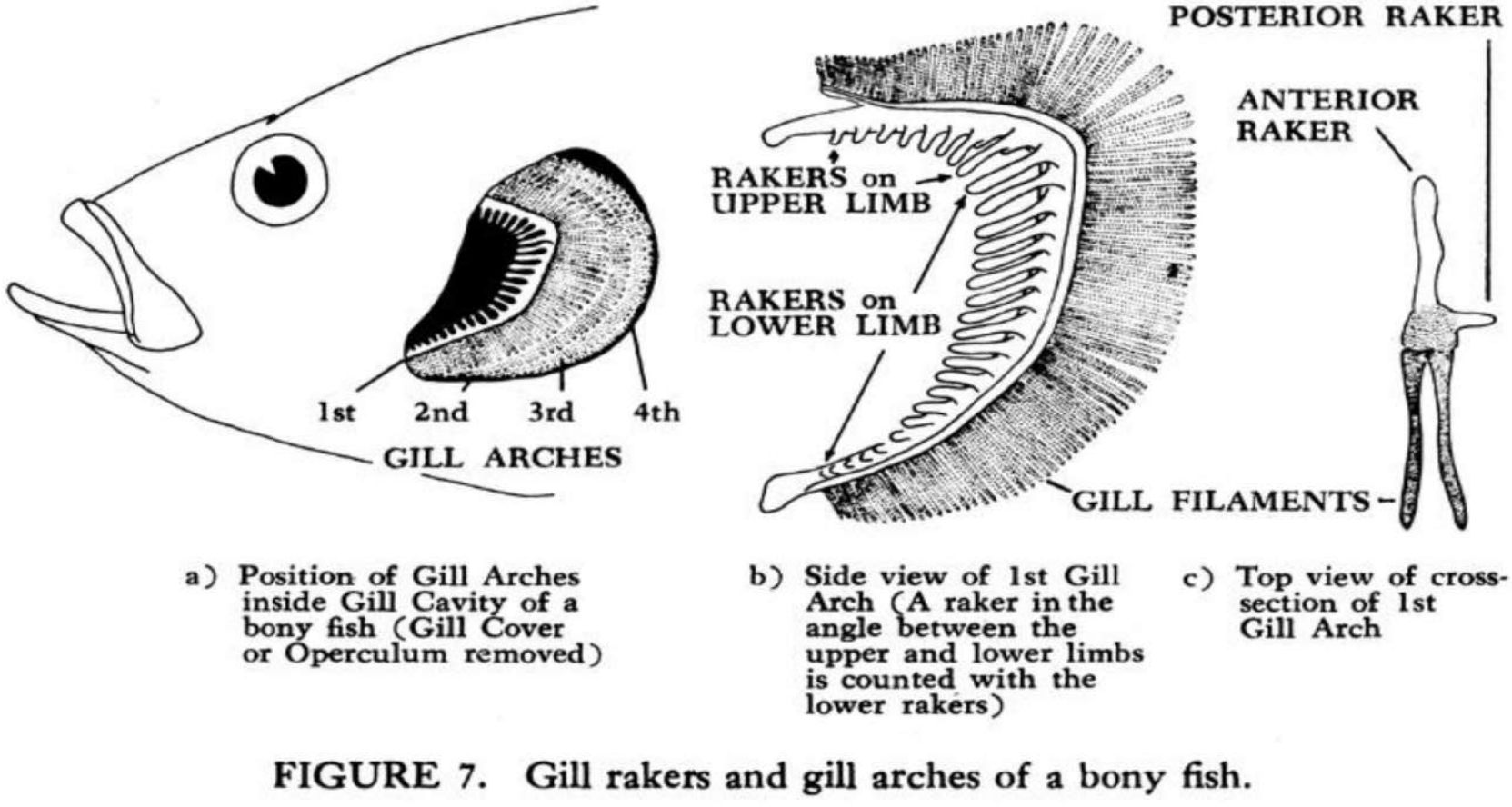



FIGURE 7. Gill rakers and gill arches of a bony fish.

# 17- Fins:

**Paired fins: pectoral & pelvic fin.**

**Unpaired fins:**

**dorsal,**
**anal,**
**caudal (shape of the caudal fin).**
**adipose fin.**

**Fin ray count: for the dorsal & anal fins)**

**Rays: may be spines or soft fin rayes.**

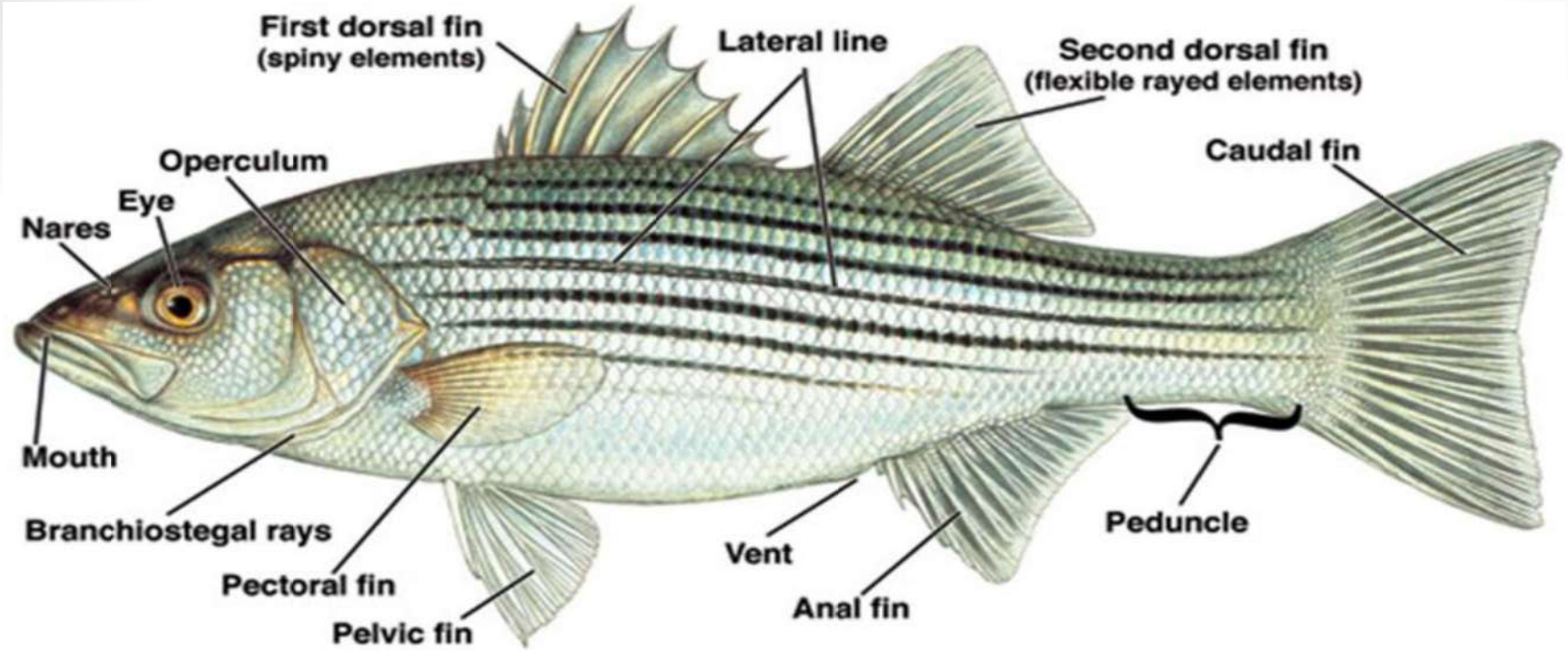
**Soft rayes: may be branched OR unbranched.**

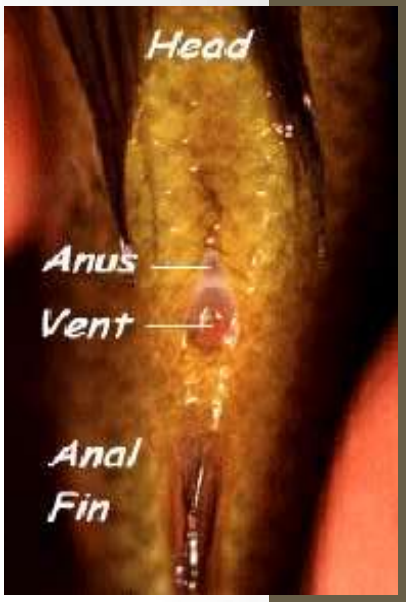
**Fin ray formula *:* Roman numbers for spines, Arabic numbers for soft- rays**

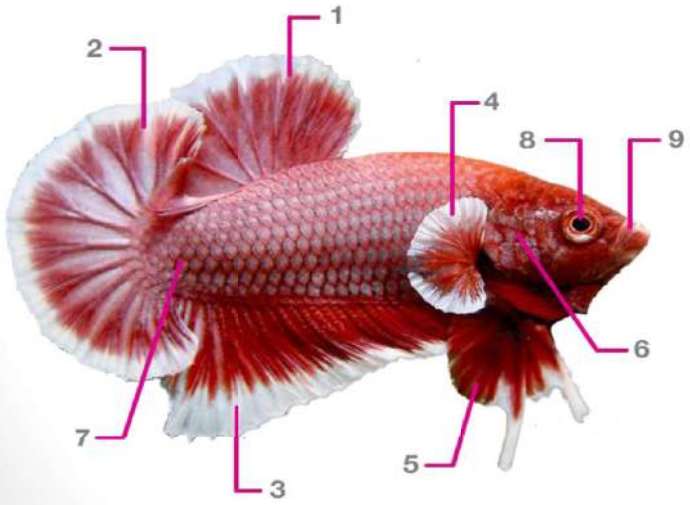
**Ex; d.f.r: IIIV,10 = IIIV, 3, 7**

**Caudal fin types: as figure**

Truncate, Pointed, Rounded, Emarginate, Crescentic [lunate], Forked




1 DORSAL FIN
2 CAUDAL FIN
3 ANAL FIN
4 PECTORAL FIN
5 VENTRAL OR PELVIC FIN
6 OPERCULUM OR GILL COVER
7 CAUDAL PEDUNCLE
8 EYE
9 MOUTH

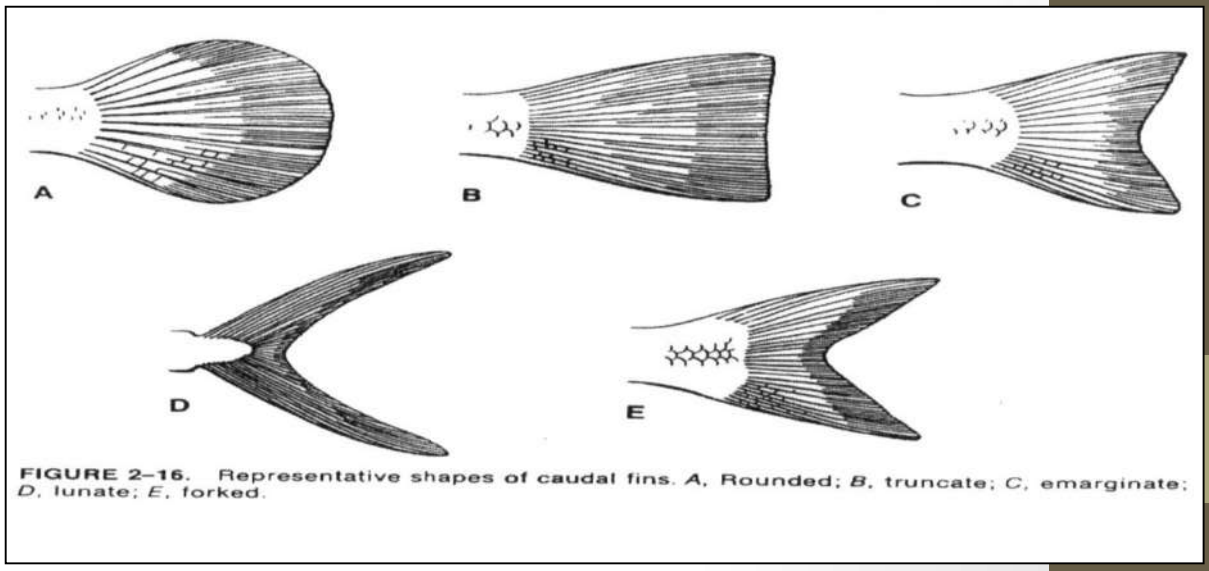



**FIGURE 2–16.** Representative shapes of caudal fins. *A*, Rounded; *B*, truncate; *C*, emarginate; *D*, lunate; *E*, forked.

## Measurements :-

**1-Total length:-[ TL]**

It is the length of fish, and it is not commonly used in the systematic work.

**2- Standard length:-[SL]**

It is the distance from the anterior margin of snout or upper lip to caudal base in a straight line.

**3- Head length:-[HL]**

The distance from the upper lip to the posterior edge of opercula bone .

**4-Body depth:-[BD]**

It is taken from the deepest point.

**5- Eye width: [EW]**

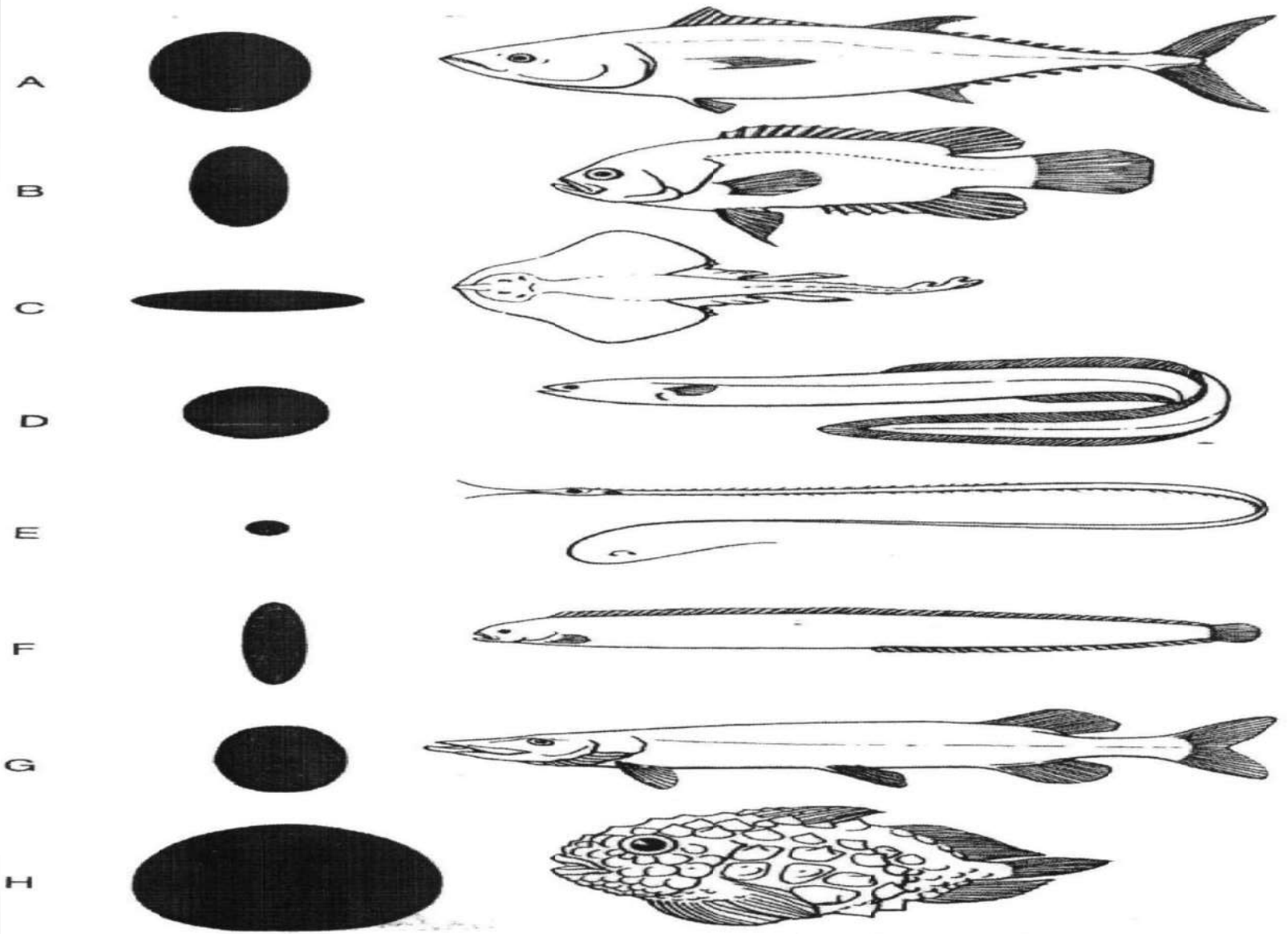
**6- Snout length:[SnL]**

**7- Caudal peduncle length:[CPL]**

# Lectures 2

# External features

# Body shapes in fishes




Fusiform, tuna

Compressiform, tilapia

Depressiform, skate

Anguilliform, eel

Filiform, snipe eel

Taeniform, tunagunnel

Sagittiform, pike

globiform, lumbsucker

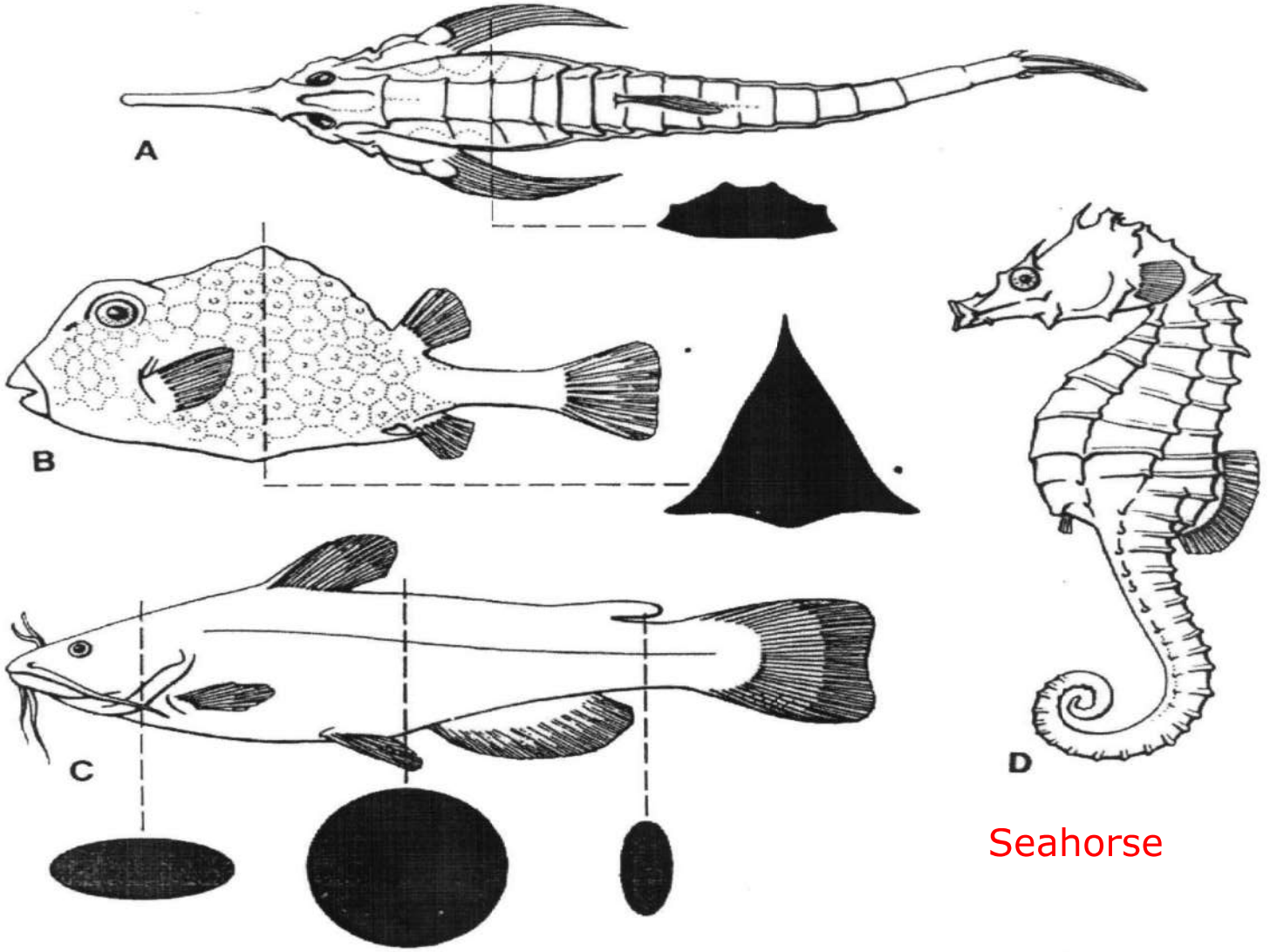
**FIGURE 2–8.** Representative body shapes in fishes, with typical cross sections. *A*, Fusiform (tuna, Scombridae); *B*, compressiform (sunfish, Centrarchidae); *C*, depressiform (skate, Rajidae), dorsal view; *D*, anguilliform (eel, Anguillidae); *E*, filiform (snipe eel, Nemichthyidae); *F*, taeniform (gunnel, Pholidae); *G*, sagittiform (pike, Esocidae); *H*, globiform (lumpsucker, Cyclopteridae). (*H* based on Jordan and Evermann, 1900.)

# *Other examples of body shapes in fishes

فراشة البحر Sea moth

السمك البقرى Cowfish

Catfish bullhead




Seahorse

**FIGURE 2–9.** Examples of body shapes in fishes: *A*, Sea moth (Pegasidae); *B*, cowfish (Ostraciidae); *C*, *bullhead* (Ictaluridae); *D*, seahorse (Syngnathidae). (*B* and *C* based on Jordan and Evermann, 1900.)

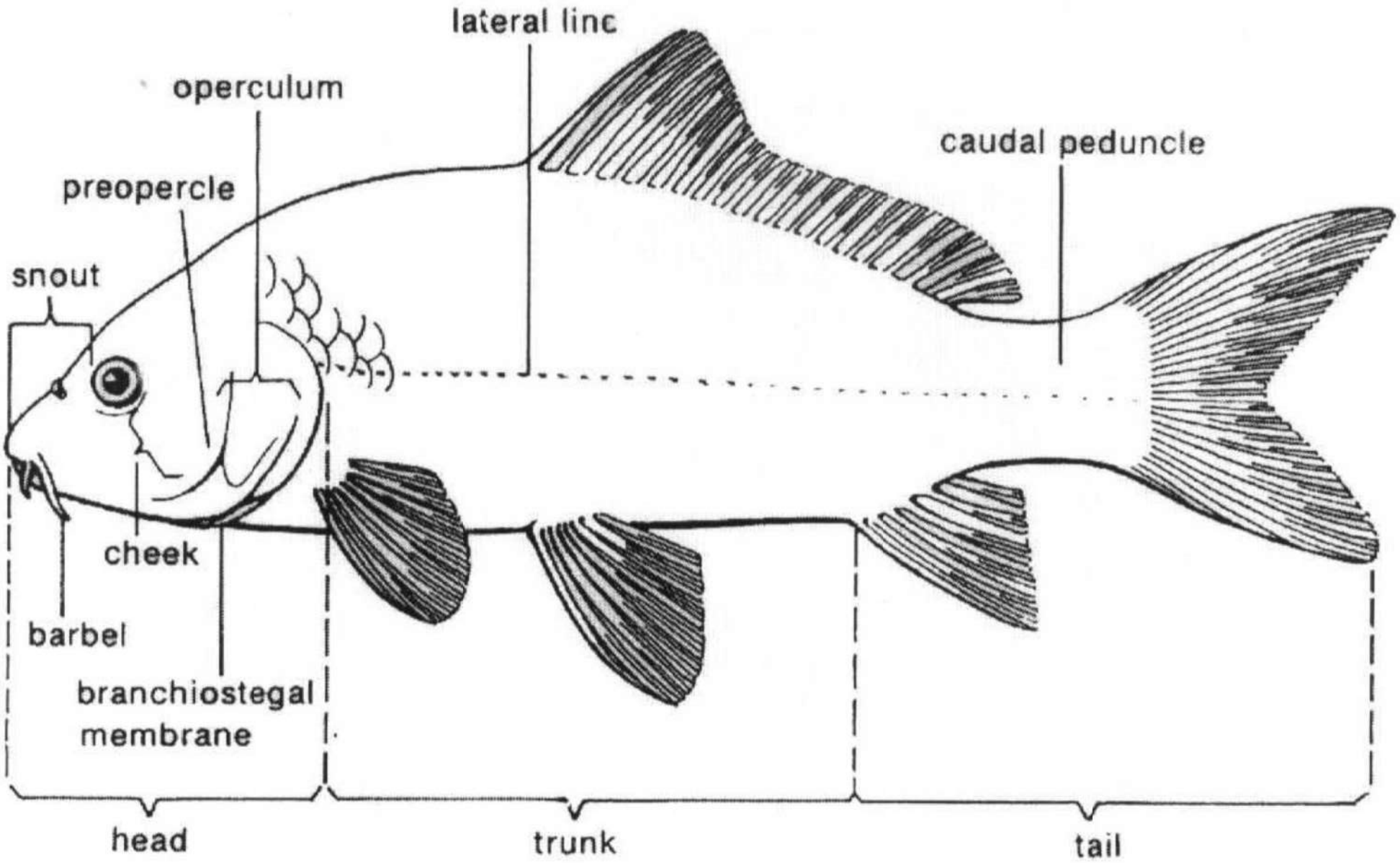
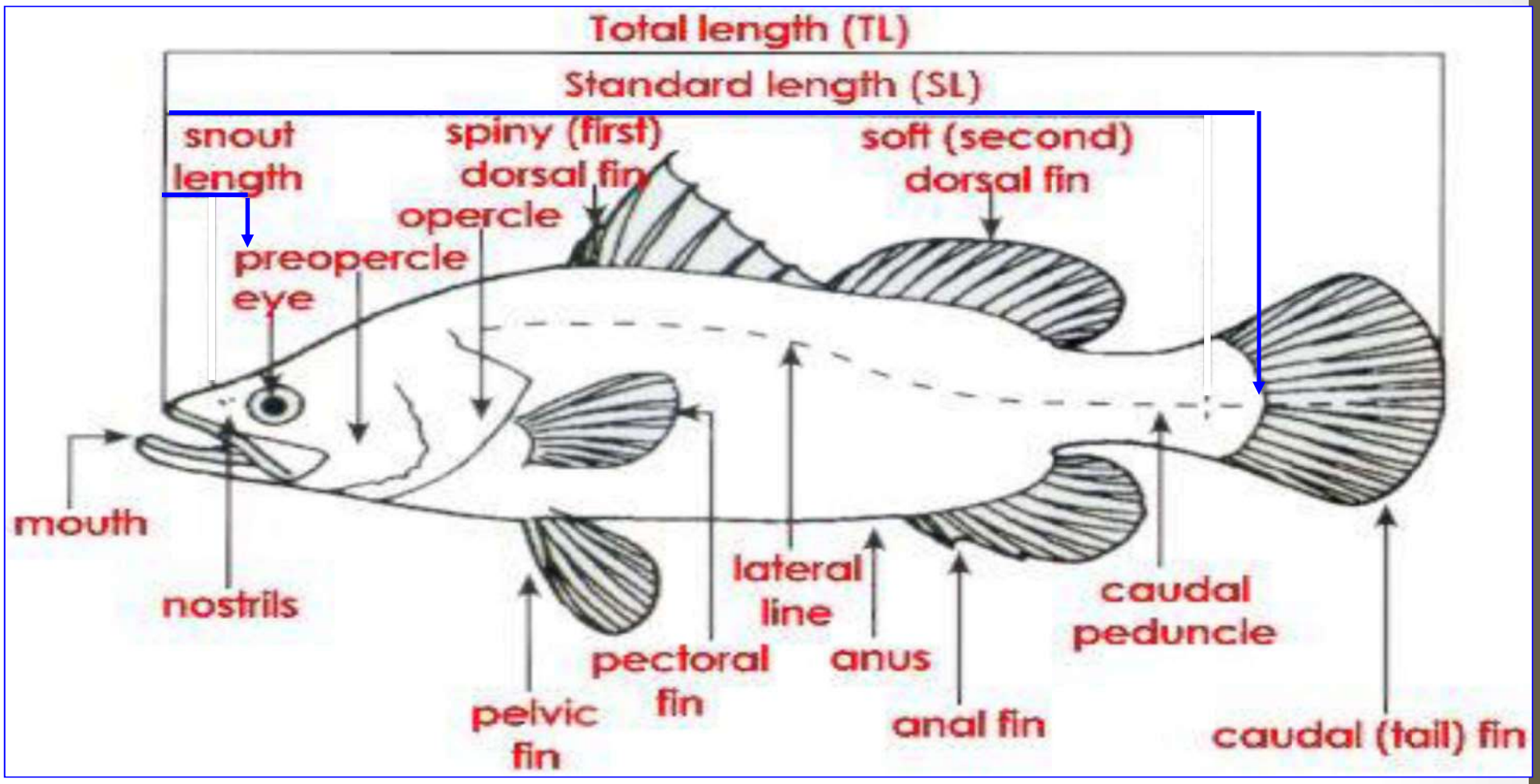
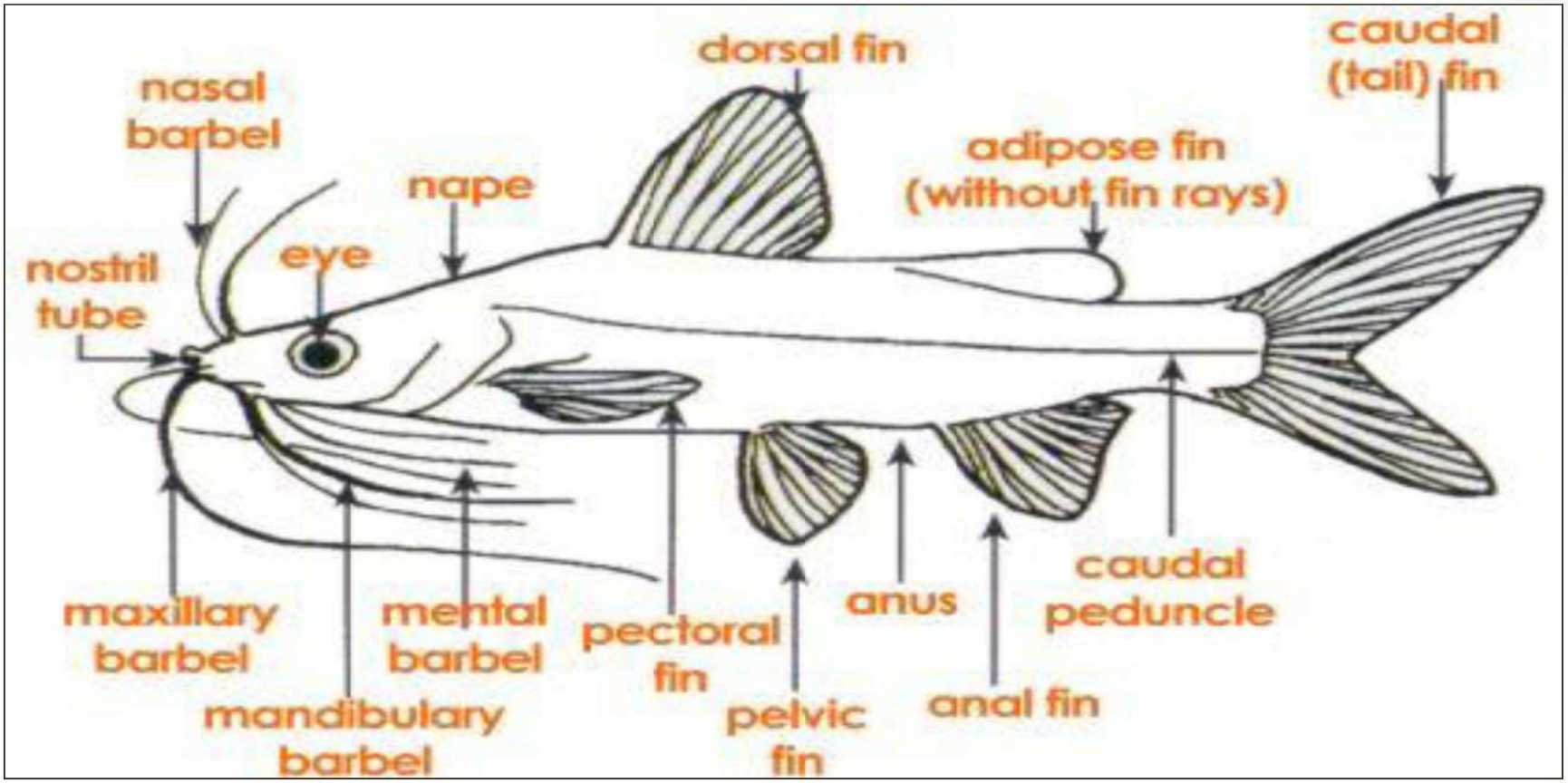
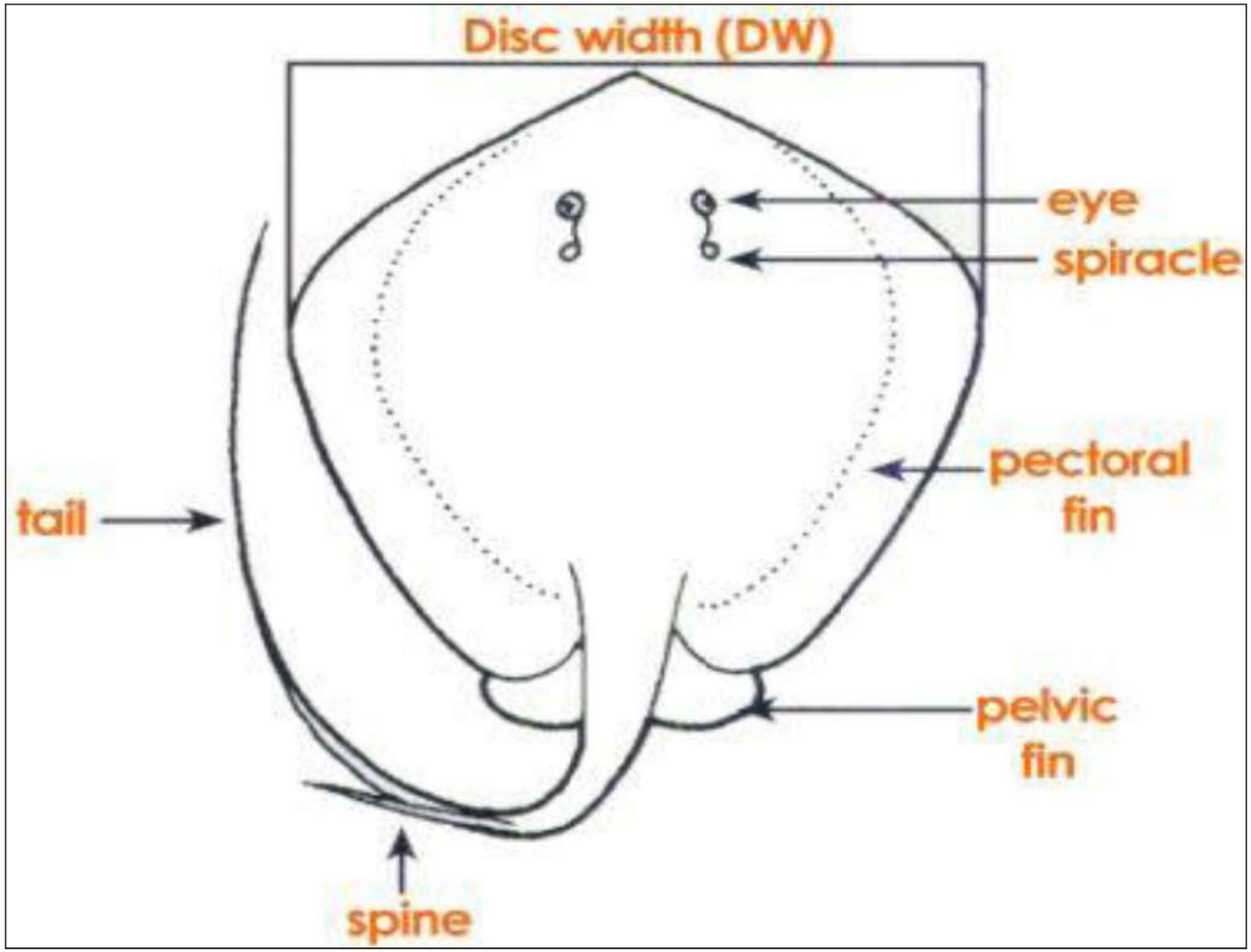



**FIGURE 2–1.** Diagram of bony fish, showing external features.


Total length (TL)
Standard length (SL)
snout length
spiny (first) dorsal fin
soft (second) dorsal fin
opercle
preopercle
eye
mouth
nostrils
lateral line
pectoral fin
anus
caudal peduncle
pelvic fin
anal fin
caudal (tail) fin

A bony fish

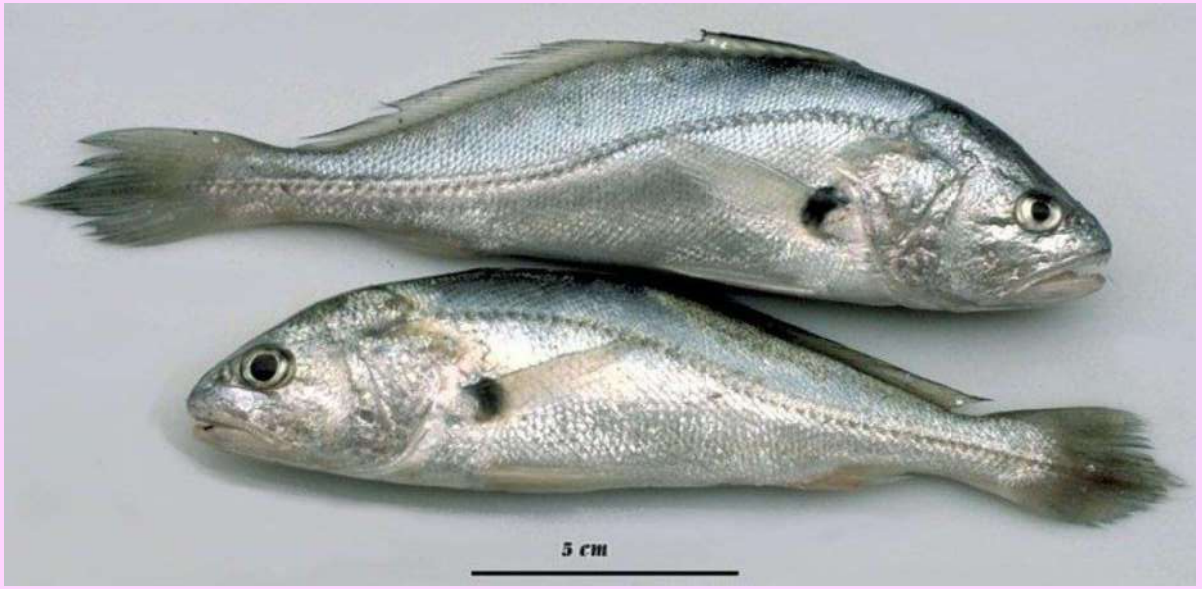

dorsal fin
caudal
(tail) fin
nasal
barbel
adipose fin
(without fin rays)
nape
eye
nostril
tube
maxillary
barbel
mental
barbel
pectoral
fin
anus
caudal
peduncle
mandibulary
barbel
pelvic
fin
anal fin


Disc width (DW)
eye
spiracle
pectoral fin
tail
pelvic fin
spine

A stingray

## ***The lateral line*** :

- **Lateral line system, also called lateralis system, unique to aquatic vertebrates from cyclostome fishes (lampreys and hagfish) to amphibians.**
- **In amphibians, the lateral line system occurs only in larval forms and in adult forms that are completely aquatic.**
- **It is a sensory system that plays an essential role in orientation, predatory behaviour, and social schooling; also, it allows fishes to detect weak water motions and pressure changes in the surrounding water.**



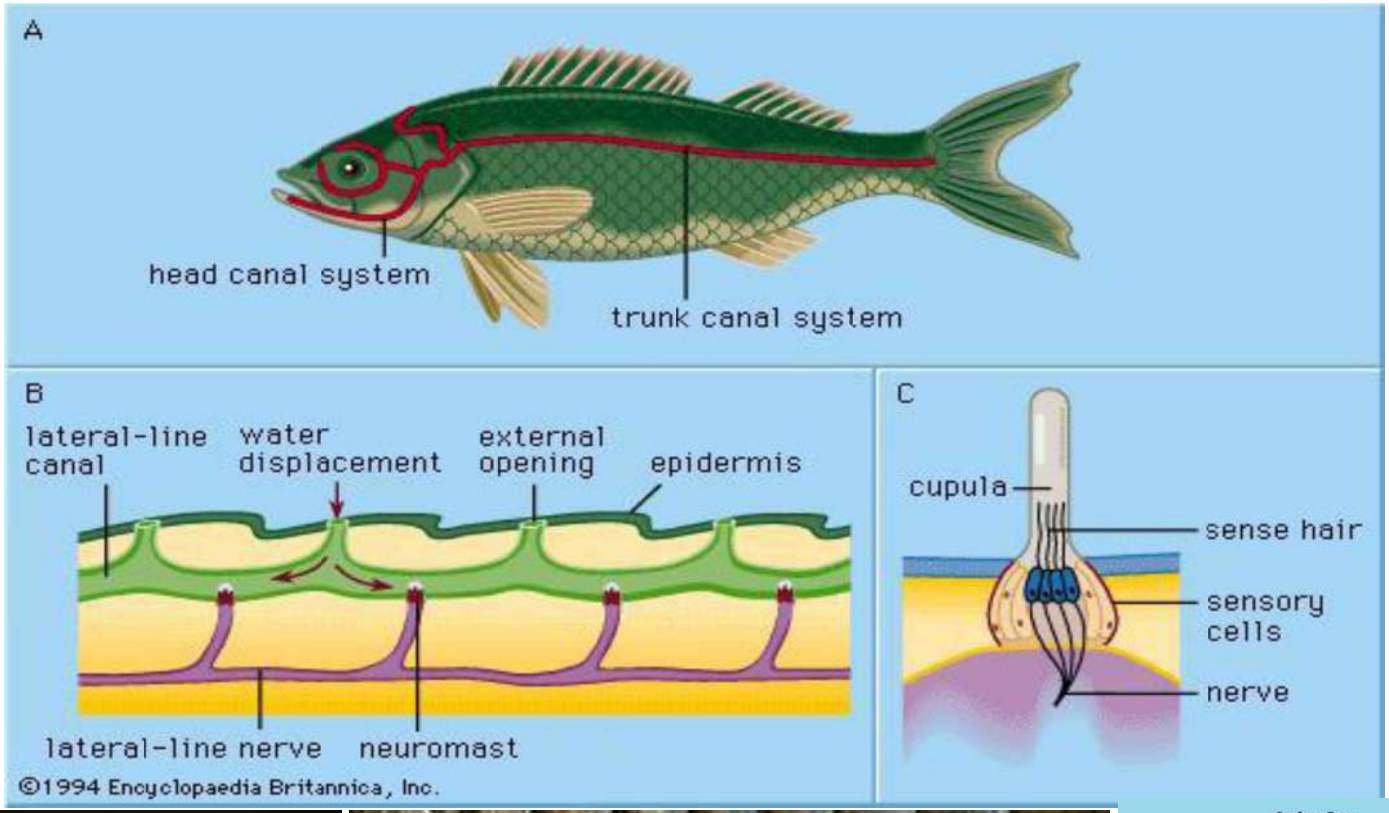
- Lateral line system consists of jelly-filled canals just below the skin. It opens to the water outside by a series of tiny pores.

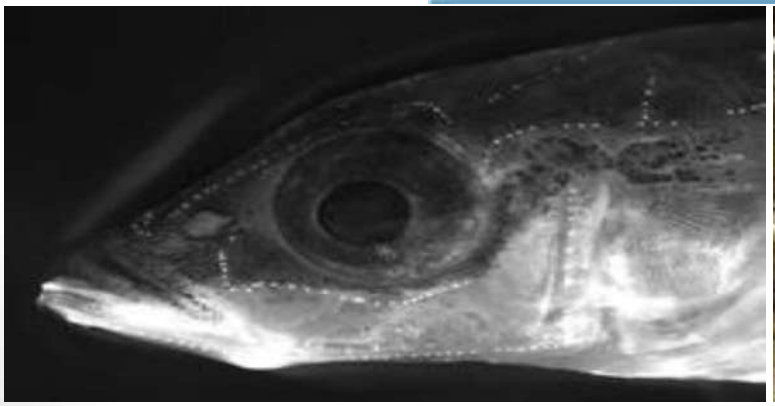
- The functional unit of the lateral line is the neuromast (mechanoreceptors).

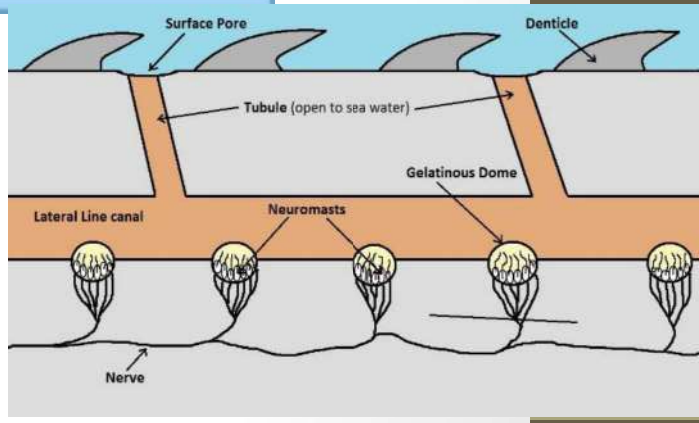
- The neuromast is a sensory structure that consists of a hair cell epithelium and a cupula.
- the cupula connects the ciliary bundles of the hair cells with the surrounding water.

- The rows of neuromasts appear on the surface of the skin & spread over the head, trunk and tail; however, for most fishes, they lie embedded in the floor of mucus-filled lateral line canals.
- The sensitivity of this system makes blind fish very difficult to be catched by hand.

# The lateral line in fishes



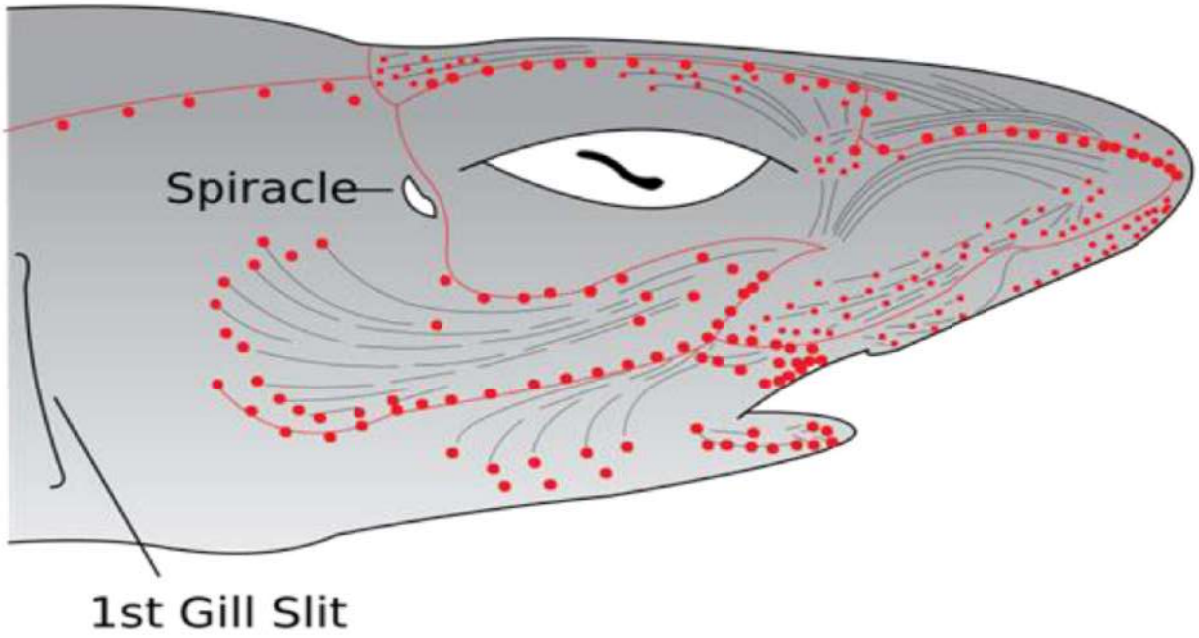





# Ampullae of Lorenzini

- The ampullae of Lorenzini are highly specialized sense organs called electroreceptors,
- They are mostly found in cartilaginous fish (sharks, rays, and chimaeras); and also, found in some other fishes.
- The ampullae of Lorenzini provide fish an additional sense capability of detecting electric and magnetic fields as well as temperature gradients in the water.
- They are used by the fish for important biological functions such as prey detection, navigation (الملاحة) and mate locations.
- Ampullae are composed of an enlarged terminal portion and a canal. The internal part of the ampulla is filled with a gelatinous mucopolysaccharide substance which plays an important role in the conductivity of the electric signals.
- The ampullae are plainly visible as dark spots in the skin.

- **Interspecific variation in the anatomical organization of the ampullae could reflect relationships with taxonomic and ecological features.**




Electroreceptors (ampullae of Lorenzini) in the head of a shark

## ***Mouth:***

Fish mouths come in a variety of sizes, shapes and orientations, each of which tells a great deal about what and where the fish eats, as well as about its behaviour.

The mouth serves for taking in food; also for the breathing current of water.

Some fish: filter microscopic plants and animals as they swim along, trapping them in gill rakers before the water is expelled from the operculum.

Predatory fish generally have the largest mouths with sharp teeth. Some species have specialized mouth parts that allow them to rasp algae of rocks.

Other species have mouths with teeth in the back, nearly in their throat. These pharyngeal teeth assist in grasping and swallowing prey.

**Most fish mouths fall into one of the following general types.**

1- Superior, **or** sometimes called supra-terminal, mouths are upturned.

2- Terminal mouths point straight forward, and are the most common mouth type.

3- sub-terminal, mouths are turned lightly downward.
4- Inferior, mouths are turned downward.

The inferior mouth type is often found in bottom dwelling species, such as the catfish family.

**Superior Mouth**

The superior mouth is oriented upwards, with the lower jaw being longer than the upper jaw. Usually, fish with this type of mouth feed at the surface. They lay in wait for prey to appear above them, then strike suddenly from below.

Many species of fish with a superior mouth feed largely on insects, however some may feed on other fish that swim near the surface.

**Terminal Mouth**

Terminal mouths are located in the middle of the head, pointed straight forward, with both jaws being the same length. Most fishes have this mouth type than any other. Fish having a terminal mouth are generally mid water feeders, however they can feed at any location. These species of fish are often omnivores, eating anything that is available. They typically feed on the move, either grabbing bits of food that they pass close to, or prey on other fish that they chase down.

**Inferior Mouth**

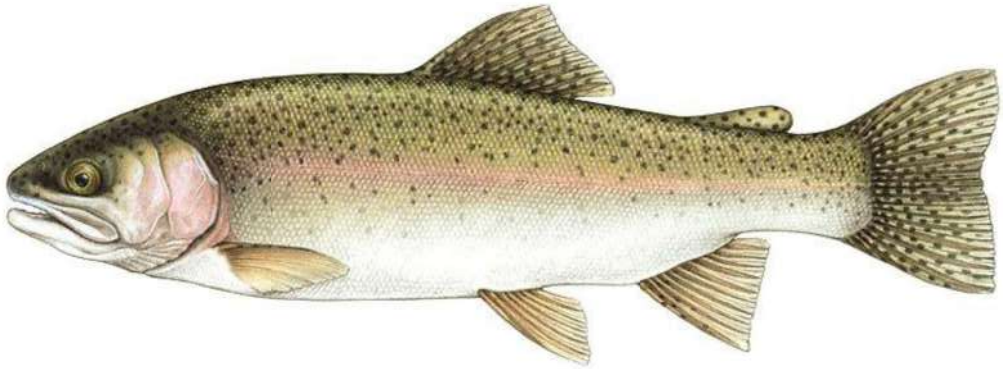
Also called a sub-terminal or ventral mouth, the inferior mouth is turned downward. The lower jaw is shorter than the upper jaw. Fish with inferior mouths are bottom feeders that often possess barbels that assist in locating food particles.

The diet of fish with inferior mouths include algae, invertebrates such as snails, as well as detritus and any food that falls to the bottom.

# Positions of fish-mouth

**A.** Inferior (sturgeon)

**B**. Subterminal (dace)



**C**. Terminal (trout)

**D**. Superior (sandfish)

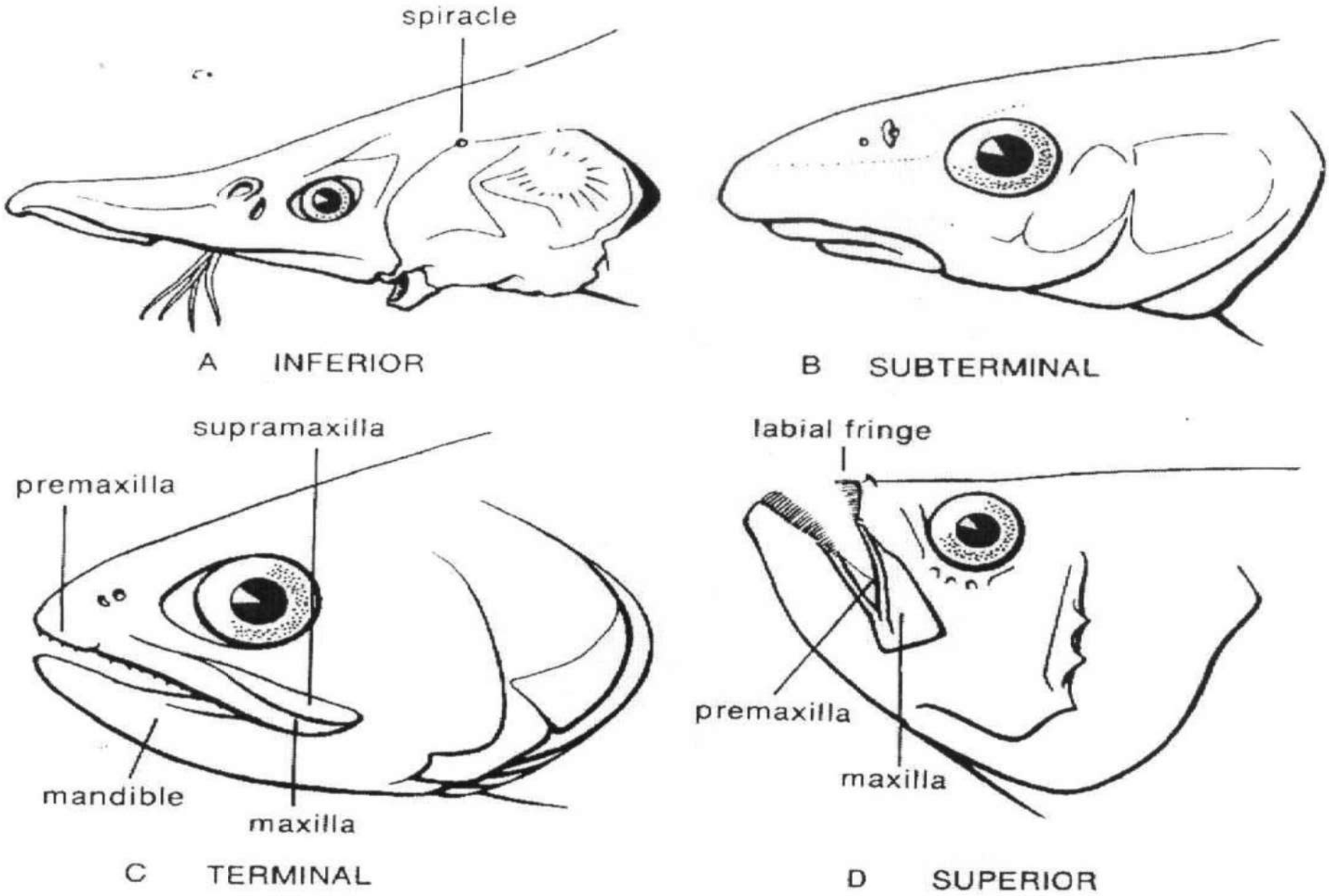



**FIGURE 2–2.** Examples of mouth positions in fishes. *A*, Inferior (sturgeon); *B*, subterminal (dace); *C*, terminal (trout); *D*, superior (sandfish). (*D*, based on Jordan and Evermann, 1900.)

# Mouth Adaptations

## Protrusile Mouth

Often fish will have a protrusile mouth feature, which allows them to extend their reach when attempting to snatch prey or food particles. This feature can be seen in all mouth types.

## Sucker Mouth

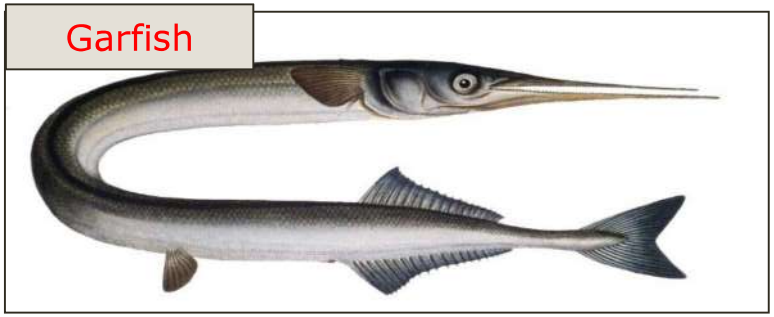
Sucker mouths are a common feature in fish with inferior mouths. Catfish such as the popular pleco, use their sucker mouth to rasp algae off driftwood or rocks. Some species may also use the sucker to help them combat currents. By attaching themselves to a rock via their sucker mouth, they are able to stay where they wish, even in a strong current.

Protrusile Mouth

Sucker Mouth

## Elongated Mouth

Elongated mouth allows the fish to poke into small crevices and holes to find food. The fish also use such a mouth to dig through the substrate to reach buried food. Elongated mouth allows the fish to scoop insects and food particles from the surface.
Freshwater species with elongated mouths include the Halfbeaks, Gars.



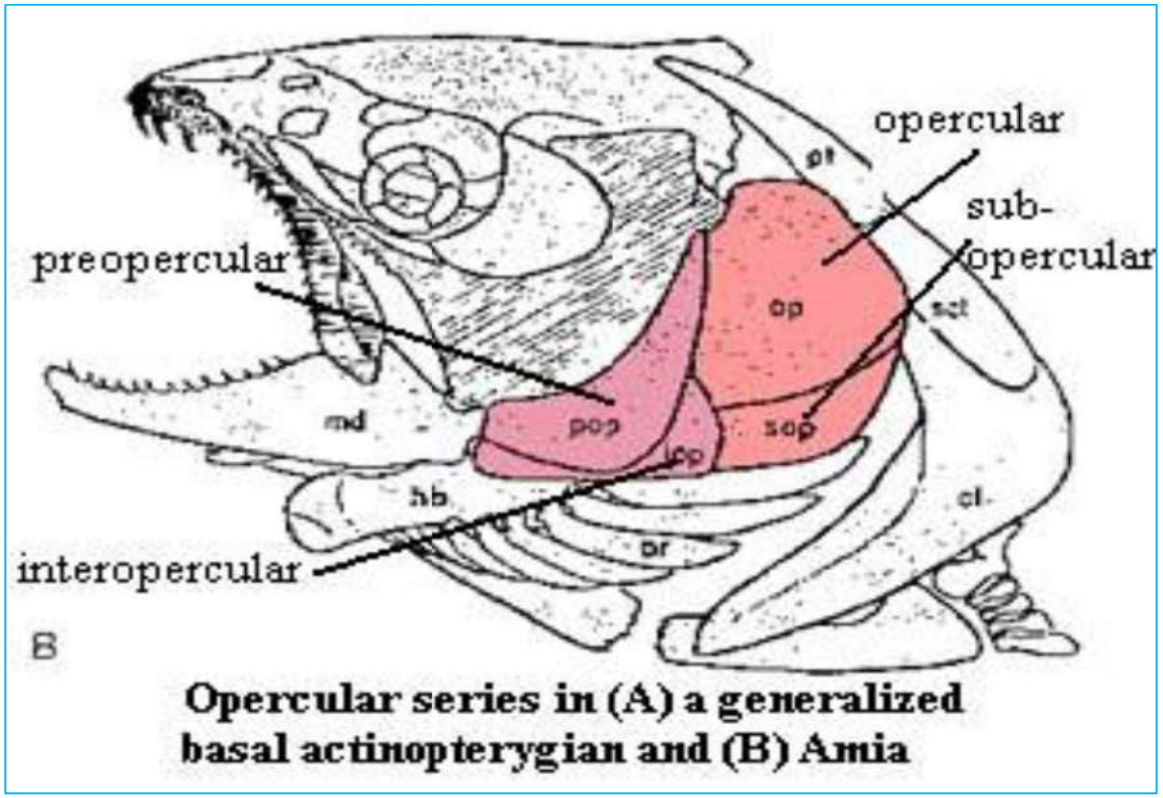


## Beak Mouth

An interesting mouth variation is the beak mouth, also known as a rostrum. In this cases the mouth consists of two very hard pieces that are hinged and come together in a scissor-like fashion. This allows them to crush hard shells on invertebrates.
Pufferfish & Saltwater Parrotfish are fish with a beak mouth.

***The operculum:***

Is a bony structure, covering and protecting the gills in teleosts; it plays an important part in the breathing mechanism. In most fish, the edge of the operculum roughly marks the division between the head and the body. The operculum is composed of four fused bones; the opercle, preopercle, interopercle, and subopercle. The posterior rim of the operculum is equipped with a flexible, ribbed structure which acts as a seal to prevent reverse water flow during respiration. Elasmobranchs do not have an operculum but there are separate gill slits for each gill.




**Opercular series in (A) a generalized basal actinopterygian and (B) Amia**

## Barbals

* **Barbals** may be minute and simple or conspicuous and complex.

* Other structure as barbels are cirri or fimbria.


Lampreys have a series of fleshy fimbria surrounding the mouth, which is a jawless sucking disc

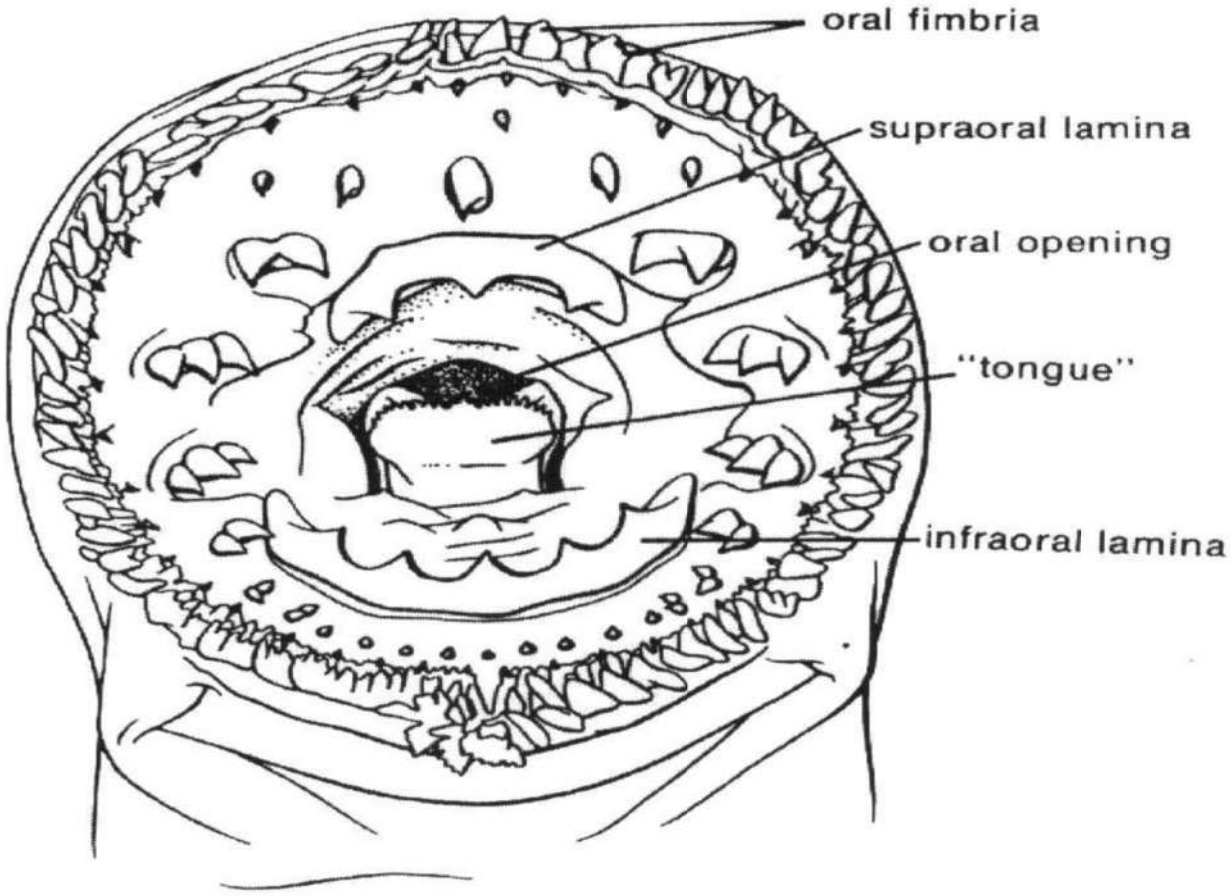



**FIGURE 2–4.** Oral disc of lamprey (*Lampetra minima*).

*Sharks may have oronasal grooves and labial folds in the mouth region

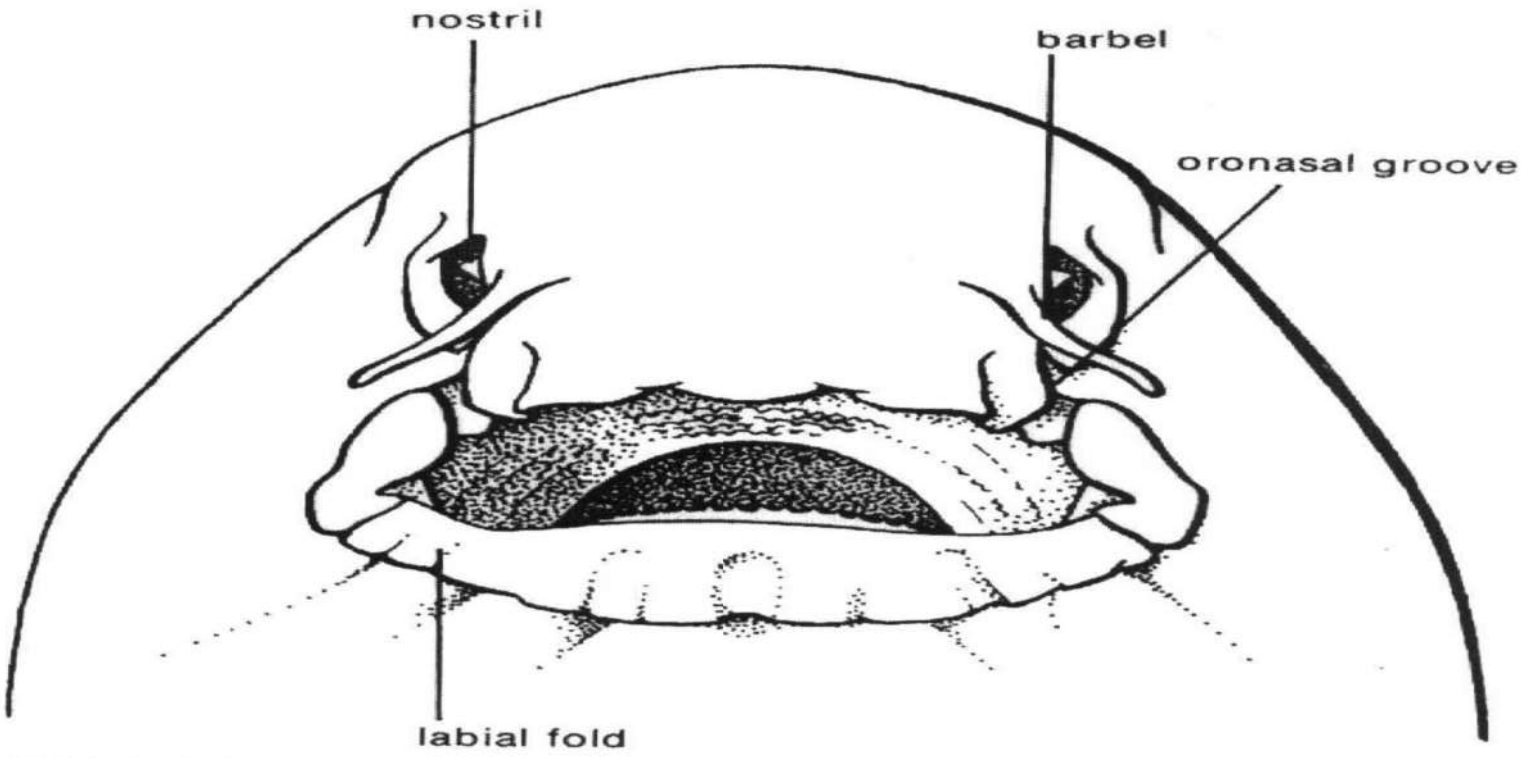



**FIGURE 2–3.** Ventral view of mouth and rostrum of shark (*Chiloscyllium indicum*) showing grooves and labial folds.

Some other prominent features of the head are spines on various bones

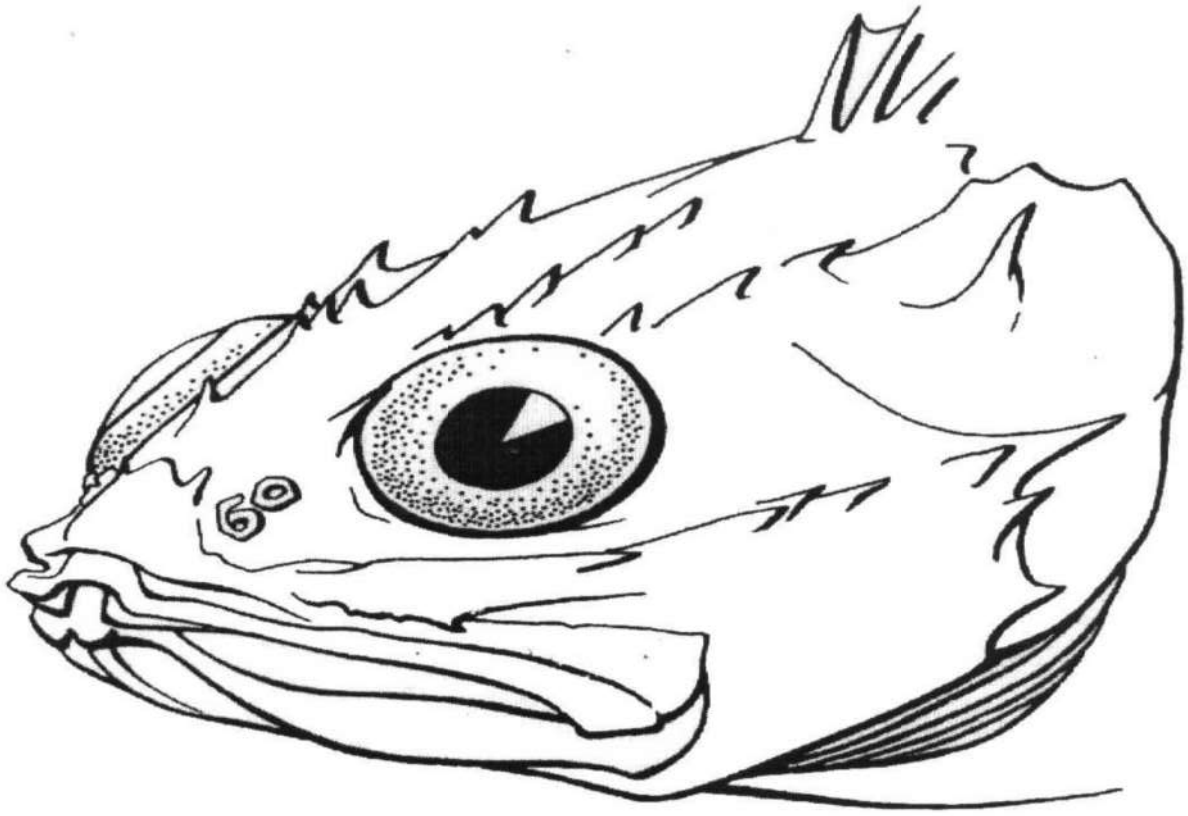


FIGURE 2–5. Diagram of head of rockfish (Scorpaenidae), showing spines.

# ***Nostrils***:

The nostrils of fish do not open into the back of the mouth as do those of mammals, and are not for breathing. They lead into organs of smell which are very sensitive, so that a fish can detect the presence of food in the water at considerable distances.

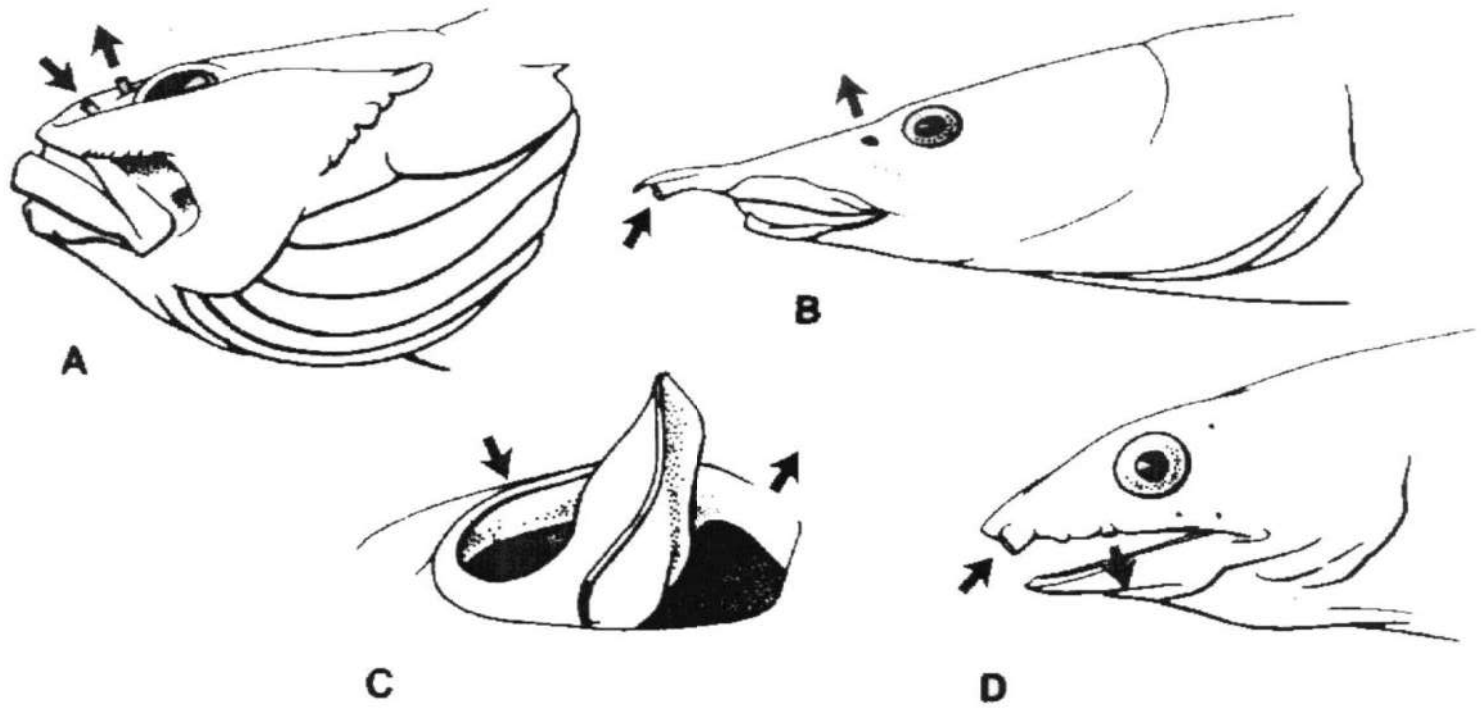



**FIGURE 2–7.** Nostril positions. *A*, Sculpin (Cottidae); *B*, spiny eel (Mastacembelidae); *C*, typical bony fish nostrils divided by flap of skin (Catostomidae); *D*, eel (*Myrophis*).

# *Fins of fishes

Fins give stability, and control the direction of movement during swimming.

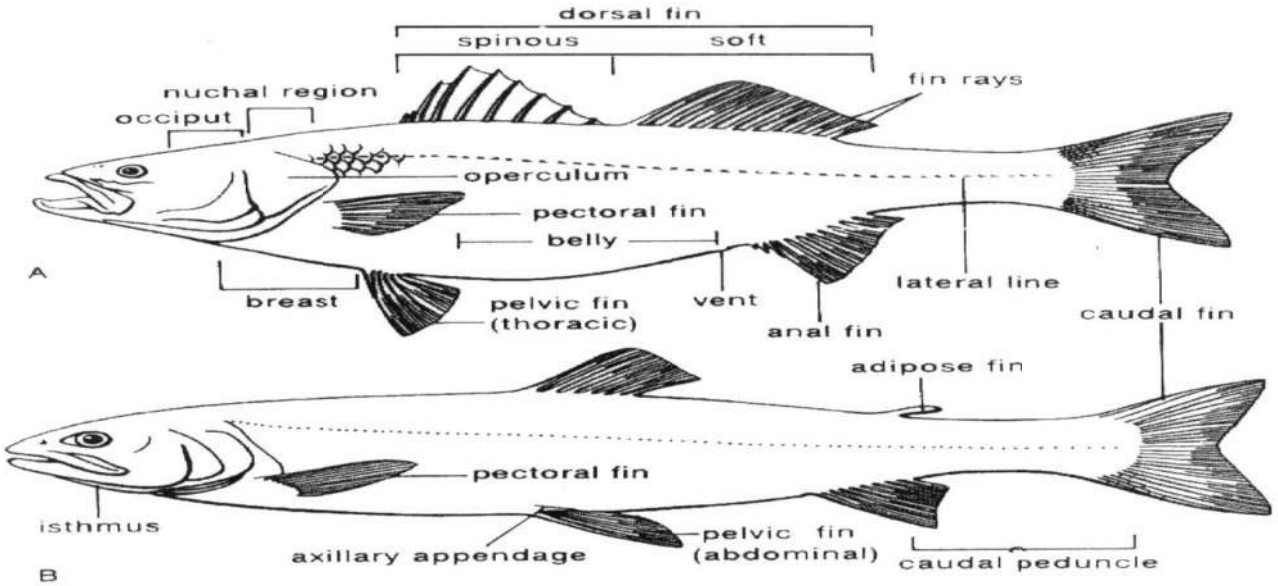



**FIGURE 2–10.** Body regions and fins. *A*, Spiny-rayed fish; *B*, soft-rayed fish.

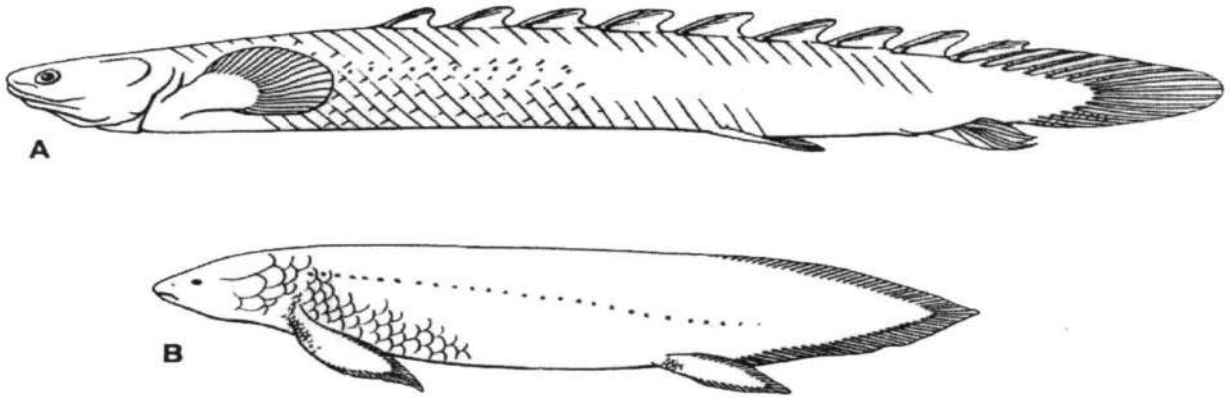



**FIGURE 2–11.** Examples of fishes with lobate paired fins. *A*, Bichir (*Polypterus*); *B*, Australian lungfish (*Neoceratodus*). (*B* based on Goodrich, in Lankester, 1909.)

**1. Paired fins**

# *Fishes with modified pectoral fins

butterflyfish

batfish

flyingfish

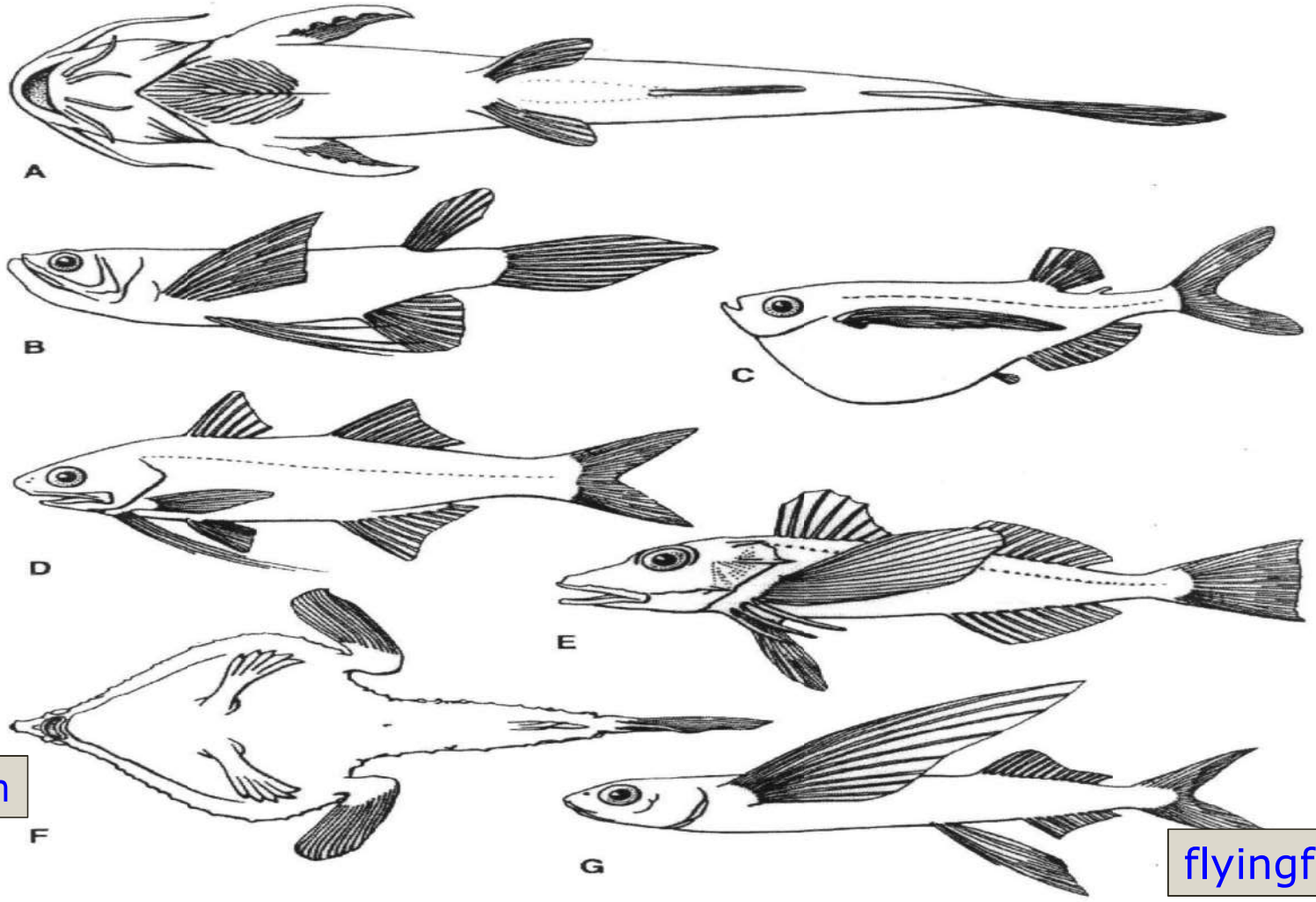
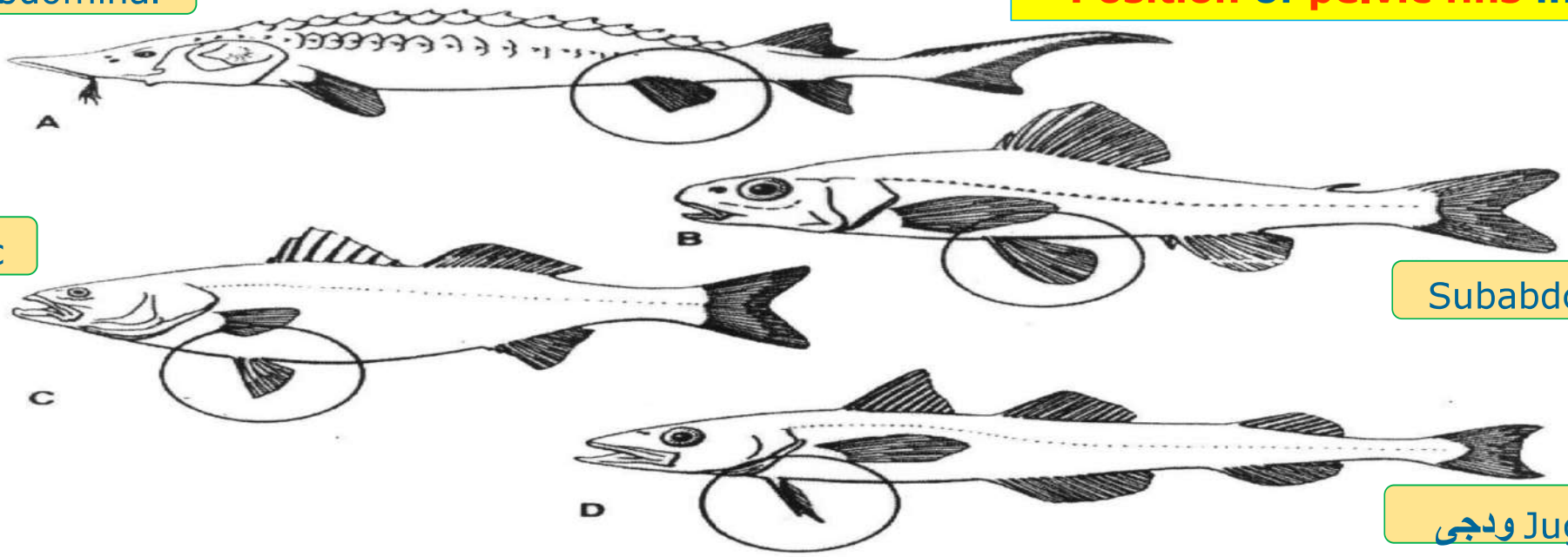



**FIGURE 2–12.** Examples of fishes with modified pectoral fins. *A*, Sisorid catfish (*Glyptothorax*); *B*, freshwater butterflyfish (*Pantodon*); *C*, hatchetfish (*Gastropelecus*); *D*, threadfin (Polynemidae); *E*, gurnard (Triglidae); *F*, batfish (Ogcocephalidae); *G*, flyingfish (Exocoetidae). (*B* based on Herald, 1961; *D*, *E*, and *G* based on Jordan and Evermann, 1900.)

Abdominal

***Position of pelvic fins in fishes**




Thoracic

Subabdominal

وجدی Jugular

**FIGURE 2–13.** Examples of pelvic fin placement, pelvic fins circled. *A*, Abdominal (sturgeon, Acipenseridae); *B*, subabdominal (sand roller, Percopsidae); *C*, thoracic (bass, Percichthyidae); *D*, jugular (pollock, Gadidae). (Based on Jordan and Evermann, 1900.)

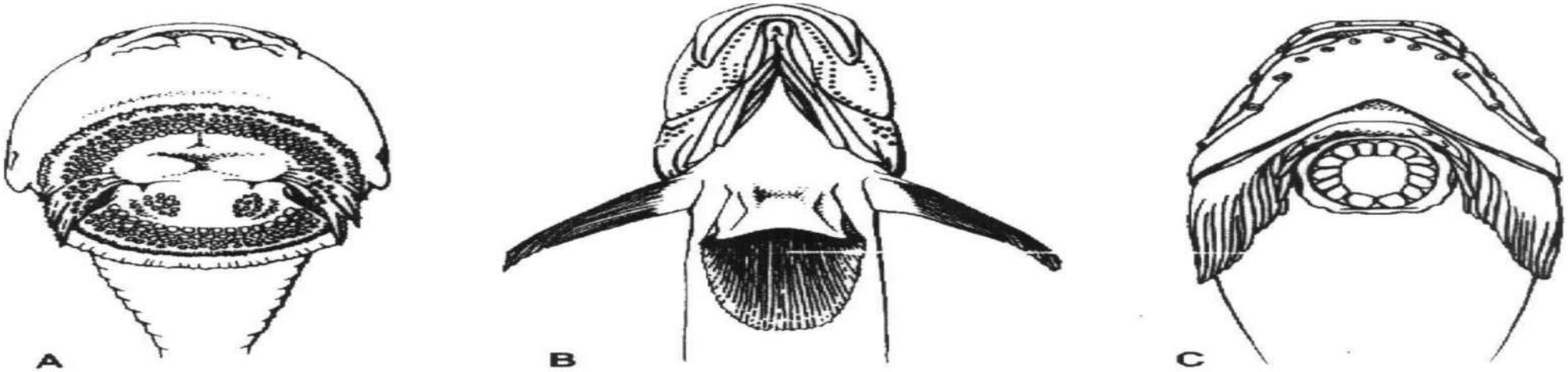



**FIGURE 2–14.** Pelvic fins modified as sucking devices. *A*, Clingfish (Gobiesocidae); *B*, goby (Gobiidae); *C*, Snailfish (Liparidae).

*Pelvic fins modified as sucking devices

## *median fins

**Dorsal fins modified into:**

(A)- sucking disc. (B)- fishing rod and lure. قصبة الصيد و خداع

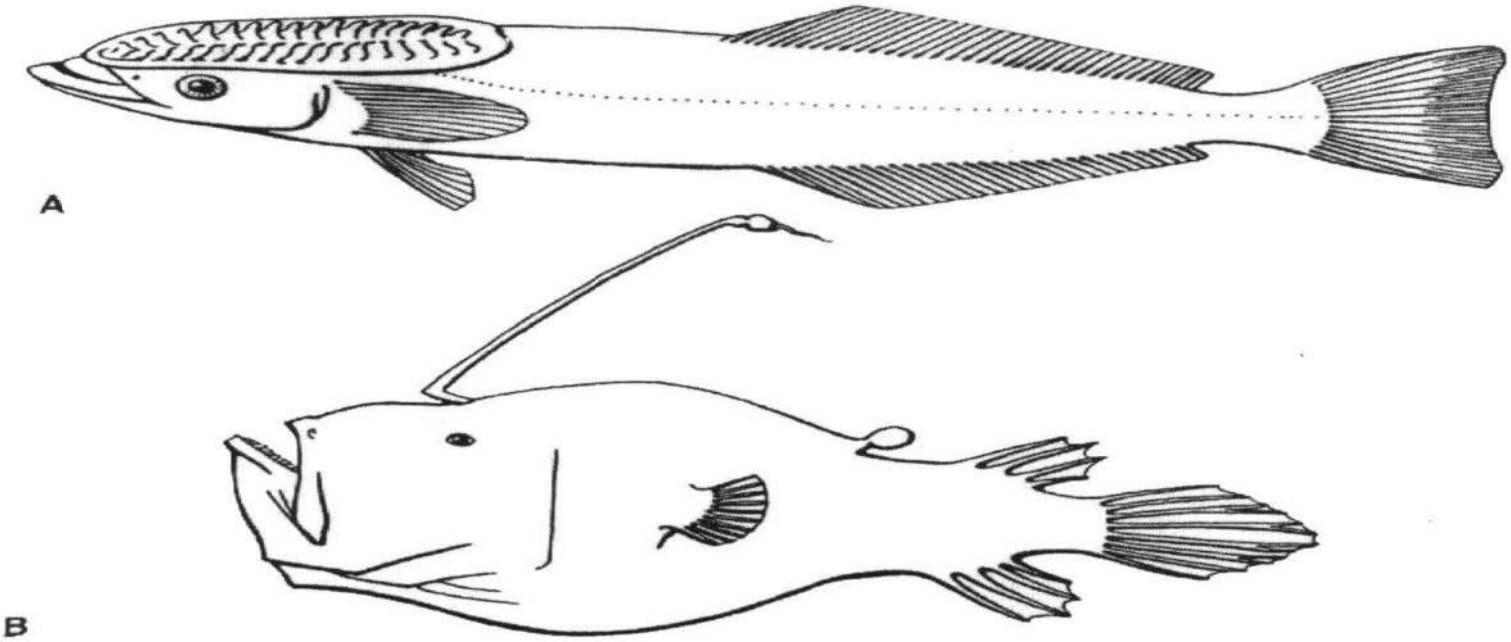
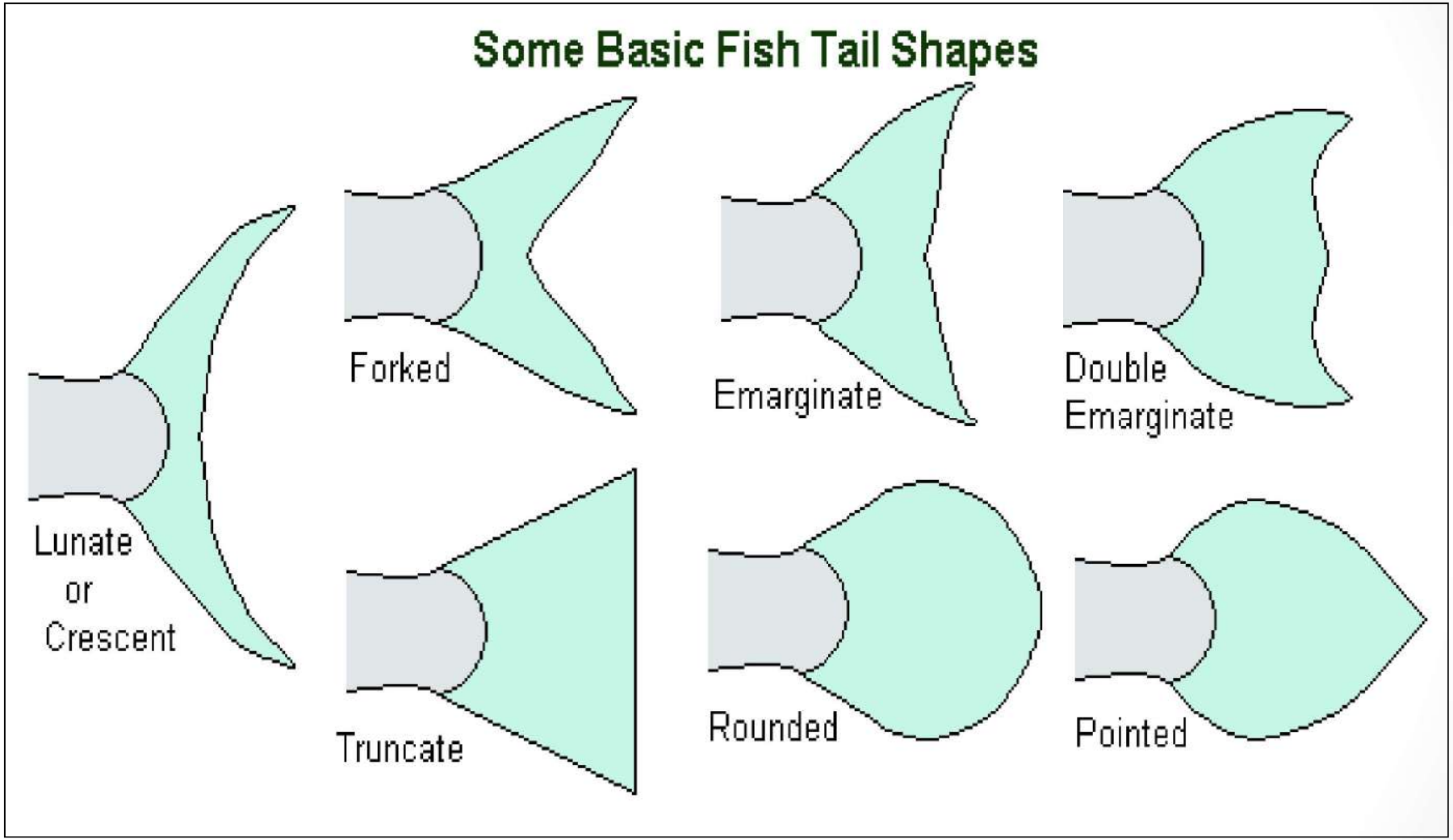



FIGURE 2–15. Modified dorsal fins. *A*, Sucking disc (remora, Echeneidae); *B*, fishing rod and lure (angler, Ceratiidae): (*B* based on Jordan and Evermann, 1900.)

# *Representative shapes of caudal fins



# Types of caudal fins

a)- Heterocercal, b)- Abbreviate heterocercal

c)- Homocercal d)- Isocercal

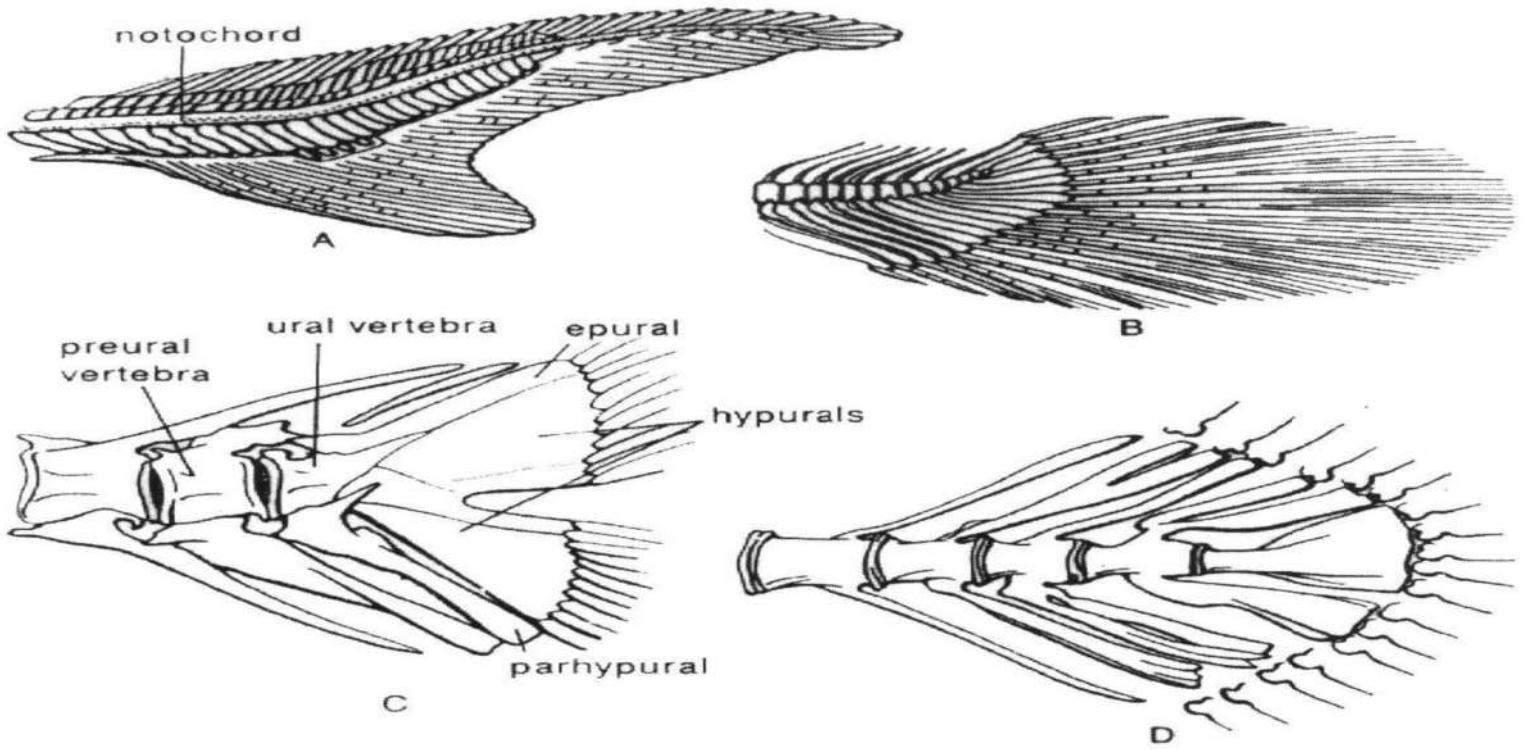


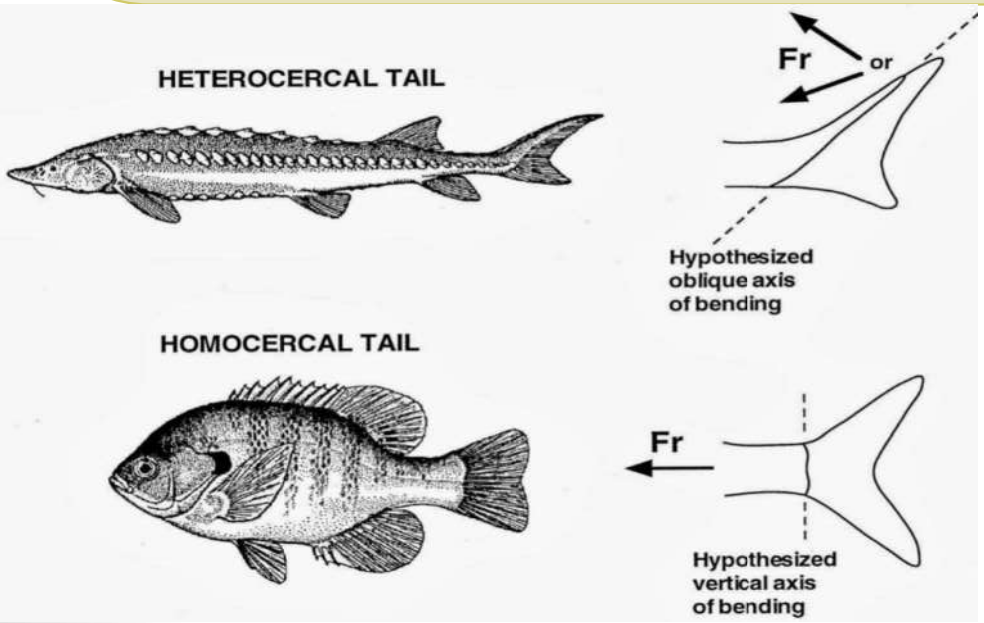

**FIGURE 2–17.** Types of caudal fins, showing structure. *A*, **Heterocercal (sturgeon, Acipenseridae)**; *B*, **abbreviate heterocercal (bowfin, Amiidae)**; *C*, **homocercal (striped bass, Percichthyidae)**; *D*, isocercal (cod, Gadidae). (*A* based on Goodrich, 1930; *B* based on Jordan and Evermann, 1900.)

**Heterocercal**:
A tail in which the tip of the vertebral column turns upward, extending into the dorsal lobe of the tail fin; the dorsal lobe is often larger than the ventral lobe. Consequently the tail becomes asymmetrical, both externally and internally.
Such a type of tail is mainly found among the elasmobranchs (in the sharks (Chondrichthyes) and in the lower forms in general.

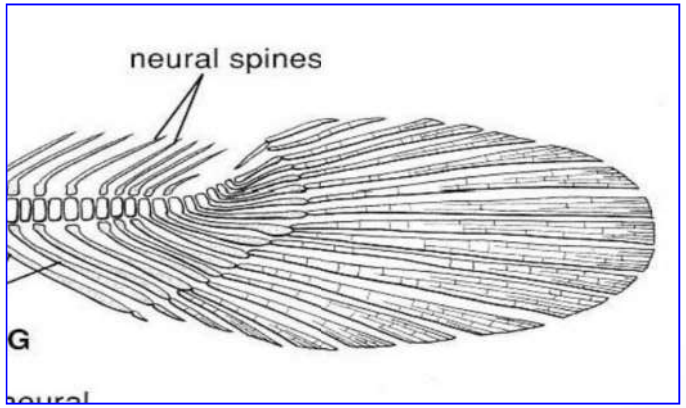
**Abbreviated heterocercal:** Vertebral column goes into upper lobe, but fin looks symmetrical.

**Homocercal**: Describing the symmetric tail of a fish that has two lobes extending from the end of the vertebral column.

**Isocercal**: Vertebral column extends along and straight. The fin fold develops, both, above & below it. The fin fold continues with the dorsal & the anal fins to form continuous fold.
Such a type of tail is mainly found in Anguilliformes.



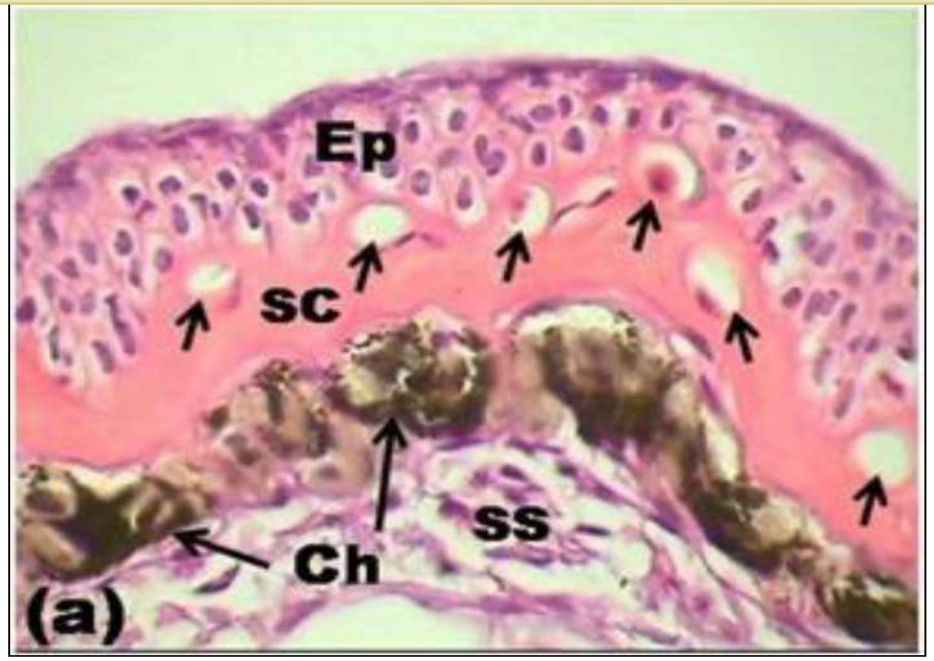

Isocercal

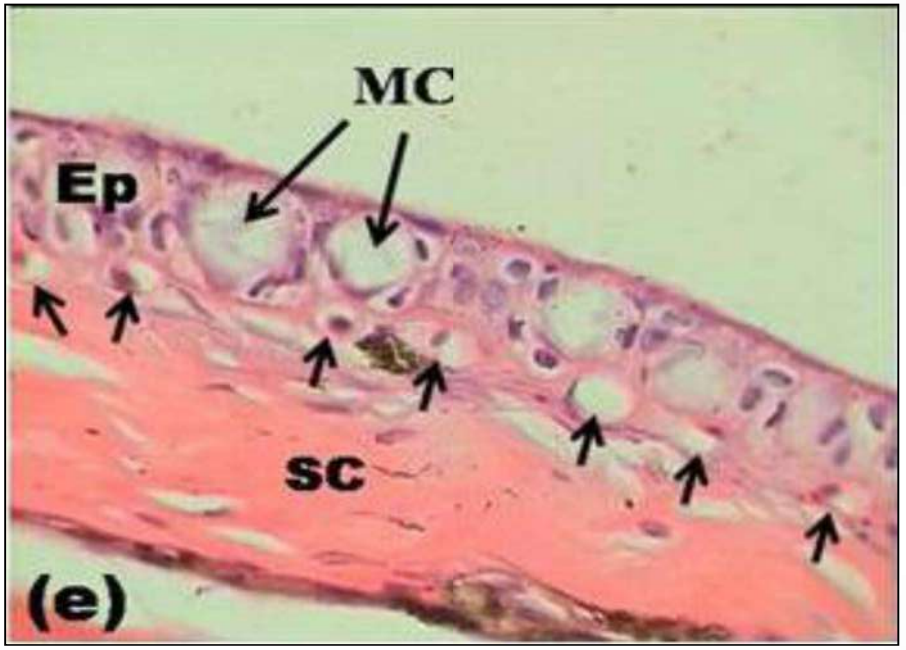



Abbreviated heterocercal

# *Skin

Usually, Fish skin is made up of two layers , an outer layer (epidermis) and an inner layer (dermis)




T.S. of the skin of different body regions of *Alticus kirkii,* (a) crest, (e) dorsal-lateral region of the trunk.

**1)-** The superficial epidermis (Ep).
**2)-** lower dermis which consists of:
A)- outer stratum compactum (SC) of collagenous fibers.
B)- inner stratum spongiosum (SS).
Note blood capillaries (small arrows), mucous cell (MC), chromatophores (Ch).

# *Skin

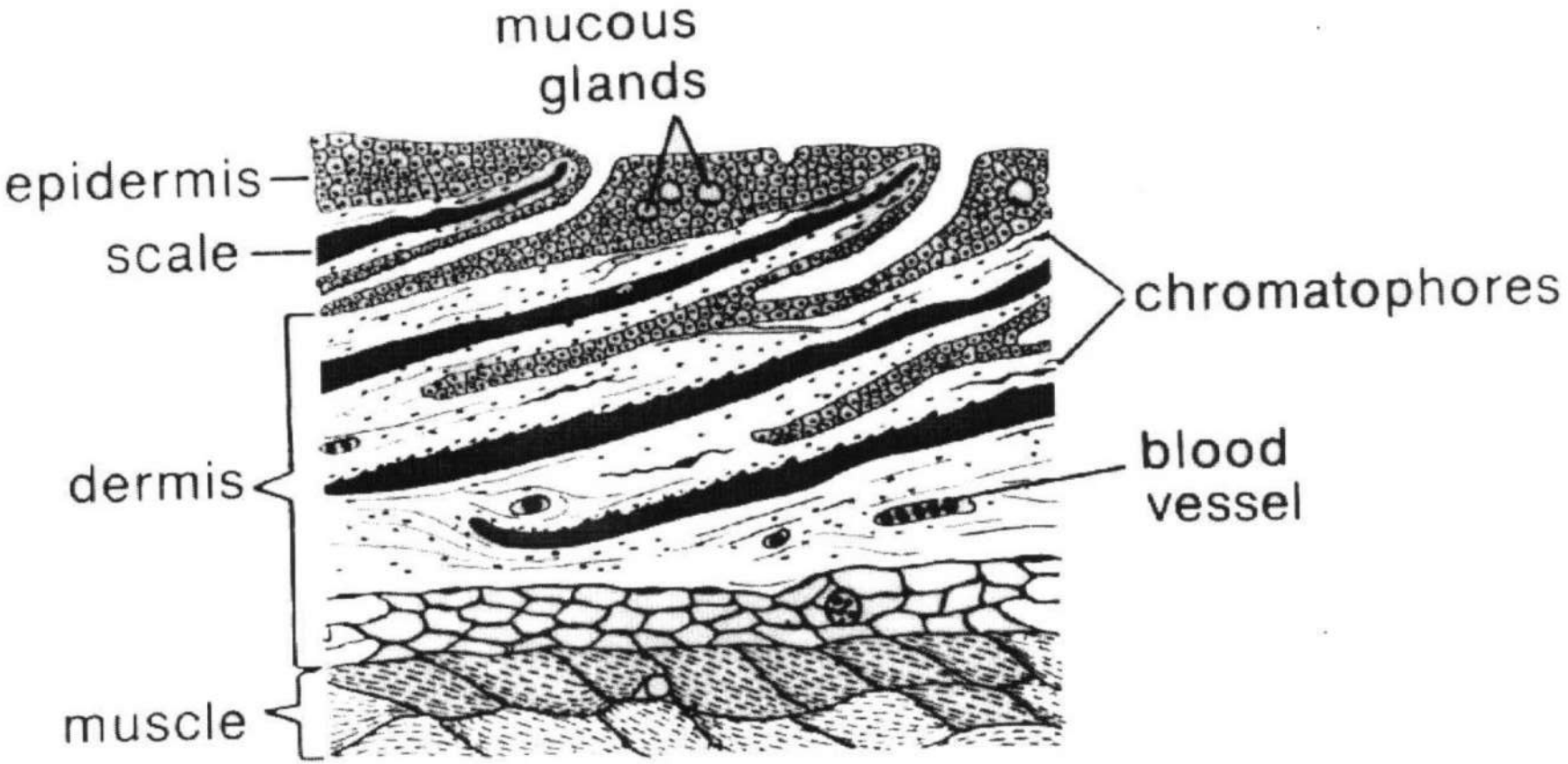



**FIGURE 2–18.** Section of fish skin. (**Based on Wunder, 1936.**)

# * Scales

* **Cartilaginous fishes:** are covered by one type of scales known as placoid scales.
* **Bony fishes:** Some bony fishes are **naked** as catfishes; Most of them are covered by **bony scales** which are dermal in origin. The scales may be modified into bony plates, scutes as in sturgeons.

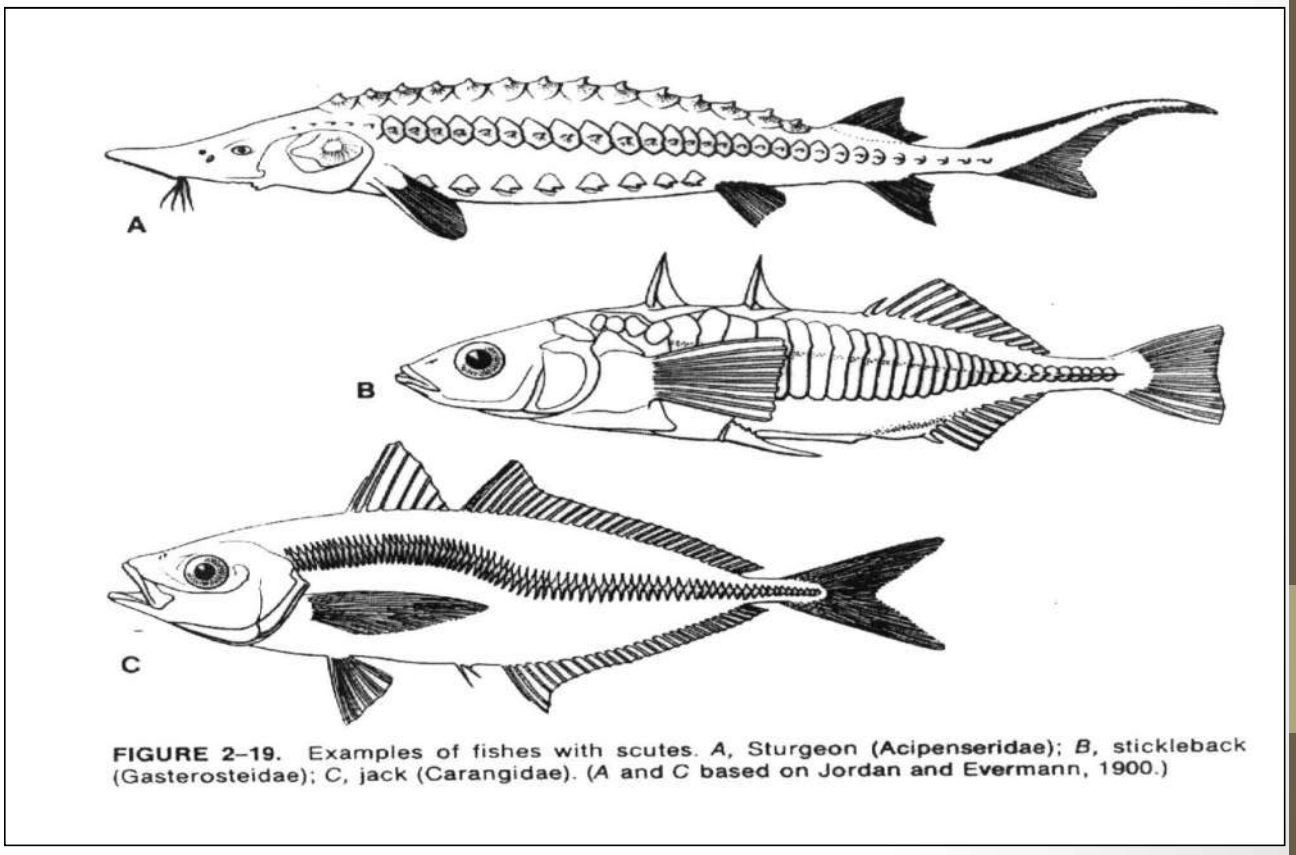



FIGURE 2–19. Examples of fishes with scutes. *A*, Sturgeon (Acipenseridae); *B*, stickleback (Gasterosteidae); *C*, jack (Carangidae). (*A* and *C* based on Jordan and Evermann, 1900.)

# Types of scales in fishes

1-Placoid

2-Ganoid

3-Cycloid

4-Ctenoid

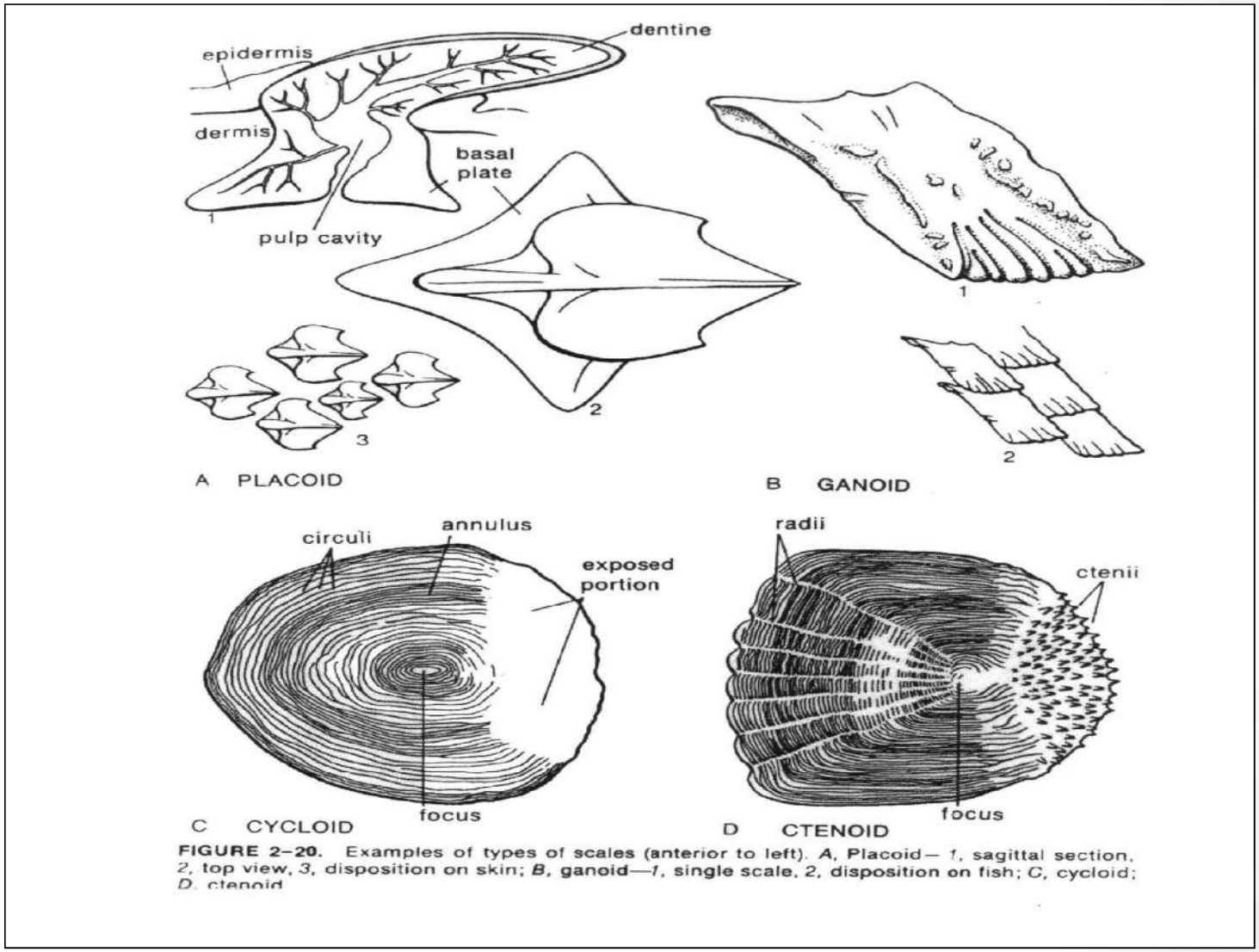



**FIGURE 2–20.** Examples of types of scales (anterior to left). *A*, Placoid—*1*, sagittal section, *2*, top view, *3*, disposition on skin; *B*, ganoid—*1*, single scale, *2*, disposition on fish; *C*, cycloid; *D*, ctenoid

# Lecture 3

# *Alimentary canal and associated structures

# Positions of bones that bearing teeth in bony fishes

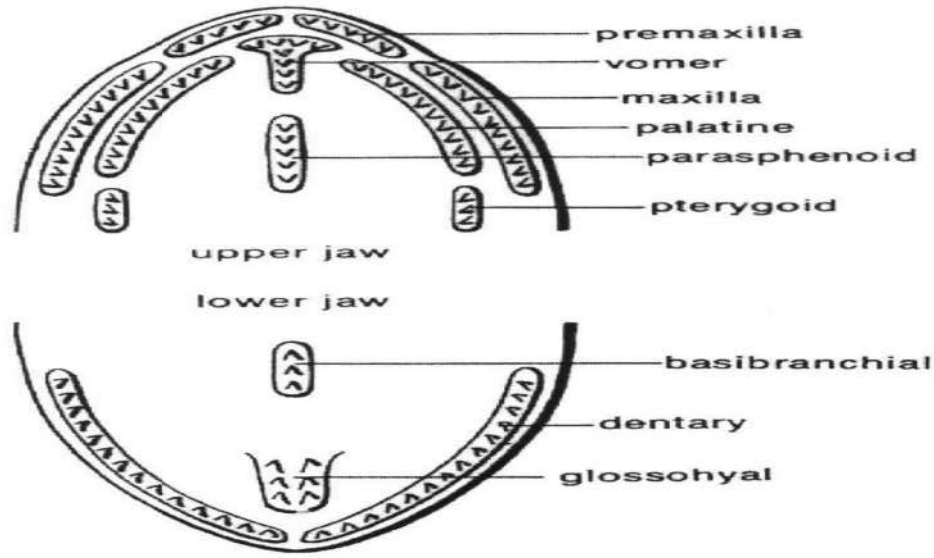



**FIGURE 2–22.** Diagram of positions of bones that can bear teeth in bony fishes.

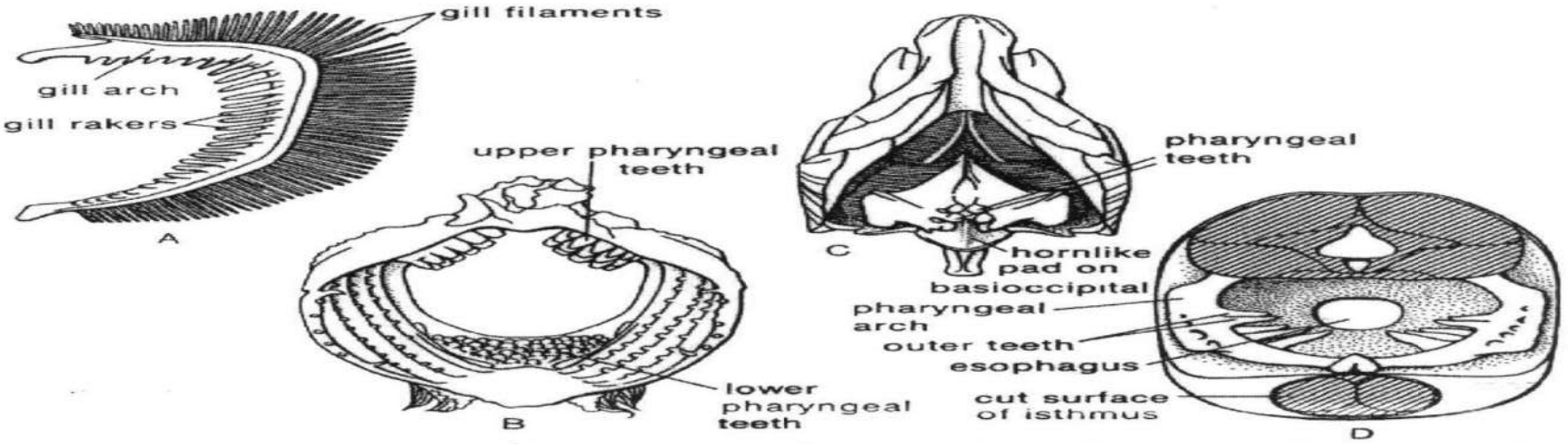



**FIGURE 2–23.** Examples of gill rakers and pharyngeal teeth. *A*, Diagram of gill arch with rakers and gills; *B*, anterior view of gill arches and pharyngeal teeth of surfperch (Embiotocidae); *C*, ventral view of the pharyngeal region of a carp (*Cyprinus*), with the pharyngeal arch displaced anteriorly to expose the basioccipital pad; *D*, anterior aspect of pharyngeal teeth of the squawfish (*Ptychocheilus*), cross section behind last gill arch with musculature and other soft tissue removed.

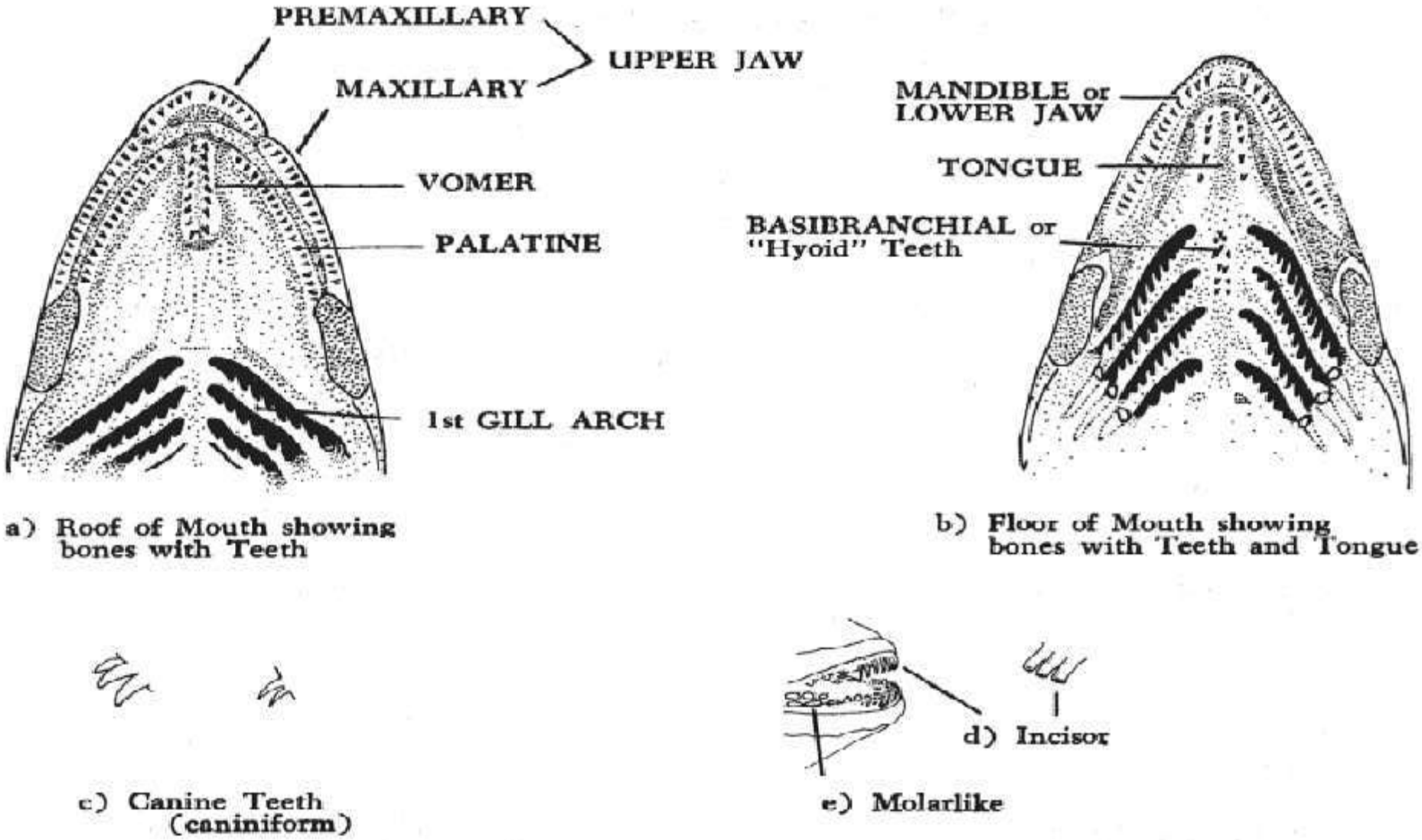


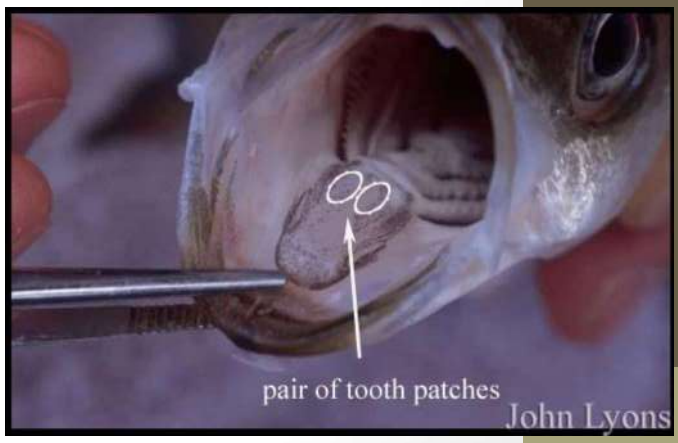

FIGURE 8. Bones and teeth inside mouth or bucal cavity.

**The sea lamprey uses its suction disk mouth which is liend with small sharp, rasping teeth**

Megalodon jaw The ancestors of fish


Red-bellied piranha, showing mouth and teeth





# Gill rakers

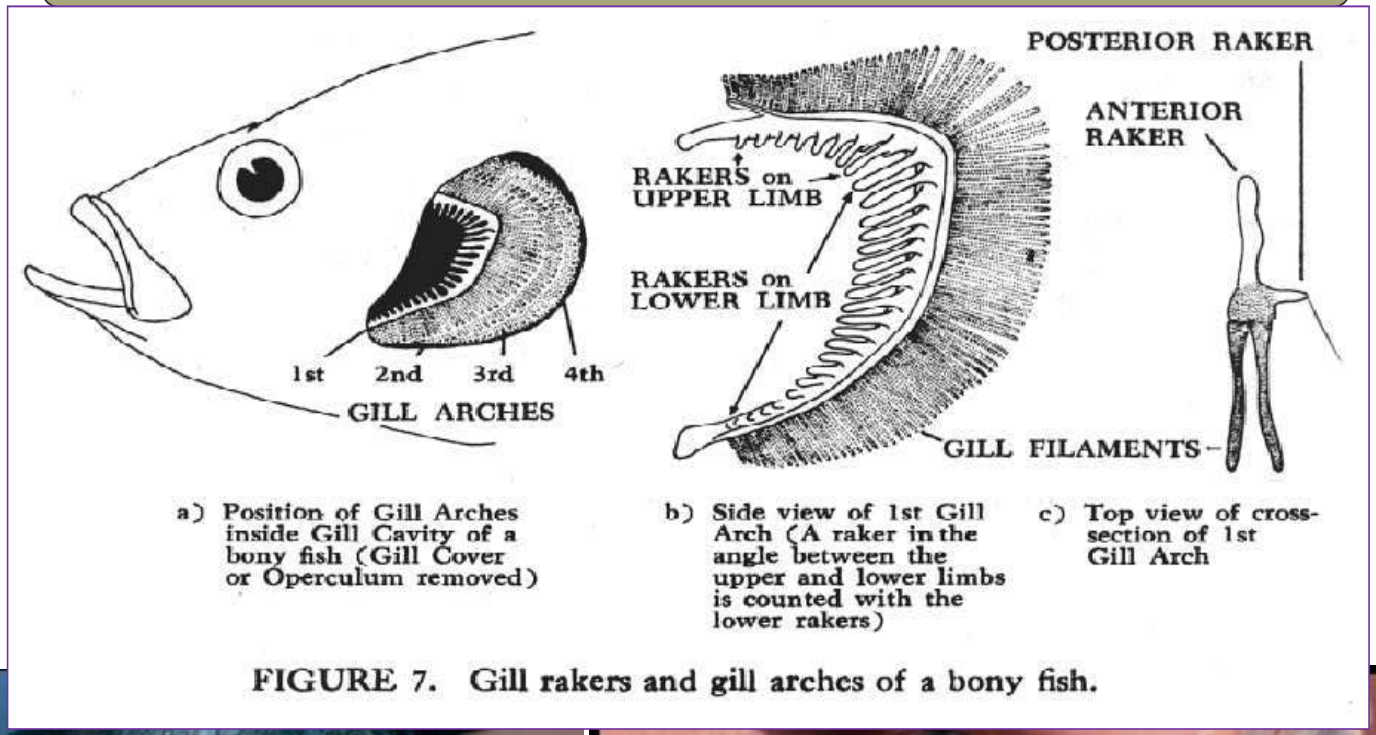
- Gill rakers are bony or cartilaginous projections which point forward and inward from the gill arches.
- They aid in fish feeding.
- They are widely varied in number, spacing, and the form, therefor, their shape and number are good indications of the diet of the fish.

A)- Carnivores and omnivores, fishes which eat large preys, have short & widely spaced gill rakers. This type of gill rakers prevents the prey item from escaping between the gills.

B)- Fishes which eat smaller prey have longer, thinner and more numerous gill rakers.

C)- Filter feeders, Species which feed on plankton and other tiny suspended matter have the longest, thinnest and most numerous gill rakers; some species have over 150 on the lower arch alone.
Because gill rakers characters often vary between closely related taxa, they are commonly used in the classification and identification of fish species.

# Gill rakers and pharyngeal teeth

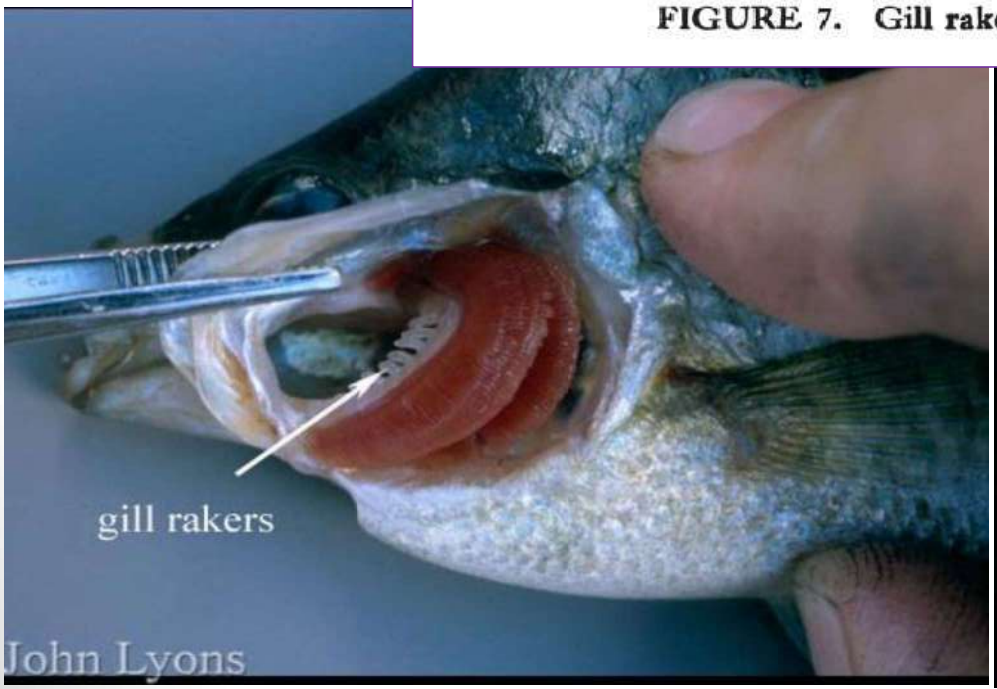


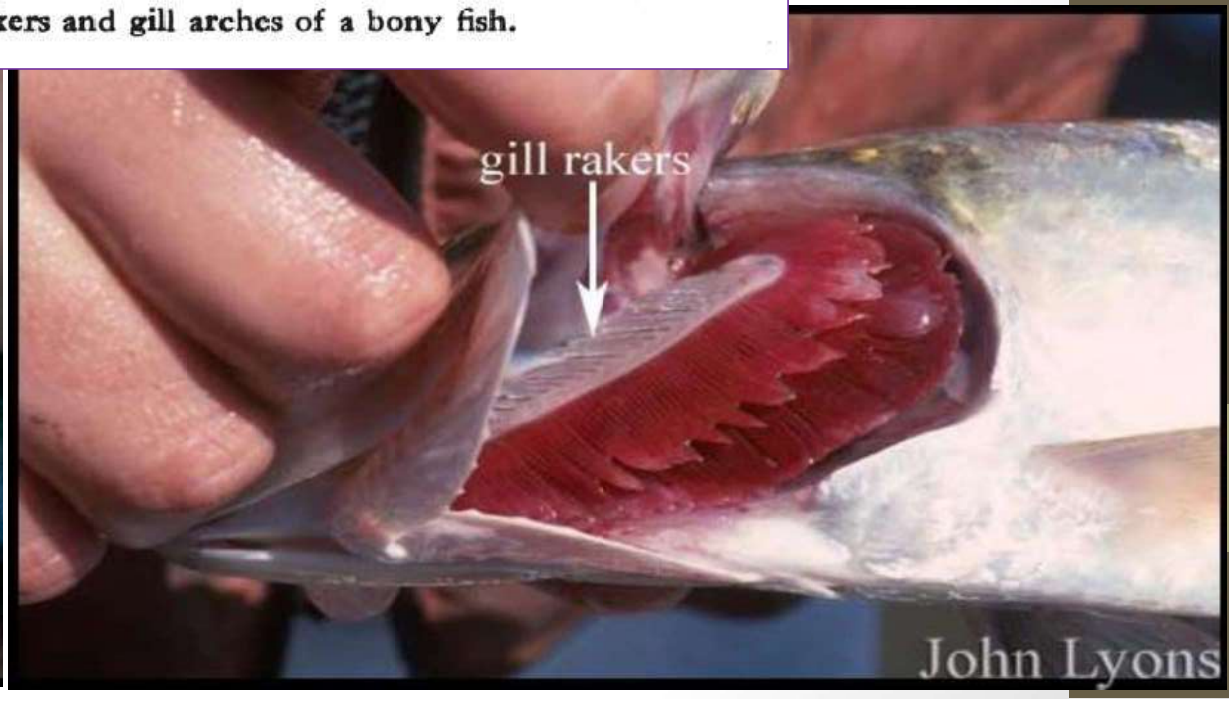

a) Position of Gill Arches inside Gill Cavity of a bony fish (Gill Cover or Operculum removed)

b) Side view of 1st Gill Arch (A raker in the angle between the upper and lower limbs is counted with the lower rakers)

c) Top view of cross-section of 1st Gill Arch

FIGURE 7. Gill rakers and gill arches of a bony fish.



# Esophagus, stomach, and intestine

- Esophagus, short with mucous cells or glands.

-Stomach take **U** or **V** shape.

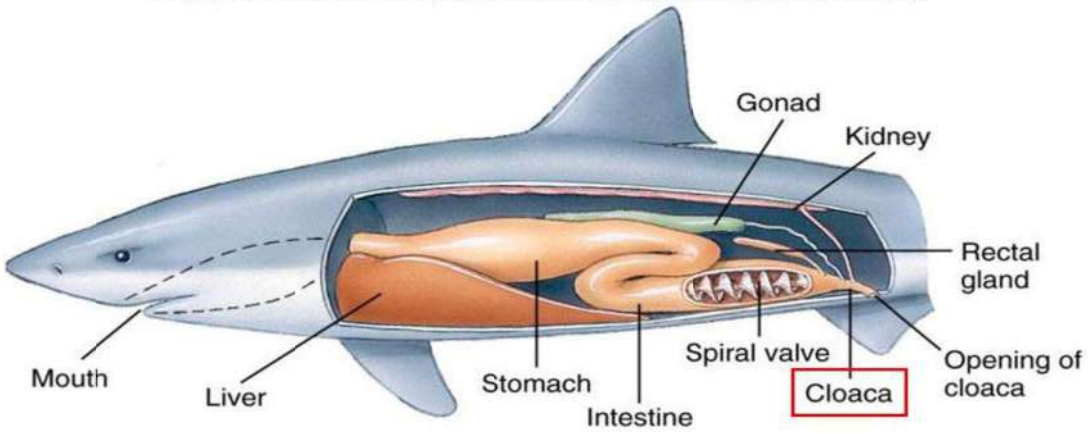
-Intestine differs in

Herbivorous carnivores omnivorous

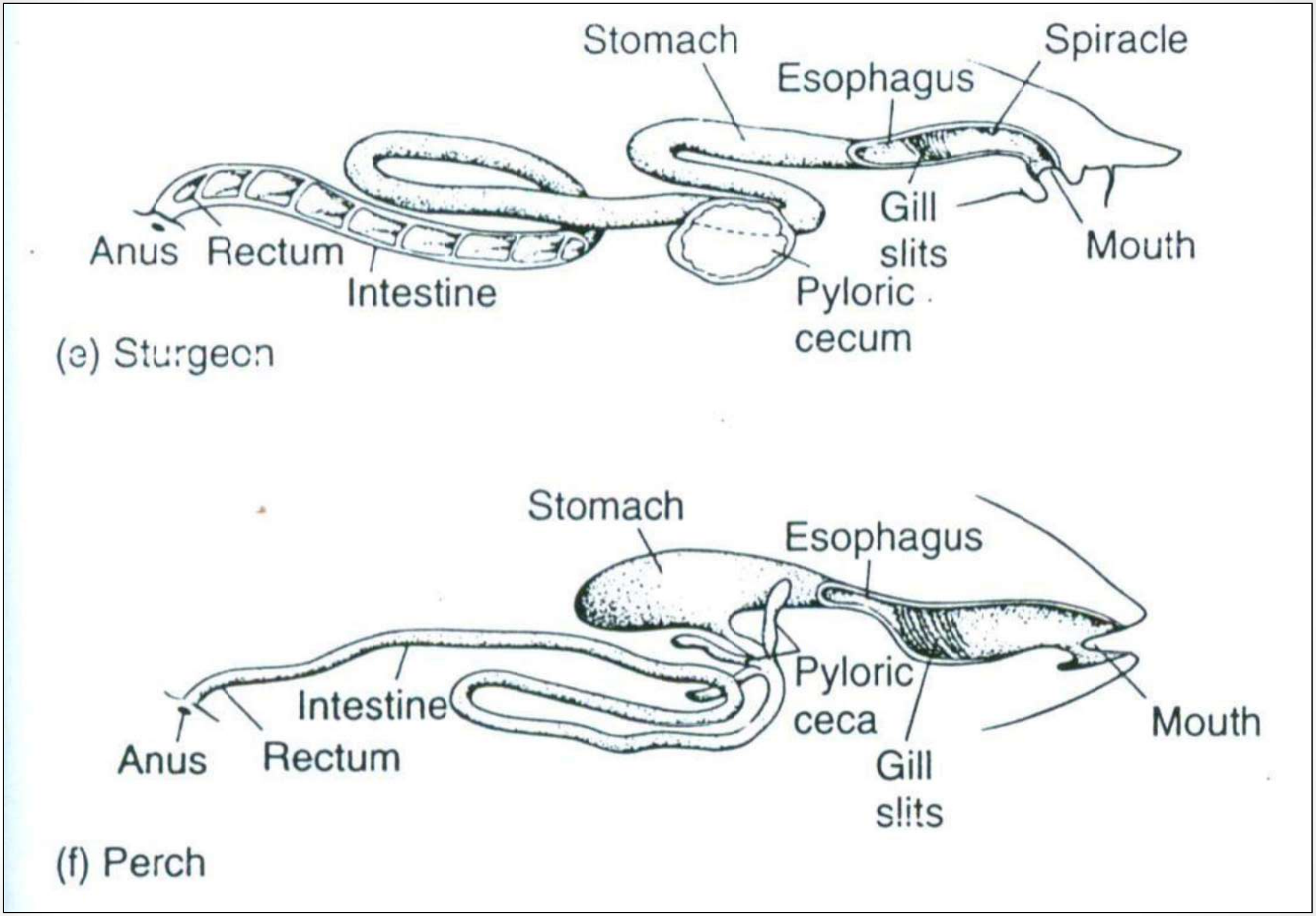
* A spiral valve present in intestine of cartilaginous fishes

-- The intestine of cartilaginous fishes and a few primitive bony fish contain spiral valve; increase internal surface area






(a) **Cartilaginous fishes**


Stomach
Spiracle
Esophagus
Gill slits
Mouth
Anus
Rectum
Intestine
Pyloric cecum
(e) Sturgeon
Stomach
Esophagus
Pyloric ceca
Intestine
Mouth
Anus
Rectum
Gill slits
(f) Perch

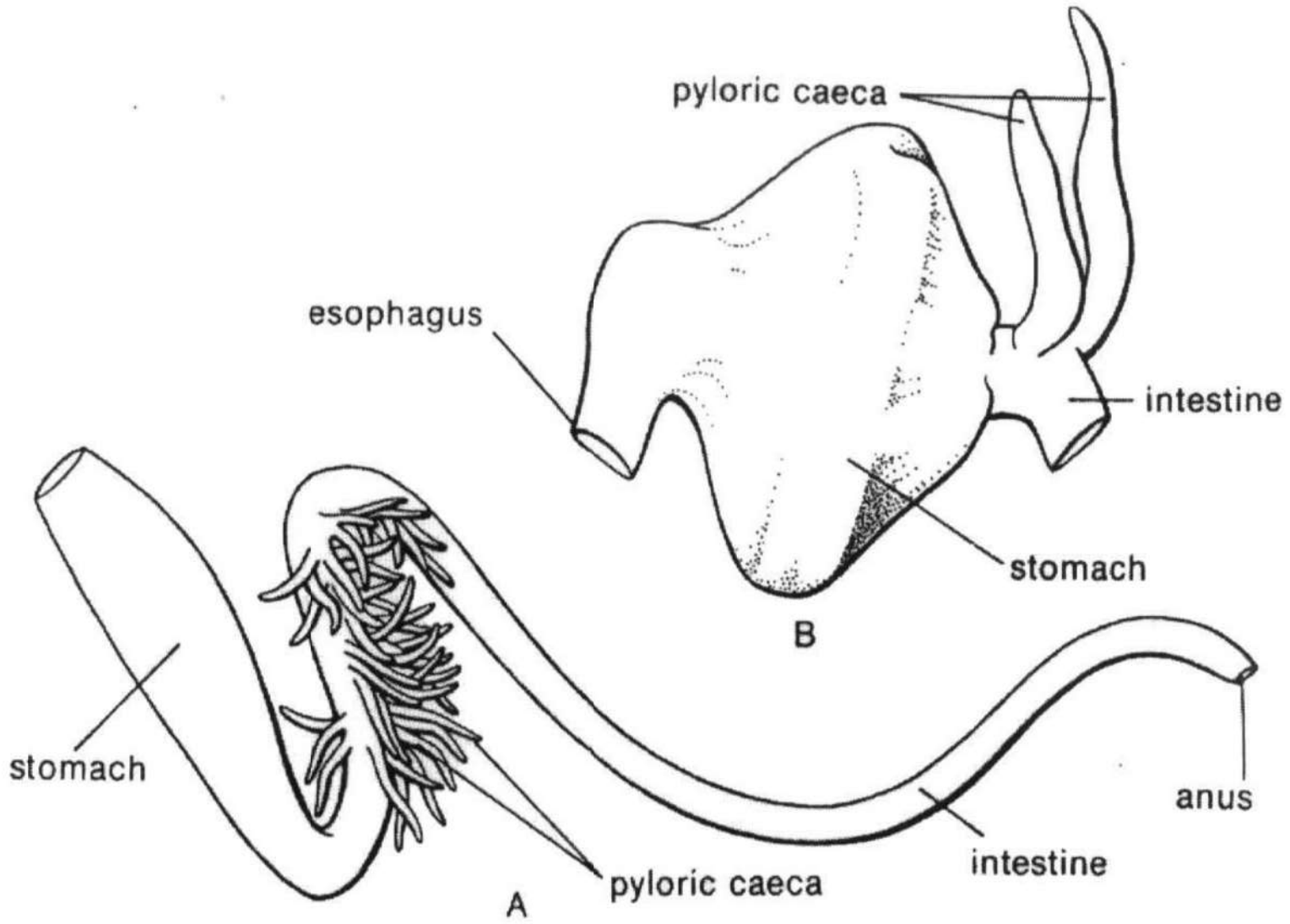



**FIGURE 2–24.** Examples of stomachs and pyloric caeca (anterior to left). *A*, Stomach, caeca, and intestine of trout (Salmonidae); *B*, stomach and pyloric caeca of mullet (Mugilidae).

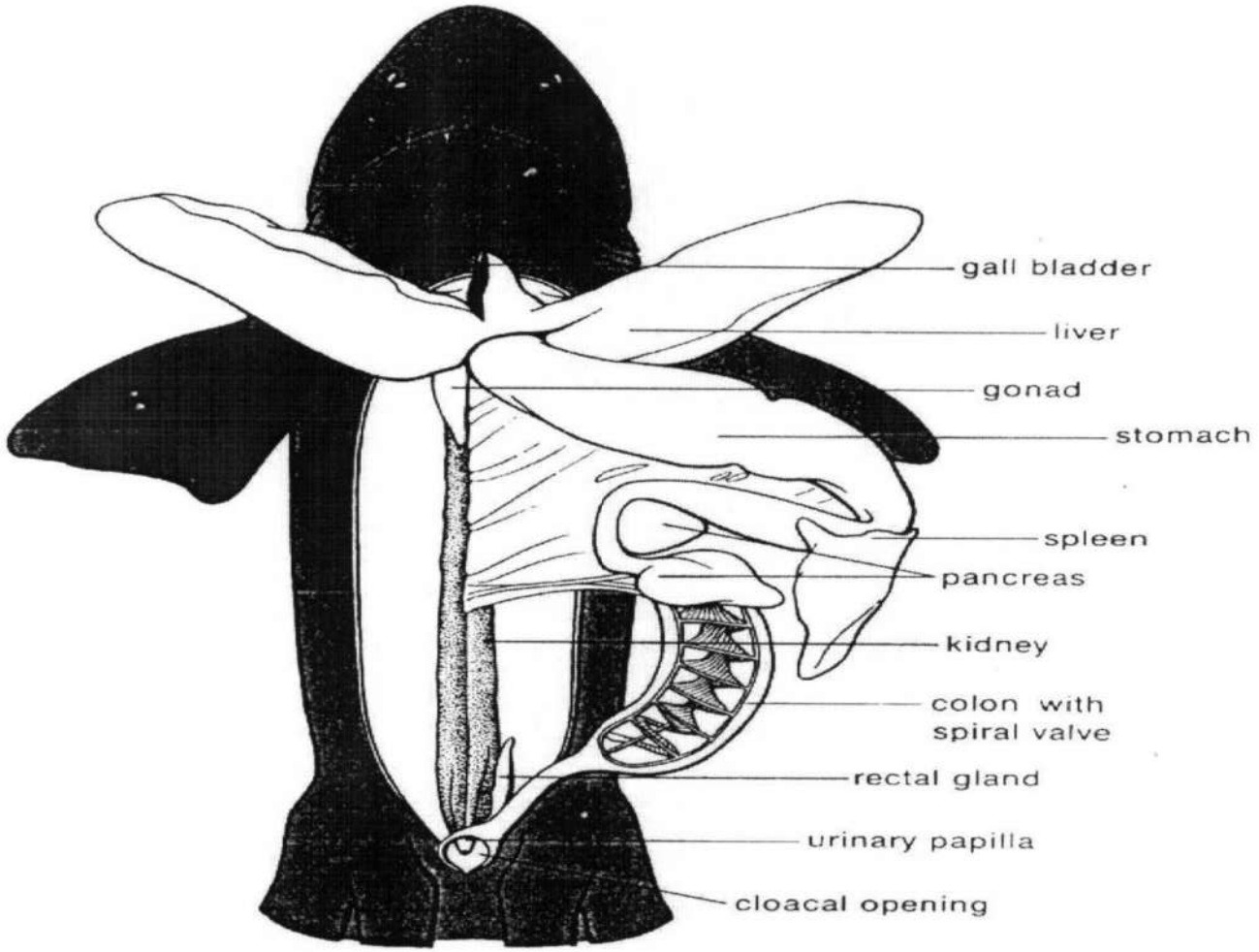



FIGURE 2–27. Diagram of viscera of shark (spiral valve opened to show internal structure). (Based on Daniels, 1934.)

The rectal gland of the dogfish secretes a fluid which is essentially a sodium chloride solution with a concentration about twice that of the plasma and greater than that of sea water; and is responsible for the active transport of chloride across other biological membranes.

# Swim bladder

Because a weightless, or buoyant, body requires a minimum of energy to keep it at a given depth.

- Also, a weightless body requires less energy than a weighted body to move at a given speed.

Therefore, many fishes have means to reduce their body weight, or density relative to the density of water.

1)- A fish whose total body density equal to that of water would be effectively weightless, neither rising nor sinking.

- Because fats are less dense than water, one method of reducing body density would be to increase the proportion of fats within the body.

- Theoretically, in order to make the fish weightless in seawater, about one-third of a fish's body weight would have to be made up of fat. In some species of deep-sea, sharks, have very large livers that contain a great amount of squalene, a fatty substance that is significantly less dense than seawater.

**2)- Another method** of reducing density is to include gases within the body. Many fishes have a gas bladder that serves in this function.

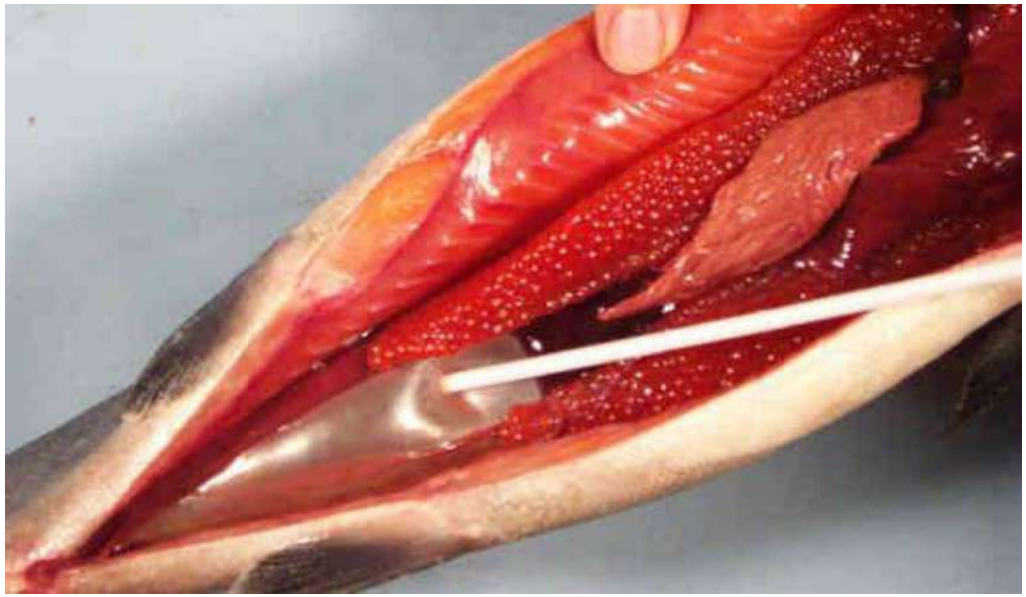
**Swim bladder**, also called **air bladder**, **buoyancy organ** possessed by most bony fish.

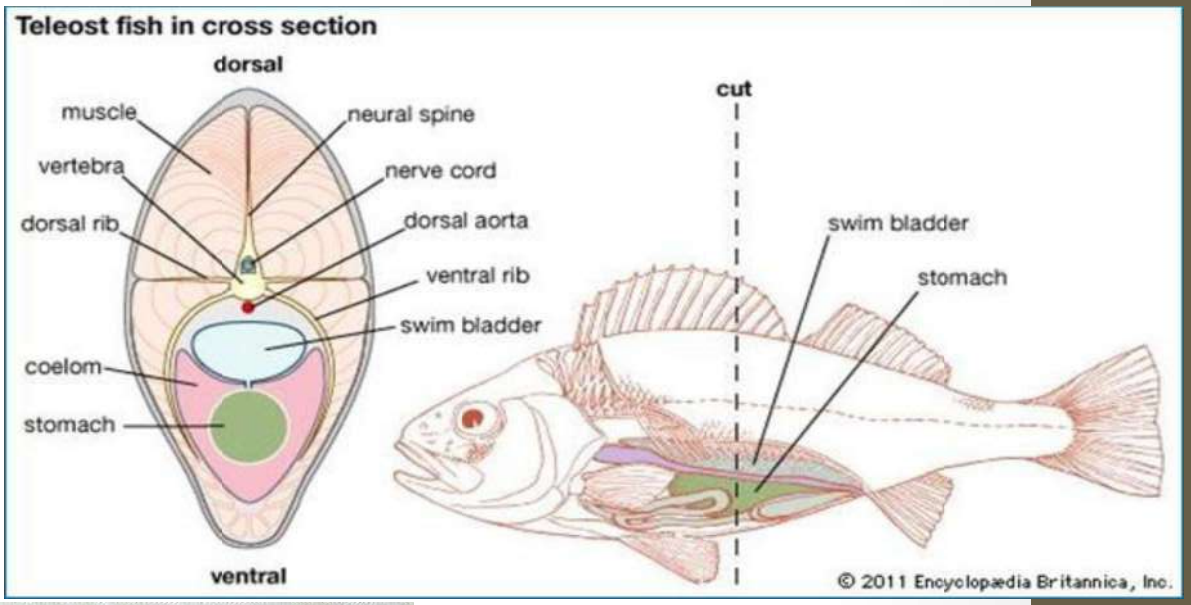
- The swim bladder is located in the body cavity and is derived from an outpocketing of the digestive tube.
- A)- It contains gas (usually oxygen) and functions as a hydrostatic organ, enabling the fish to maintain fish's depth without floating upward or sinking.
- It also serves as a resonating chamber to produce or receive sound.
- ** Fresh water is less dense than seawater and consequently provides less buoyancy. Therefore, Freshwater fishes, require a larger gas bladder than marine fishes to keep them from sinking.
- According to calculations, the capacity of a gas bladder should be about **7%** of body volume for a freshwater fish and **5%** for a marine fish.
- In actual measurements, gas bladders of freshwater fishes are ranged from 7 to 11% of body volume, while those of marine fishes are ranged from 4 to 6% of body volume.

**B)-** In some species the swim bladder contains **oil** instead of **gas**.

**C)-** In certain primitive fish the swim bladder functions as a **lung or** respiratory aid instead of a hydrostatic organ.

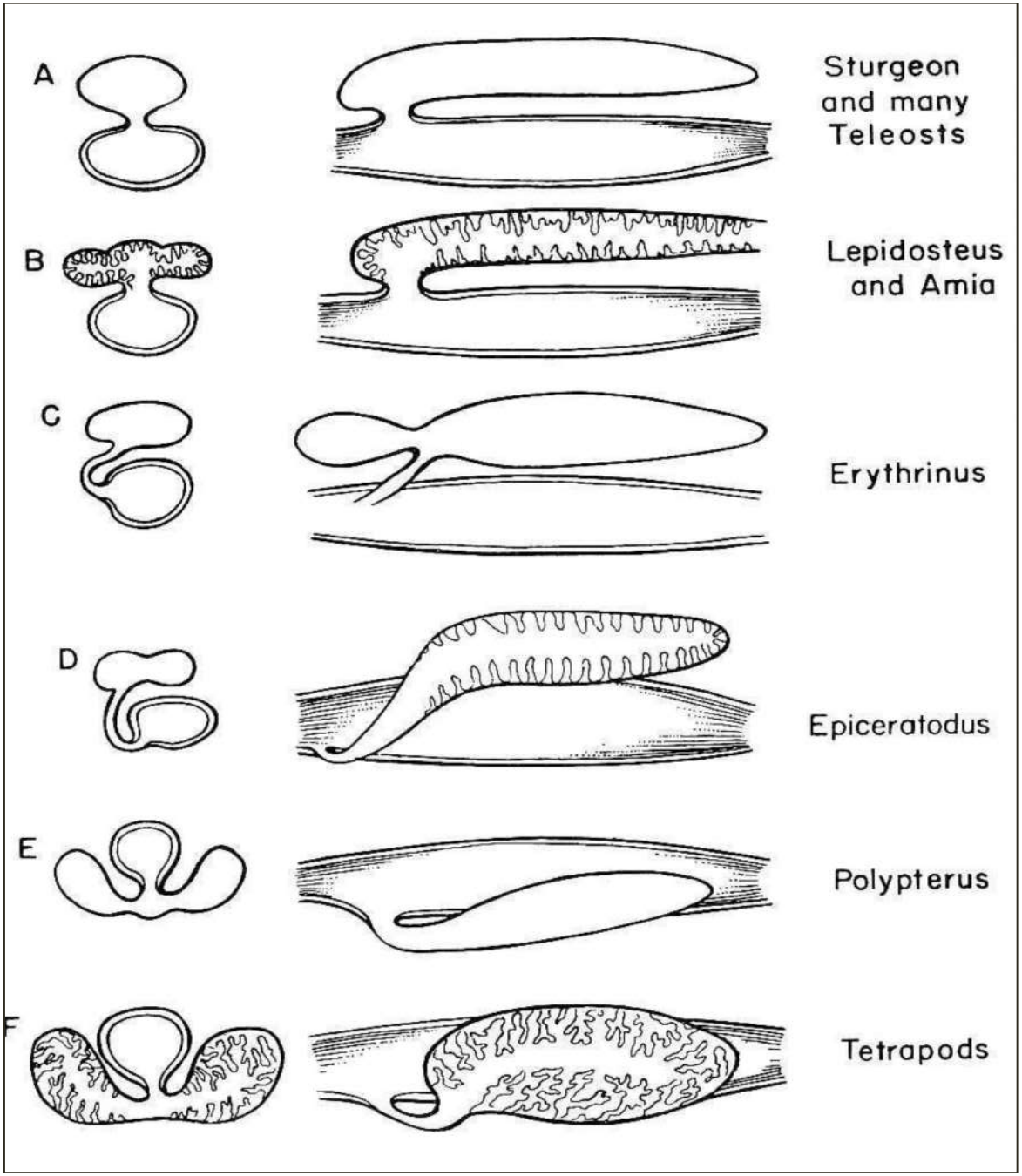
**D)-** The swim bladder is missing in some bottom-dwelling teleosts (deep-sea bony fish) and in all cartilaginous fish (sharks, skates, and rays).






A swim bladder

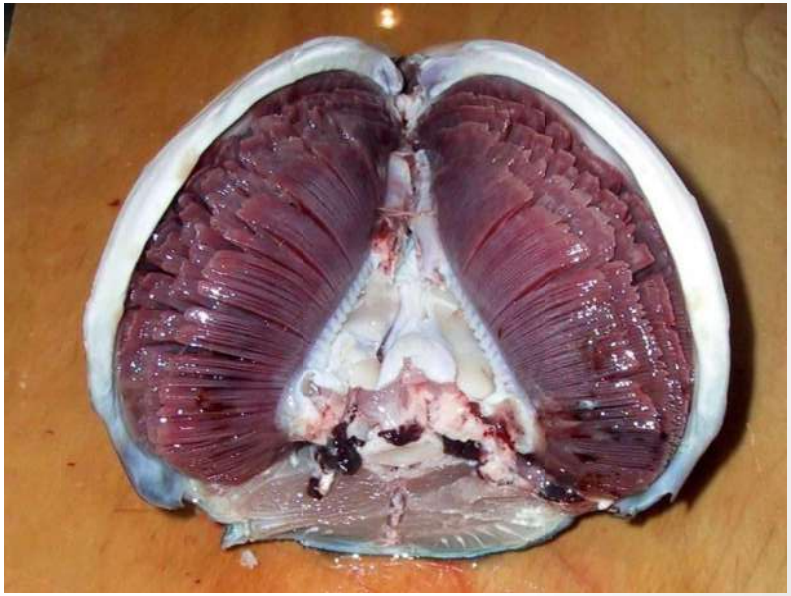
# Examples of gas bladder



# Gills

*Gills have different types of arrangement in frontal section in different fishes.

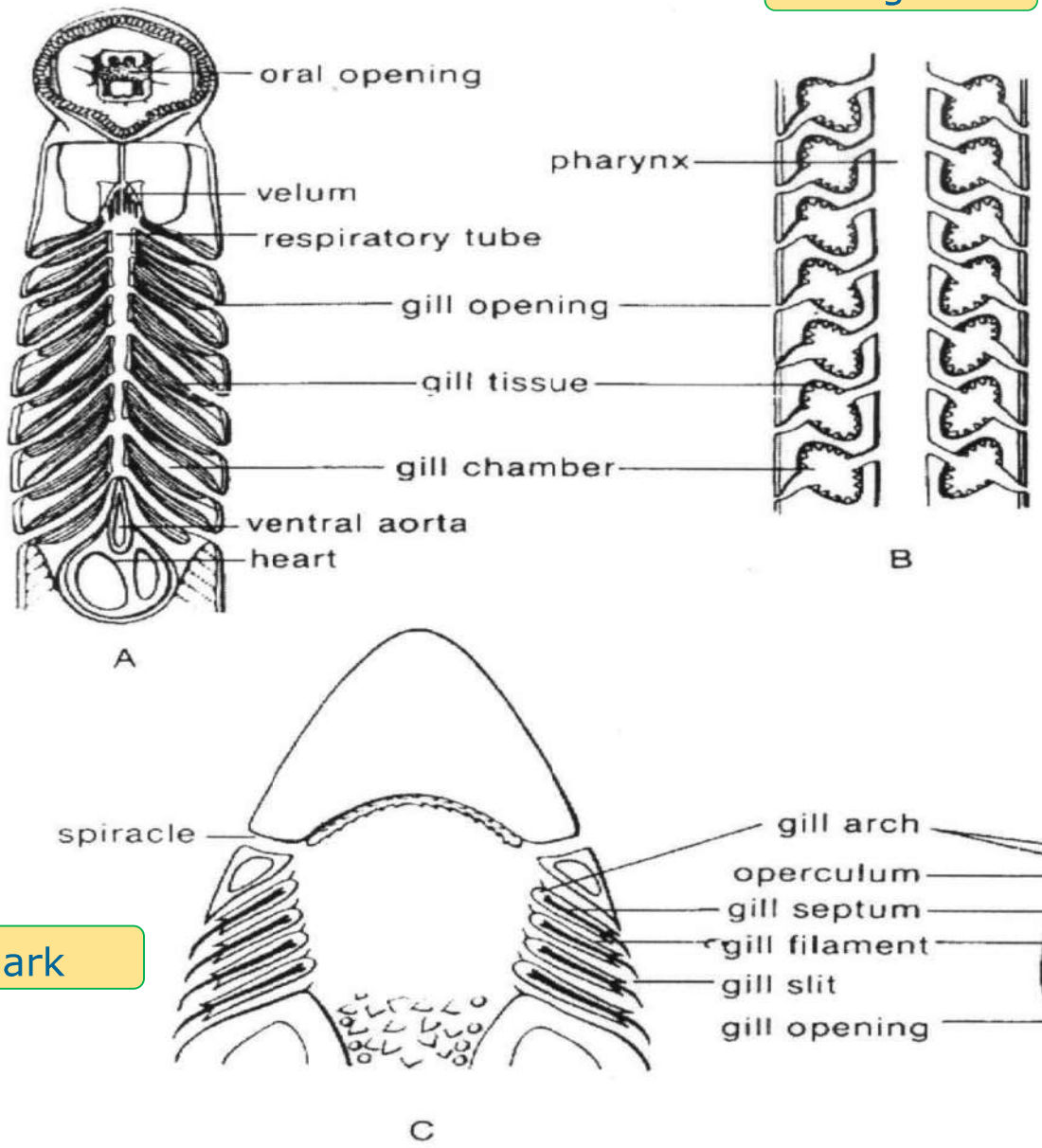
* Types of gills in fishes.



Lamprey

Hagfish

Diagrams showing the arrangement of gills in frontal section.




Shark

Bony fish

**FIGURE 2–29.** Diagrams showing arrangement of gills in frontal section. *A*, Lamprey (*Lampetra*); *B*, hagfish (*Eptatretus*); *C*, shark; *D*, bony fish. (*C* based on Weichert, 1951.)

Shark

Sturgeon

teleost

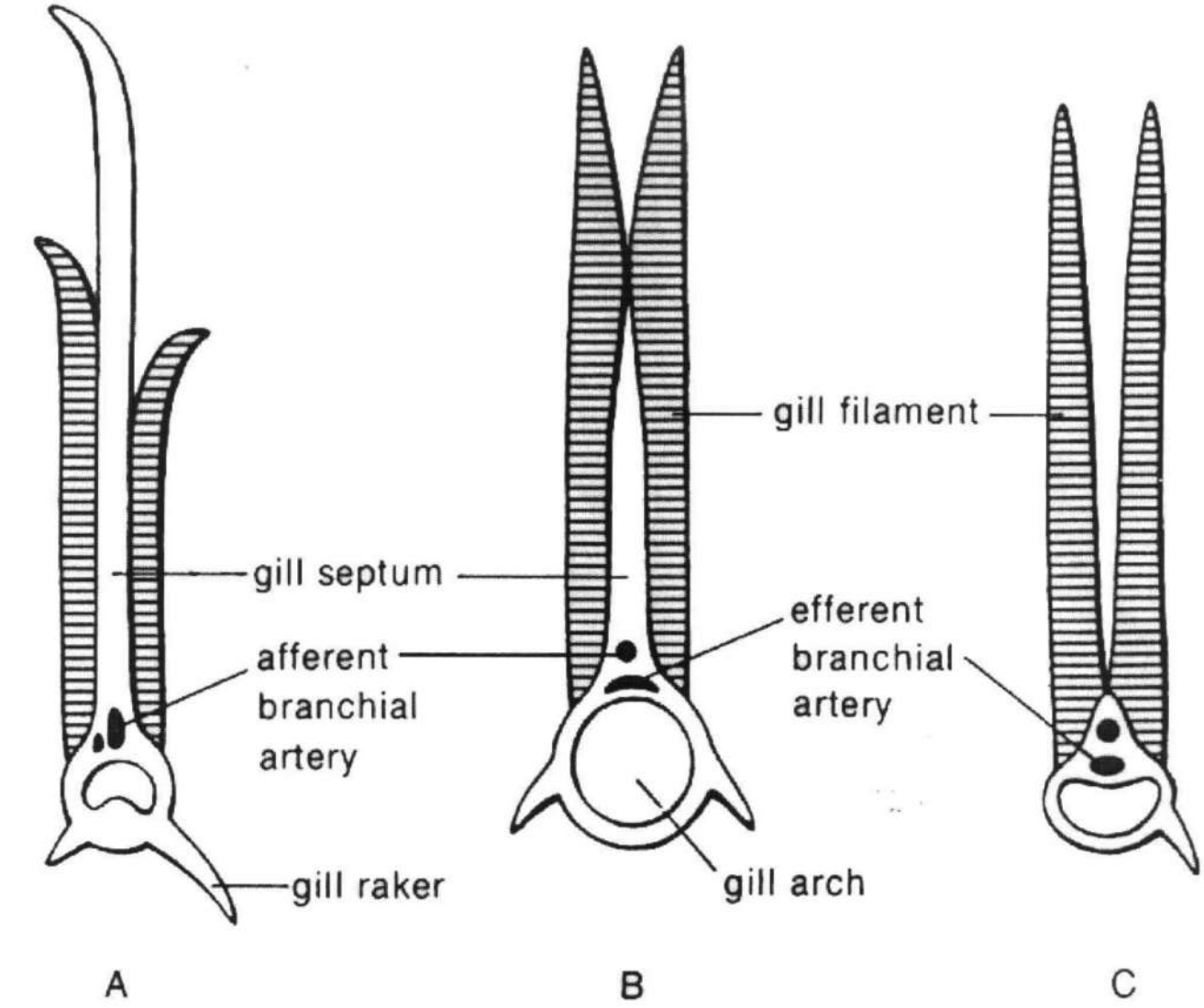



**FIGURE 2–30.** Relationship of branchial septum and gill tissue. *A*, Shark; *B*, sturgeon; *C*, teleost.

*The pseudobranch is the reduced 1st gill arch of a fish (on the inner surface of the opercle.

*In teleost fish*, the pseudobranchs are mostly without respiratory function.

In elasmobranchs they are the gill arch of the spiracle.

The function of the pseudobranch is unknown, but it is believed that it supplies highly oxygenated blood to the optic choroid and retina. , and may have baroreception (pressure) and thermoregulation functions. It may also be a site of oxygen chemoreception.

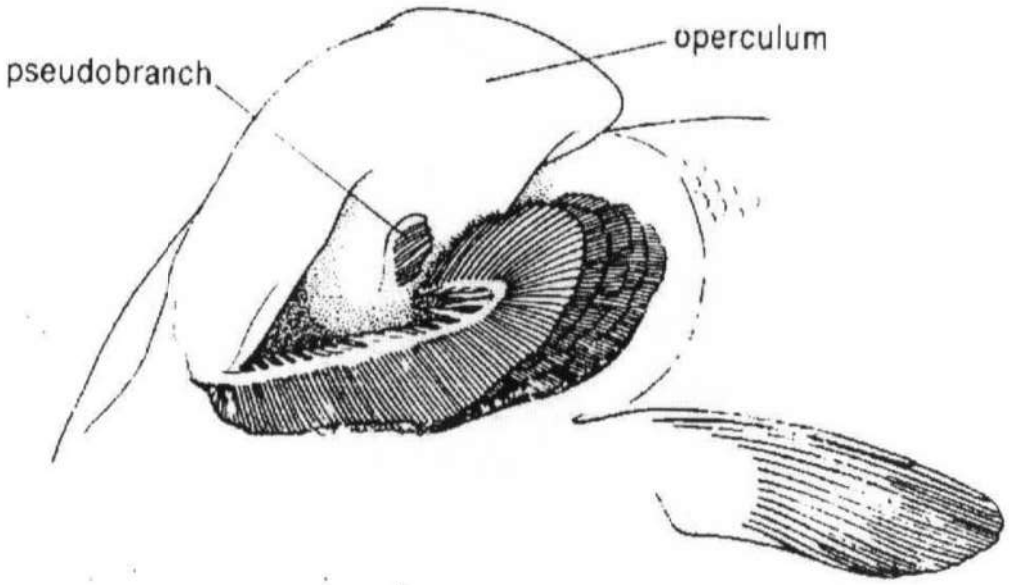



FIGURE 2-31. Position of pseudobranch in trout (Salmonidae).

**Sturgeon** الحفش سمك

Their evolution dates back to 245 to 208 million years ago. (2-3.5 - 5.5 m long)

Atlantic sturgeon
(*Acipenser oxyrinchus oxyrinchus*)

| Scientific classification | |
|---|---|
| Kingdom: | Animalia |
| Phylum: | Chordata |
| Superclass: | Osteichthyes |
| Class: | Actinopterygii |
| Order: | Acipenseriformes |
| Family: | **Acipenseridae** Bonaparte, 1831 |

# Vascular system

***Heart structure**
***blood circulation**

**The circulatory system of the bony fish is:**

- a "closed system" (it includs a heart, vessels and blood capillaries).
- One main circuit, from the heart to the gills, to the cells.

**Structure of Heart in fishes:**

The heart of fishes is known as branchial heart, because its main function is to pump venous blood to ventral aorta into gills (branchial) and then to somatic vasculature.

The heart of fishes consists of four portions, a sinus venosus, an atrium, a ventricle and a conus arteriosus **or** a bulbus arteriosus.

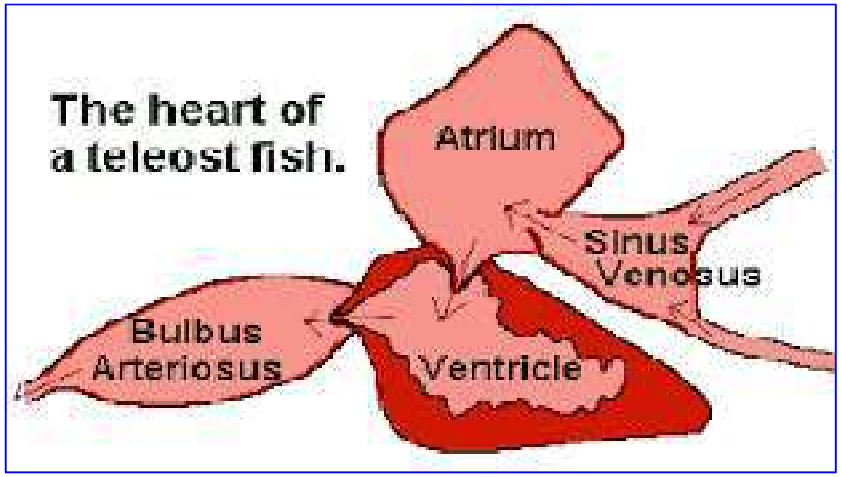
Some authors considered atrium and ventricles as the chambers of heart; while some considered sinus venosus and conus arteriosus also as the chambers of the heart.

There is some confusion in bulbus and conus arteriosus in fishes.
In elasmobranchs the 4$^{th}$ chamber is designated as conus arteriosus whereas it is known as bulbus arteriosus in teleost, a specialized ventral aorta in teleosts.

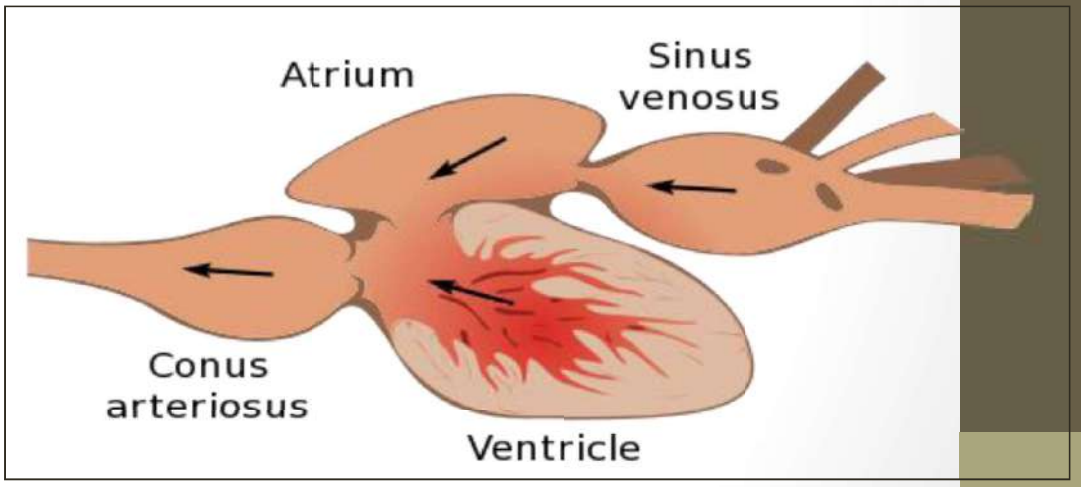
The distinction between the two is that: **the conus** arteriosus consists of cardiac musculature similar to the ventricle and is provided by a large number of valves arranged in successive rows; **while bulbus** arteriosus consists of only smooth muscle fibres and elastic tissues.

## Heart of bony fish:

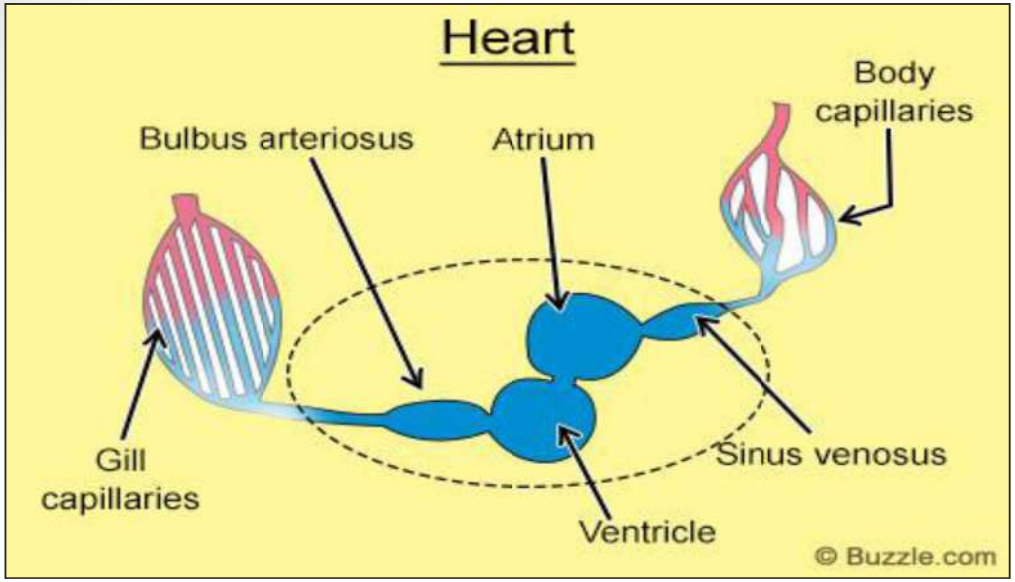
- A bony fish's heart has two chambers: an atrium and a ventricle.
- The venous side of the heart is preceded by an enlarged chamber called the sinus venosus.
- The arterial side of the heart is followed by a thickened muscular cavity called the bulbus arteriosus.

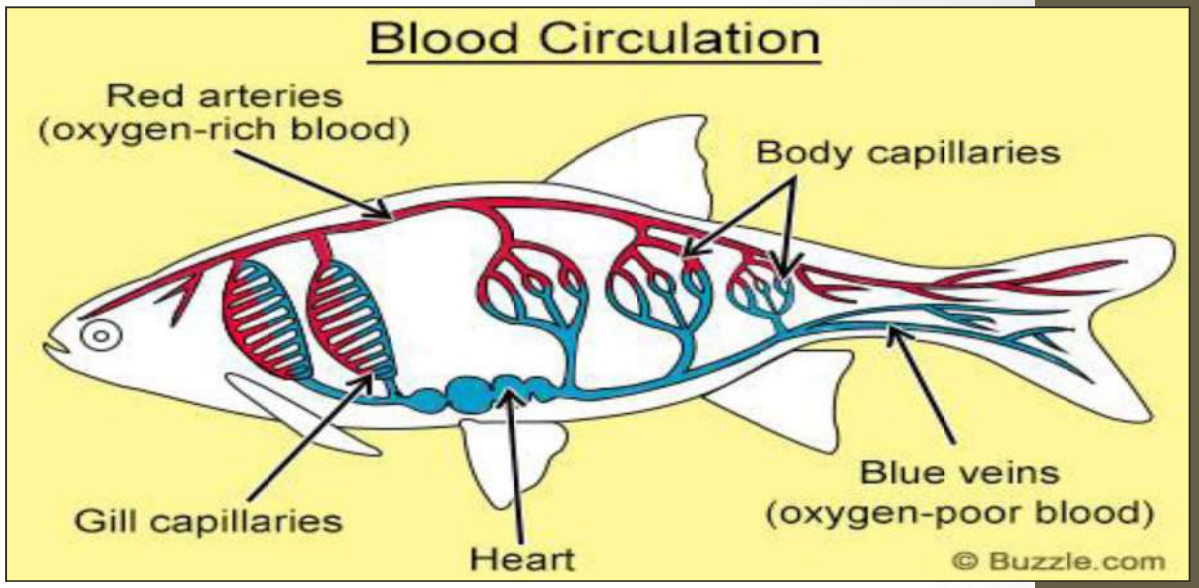


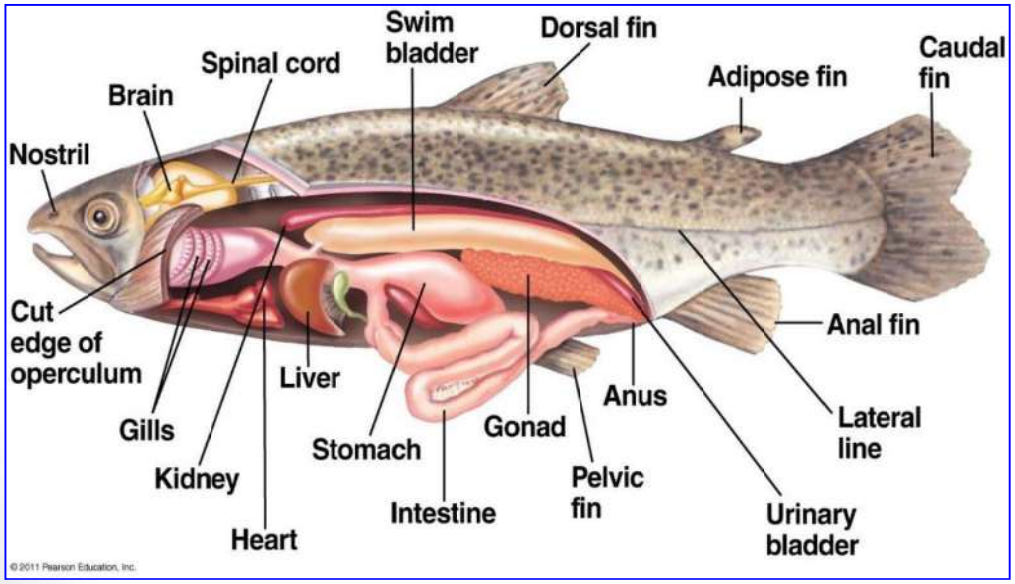

Heart of bony fish

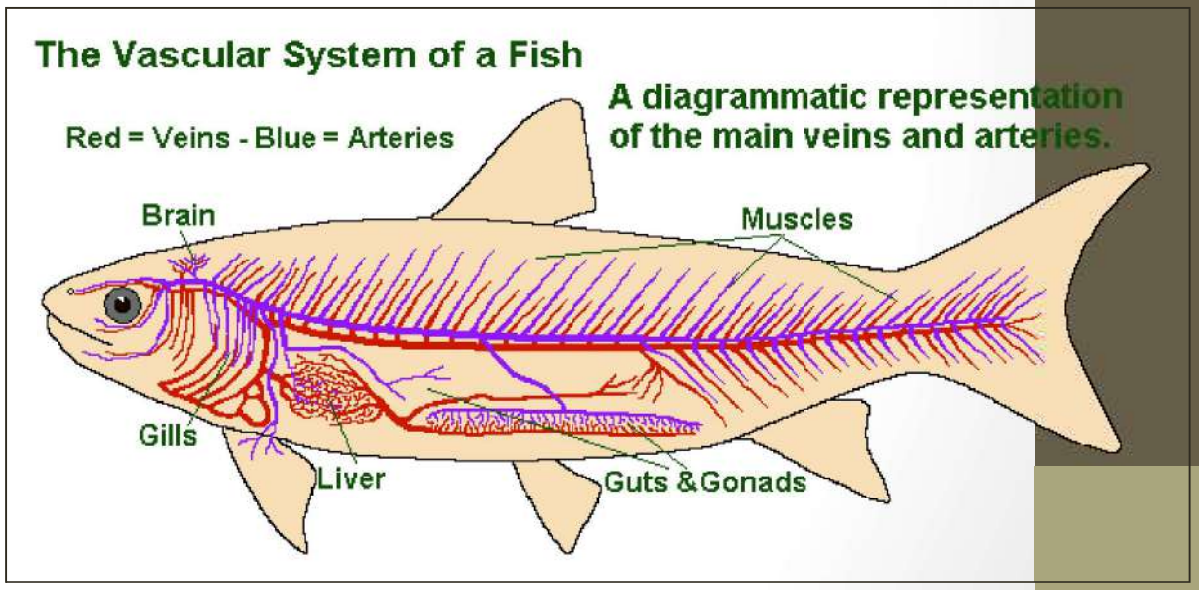



Heart of cartilaginous fish

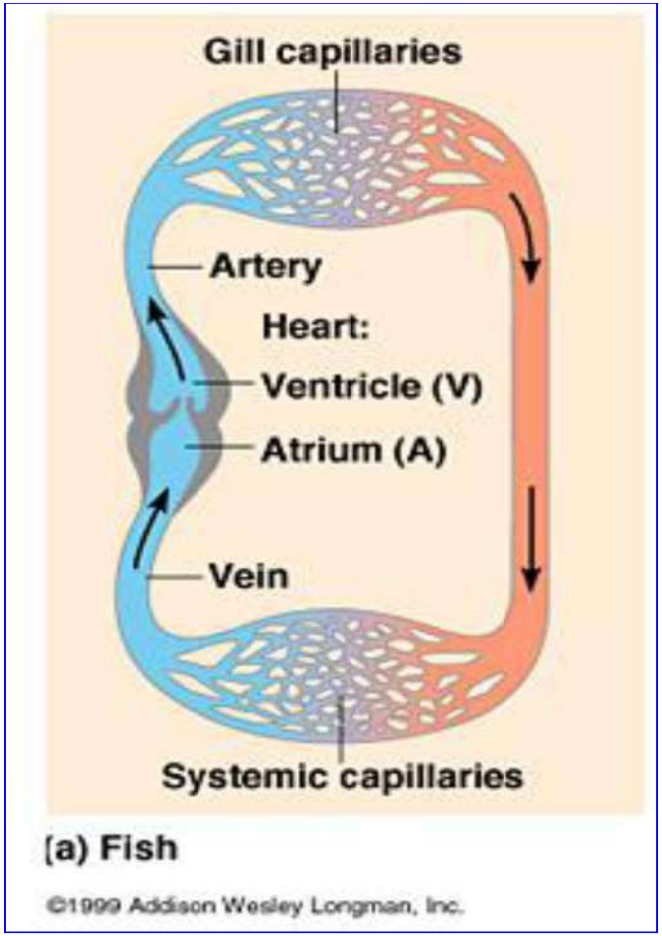

Heart
Body capillaries
Bulbus arteriosus
Atrium
Gill capillaries
Sinus venosus
Ventricle
© Buzzle.com

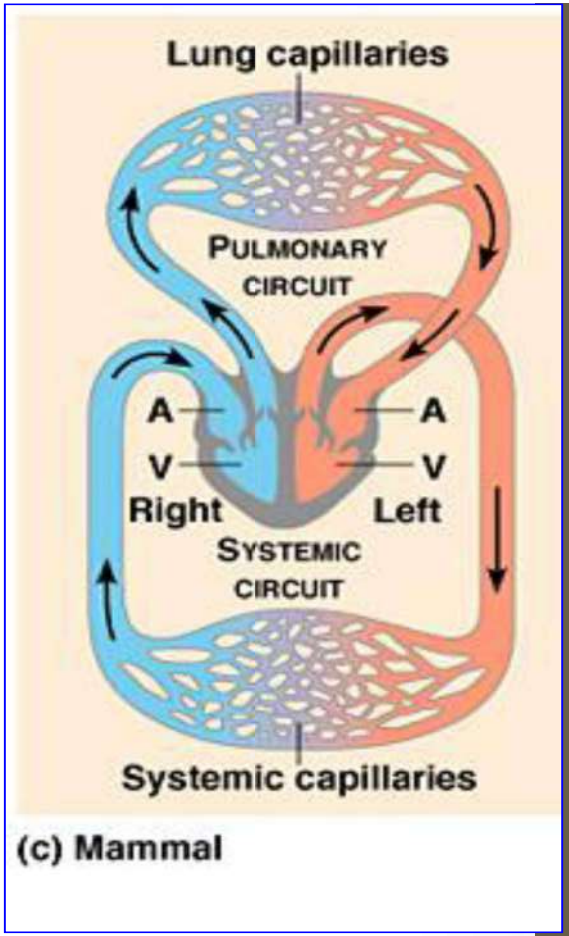

Blood Circulation
Red arteries (oxygen-rich blood)
Body capillaries
Gill capillaries
Heart
Blue veins (oxygen-poor blood)
© Buzzle.com


Swim bladder
Dorsal fin
Spinal cord
Caudal fin
Brain
Adipose fin
Nostril
Cut edge of operculum
Anal fin
Liver
Anus
Gills
Gonad
Lateral line
Stomach
Kidney
Pelvic fin
Intestine
Urinary bladder
Heart
© 2011 Pearson Education, Inc.


The Vascular System of a Fish
A diagrammatic representation of the main veins and arteries.
Red = Veins - Blue = Arteries
Brain
Muscles
Gills
Liver
Guts &Gonads

**Fishes have a Single-circuit closed circulatory system.**



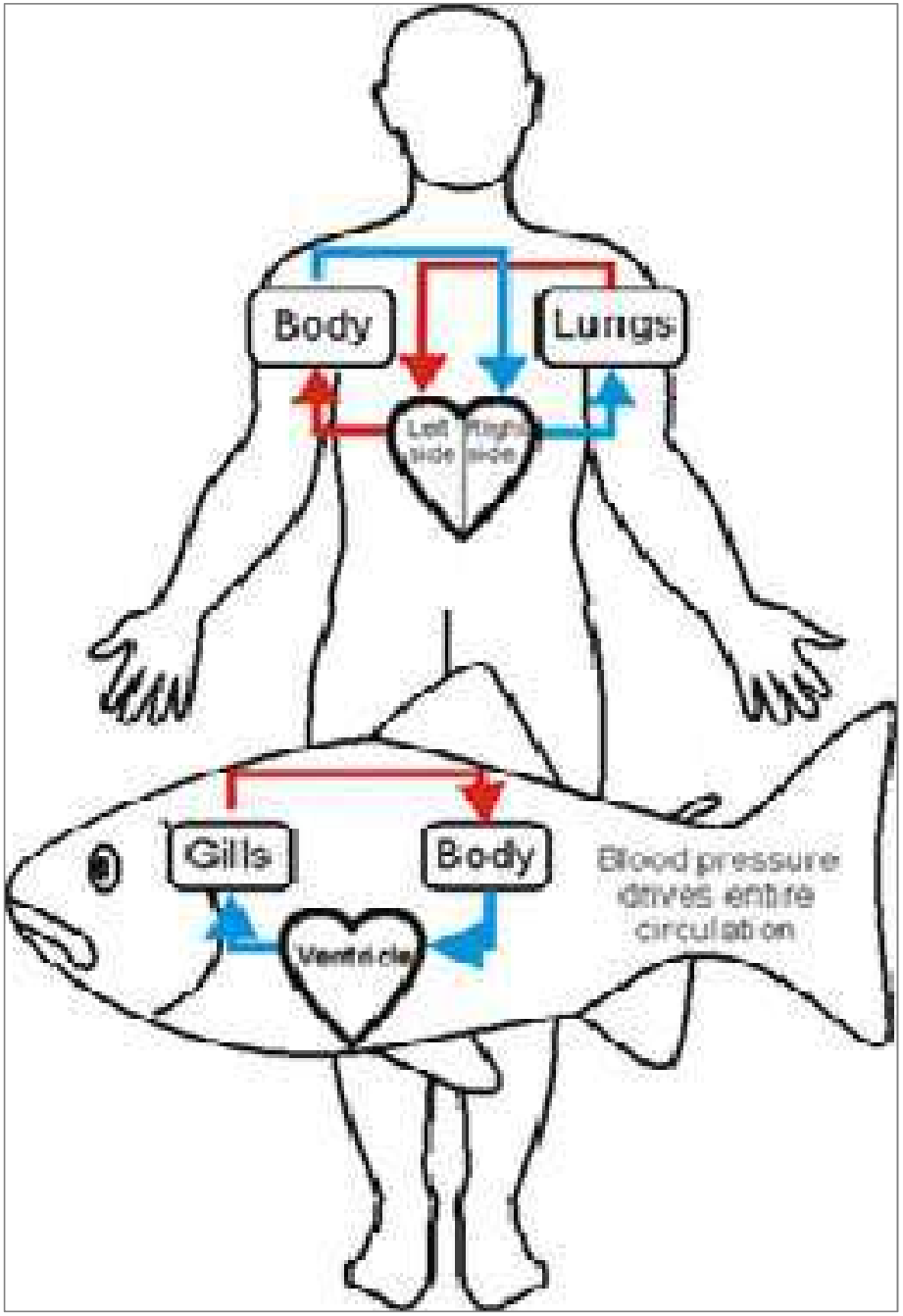




## There are two types of closed blood circulation systems:

**A)- Single Circulation Systems** (Single circuit Circulation)
**B)- Double Circulation Systems**

Fish have single circuit circulatory systems in which blood passes through the heart **only once** each time it completes a full circuit around the fish's body.

Where the heart pumps the blood to the gills to be re-oxygenated (gill circulation), after which the blood flows to the rest of the body (systemic circulation) and then back to the heart.


Body
Lungs
Gills
Body
Blood pressure
drives entire
circulation

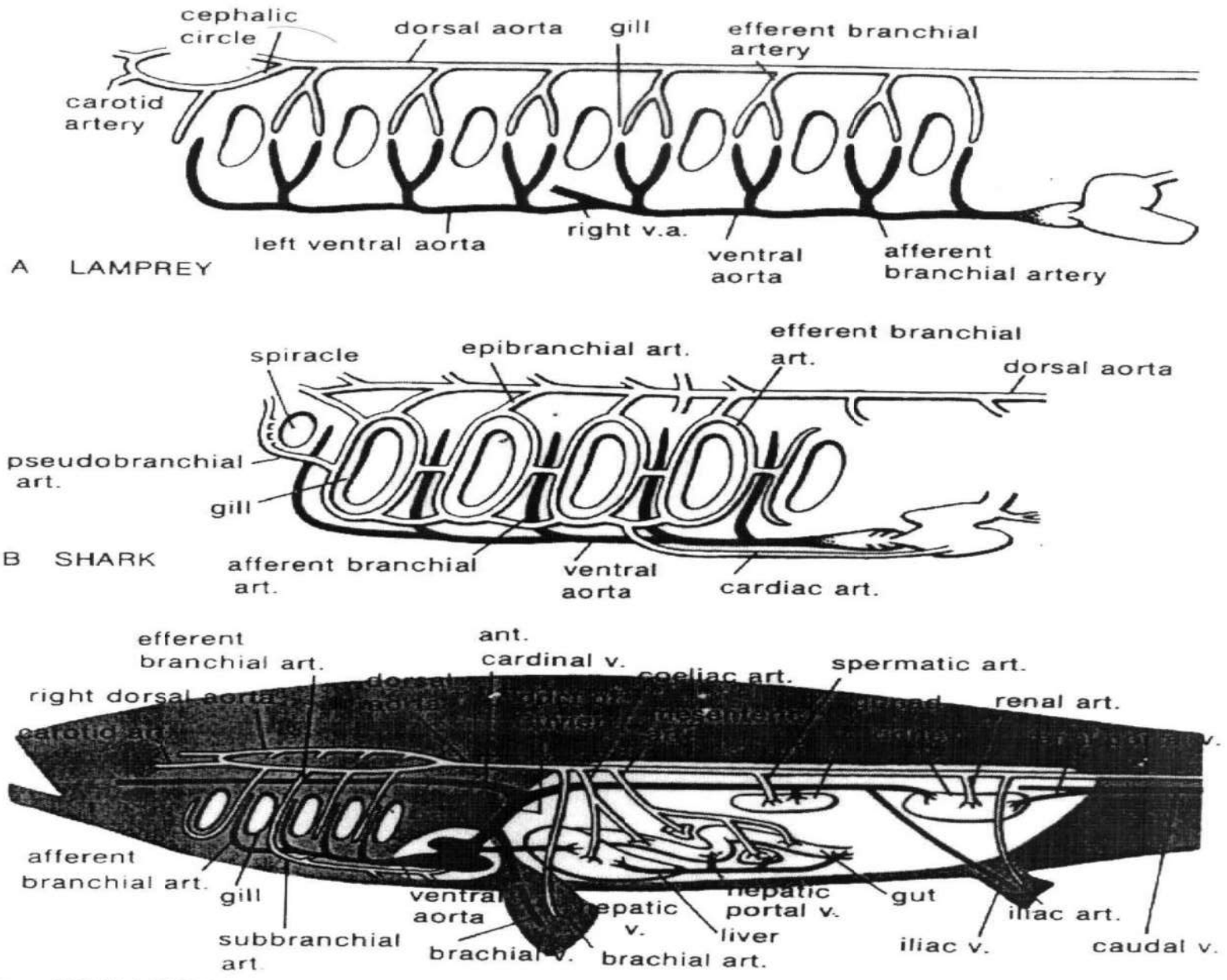


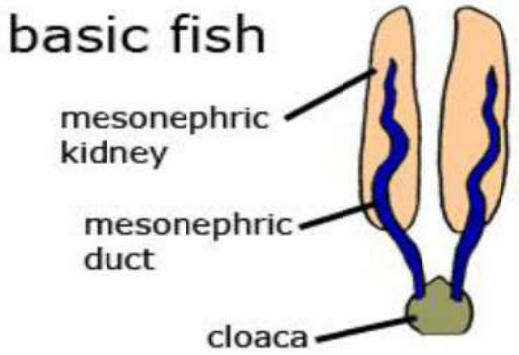

**FIGURE 2–33.** Diagrams of blood circulation. *A*, Lamprey, branchial arteries; *B*, shark, br arteries; *C*, bony fish, showing major blood vessels.

# Urinogenital system

* kidney.

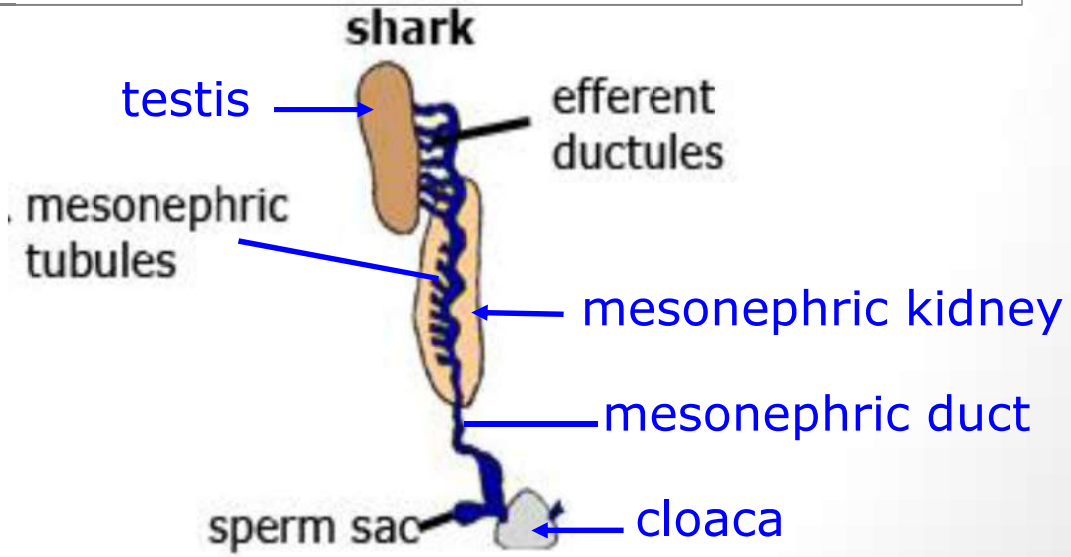
**Gonads

Urinary passages of fishes are composed of mesonephric kidney, mesonephric ducts, and the cloaca.

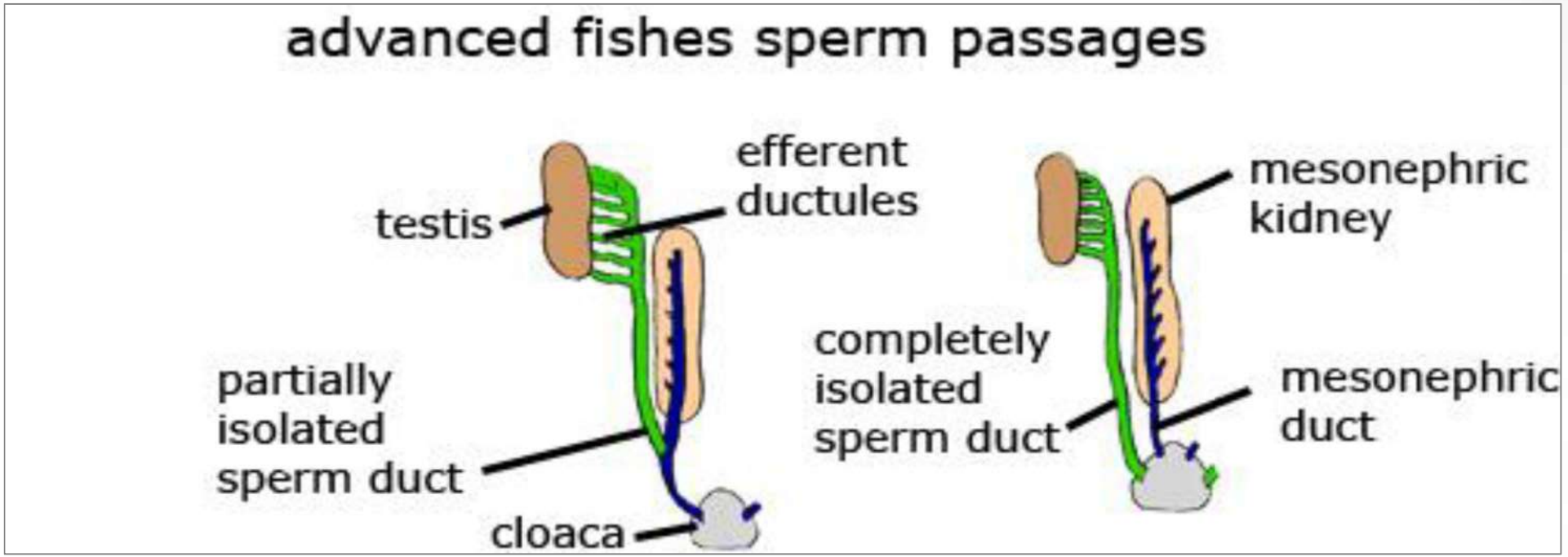



In sharks, and some other primitive bony fish, the testis is connected to the mesonephric duct by a series of small tubules (efferent ductules). In some instances these ducts are shared with the urinary system, in other species the efferent ductules from the testis are separated from the nephric tubules, but still drain into the same mesonephric duct.

**Sharks & primitive bony fish kidney & sperm passage**



Some species of fishes have a sperm duct which is either partially or completely separate from the mesonephric duct.




The mullerian ducts (**oviducts**) of fishes, are paired ducts which extend to the cloaca. Eggs typically move into the ducts at the anterior end, and in most fishes, these eggs are deposited and fertilized externally. A few fish species experience internal fertilization and the embryos develop within a portion of the duct called the uterus.

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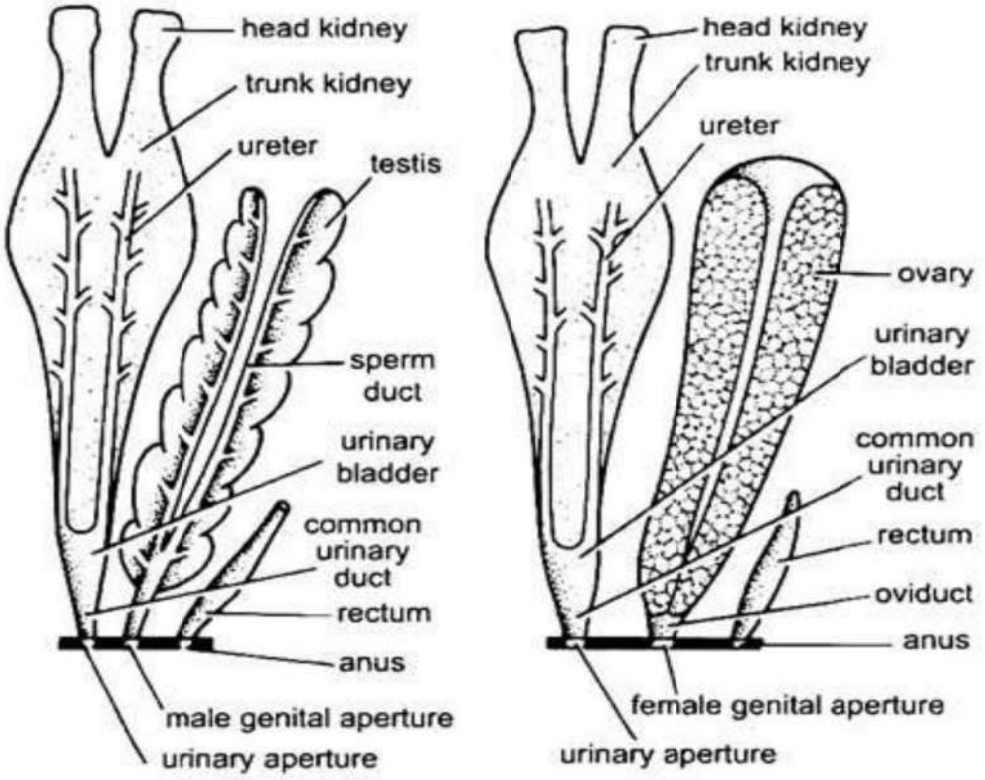
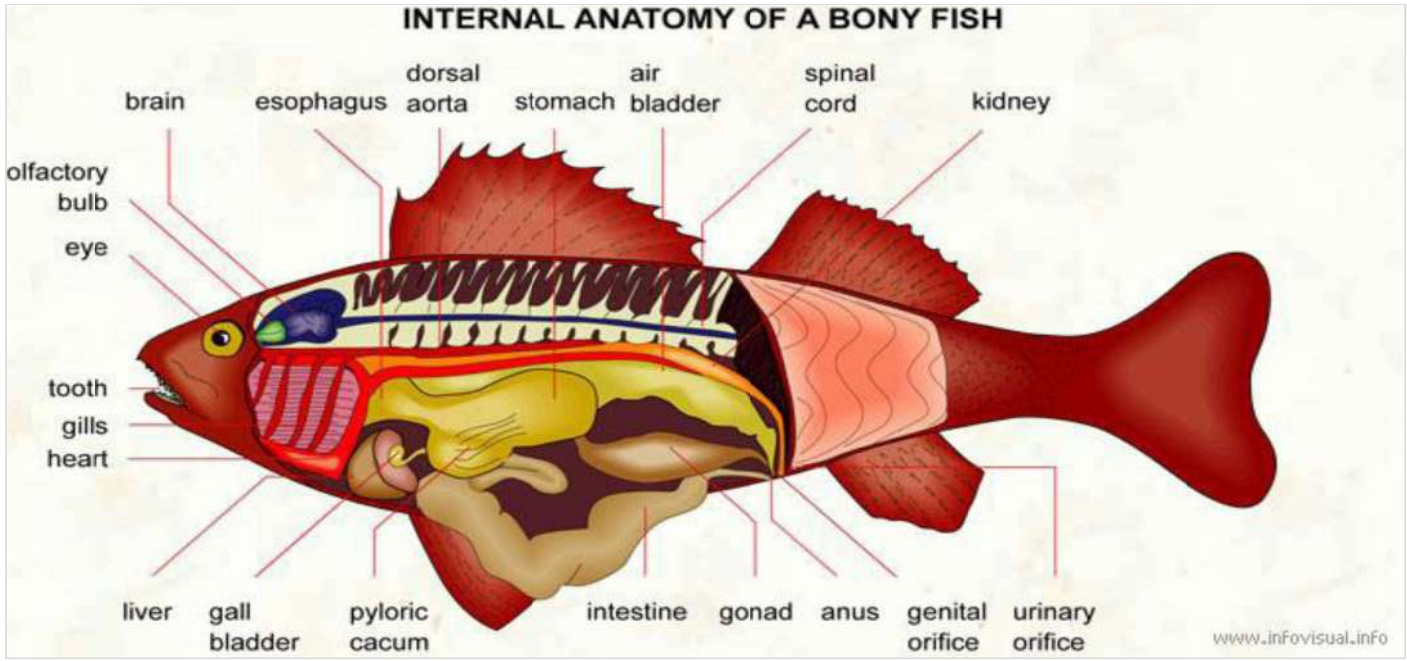
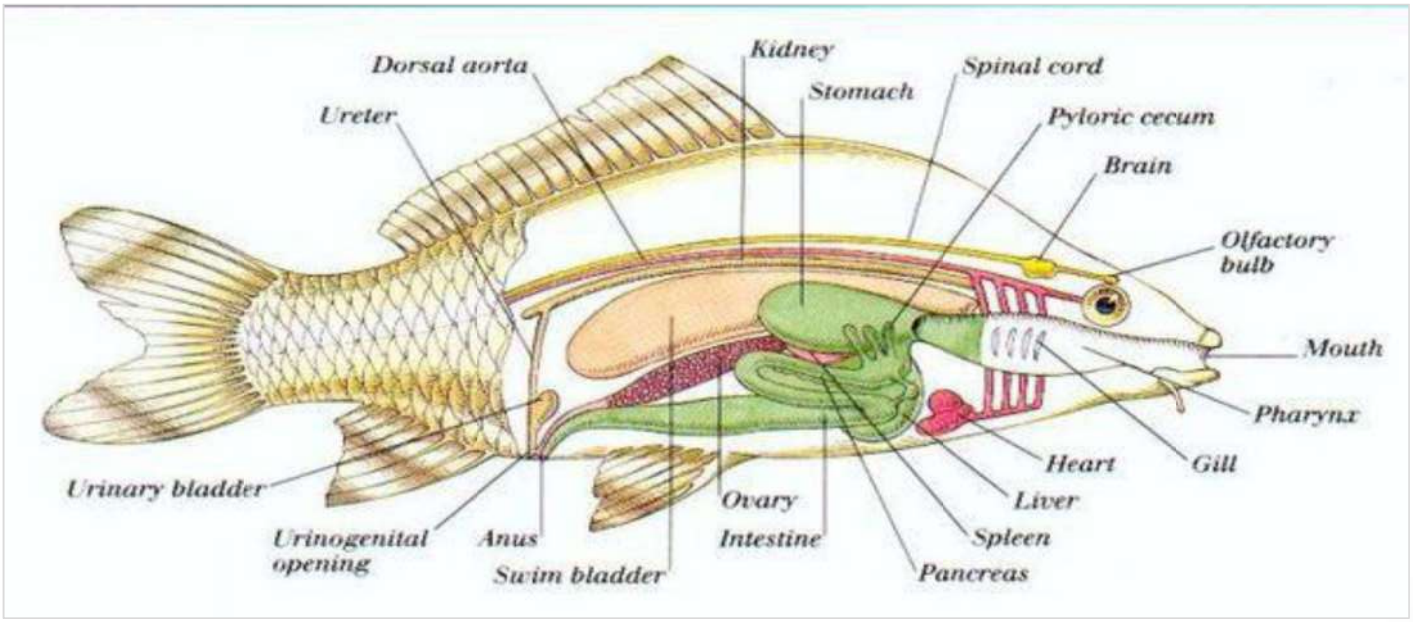



**Fig. 15.14.** *Labeo*. Urinogenital organs. A–Male; B–Female.


INTERNAL ANATOMY OF A BONY FISH
brain
esophagus
dorsal aorta
stomach
air bladder
spinal cord
kidney
olfactory bulb
eye
tooth
gills
heart
liver
gall bladder
pyloric cacum
intestine
gonad
anus
genital orifice
urinary orifice
www.infovisual.info


Dorsal aorta
Kidney
Spinal cord
Stomach
Ureter
Pyloric cecum
Brain
Olfactory bulb
Mouth
Pharynx
Heart
Gill
Liver
Spleen
Pancreas
Ovary
Intestine
Swim bladder
Urinary bladder
Urinogenital opening
Anus

**Pronephros** the most basic type of the three excretory organs that develop in vertebrates.

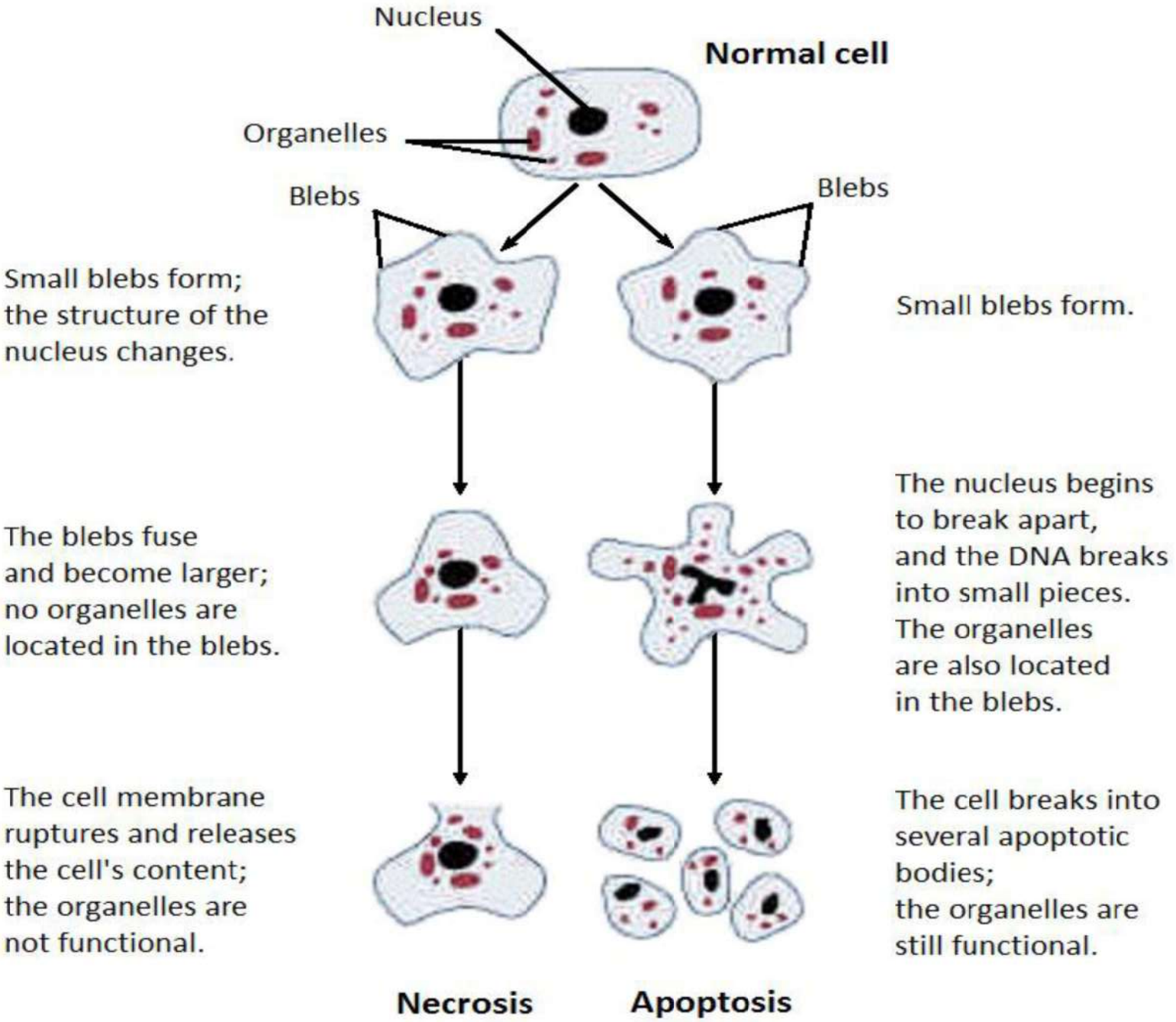
The pronephros is active in adult forms of some primitive fish, like lampreys or hagfish.

The pronephros is present **at** the embryo of more advanced fish **and** at the larval stage of amphibians where it plays an essential role in osmoregulation.

**Mesonephros:** is present in the adults of fish and amphibians .

**Metanephros:** In amniotes the mesonephros is the embryonic kidney and a more complex metanephros acts as the adult kidney.

Once a more advanced kidney is formed, the previous version typically degenerates by apoptosis or becomes part of the male reproductive system.


Nucleus
Normal cell
Organelles
Blebs
Blebs
Small blebs form;
the structure of the
nucleus changes.
Small blebs form.
The blebs fuse
and become larger;
no organelles are
located in the blebs.
The nucleus begins
to break apart,
and the DNA breaks
into small pieces.
The organelles
are also located
in the blebs.
The cell membrane
ruptures and releases
the cell's content;
the organelles are
not functional.
The cell breaks into
several apoptotic
bodies;
the organelles are
still functional.
Necrosis
Apoptosis

# Fish kidneys

- Diffuse organs on either side of vertebral column
- Varying degree of connection with reproductive system
- Little connection in most advanced fishes

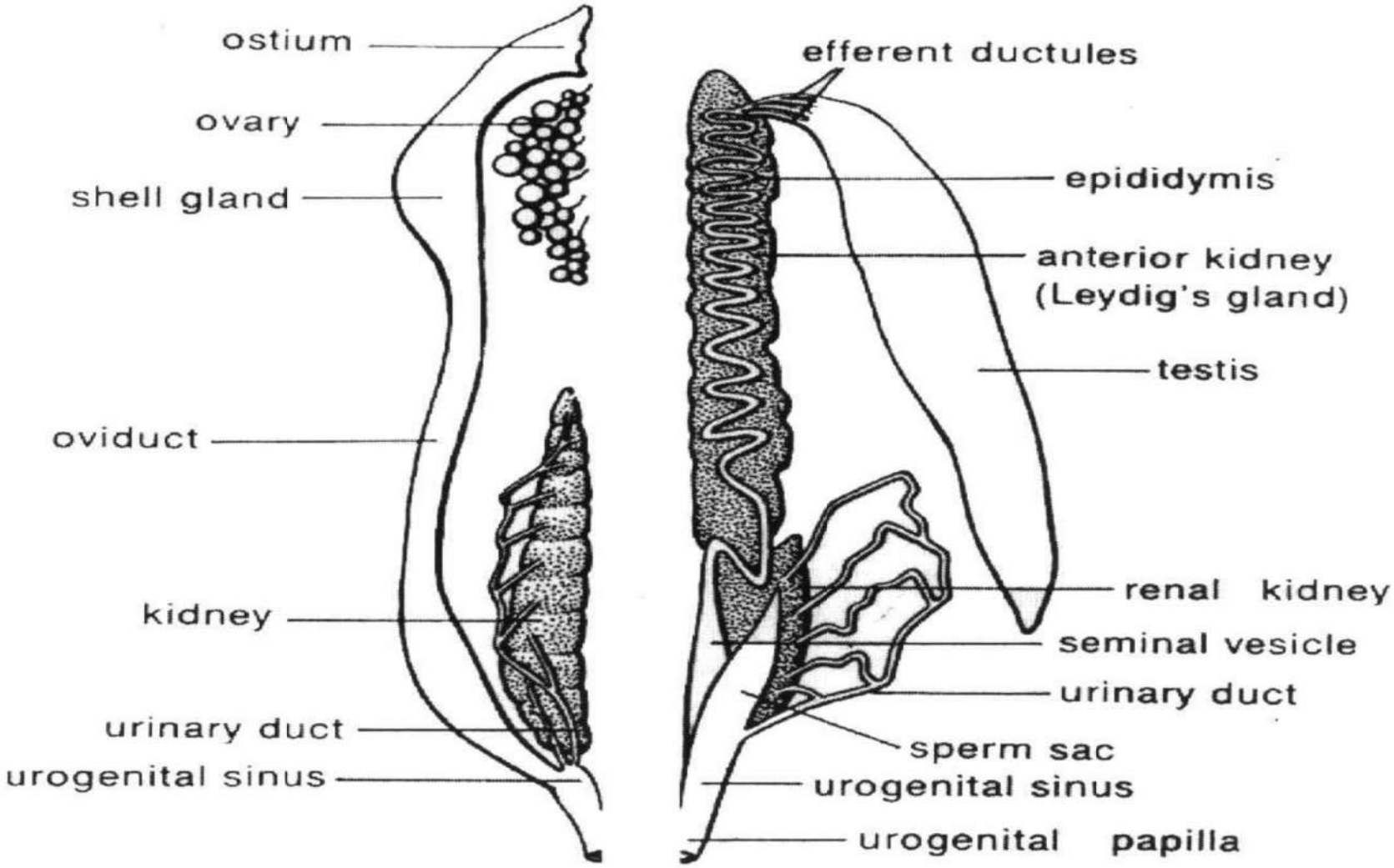



**FIGURE 2–35.** Diagram of urogenital organs of shark. *A*, Female; *B*, male. (Based on Goodrich, in Lankester, 1909.)

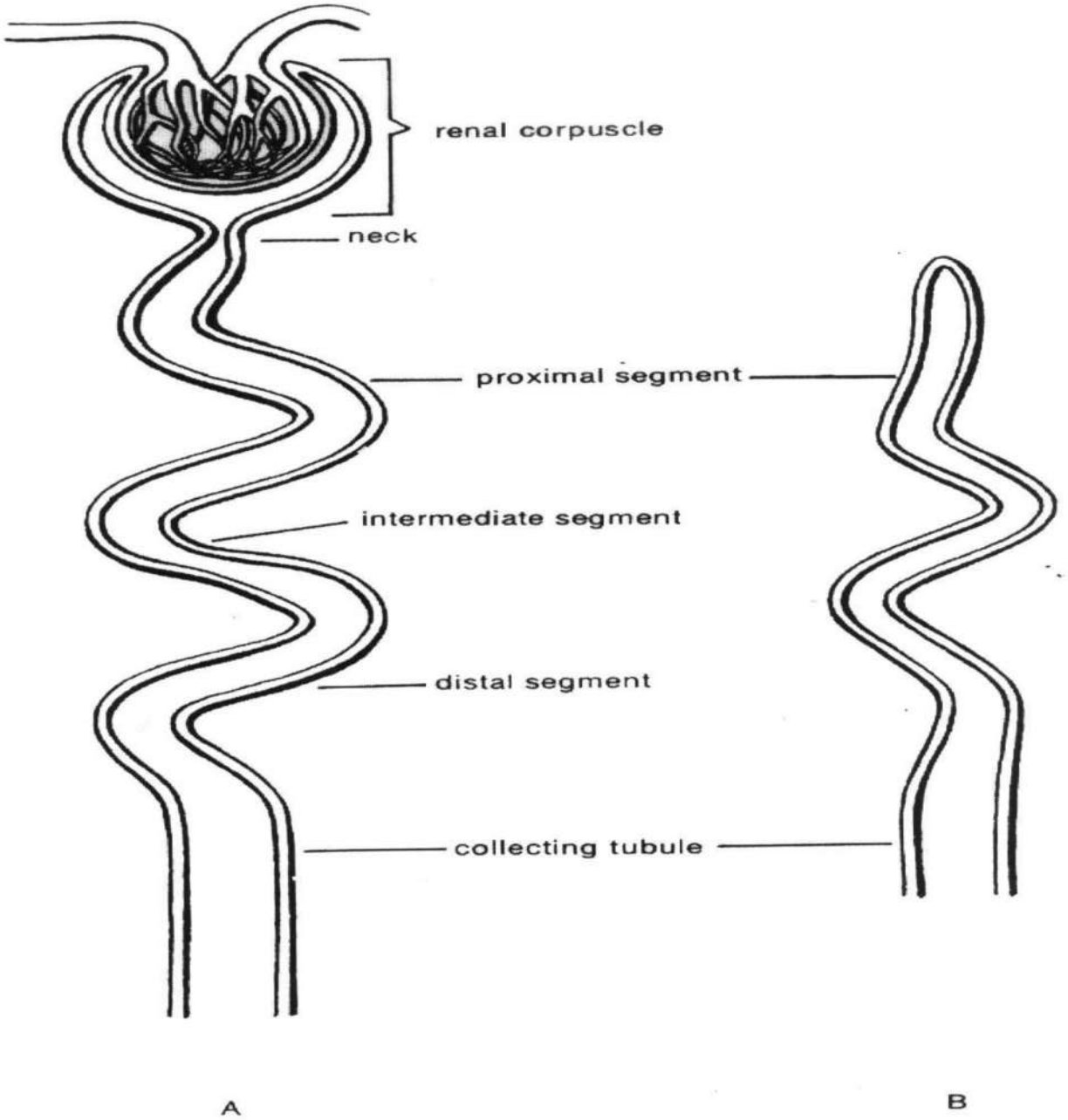



**FIGURE 2–36.** Schematic diagrams showing components of two types of nephrons found in bony fishes. *A*, Glomerular; *B*, aglomerular (in some marine fishes).

# Lecture 4

# Food and feeding habits of fishes

## The food supply is a determining factor for

- Distribution
- Abundance
- Rate of growth
- Condition
- Movements
- Fertility

**There are three ways for studying the food data (knowledge on food)**

- Direct observation
- Observation in captivity
- Examination of contents of the stomach

# Classification of fishes according to their food and feeding habits

## (1)- Herbivorous fishes

As *Tilapia mossambicus* which feeds on algae , diatoms , flowering plants and seeds

## (2)- Carnivorous fishes

These may be :-

- Piscivorous as in case of *Hydrocyon* sp
- Insectivorous as in case of cichlids.
- Mollusc-feeders as in case of *Tetradon* .
- Worm feeders.
- Living animals feeders.

## (3)Omnivorous fishes

They may feed on plants & animals as in case of *Clarias gariepinus*

## (4)Scavengers (detrivorous or bottom feeders)

These feed on the particles of organic matter as in case of *Oreochromis niloticus* and certain species of *Labeo*.

## (5)Plankton feeders

**(phytoplankton or zooplankton)**

# Factors affecting food and feeding habits of fishes

. There are six factors affecting the food and feeding habits of fishes, these are:-

*SEASON*

*LOCALITY*

*LIGHT*

*TEMPERATURE*

*LENGTH OF THE FISH*

*SEX*

## (1)- Season

The season may affect the food items or the intensity of feeding (degree of fullness of the stomach).

Example : -

*Labeo niloticus*: Increases the intensity of feeding during April-September and decreases it during October-March, and the reverse occur in case of *Schilbe mystus.*

The seasonal differences result from the abundance of food in the different seasons.

## (2)Sex

The females of the bream feed on *Hypaniola kovalevskii* while males feed on *Nereis succinea.*

The females of the deep-water anglers live predatory life while males live as parasites on females.

## (3)- Locality

The pond specimens differ from the Nile specimens in the kind of food and also in it's intensity.

# (4)Length of the fish (and consequently age)

-Small cod, *Gadus calarias*:

*Individuals at 11-30 cm length:* feed on pelagic crustaceans, fish and benthic invertebrates.

*Individuals at* 70 cm *length:* feed on pelagic and bottom forms.

-*Schilbe mystus:*

As the length increases they increase the consumption of the adult insects and decrease the consumption of the smaller insects and daphnia.

## (5)Temperature

***Micropterus salmoides:***

It consumes at 20Cº three times than at 10Cº.

Some other fishes stop feeding during the winter as they are sensitive to temperature as :-

*Cirrhina mrigala and Labeo rohita*

## *(6)*Light

it is a detrmining factor for food and feeding habits where :-

the catfish *Ictalurus locustris punctatus* feeds actively from sundown to midnight.

# The adaptation of the alimentary tract of fishes to their normal diet and feeding habits.

**(1)The mouth:**

According to the size (a) Small : herbivorous & scavengers

(b) Large : piscivorous fishes

According to the position (a) Terminal

(b) Dorsal

(c) Ventral & (d) subterminal

**(2)- Dentition**

(a)- strong and a cutely pointed teeth in piscivorous (Godus perch).

(b)- single plate in fishes which feed on hard corals & mollusks.

(c)- Nibbling mouth with incisiform teeth (incisors) (herbivorous ).

(d)- Plankton feeders (Herring : as small teeth).

(e)- Scavengers toothless mouth but with pharyngeal teeth pad.