

# **BIO 102: GENERAL BIOLOGY 2**

**TOPICS: UROCHORDATES, CEPHALOCHORDATES  
AND VERTEBRATES**

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# CHORDATES

## THE PHYLUM CHORDATA IS DIVIDED INTO THREE SUBPHYLA:

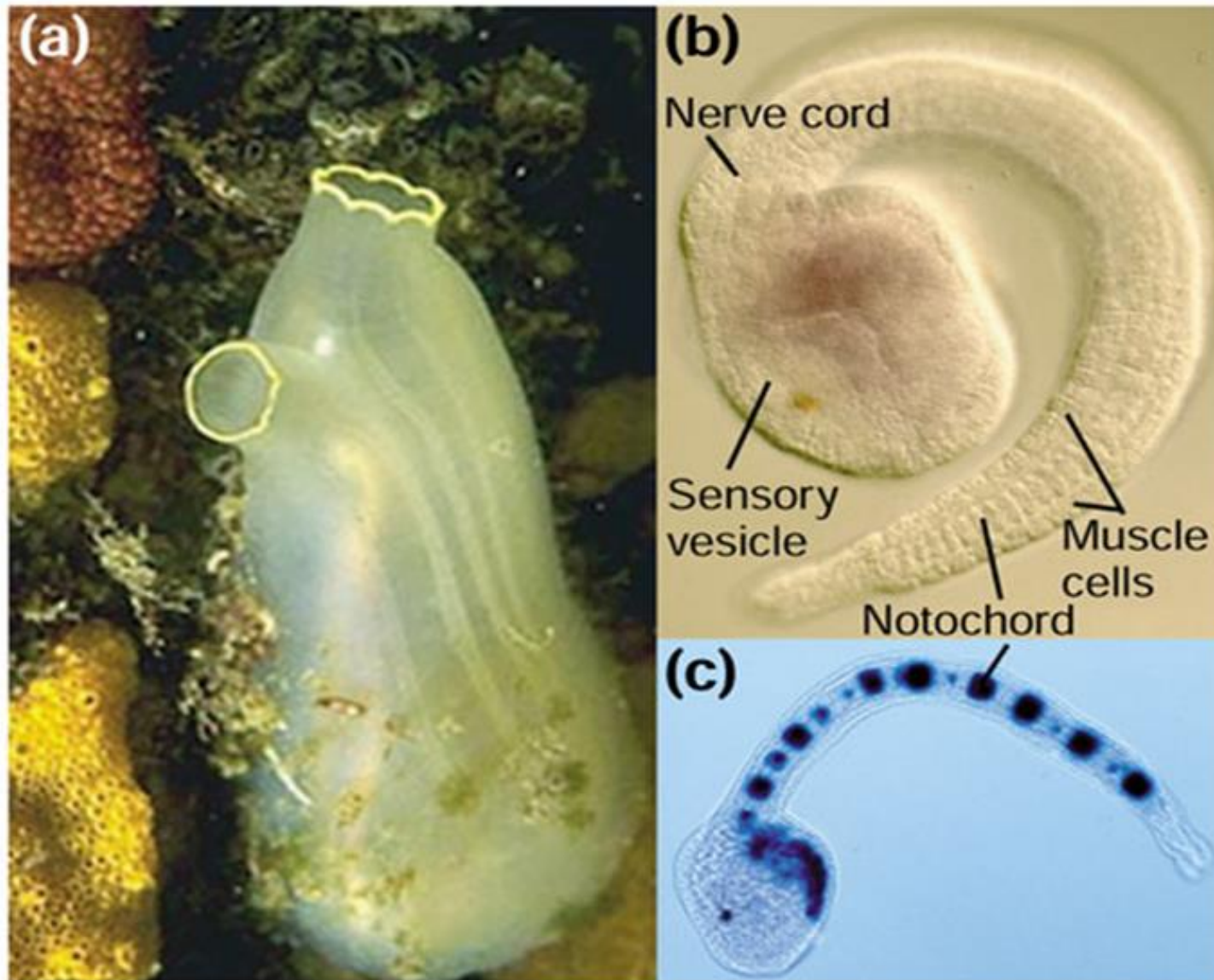
- Urochordata (tunicates)
- Cephalachordata (lancelets)
- Vertebrata (vertebrates)

## SUBPHYLUM UROCHORDATA e.g. *Ciona* (*Ciona intestinalis*)

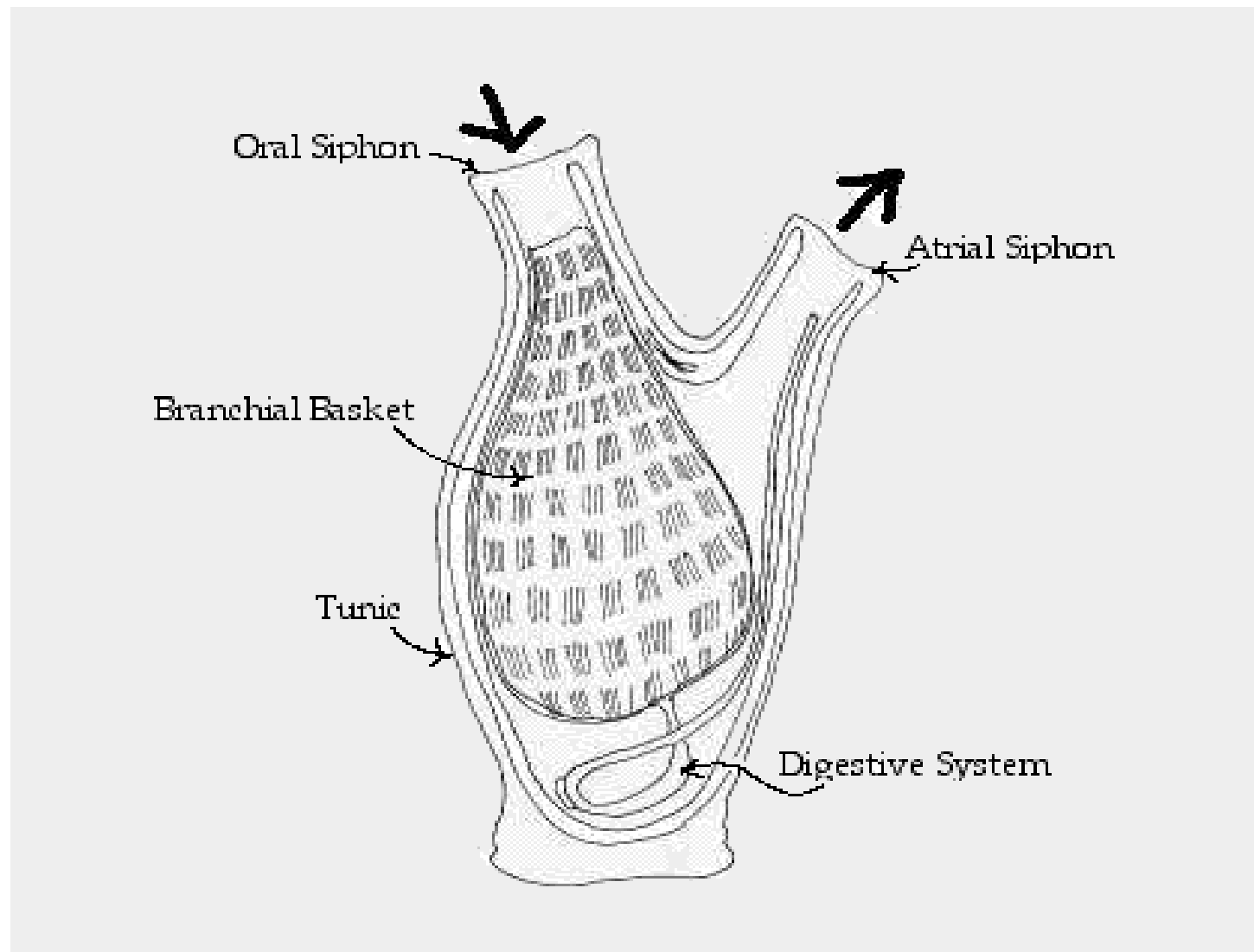
- The Urochordates are more commonly referred to as tunicates
- This group (also called tunicata) also includes animals known as ascidians (and commonly called sea squirts).

## External Features:

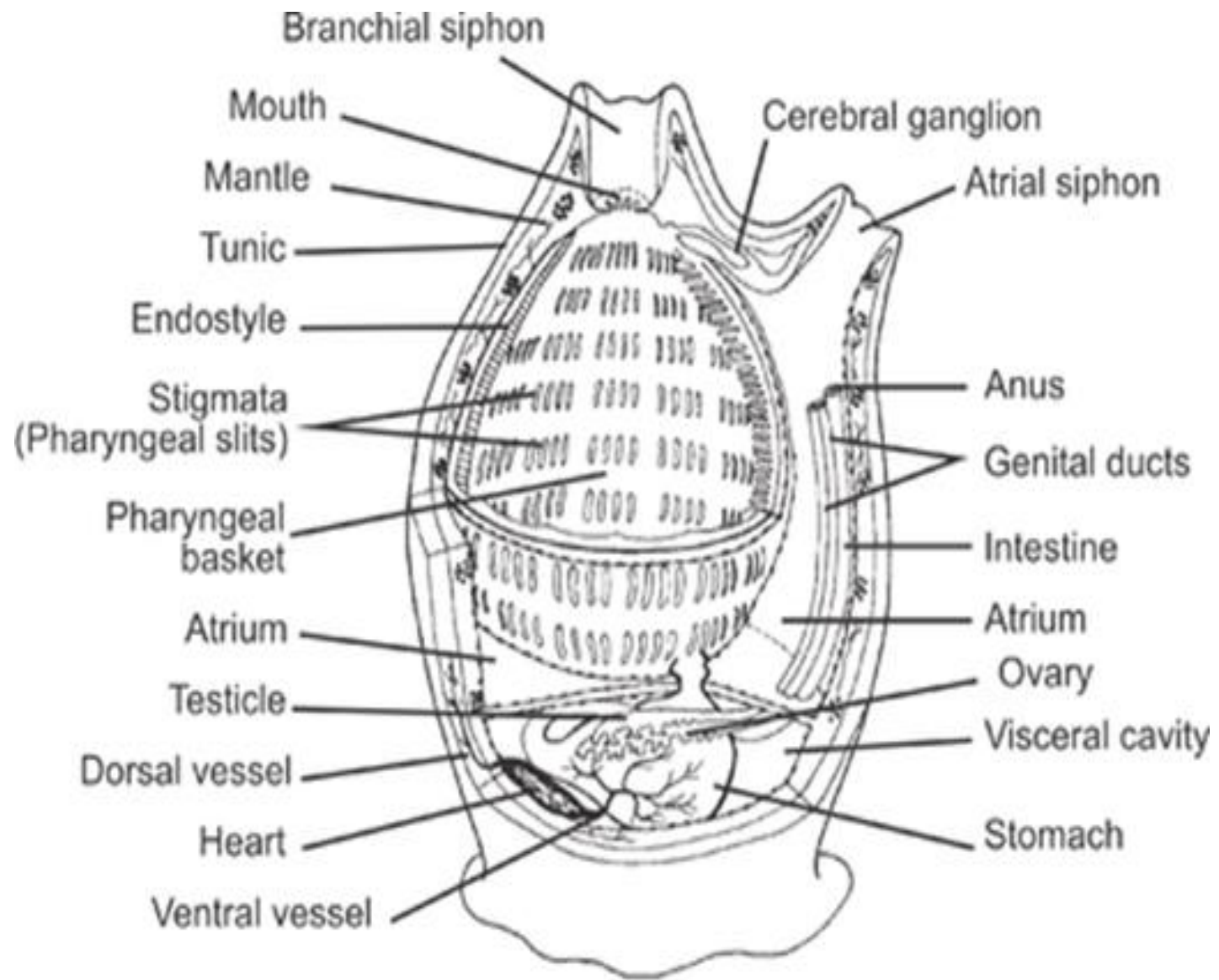
- All the animals in the family Cionidae are called tunicates because the body is surrounded by a test or tunic
- The tunic is composed of proteins and complex carbohydrates, and includes tunicin, a variety of cellulose.
- The tunic can grow as the animal enlarges and does not need to be periodically shed
- Two openings are found in the body wall:
  - The buccal siphon at the top through which water flows into the interior
  - The atrial siphon on the ventral side through which it is expelled



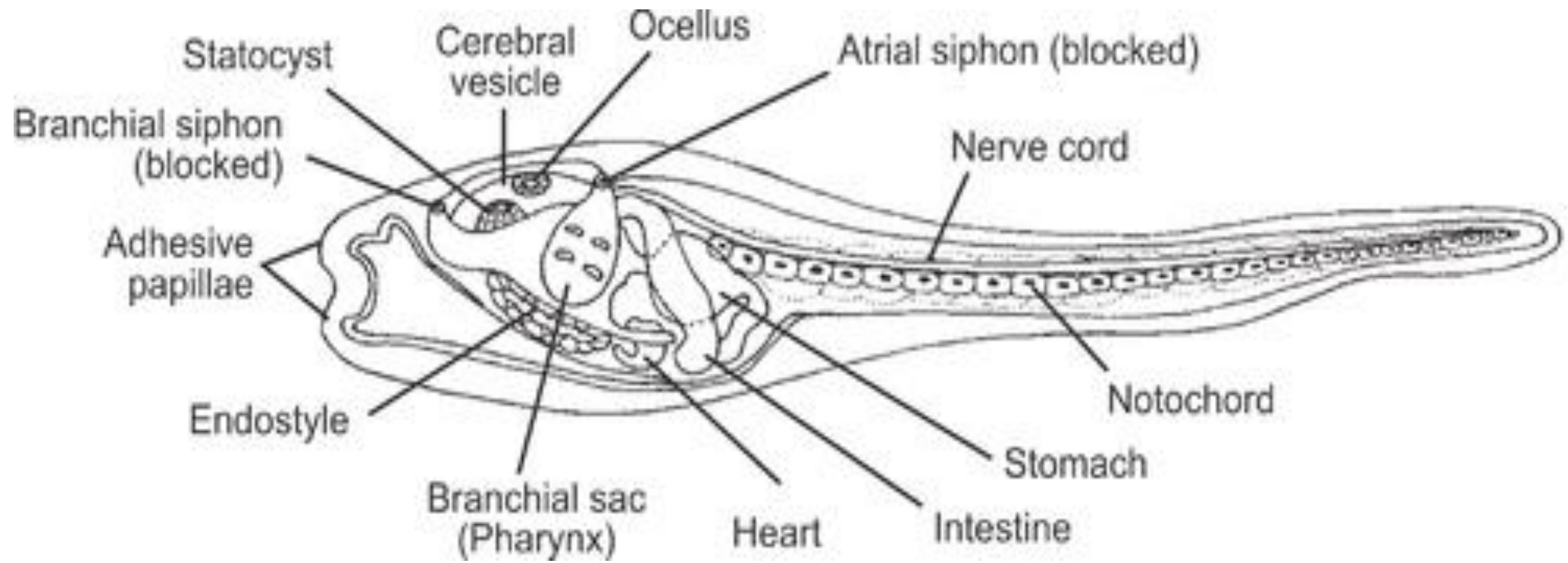
(a) Adult *Ciona*, (b) and (c) Larval *Ciona*



External features of *Ciona*



Internal features of *Ciona*



Larval stage of *Ciona*

## Ecological Adaptations of *Ciona* (e.g. *Ciona intestinalis*):

- *Ciona intestinalis* can be found in the marine habitat
- They are normally found from near shoreline areas to deeper waters, and in estuaries, and is more common in silty conditions in shallow waters
- Majority are sessile as adult, although some are free living
- They grow in dense aggregations on rocky substrate, marine plants, shells, on any floating or submerged substrate
- They are cylindrical, translucent ascidians, ending in a cone-shaped siphon
- The body wall is a pale yellow-green, translucent, and tubular with terminal inhalent and sub-terminal exhalent siphons (openings)





Adult stage of *Ciona intestinalis*

# ***Ciona intestinalis* is a filter feeder, and feeds mainly on fine detrital particles and phytoplankton**

- During the circulation of water through the large gill basket, food particles are taken from the water and the endostyle secretes mucus to trap the food
- It is then passed to the dorsal midline of the pharynx where it is rolled into a mucus rope and passed to the stomach
- It passes to the intestine, and the faecal pellets formed go from the anus to the atrial opening where they are expelled from the body

## ***Ciona intestinalis* is hermaphroditic**

- They release sperm and eggs through the exhalant siphon
- Fertilization occurs at sea, and a tadpole-like larva is formed about 25 hours later
- The larval form of *C. intestinalis* is free-swimming and appears similar to a tadpole
- After a period of 1-5 days the larvae will metamorphosis into a sessile adult.

# **SUBPHYLUM CEPHALOCHORDATA e.g. *Branchistoma***

**Also called Acrania or Lancelet**

- *Branchiostoma* was formally called *Amphioxus*
- They inhabit the sandy bottoms of coastal waters around the world

**External Features:**

- They are small, fishlike marine invertebrates
- They are slender, laterally compressed, translucent animals about 5 to 7cm in length

**They possess the following characteristics:**

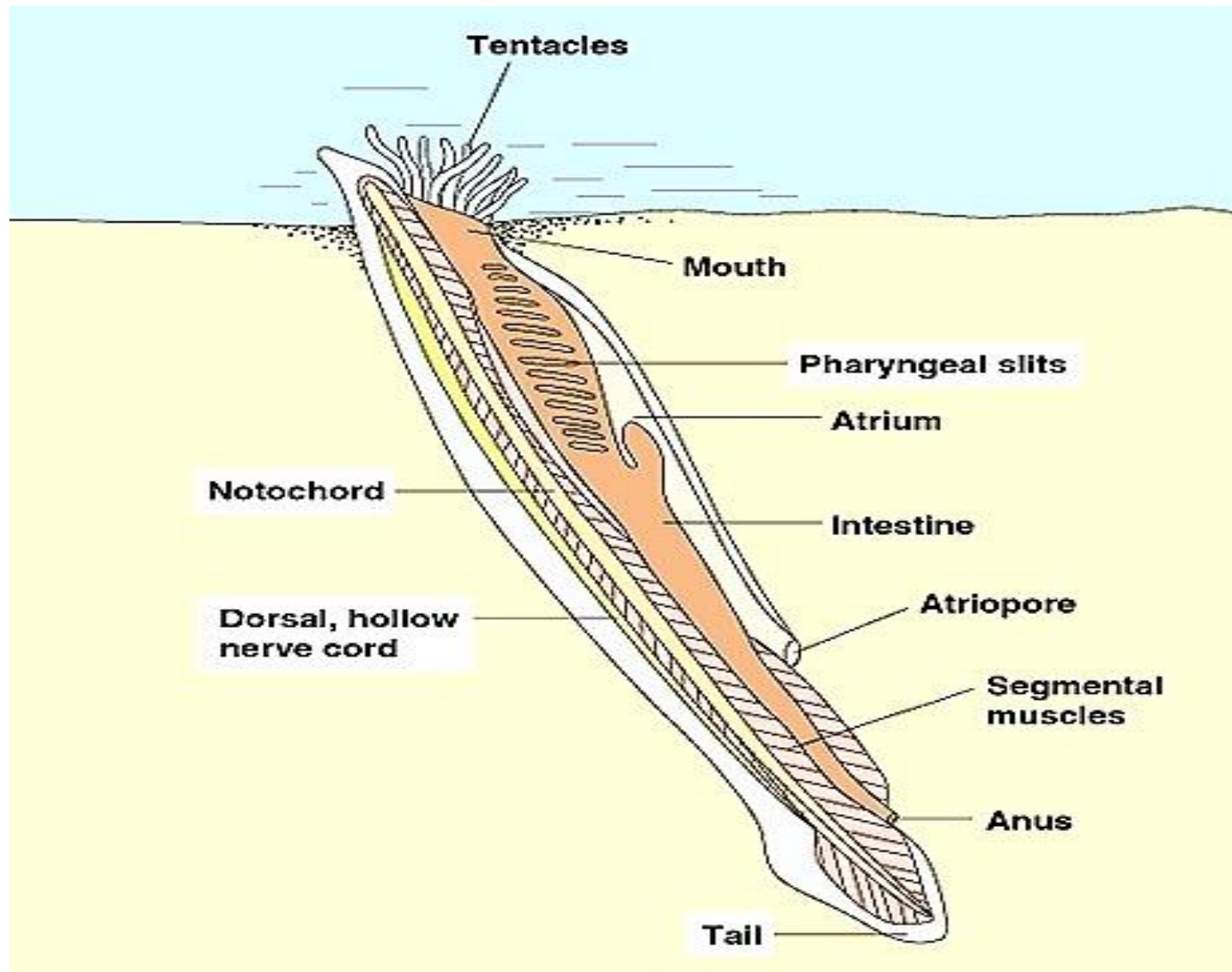
- Elongate and bilaterally flattened

- Possess a tail, that portion of the body that projects behind the opening of the anus
- Muscles arranged in blocks (myotomes) that are easily visible
- There is a notochord composed of muscle fibres
- Sense organs apparently located on cirri anterior and in a few places along the nerve cord

- Lancelets are streamlined bodied, swimming animals.
- They have several fins; a dorsal, a caudal fin and a ventral fin.
- Paired fins are absent, but metapleural folds are present
- The anus opens well behind the atriopore, on the left side of the ventral fin
- The general body surface is covered by a smooth cuticle layer



**Adult stage of *Branchistoma* (formally called *Amphioxus*)**



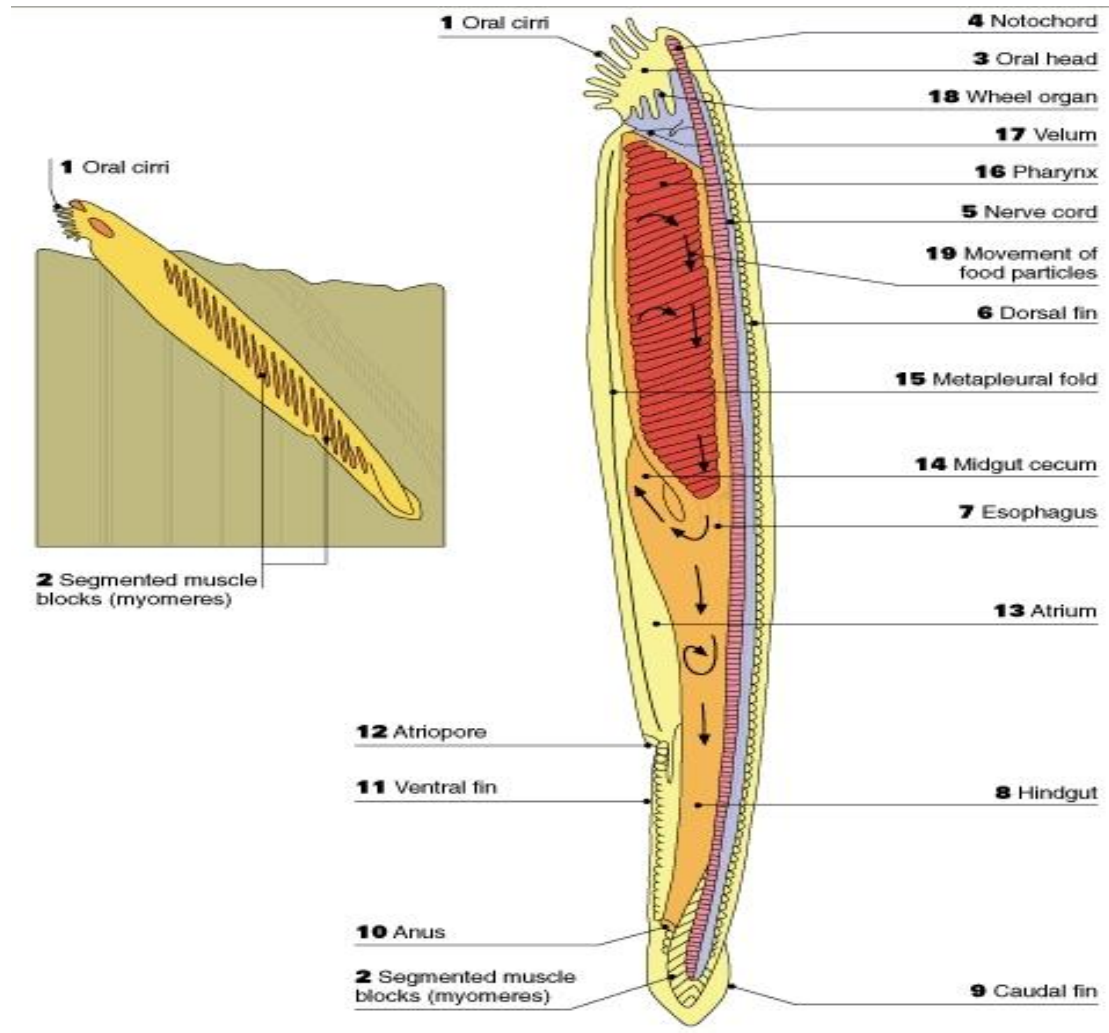
A diagrammatic representation of *Branchistoma* (formally called *Amphioxus*)



## Ecological Adaptations:

- Branchiostoma (Amphioxus) is a suspension-feeder, feeding on microscopic organisms.
- When they are buried, their head sticks out to filter out food particles from the water
- Water and food enters through the mouth, with a set of ridges lying inside the mouth
- It then passes through the pharyngeal gill slits that are enclosed in a form of body cavity known as the atrium.

- Food particles suspended in the water are trapped in a sheet of mucus
- Water passes through the slits and out of the atrium through the atriopore
- The food particles together with mucus are rolled into a mass that is passed on into the oesophagus where they are digested



A diagrammatic representation of *Branchiostoma* showing some internal organs

- Lancelets can swim both forward and backward
- When undisturbed they are buried in the sand with only the anterior oral hood above the surface
- When flushed out of the sand in which it lies, the animal swims quickly with serpentine movements
- Burrowing is accomplished head or tail first



***Branchistoma* buried in the sand with only the anterior oral hood above the surface**

- Lancelet sexes are separate, and asexual reproduction does not occur
- Eggs and sperm are shed directly into the water, where fertilization occurs
- The eggs are not yolky, and the fertilized eggs develop into free-swimming larvae

**SUBPHYLUM VERTEBRATA (OR CRANIATA;  
VERTEBRATES)**

- Also called Craniata, any animal of the subphylum Vertebrata
- The predominant subphylum of the phylum Chordata
- They have backbones, from which they derive their names
- The vertebrates are also characterized by a muscular system consisting primarily of bilaterally paired masses and a central nervous system partly enclosed within the backbone
- They include the classes Agnatha, Chondrichthyes and Osteichthyes (all fishes); Amphibia (amphibians); Reptilia (reptiles); Aves (birds); and Mammalia (mammals)



- Fishes are cold blooded vertebrate animals
- Found in the fresh and salt waters of the world
- Cartilaginous fishes and bony fishes
- The study of fishes is called Ichthyology
- Locomotory organs are fins – paired pectorals fins, pelvic fins, unpaired ventral fins or anal fins and caudal fins.
- Organs of respiration are gills (and “lungs” in only the lung fishes)
- Their bodies have scales which are used for various purposes e.g. protection from injury and diseases; colouration; growth and age declaration.
- All live in water

# Classification

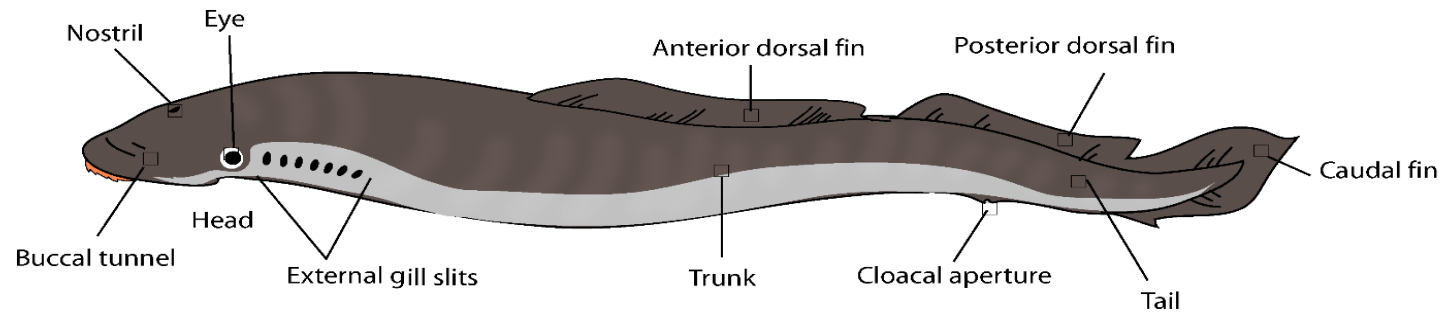
- Fishes are best arranged in two super classes and four classes of lower vertebrates:
- Super Class Agnatha (for Jawless fishes)
- Class Myxini (Hagfishes)
- Class Cephalaspidomorphi (lamprey)
- Super Class Gnathostomata
- Class Chondrichthyes (Cartilaginous fishes)
- Class Osteichthyes (Bony fishes)

# **SUPER CLASS AGNATHA - Lampreys (e.g. *Petromyzon marinus*)**

## **External Features**

- They possess a round sucking mouth with horny teeth and rasping tongue
- They have 7 pairs of pharyngeal gill pouches
- They are predaceous
- Their nostrils are located on top of the head
- They have a distinct freshwater larval stage called ammocoete
- They possess one or two median fins
- They have a blind olfactory sac.

- Lampreys are found in cool, fresh, and coastal waters of all continents except Africa.
- They are primitive jawless, with their bodies being smooth, slimy, scaleless, and eel-shaped
- They have a soft, cartilaginous skeleton
- They lack paired fins but have well-developed dorsal and caudal fins
- They have seven open gill slits on each side
- In the adult the jaws are rudimentary
- The mouth is surrounded by a suctional oral disk bearing horny teeth
- Well developed, and the single nostril is on the top of the head



**Basic external anatomy of a lamprey**



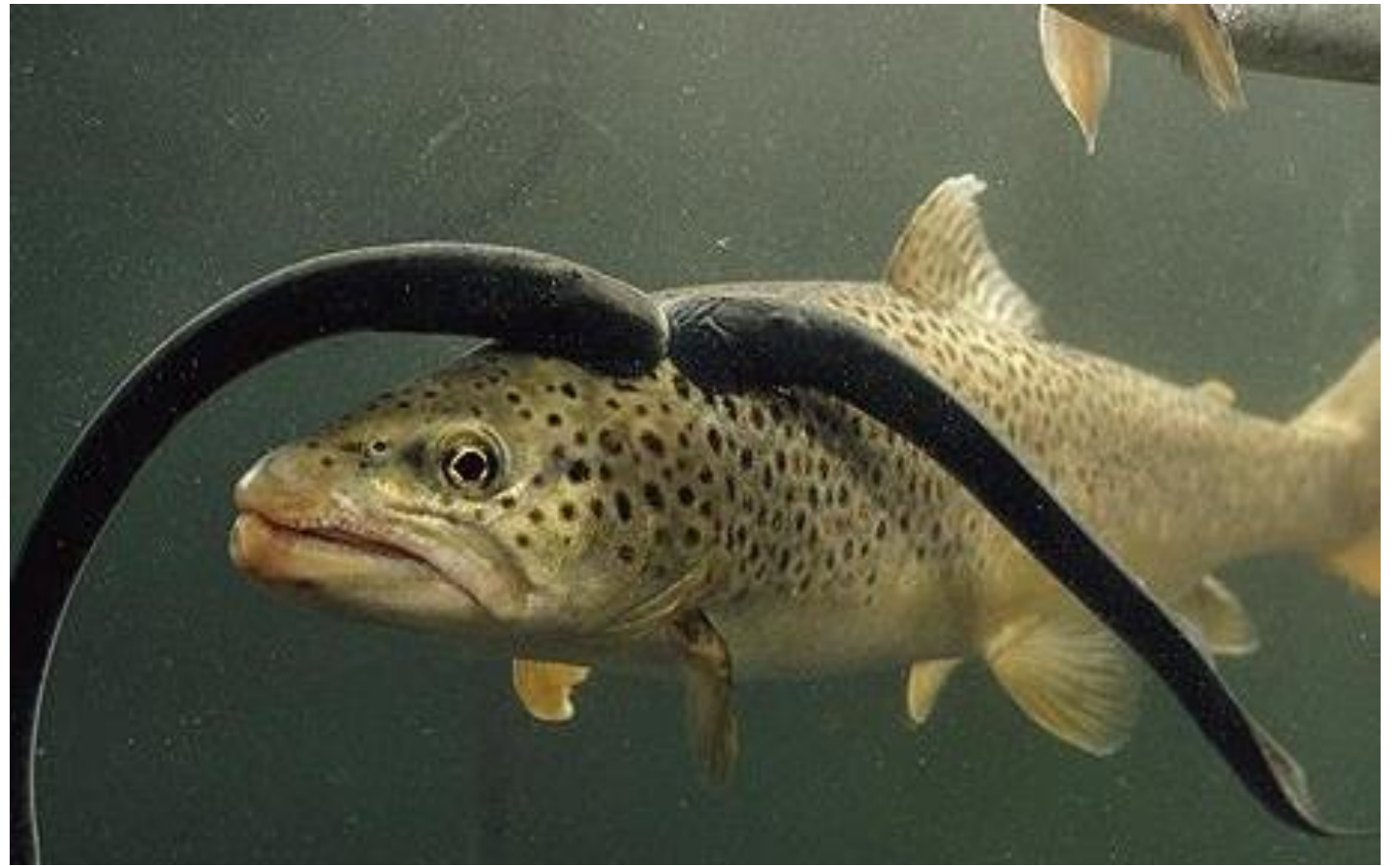
**Sea lamprey (*Petromyzon marinus*)**

## **Ecological Adaptations:**

- Adult lampreys inhabit a saltwater marine environment but breed in freshwaters
- Lampreys are parasitic species
- They ingest blood and muscle tissue
- On attaining full adult size, the lamprey ceases to feed
- Migrates upstream to a spawning ground, mates, and dies



**(a) Head of a lamprey (b) Sucking mouth of a lamprey with horny teeth**

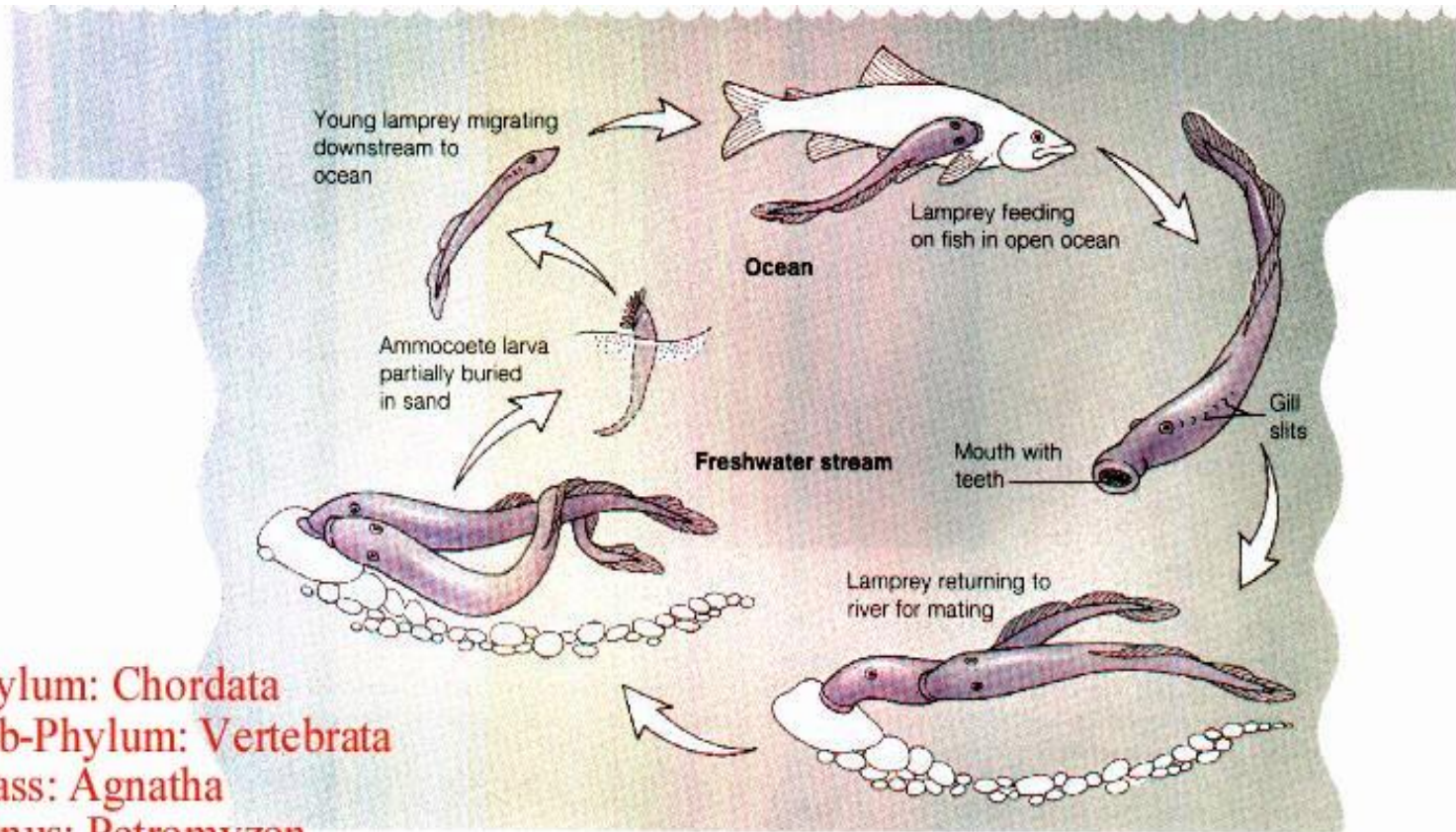


**A fish with a pair of sea lampreys attached**

- They reproduce in freshwater riverbeds
- Fertilization in lampreys is external
- They mate in a nestlike depression excavated by the male in the gravel bed of a stream
- Lampreys breed only once in their lifetime
- The egg hatches into an ammocoete larva (a blind, wormlike animal) that burrows in silt
- The larva's mouth is overhung by a hoodlike upper lip
- A continuous stream of water passes in through the mouth and out through the seven pairs of gills



- Microscopic plants, the food of the ammocoete, are filtered from this respiratory current by strands of mucus produced by the endostyle, which is a gland in the floor of the pharynx
- After external fertilization, the lamprey's cloacas remain open, allowing a fungus to enter their intestines, killing them
- The resulting hatchlings go through four years of larval development before becoming adults



Phylum: Chordata  
 Sub-Phylum: Vertebrata  
 Class: Agnatha  
 Genus: Petromyzon  
 Lampreys

Life Cycle of Lamprey

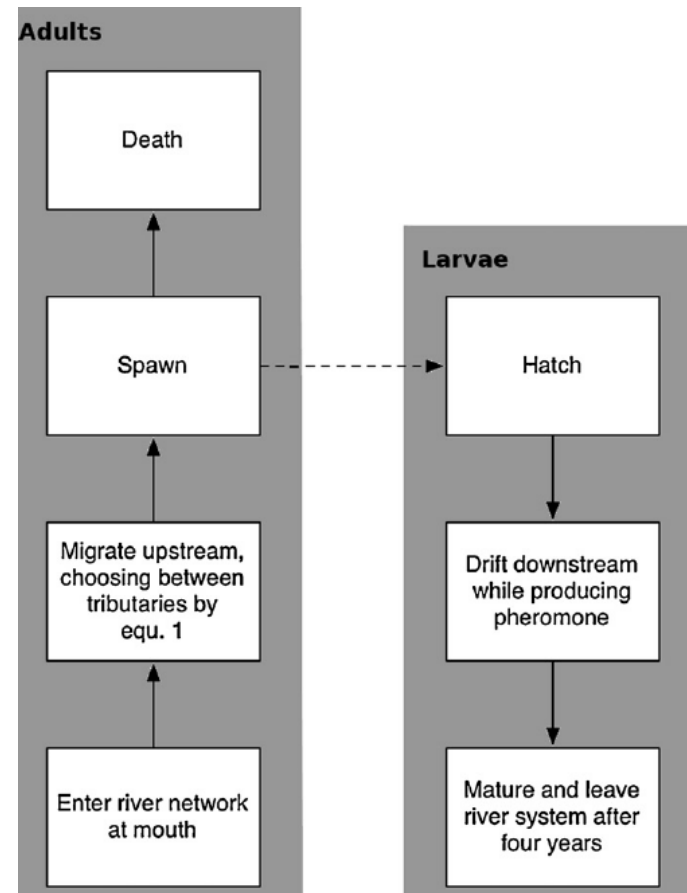


Diagram of the behavior and life cycle of sea lamprey adults (left) and larvae (right)

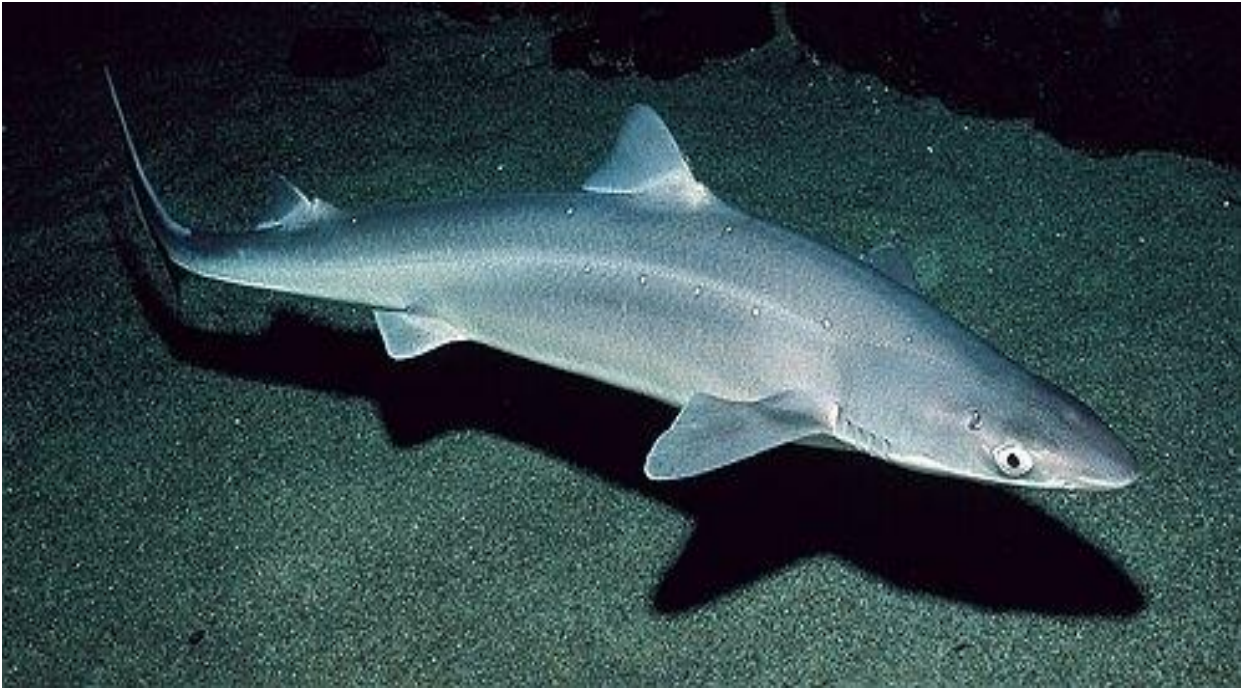
**SUPER CLASS GNATHOSTOMATA**  
**CLASS CHONDRICHTHYES**  
**(E.g. Sharks, Rays and Skates)**

- These are cartilaginous fishes with strong jaws lined with teeth
- Their bodies are dorsoventrally flattened, fusiform (spindle shaped)
- They possess heterocercal tail (diphycercal in chimaeras); paired fins; no swim bladder or lungs
- The pelvic fins in males are often modified to form claspers
- They also have gill arches which are internal to the gills
- They have reduced notochord, lateral-line system
- They have paired nostrils, while internal nares are absent
- Their sexes are separate while fertilization is internal and direct development

# **A representative Chondrichthyes – Dogfish or Dogfish Shark**

## **External Features of the Dogfish or Dogfish Shark**

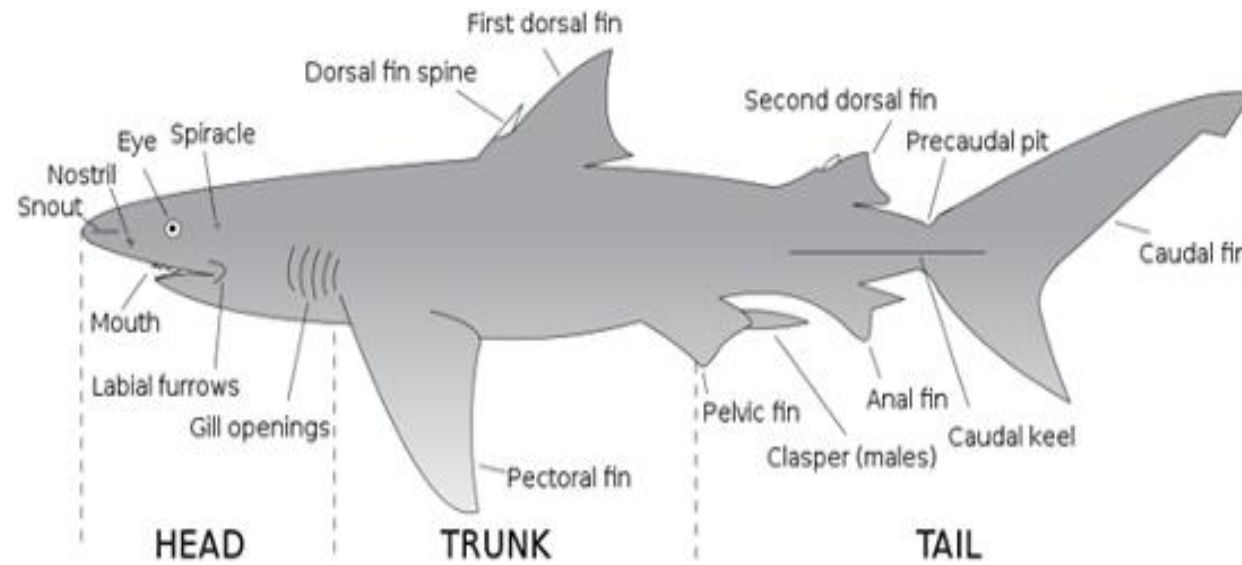
- The head is bluntly pointed, and the trunk is spindle shaped
- They are largest near the pectoral fin, and tapering behind
- There are two separate median dorsal fins
- A median caudal fin, and two pairs of lateral fins, pectoral and pelvic
- The tail is heterocercal
- The eyes are lateral and without lids
- There are five oval gill slits open anteriorly to each pectoral fin
- There is a gill-like cleft, or spiracle, which opens behind each eye
- The caudal fin is bilobed, with the upper part usually narrower than the ventral lobe



**A dogfish**



**Dogfish**



**External features of a dogfish**

# Ecological Adaptations

- The dogfish can be found in many saltwater environments around the world
- Capable of engaging in long migrations influenced partly by the availability of food and partly by water temperatures
- When not eating or swimming, it can be found resting on the sea floor
- They can be found at extreme depths
- They often live in swarms consisting of thousands of animals
- These swarms are formed in order to hunt together, but also as protection against enemies
- Females and males usually live in separate swarms

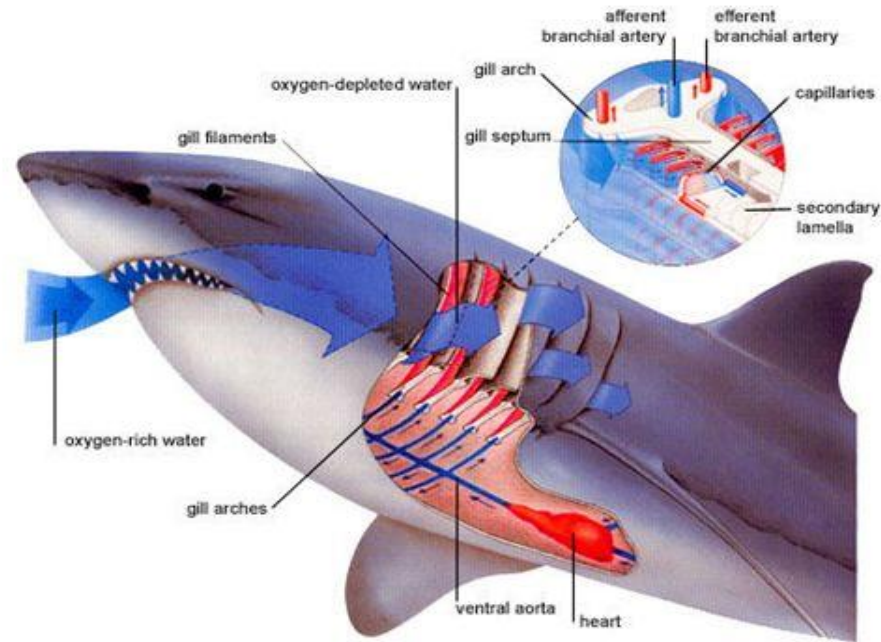
- Their dorsal side is gray, and they have a white ventral side
- They possess a lateral line
- Their anterior dorsal fins are larger than the posterior ones
- The pectoral fins are used to keep the fish from sinking
- The rostrum, a pointed snout, helps the fish overcome water resistance
- The nostrils are on the underside of the rostrum, and its mouth is located under the nostrils
- Paired fins act as stabilizers and rudders, while the streamlined body decreases friction



- The gill slits at the sides of their head is the site of gas exchange
- By opening and closing the mouth, the dogfish draws in water
- The water is forced over the gill filaments after passing through the mouth and pharynx
- Gas exchange occurs and the deoxygenated water leaves through the gill slits and spiracles
- The gills are made of many parallel feathery, threadlike filaments containing capillaries
- Blood from the ventral aorta passes through these ventral capillaries

# Respiration

- Most sharks have to keep moving to move water over their gills
- Water enters the gill chambers through the mouth or spiracles and exits through the gill slits.
- Blood in the gill filaments absorbs oxygen from the incoming water.

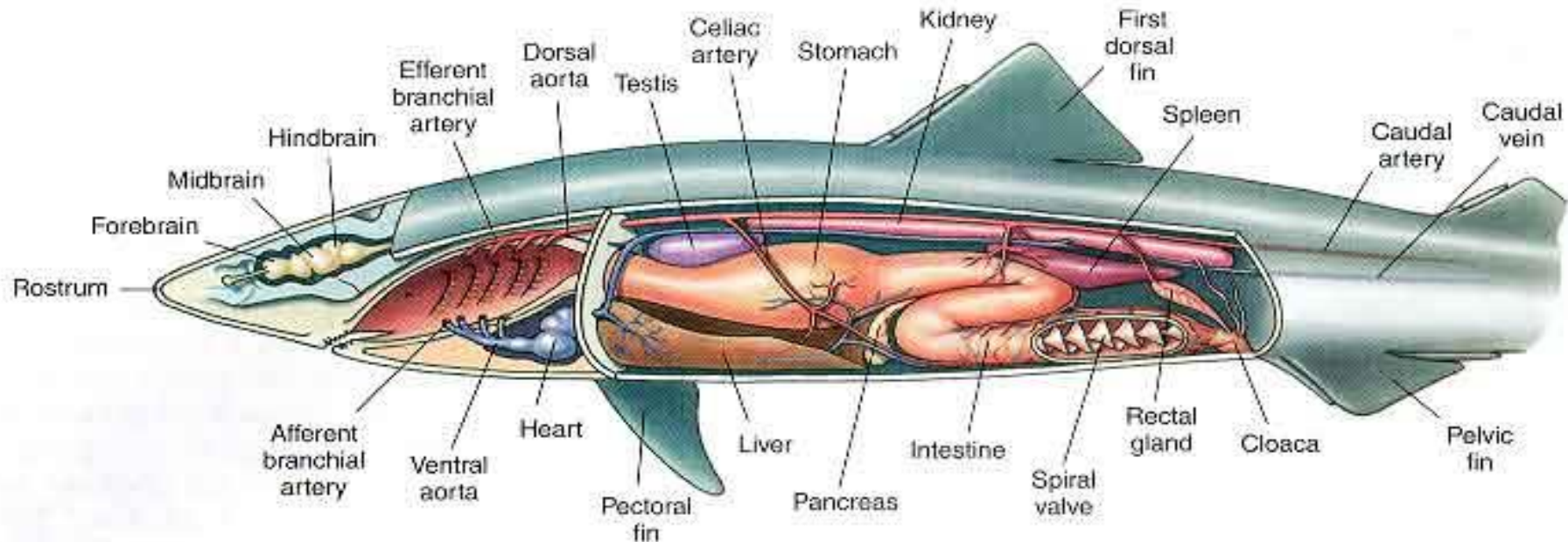


- As the tail is moved from side to side in swimming
- They lack a swim bladder
- The dogfish is an opportunistic feeder eating whatever prey is abundant
- In general their diet is comprised of small fishes such as capelin, cod, herring etc.
- They also eat invertebrates such as krill, crabs, polychaete worms, jellyfish, ctenophores, amphipods, squid and octopus; It also feed on small fishes

- Mouth is margined by transverse rows of sharply pointed teeth
- The teeth are embedded in flesh and not attached in jaws as in bony fishes
- The teeth serves to grasp prey such as small fishes, which are often swallowed entire
- The flat tongue adheres to the floor of the mouth
- The short Oesophagus leads to the J shaped stomach
- The Intestine follows and connects directly to the cloaca and anus
- The large liver is of two long lobes, attached at the anterior end of the body cavity
- The pancreas lies between the stomach and the intestine

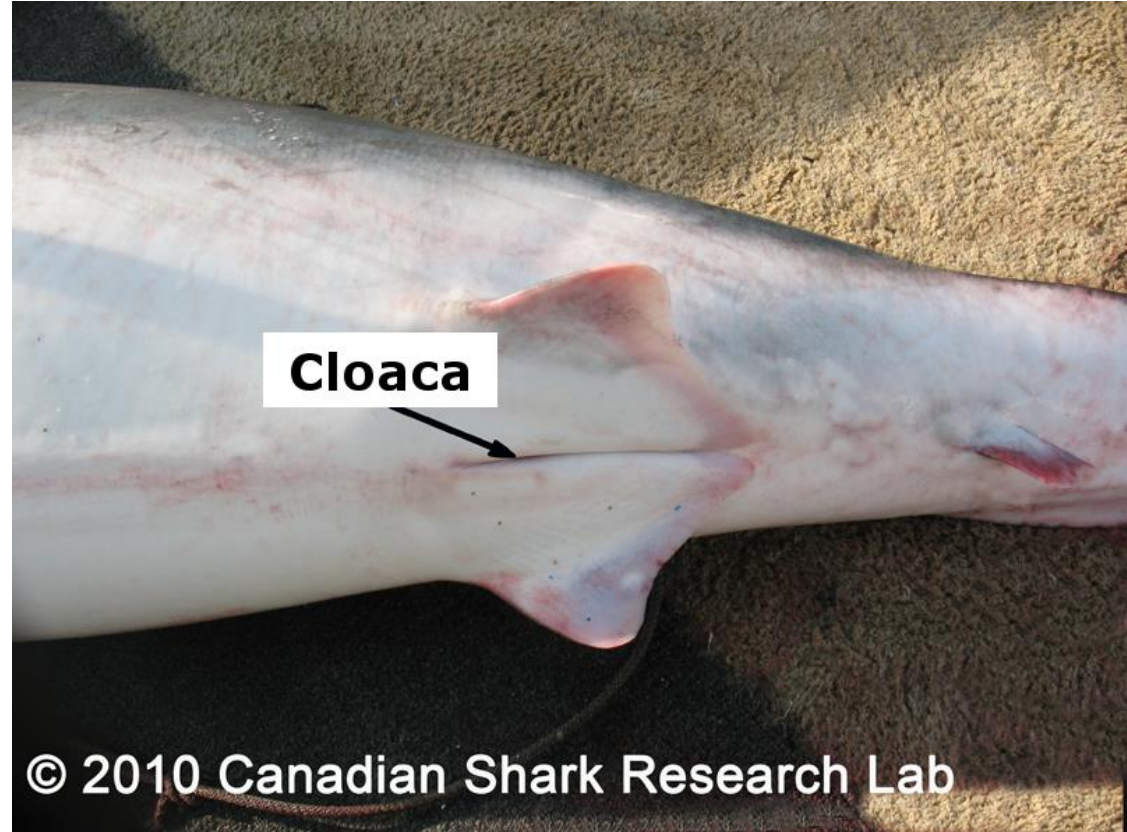
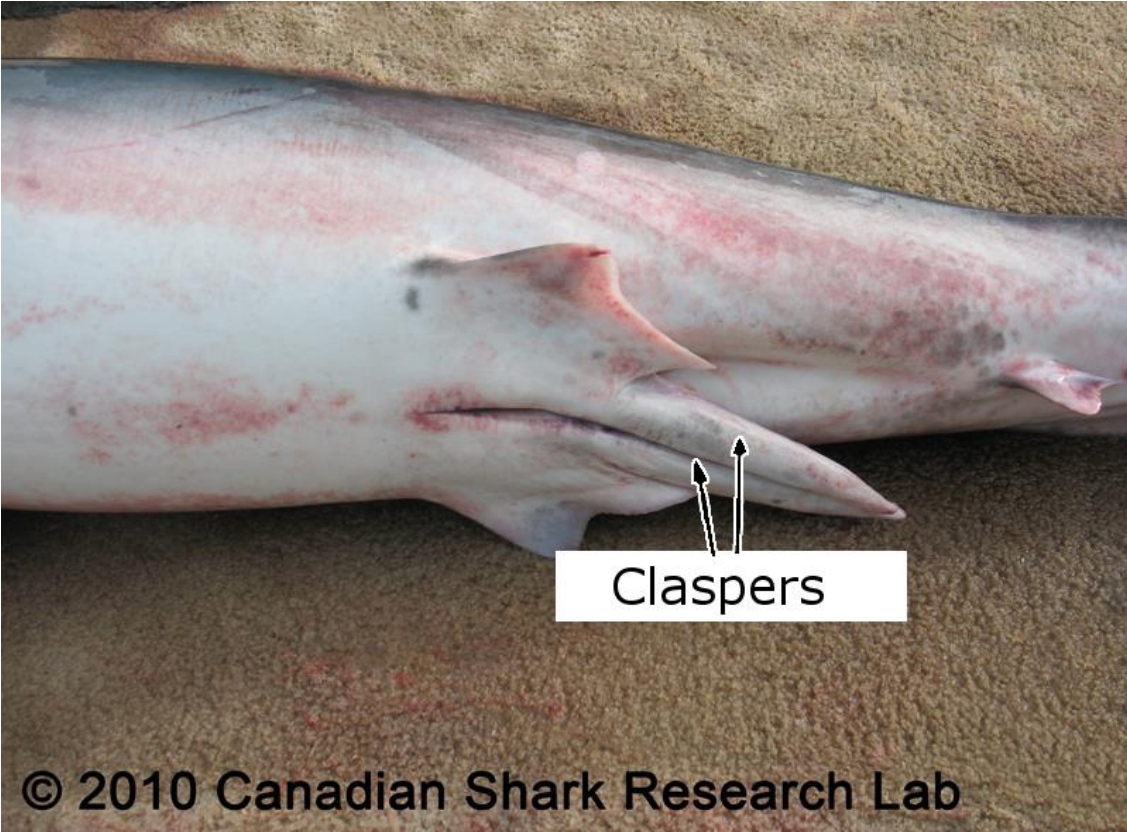


**Mouth of the Dogfish showing its teeth**



**Internal and External features of a dogfish**

- The sexes are separate
- In the male, sperm develop in two long testes anterior in the body cavity
- Males are identified by a pair of pelvic fins modified as sperm-transfer organs, or "claspers"
- At mating, the claspers are placed closed together, and the two organs are inserted into the cloaca
- Dogfish usually have a life span of 25-100 years
- Female dogfish are ovoviviparous
- This method provides the young with protection from predators during their earliest developmental stages



- This method provides the young with protection from predators during their earliest developmental stages
- They produce large, yolky eggs called ova
- The number of young born in a litter is dependent on the size of the female
- Most litters are between 2 and 16 individuals
- Sexual maturity in males is reached at about 11 years of age
- In the female sexual maturity is reached at between 18 and 21 years of age





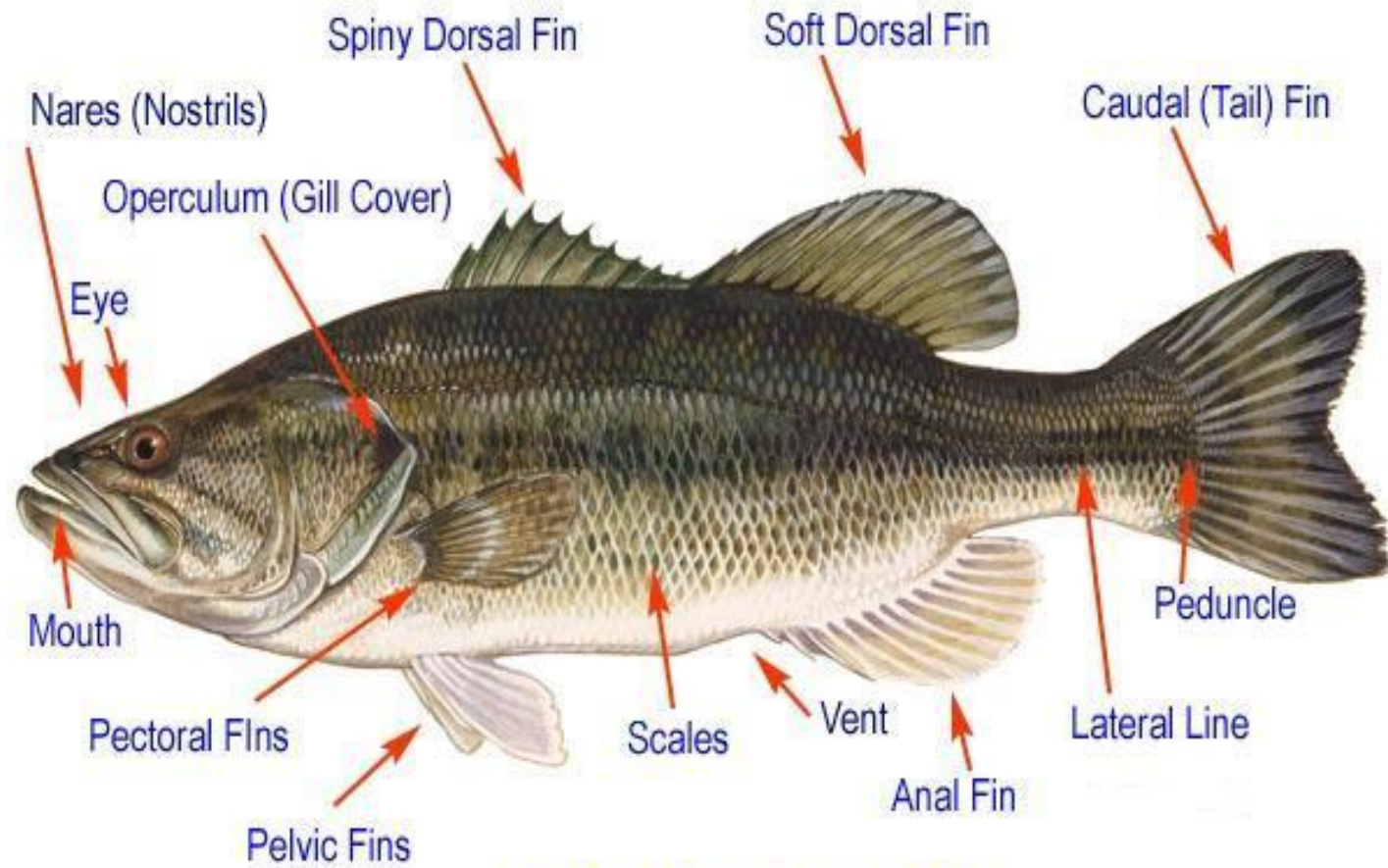
**Life Cycle of Dogfish Shark**

# **CLASS OSTEICHTHYES (BONY FISHES)**

**E.g. Nile Perch, Tilapia, Mackerel etc.**

- The body is spindle shaped, higher than wide, and of oval cross section
- The head extends from the tip of the snout to the hind edge of the operculum
- The trunk from point to the anus, and the remainder is the tail
- The mouth is terminal with distinct jaws that bear teeth
- Their skeleton are partially or fully ossified, while there are scales on the body
- There is also the presence of a swim bladder, paired fins and gills for respiration
- Dorsally on the snout are double nostrils, the eyes are lateral without lids
- Behind each eye thin gill cover or operculum, with free edges below and posteriorly

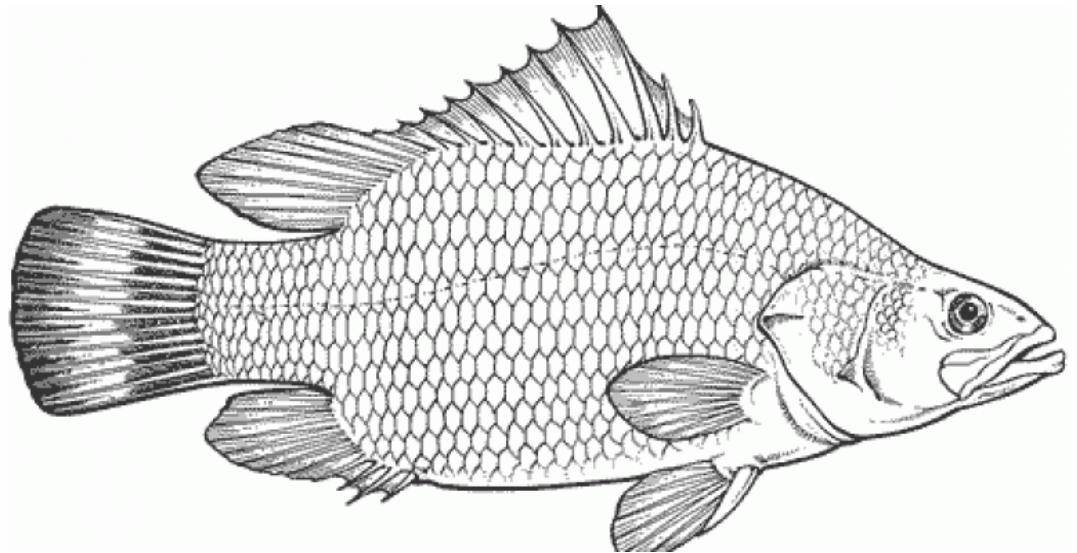
- Under each operculum are comb-like gills
- The anus and urogenital aperture precede the anal fin
- They possess two separate dorsal fins, a caudal fin, and an anal fin; all these are median.
- The lateral, or paired, fins are the pectoral fins and the ventral or pelvic fins
- The fins are membranous extensions of the body covering, supported by calcified fin rays
- The spines are stiff and unjointed
- The soft rays are flexible, with many joints, and are usually branched
- The fins aid in maintaining equilibrium, in steering, and in locomotion
- They are mostly oviparous , while some are however ovoviviparous or viviparous



## EXTERNAL ANATOMY

# A representative Osteichthyes (Bony Fishes – Nile Perch)

- **External features**
- Nile Perch (*Lates niloticus*) is a large-mouthed fish
- The Nile perch is greenish or brownish above and silvery below
- It grows to about 6 ft. and 140 kg
- It has an elongated body, a protruding lower jaw, a rounded tail, and two dorsal fins
- It has distinctive dark-black eyes, with a bright-yellow outer ring
- It is one of the largest freshwater fish
- it reaches a maximum length of more than 6 ft. weighing up to 200 kg



**Nile Perch**



**Nile Perch (*Lates niloticus*)**



***Lates niloticus* (Nile perch)**

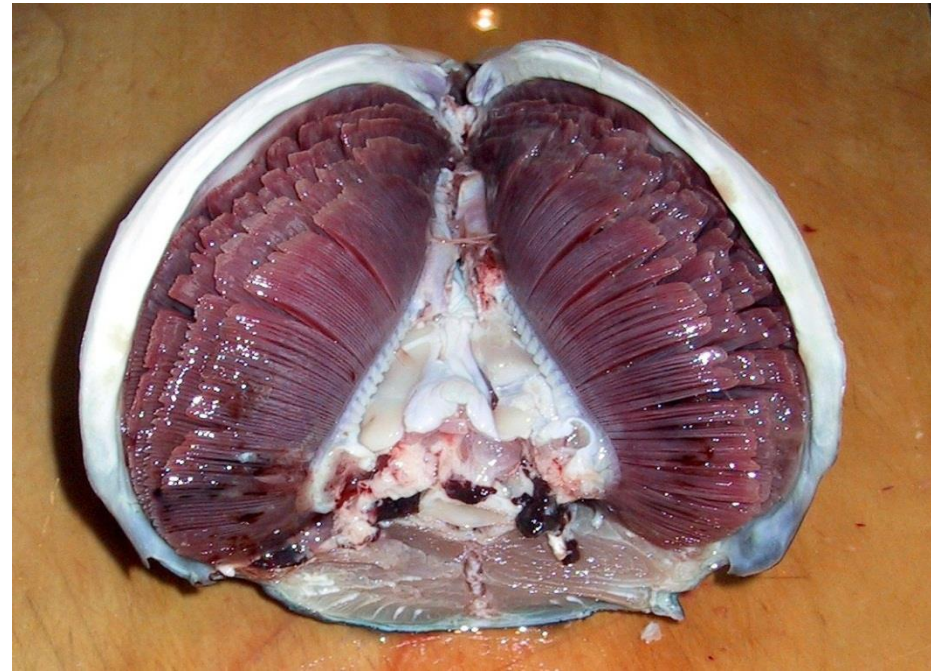
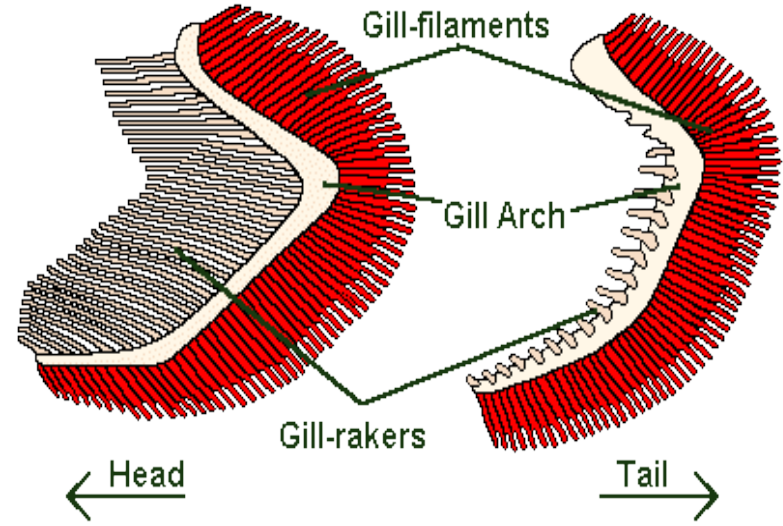
## • **Ecological Adaptations**

- The Nile perch is a species of freshwater fish in family Latidae of order Perciformes
- It is widespread throughout much of the Afrotropic ecozone
- Native to the Congo, Nile, Senegal, Niger, and Lake Chad, Volta, Lake Turkana etc.
- Not found in the Gambia
- This species is demersal and potamodromous
- Inhabits a wide variety of habitats, including rivers and lakes
- Prefers sandy bottoms but is also found in rocky to muddy bottoms
- Relatively intolerant of low-oxygen waters
- They are somewhat restricted from entering swamps
- Zones with vegetation in calm waters provide shelter to larvae and young
- Adults inhabit deep water, while juveniles are found in shallow to or near shore environments



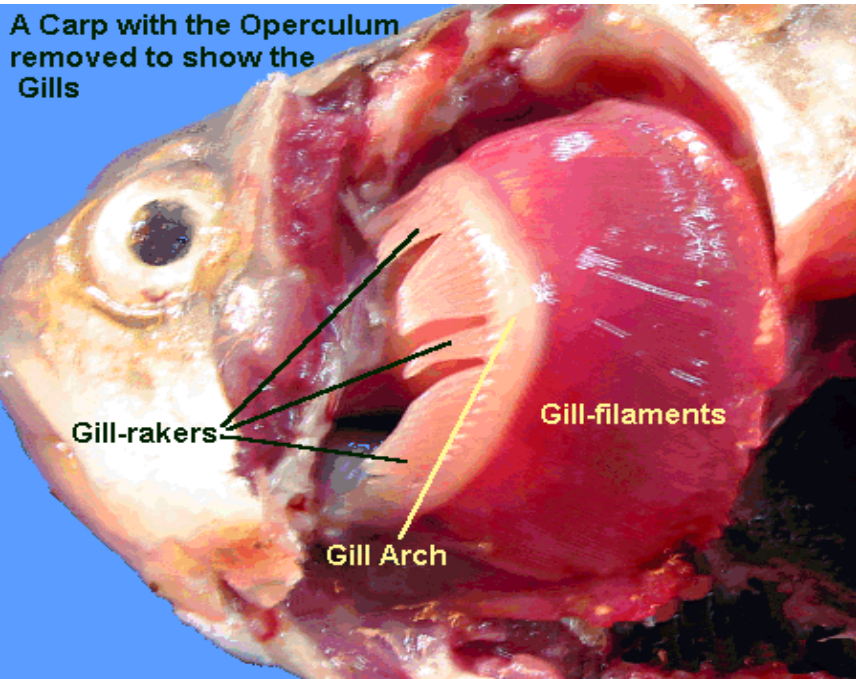
- The perch respire by means of gills (four in a common gill chamber on each side of the pharynx)
- A gill consists of a double row of slender gill filaments
- Every filament bears many minute transverse plates covered with thin epithelium and containing capillaries
- Each gill is supported on a cartilaginous gill arch, and its inner borders have expanded gill rakers
- The gill rakes protect against hard particles and keep food from passing out of the gill slits
- A swim bladder (or air bladder) occupies the dorsal portion of the body cavity
- The bladder is filled with gases (O, N, CO<sub>2</sub>) and acts as a hydrostatic organ to adjust the specific gravity of the fish
- By secreting or absorption of gases through the blood vessels in the wall, a fish makes this adjustment its depth

## Diagrammatic Representation of Two Forms of Fish Gills

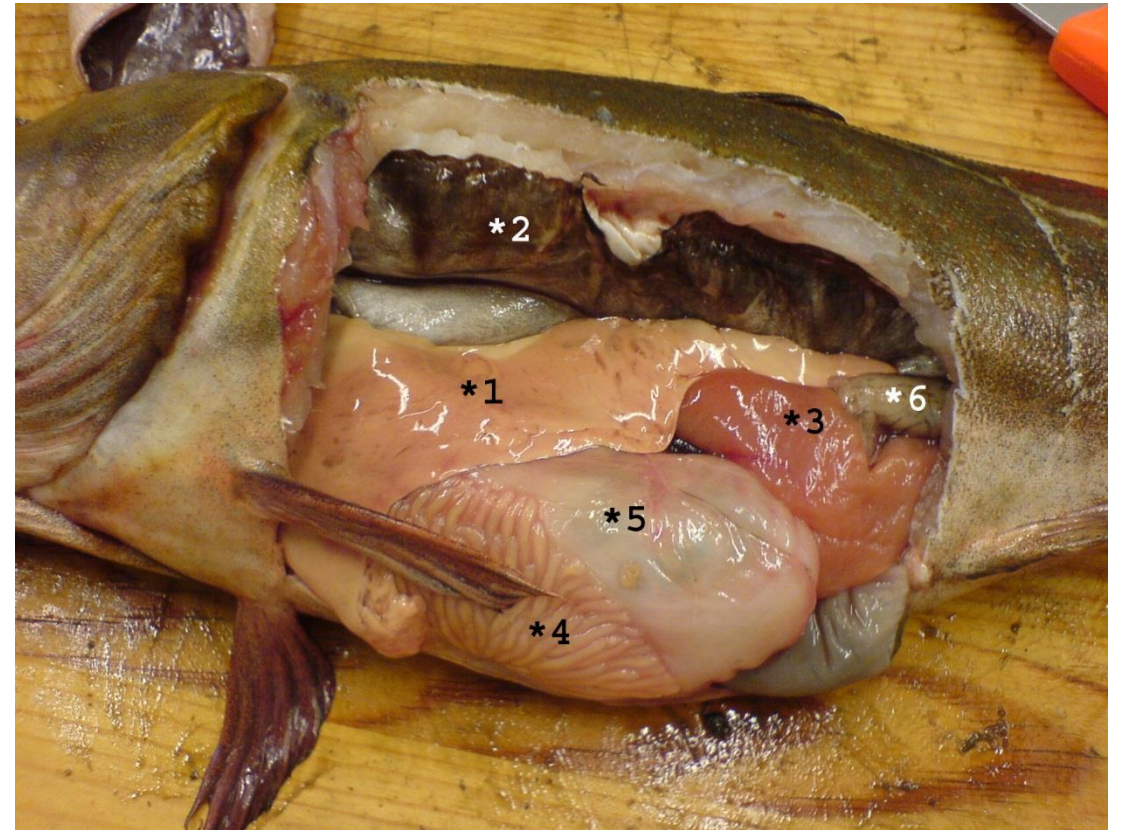
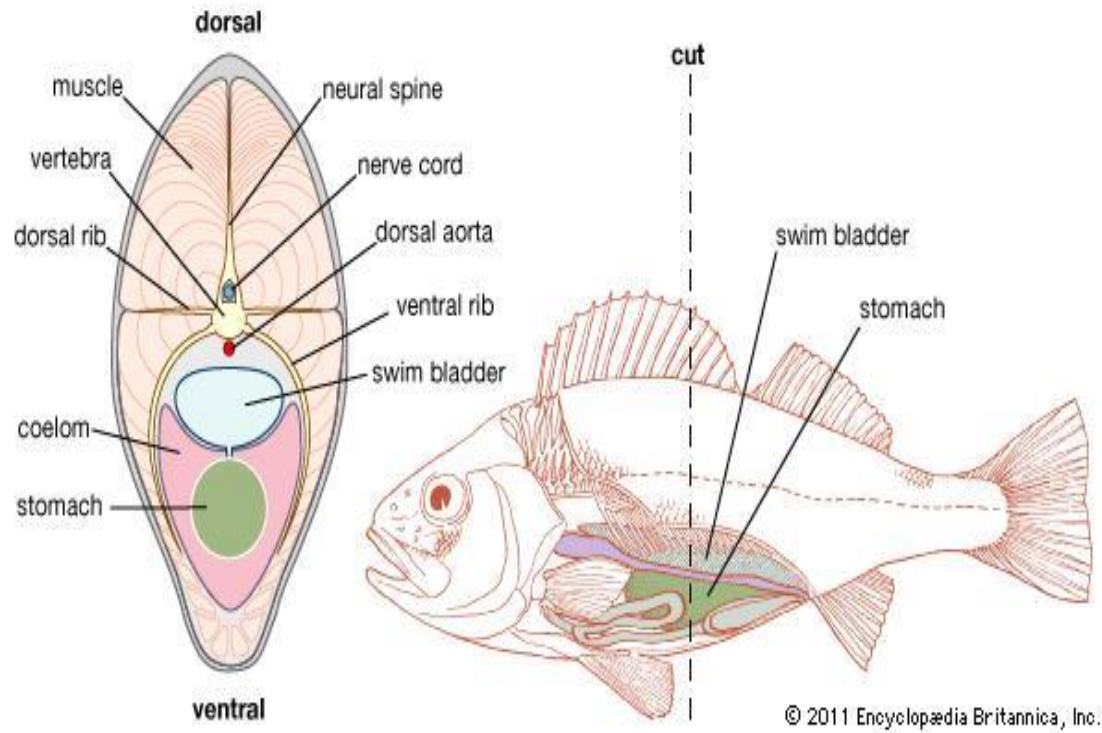


**Gill Filaments**

A Carp with the Operculum removed to show the Gills



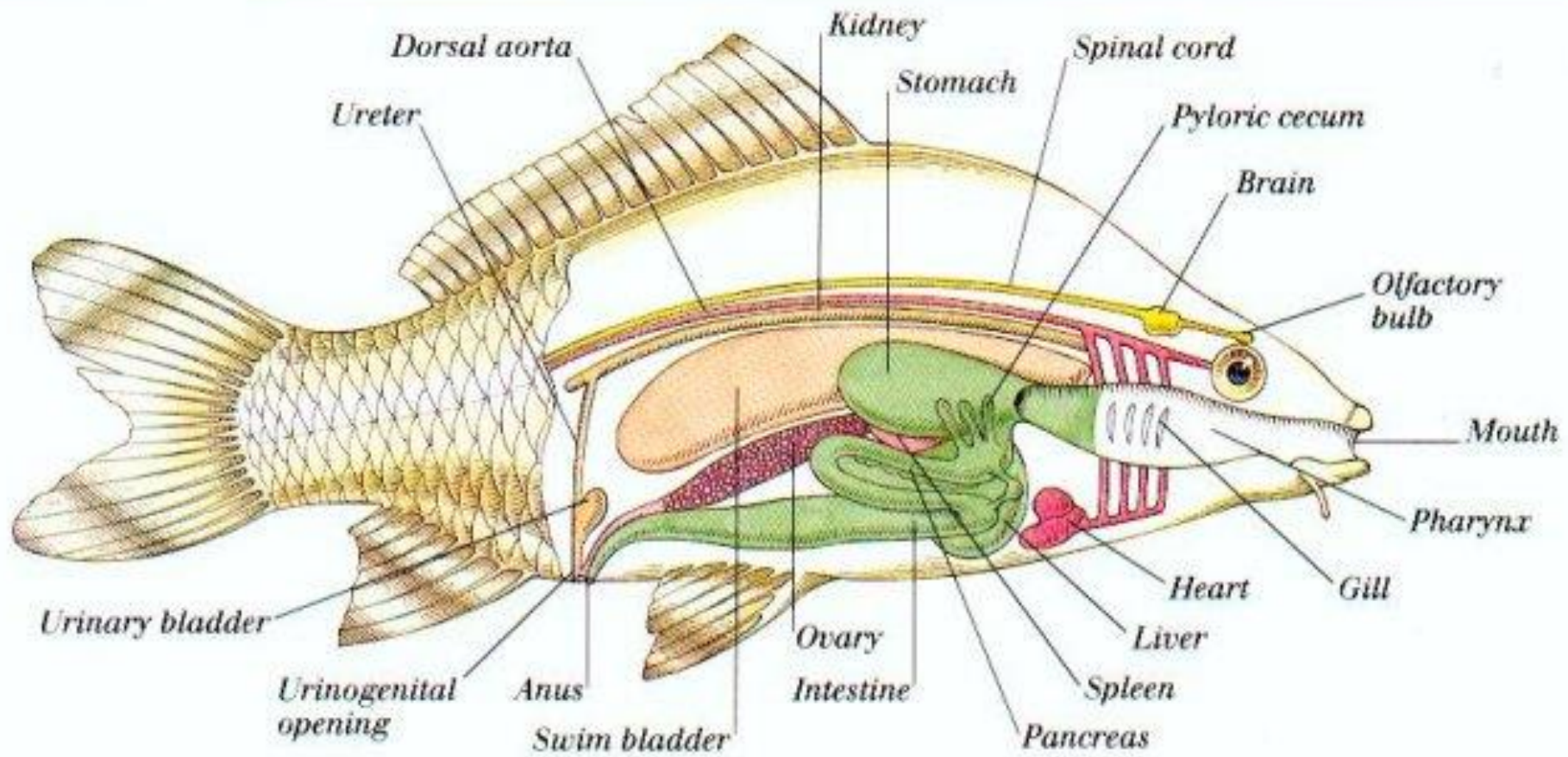
**Teleost fish in cross section**



**Section of a bony fish showing the swim bladder (\*2)**

- The jaws have many conical teeth to grasp food
- The pharyngeal and gill raker teeth help in holding and crushing it
- Mucous glands are numerous, but there are no salivary glands
- The small tongue is attached to the floor of the mouth cavity and may aid in respiratory movements
- The pharynx has no gills on the sides and leads to a short oesophagus followed by the recurved stomach
- A pyloric valve separates the latter from the intestine
- There are three tubular pyloric caeca, secretive or absorptive in function attached to the intestine

- The pancreas is diffuse
- There is a large liver anteriorly in the body cavity, a gall bladder and a bile duct to the intestine
- A voracious predator which predominantly feeds on fish (including its own species), crustaceans, and insects,
- while the juveniles feed on larger crustaceans and insects (e.g., anisopteran, zygopteran and chironomid),
- and are also planktivorous.
- They however use schooling as a mechanism to protect themselves from other predators.



**A generalized bony fish anatomy**

- In the males the two testes enlarge greatly in the breeding season
- At mating the “milt” or sperm passes in a ductus deferens from each to emerge from the urogenital aperture
- In a female the eggs pass from the two united ovaries through the oviduct
- It reproduces around the year, with peaks in the rainy season
- It probably spawns in shallow sheltered areas
- Juveniles occur over wide depth range but the highest concentration of small juveniles are found in littoral and sub-littoral zones
- Sexual dimorphism: females larger than males

- They have a lateral-line system, while the nervous system comprises of a brain with small olfactory lobes,
- large cerebellum, 10 pairs of cranial nerves and 3 semicircular canals
- There are dorsal olfactory sacs on the snout containing cells sensitive to substances dissolved in water
- Each sac has an anterior and a posterior opening
- Water enters the front nostril and flows out the rear, passing over folds of sensory epithelium on the floor of each sac as it does so
- Taste buds are present in and around the mouth
- Each internal ear contains three semicircular canals and otoliths serving the sense of equilibrium
- The lateral line system includes the lateral line and various extensions on the head



# REPRESENTATIVE OF AMPHIBIANS

The word Bufo is a latin word for toad. Toad is any of a number of species of amphibians in the order Anura that are characterized by dry, leathery skin, short legs and parotoid glands.

The Nigerian toad is Bufo *perreti*

# Problems amphibians encountered when invading the terrestrial environment:

## 1).The problem of utilizing atmospheric oxygen.

- They developed lungs to enable them secure oxygen from the air
- Their fishlike ancestors the crossopterygians had already begun the preparation by acquiring well developed and frequently used lungs.

# Problems amphibians encountered when invading the terrestrial environment:

## 2). The problem of gravity:

- Gravity is an active force on land
- They had to develop strong backbone and limbs to solve the problem of gravity
- Modifications to the backbone /vertebral column
- The number of vertebrae in the backbone reduced to make it stronger
- The vertebrae was of the procoelous type
- Procoelous cupped in front to allow preceding vertebrae to sit and fit in tightly
- The vertebral column was supported at two points by structures called girdles. The pectoral girdle in front and pelvic girdle in the back
- The girdles were in turn supported by limbs and feet.

# Problems amphibians encountered when invading the terrestrial environment:

## 3). The problem of locomotion:

- Aquatic organisms were assisted by the media and locomotion was effected primarily by body, tail and paired fins.
- On land however, a new method of locomotion in which the limbs and feet became of prime importance was developed.
- Tail was reduced to a balancing organ with the paired appendages becoming chief locomotory organs
- The limbs became very functional in
  - a). Propelling animal across land
  - b). Holding up body to counteract force of gravity
- The limb type was called the PENTADACTYL LIMB

# Problems amphibians encountered when invading the terrestrial environment:

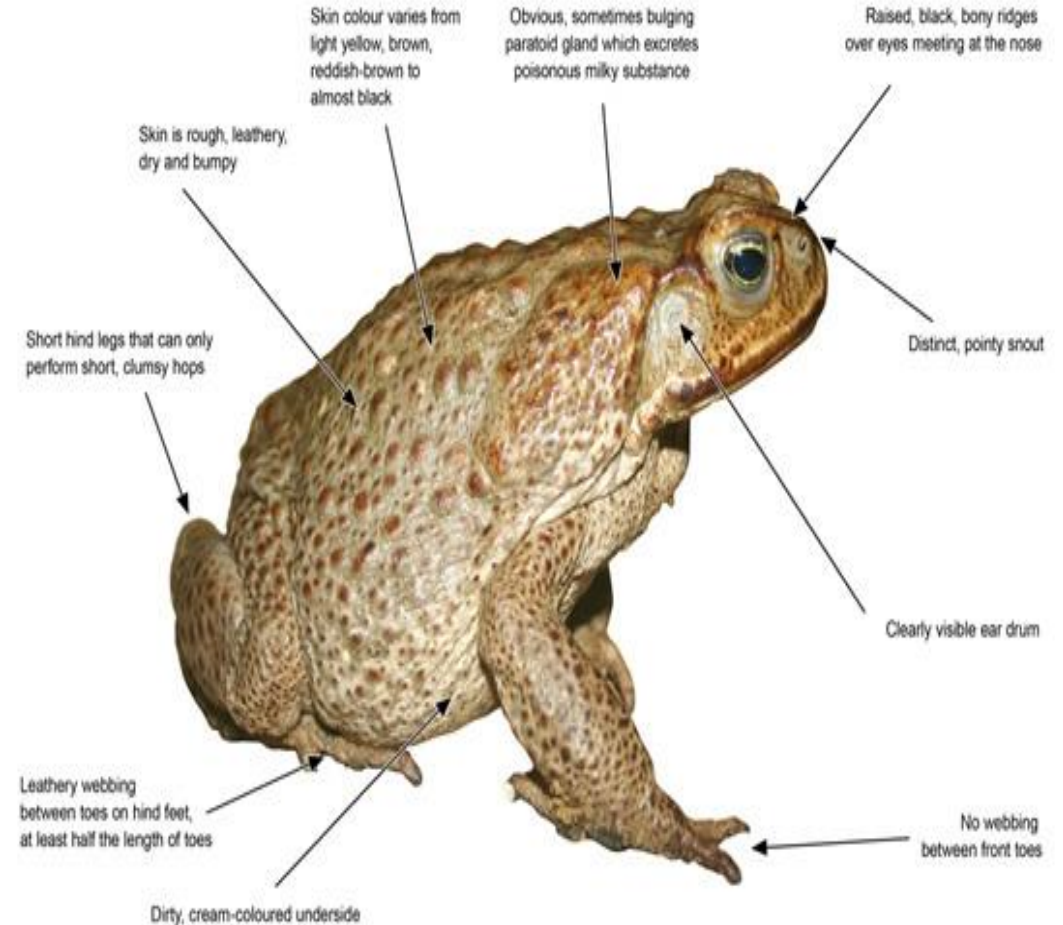
- **4). Problem of Desiccation:**
- They were faced with the necessity of retaining their body fluids when they were no longer immersed in water.
- The earliest amphibians ICHTHYOSTEGIDS solved this problem by never venturing far away from water and returning frequently to streams and lakes as some modern forms also do.
- They developed body coverings that would protect them against drying effects of air.
- **Note:** The amphibians made several great advances in their adaptation to life on land but they never solved the problem of reproducing away from water.
- Throughout their life history they return to water or in specialized forms, they must keep their egg in moist places.

# CLASSIFICATION

- **Kingdom : Animalia**
- **Phylum : Chordata**
- **Class : Amphibia**
- **Order : Anura**
- **Family : Bufonidae**
- **Genus : Bufo**
- **Species : perreti**

# EXTERNAL STRUCTURE OF *BUFO PERRETI*

- APPEARANCE: They are generally warty in appearance.
- WARTY means to have warts.
- Wart is a hard rough lump growing on the skin and caused by certain viruses.
- COLOR: Most species in the family are dull in appearance.
- SIZE: Common toad can reach about 15cm (6 inches) in length.

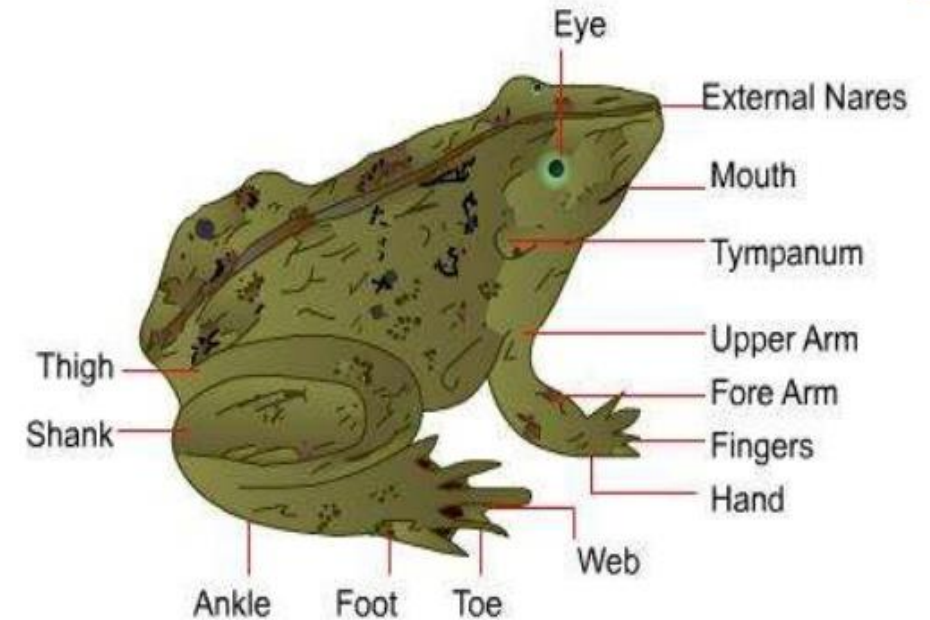


## EXTERNAL STRUCTURE OF FROG

**BODY:** The toad has a plump body. The body is twice as long as it is wide. Females are normally stouter than males. The body is dorsoventrally flattened.

**SKIN:** The entire body is covered by a dry warty, loose fitting skin. The skin is greyish brown in color with dark irregular patches on back and limb.

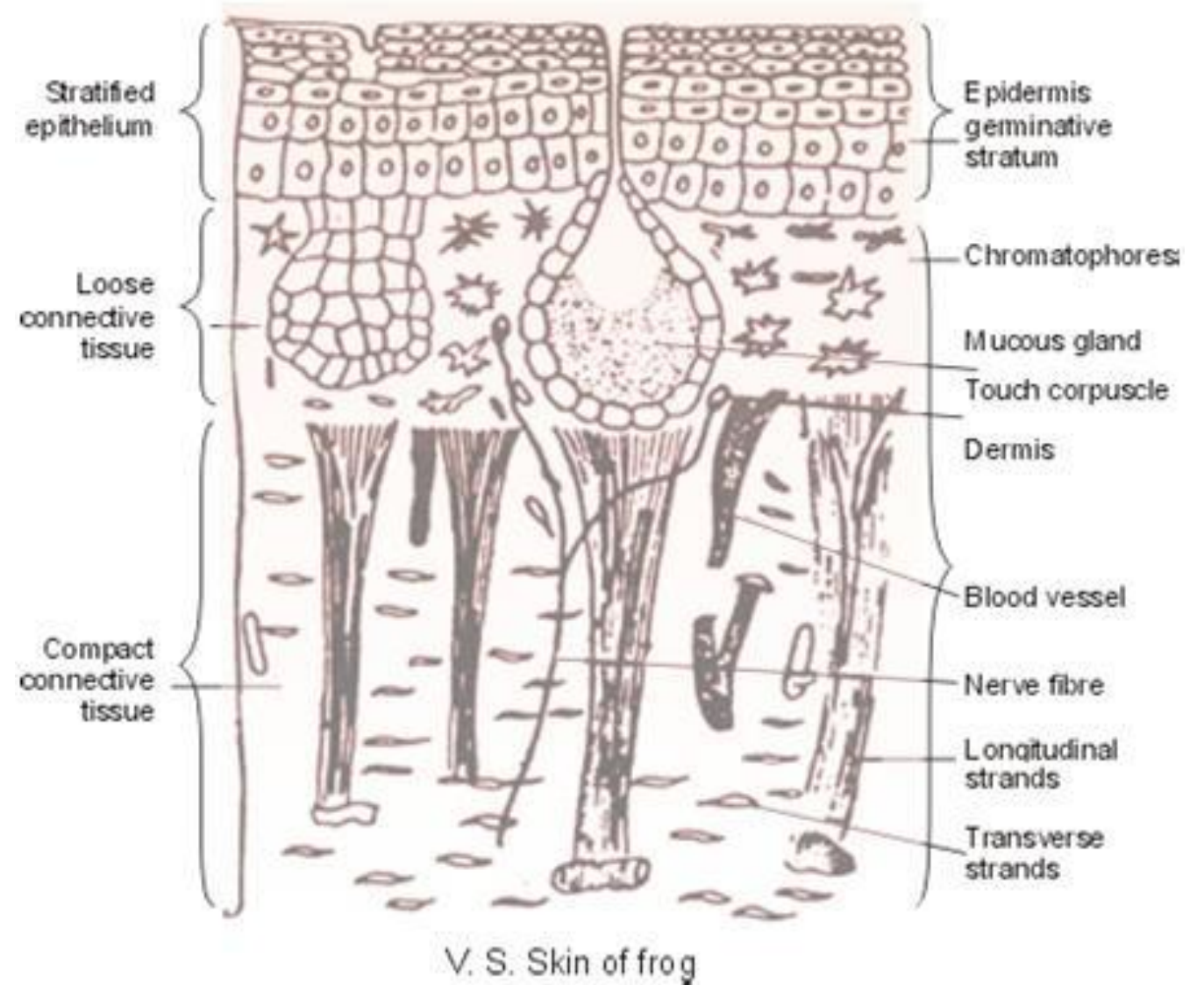
## External Feature of the Frog





# Functions of the skin:

- Prevent evaporation of water from body.
- Protect the toad.
- The color of skin can change to blend with environment.
- When toad is in open it becomes light brown.
- When toad is in dark skin becomes dark brown.



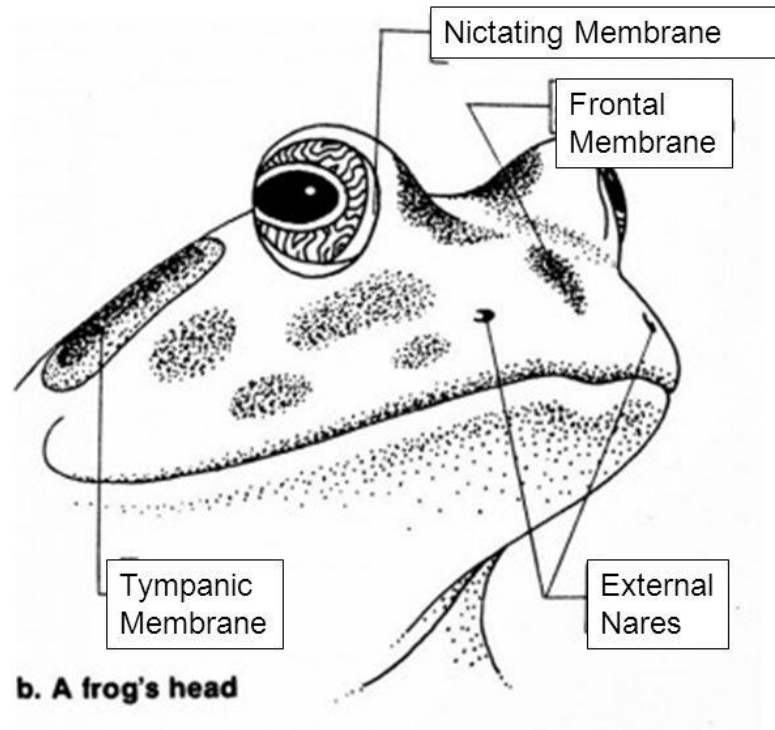
## BODY DIVISION:

- The body is divided into a head joined directly to the trunk.
- There is no neck and tail.

## ECOLOGICAL SIGNIFICANCE OF NO NECK AND TAIL:

- The absence of a neck is an advantage as water can flow more easily past the toad's body when it is swimming.
- The tail normally intervenes in movement and the absence helps the toad on land.
- Tail is however usually found in the younger stages, the tadpole.

# External Anatomy of the Frog's Head



The Head is flattened and broad.

The head has two nostrils (Nares) on a terminal snout

## **NARES:**

**The nares are made up of 3 parts:**

**The external nares, that opens out at the tip of the snout.**

**The nasal passage connects the external to the internal nares.**

**The internal nares are smaller openings in the front of the mouth cavity.**

## **Ecological adaptations for nares:**

**Both external nares can be closed by special valves so as to prevent water from getting in.**

**The external nares are situated in a position which allows the toad to breathe in air while it is swimming at water surface.**

## **MOUTH:**

**The head of the toad also bears a mouth.**

**The mouth is a wide opening.**

**It leads into a large mouth cavity called the buccal cavity.**

## **TONGUE:**

**The mouth bears a tongue.**

**The tongue is fleshy and bifid at the tip.**

**The tongue is attached at the front of the floor of the mouth.**

## **ECOLOGICAL ADAPTATION:**

**The free end of the tongue that lies close to the throat can be flicked out suddenly to catch insects and other small animals.**

## **TEETH:**

**The toads have no teeth or breast bone.**

## **EYES:**

**The toad has two large spherical eyes.**

**The eyes are bulbous and protruding.**

**The iris is yellow or copper colored.**

**Each eye has a fleshy opaque upper eyelid as well as lower eyelid.**

**The lower eyelid is capable of slight movement.**

**The upper eyelid is immobile.**

**A transparent membrane called the nictitating membrane is attached under the lower eyelid.**

**The nictitating membrane is drawn upwards over the surface of the eye.**

## **ECOLOGICAL ADAPTATIONS OF THE EYES:**

**The eyes are positioned such that they can lie above the water surface, while the rest of the toad's body is submerged.**

**The nictitating membrane is drawn upwards over the surface of the eye to clean and moisten it when toad is on land.**

**The membrane also protects the eye of toad when it is on land.**

**The eyes which appear as two prominent bulges on the roof of mouth cavity can be partially withdrawn into the mouth cavity by certain muscles.**

**This often happen when toad swallows its food.**

## **TYMPANUM/TYMPANIC MEMBRANE/EAR DRUM:**

**At each side of the head behind the eye is the eardrum.**

**It is a dark round patch of stretched skin.**

**The toad hears when its eardrum vibrates (It picks up sound by vibration)**

**The amphibian ear consists of a middle ear as well as an inner ear but no outer ear (Outer ear present in mammals).**



# **PAROTOID GLANDS/POISON GLANDS:**

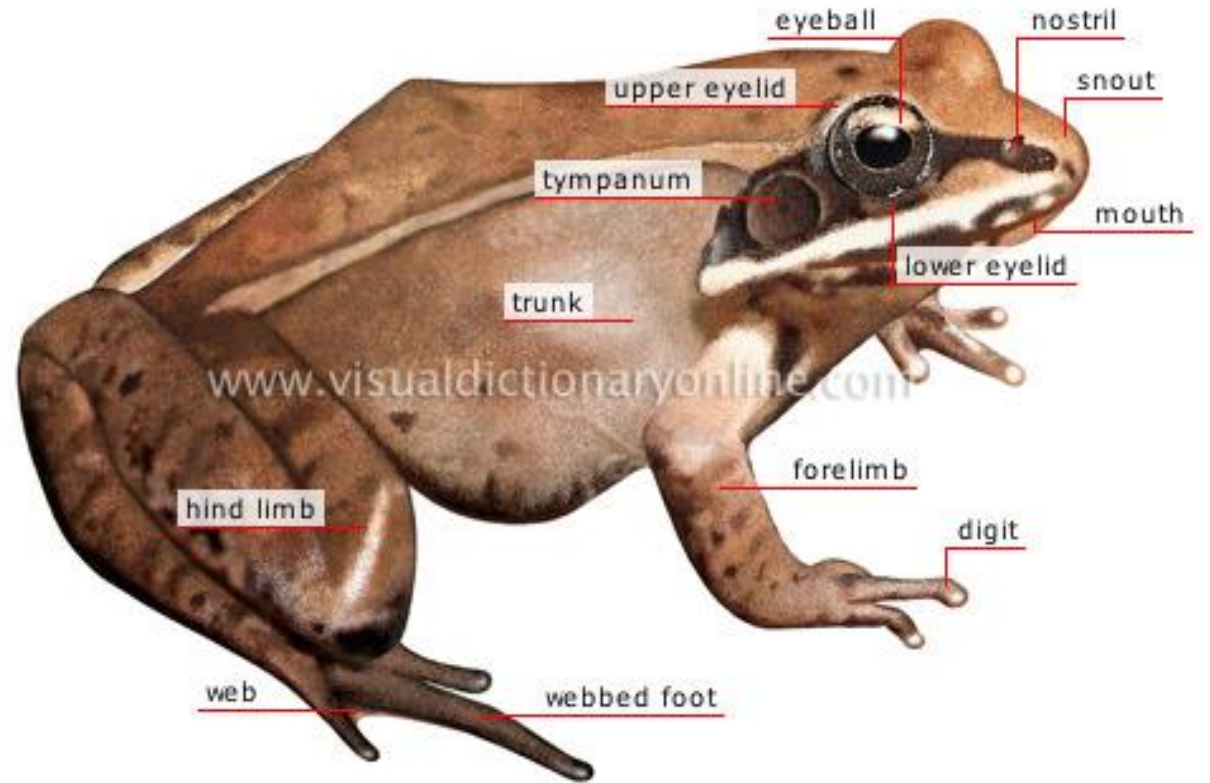
- **It is an oval bulge behind each eardrum.**
- **It is a large external gland running down from back of neck behind the eye to below shoulder in some species. (Glandular patch of skin).**
- **It secretes a foul tasting substance when the animal is attacked by predation.**
- **The toad excretes it when stressed and it is released as a defense mechanism against predator.**
- **The secretion is an alkaloid neurotoxin (Poison) called bufotoxin.**
- **It causes mild to severe irritation when in contact with human skin.**

# TRUNK

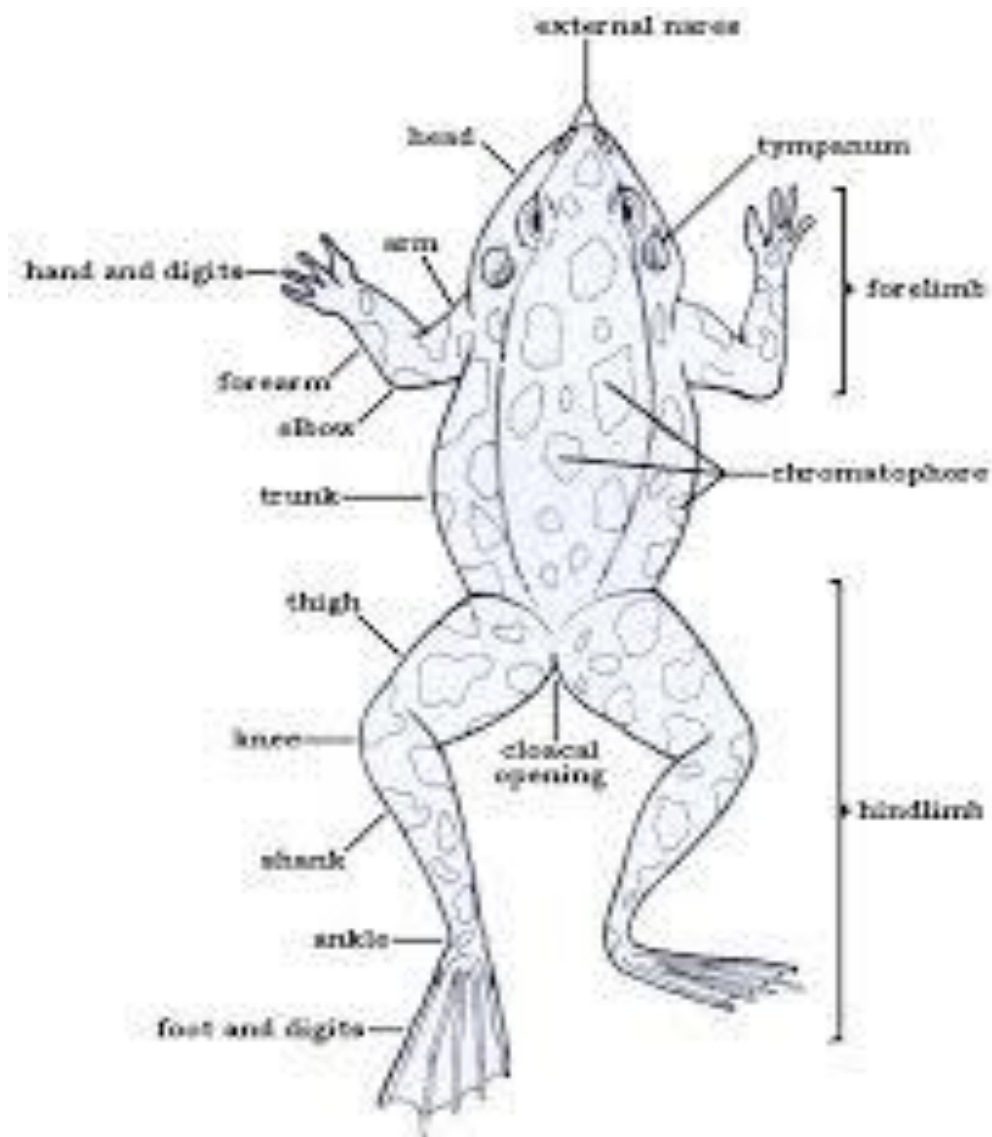
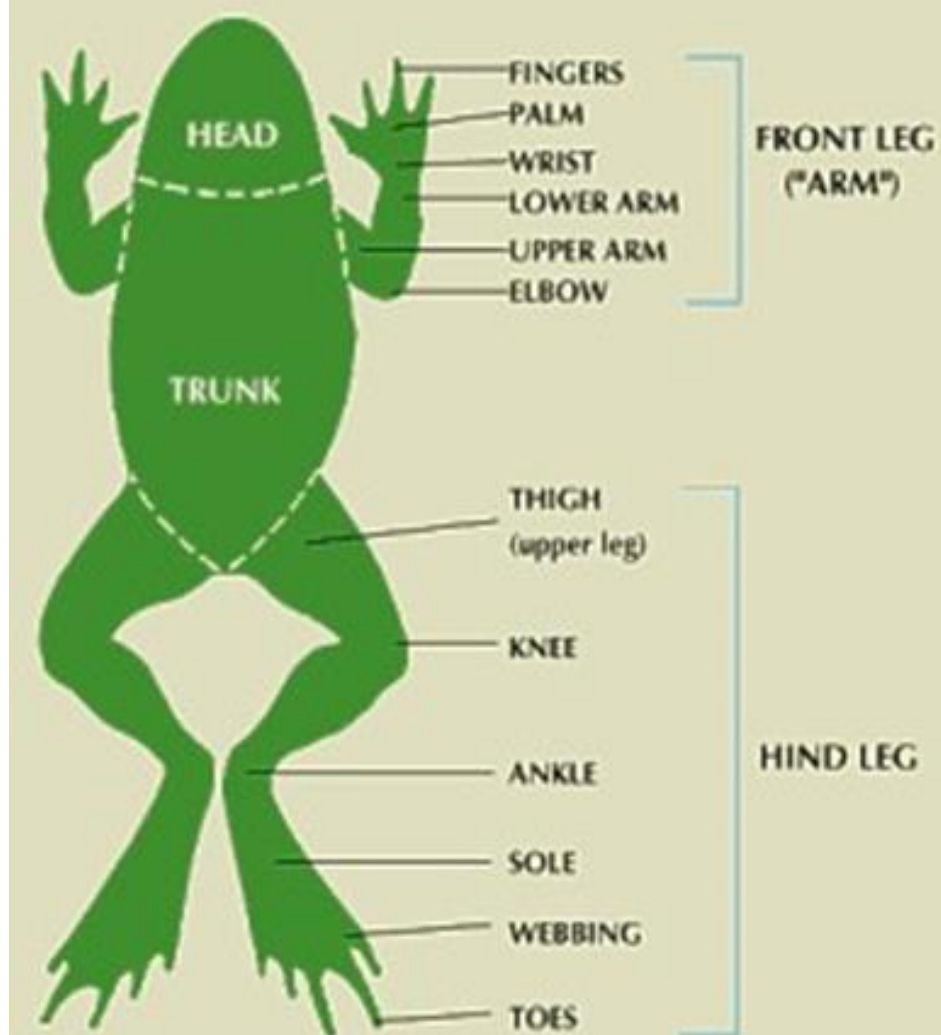
The trunk bears two pairs of joi limbs

a) Forelimb.

b) Hind limbs.



## PARTS OF THE FROG



# External Anatomy of the Frog



## **FORELIMB:**

**The forelimb is short and angular.**

**The forelimb is made up of:**

**Upper arm**

**Forearm**

**Forefoot. (bears 4 digits)**

**The joint between the upper arm and the forearm is the elbow.**

**The joint between the forearm and the forefoot is the wrist.**

## **FUNCTIONS OF FOREARM:**

**Brake landing = adapted to withstanding stress and shock when toad lands.**

**Support weight of toad on land.**

**Used in swimming.**

## **HIND LIMBS:**

- **The hind limb is made up of**
  - **Thigh**
  - **Shank**
  - **Hind foot (Bears 5 long slender webbed digits)**
- **The hind foot is long and broad.**
- **The joint between thigh and shank is knee.**
- **The joint between shank and hind foot is ankle.**

## **FUNCTION OF HINDLIMB:**

- 1) It is adapted for leaping.**
- 2) It helps toad to hop on land and swim.**

## **CLOACA:**

- **It is located at the posterior end of trunk.**
- **It serves as an anal opening, urinary opening and reproductive opening.**

# DEFINE ADAPTATION

An adaptation can be defined as a characteristic of an organism suited to its environment or its particular way of life.

It is a structural, physiological (concerned with the body and how a functions) or behavioural characteristic that enables the organism and reproduce.

Anything that helps an organism to survive and successfully ecosystem is regarded as an adaptation.

Adaptation ensures that the organism has a better rate of survival able to reproduce, cope with the physical conditions, defend enemies and respond to changes around them.



# ECOLOGICAL ADAPTATIONS OF THE TOAD

The strengthening of skeletal system as gravity is a factor  
The mode of movement on land has resulted in the jointed fore and hind limbs.

The length of the hind limb of the toad is an obvious for its hopping movement.

No tail which if present will interfere with its jumping  
Webbed digits of its hind feet and fairly streamlined toad to swim easily in water.

Positioning of the nostril and eyes are adaptations which possible for the toad to float in water with the nostrils and above water level.

# ECOLOGICAL ADAPTATIONS OF THE TOAD

Respiratory system of toad is adapted to utilize gaseous oxygen the presence of lungs and loss of gills.

The skin of toad can resist drying up in a terrestrial environment. It sensitive to mechanical and chemical stimuli and to temperature Skin on the digits are sensitive and become increasingly so during season. When the toad is swimming, its dark dorsal surface and surface make it difficult to detect.

On land, it changes its colour to blend with environment to escape predators.

When the toad is disturbed, the skin produces a poisonous and distasteful substance.

Various sense organs of a toad are modified to detect stimuli in terrestrial as well as aquatic environment. The toad smells its food by using special olfactory organs in the head and this functions both in water and air.

- **Well developed eyes that shows the animal a wide field of vision as well as sharp eyesight. It depends on good vision to obtain food, mate and avoid danger.**
- **They possess organs that produce sound. During breeding season, females are attracted to males by loud croaking of the latter. Females must be able to preserve and recognize the croaking of males (sound perception). So that mating follows. Sound perception is also important to toads recognizing food on land. Toads are able to perceive the sound made by different insects. The ears of toad are sufficiently developed to perform all these functions.**

# Similarities between frog and toad

Both frogs and toads have a brain.

Both are amphibians.

Both hatch from eggs.

The young of both have gills.

Both are omnivorous

## Differences between frog and toad

	<b>FROG</b>	<b>TOAD</b>
<b>Hind legs</b>	<b>Long, powerful jumping legs</b>	<b>Shorter legs for walking or hopping.</b>
<b>Eggs</b>	<b>Frogs lay eggs in clusters. Young live in water</b>	<b>Toads lay eggs in long chains. Some toads do not lay eggs but give birth to young live in water.</b>
<b>Skin</b>	<b>Soft, moist and smooth. Hang loosely on body</b>	<b>Dry, bumpy, warty skin</b>
<b>Habitat</b>	<b>Prefer moist environment. Keep mostly to water</b>	<b>Prefer dry environment but adapt to moist conditions as well. Keep mostly on land.</b>
<b>Teeth</b>	<b>Frogs have vomerine teeth in their upper jaws</b>	<b>Toads have no teeth</b>
<b>Eyes</b>	<b>Eyes bulge out. Eyes tend to be protuberant and bulge out of bodies</b>	<b>Eyes do not bulge out, poison gland behind eyes</b>
<b>Toes</b>	<b>Webbed</b>	<b>Not webbed</b>
<b>Body and legs</b>	<b>Frogs tend to have longer legs</b>	<b>Shorter body and legs are often described as stubby or muscular</b>
<b>Movement</b>	<b>Due to long legs, frogs are capable of very long jumps</b>	<b>The typical toad moves in short hops</b>

# REPRESENTATIVE OF REPTILES

## *Agama agama*



k4904944 fotosearch.com ©

Commonly called the redheaded Agama or The rainbow lizard. It is called the rainbow lizard because of the impressive colouration on the body of the dominant male.

Agama means "Unmarried", because the animals are polygamous. The Agama lives in groups that comprise one dominant male, a couple of subordinate males and a large number of females (six or more females).

**COLOUR:** The color of the species depends on the gender and its position within the group.

**Females:** All females are green or brown.

**Subordinate males:** They have a body that is brown, grey, red, blue or yellow in color.

**Dominant male:**

The dominant male is brightly colored. It has blue body with red or yellow head. Dominance in the group is accomplished through cock fighting. The dominant male is called cock and has privileges:

- a) Mates with the females.
- b) Gets the best place for rest.

**SIZE:**



# CLASSIFICATION

- **Kingdom** : **Animalia**
- **Phylum** : **Chordata**
- **Subphylum**: **Vertebrata**
- **Class** : **Reptilia**
- **Order** : **Squamata**
- **Sub Order**: **Lacertilia**
- **Family** : **Agamidae**
- **Subfamily**: **Agaminae**
- **Genus** : *Agama*
- **Species** : *agama*

# EXTERNAL FEATURES

- The body is elongated.

## **THE SKIN:**

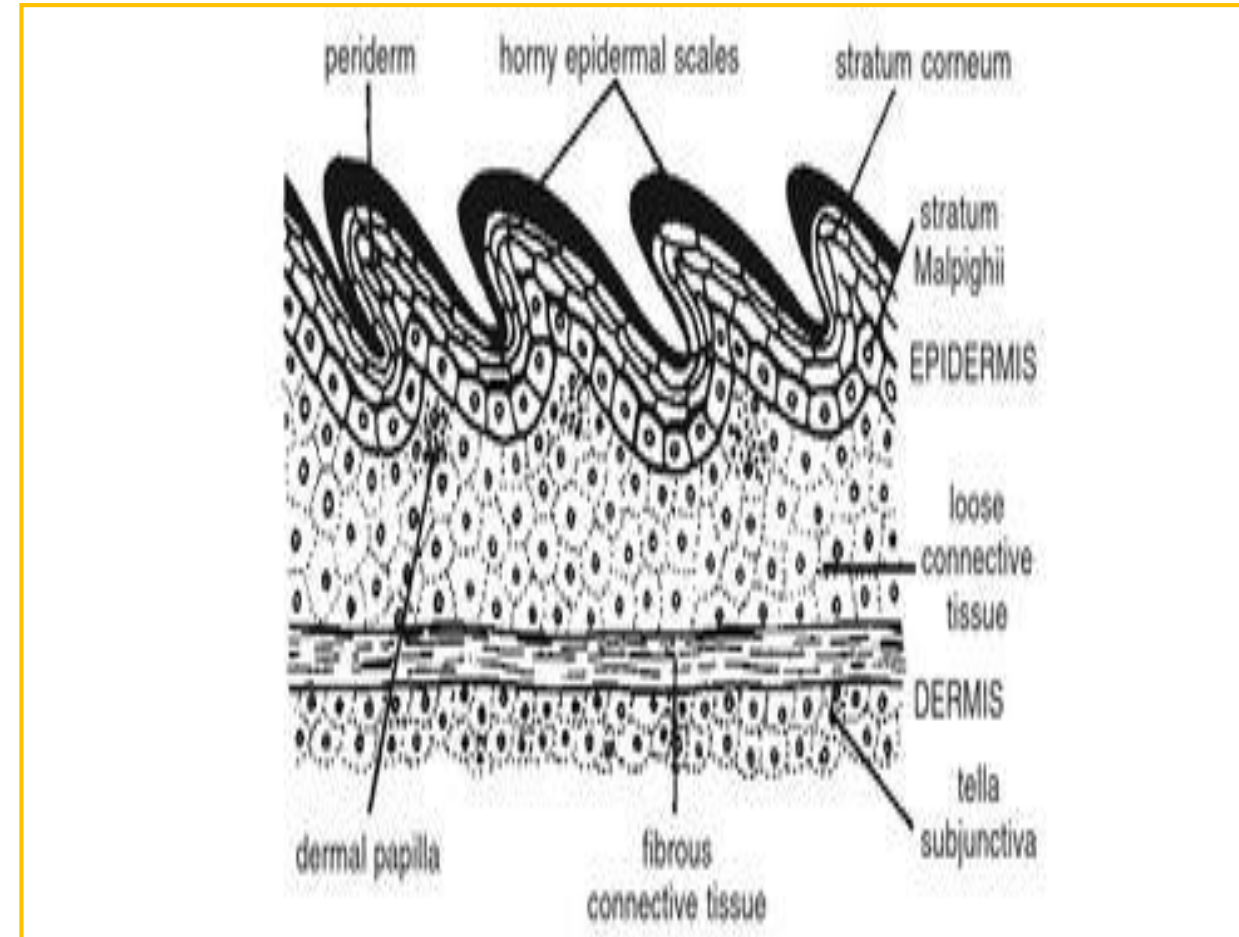
- Agama is covered with dry, scaly skin.
- The skin protects the body from drying up.
- This is a necessary adaptation to terrestrial life, since there is a tendency to lose water from body by evaporation.
- The skin in lizards do not have a respiratory function, therefore they have improved on the lung and blood circulation.

# DESCRIPTION OF LIZARD SKIN:

- The skin of lizard is scaly and has no cutaneous gland.
- The skin is divided into two layers:
  - a) Epidermis (Outer Layer)
  - b) Dermis (Inner layer)

**Epidermis:** The epidermis is made up of two layers:

- Stratum corneum.
- Stratum germinativum.

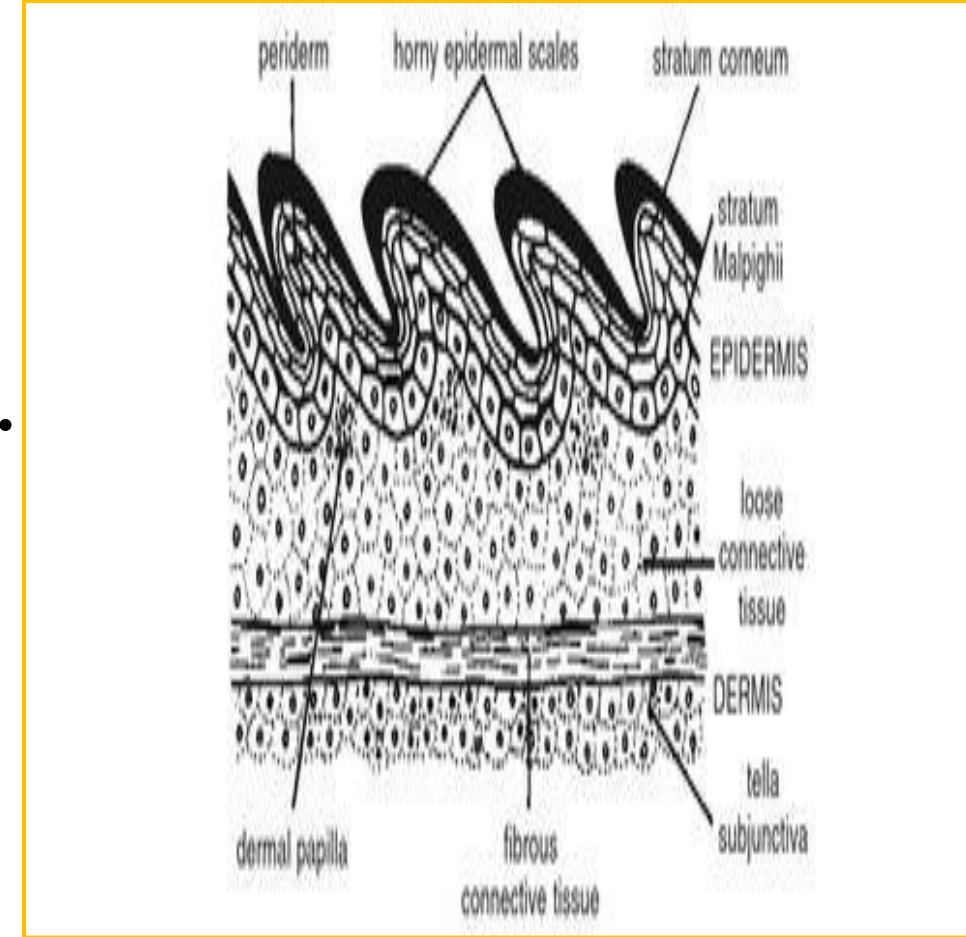


## Stratum corneum

- **Outermost layer of epidermis.**
- **Thick layer.**
- **Consists of flat dead horny cells.**
- **Scales are formed from dead horny cells.**
- **The scales are the protective exoskeleton of the lizard.**
- **They are periodically shed from the body.**

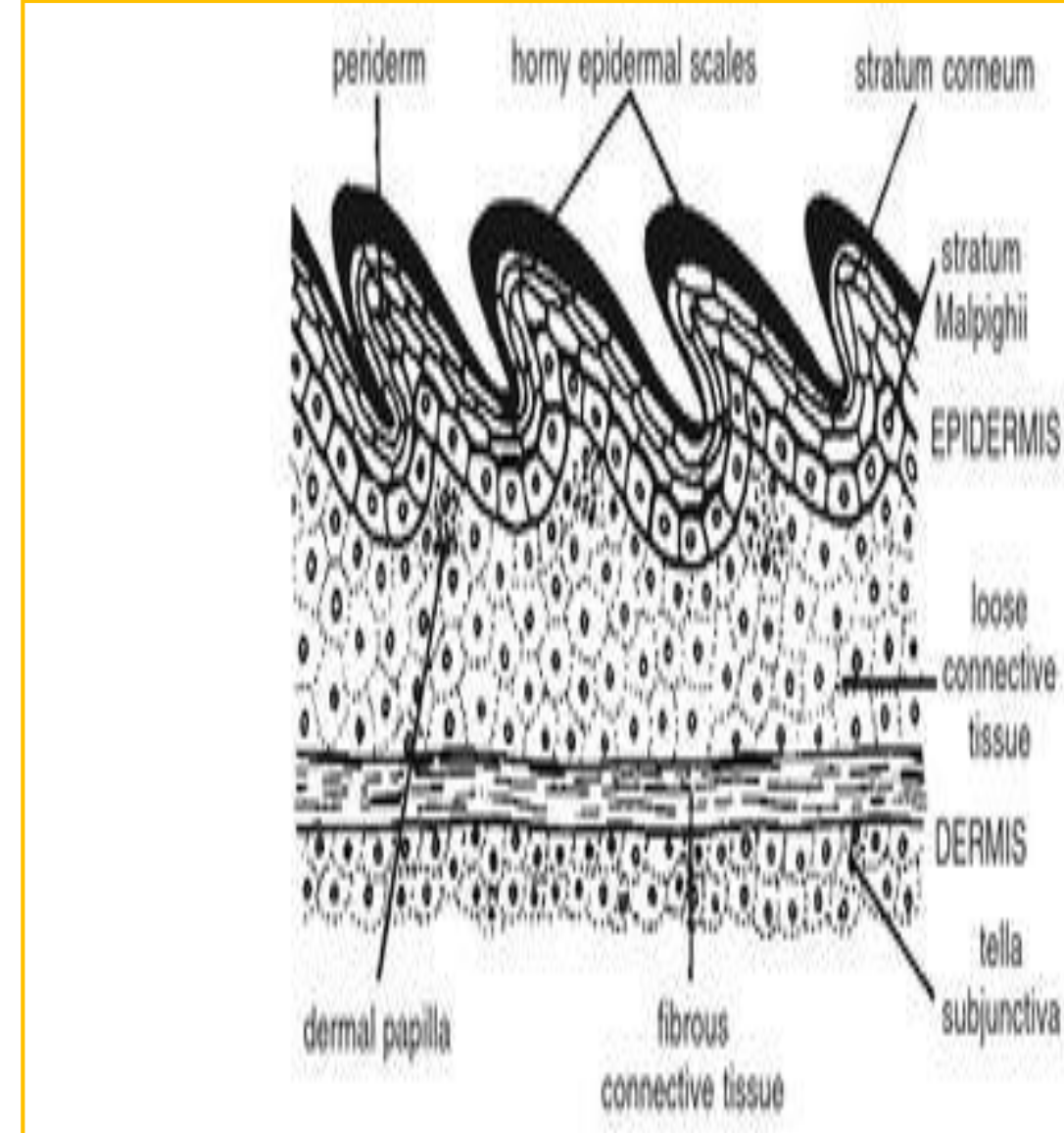
## Stratum germinativum

- **The innermost layer of epidermis.**
- **Single layered.**
- **Contains cells that actively divide and move towards the upper surface.**



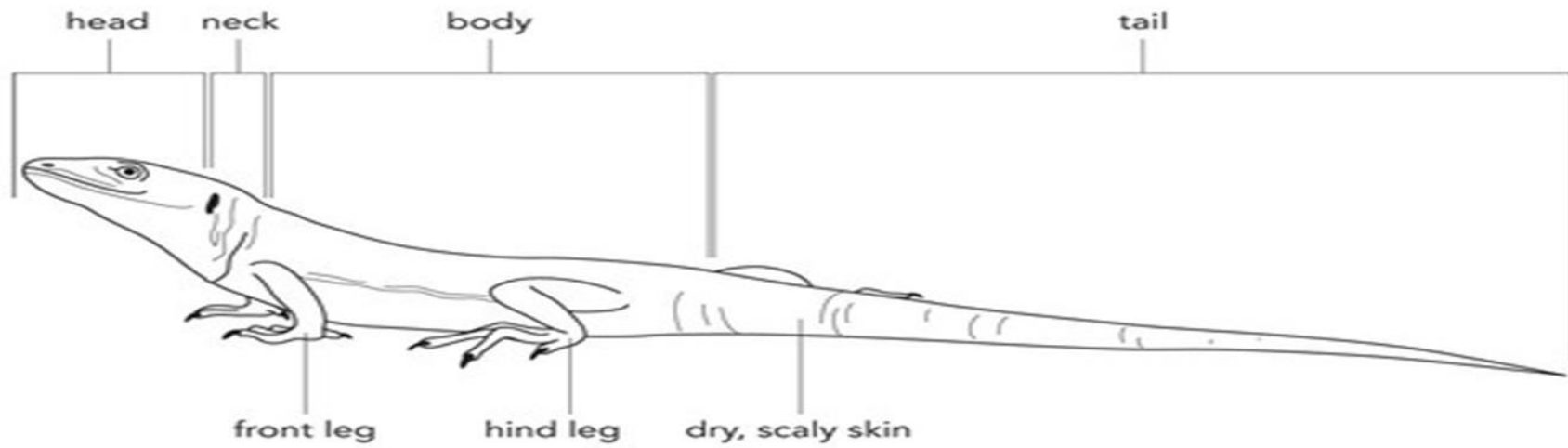
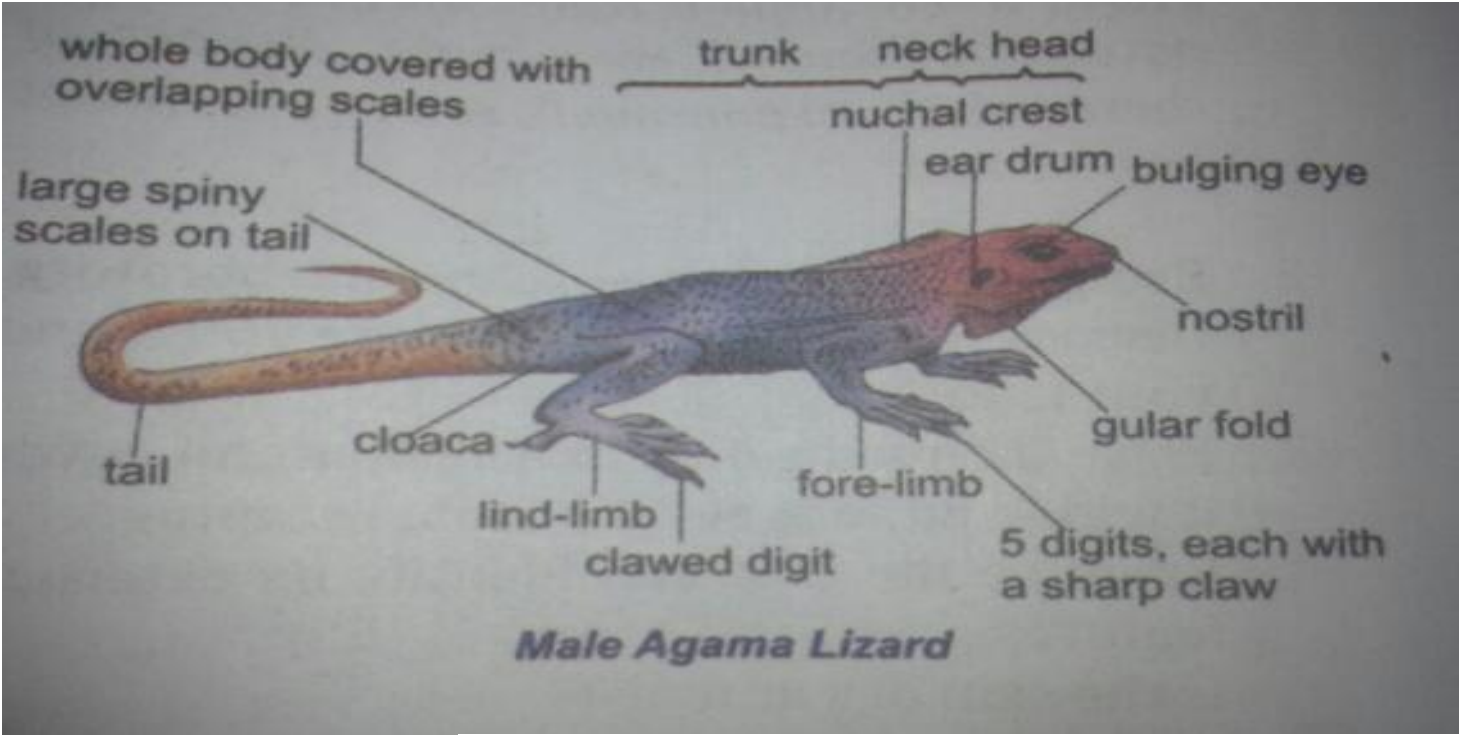
## **Dermis:**

- **A thick layer of fibrous connective tissue.**
- **The dermis contains blood vessels, nerves, muscle fibres and chromatophores.**
- **Integumentary glands are absent except femoral glands over the thigh.**



## **BODY DIVISION:**

- **The body is divided into head, trunk and tail.**
- **The head is joined to the trunk by a neck.**
- **The neck enables the lizard to move its head independently of its body, so that it can watch prey without moving .**
- **The head, neck and thighs of agama are covered with scales.**



# **THE HEAD:**

- **The head is triangular in shape when observed from above.**
- **The head contains a wide mouth.**
- **The mouth is terminal.**
- **The mouth has small uniform (homodont) teeth on both upper and lower jaw.**
- **Homodont teeth are functionally and anatomically of the same type ,although**
- **Their size may be variable .**
- **The teeth are sharp and pointed and are located in sockets.**



- **TONGUE:**

- **A sticky and broad tongue is located on the floor of mouth.**
- **Tongue is well developed and can be extended.**
- **The tongue can also be used as a sense organ .**
- **It samples molecules from the environment and obtain chemical information from them .**
- **The site of the chemical sensation is called JACOBSONS ORGAN OR VOMERONASAL.**

- **NOSTRILS:**

- **The nostrils are located near the tip of the snout.**

- **EYES:**
- **Further back from the nostrils are the eyes.**
- **The eyes are bulging or protruding .**
- **The eyes are bulging for a wide view.**
- **They are directed laterally.**  
**Have well developed sense of vision for hunting prey and avoiding predator.**
- **The eyes are protected with nictitating membrane and have moveable eyelids.**
- **TYMPANUM:**
- **They are located behind each eyes.**
- **An oval semitransparent area.**

- **GULAR FOLD:**

- **A granular fold of skin below the chin.**
- **It is found on the ventral throat immediately in front of the forelegs.**
- **The gular fold is used in courtship to attract the female and also in defense to scare of intruder.**

- **NUCHAL CREST:**

- **A collection of spikes , tooth like protrusions or scales on the back of neck.**
- **They are large at the start at base of head and get smaller as you move towards base of tail.**
- **When extended in conjunction with the gular fold are used in intimidating the intruder.**

## • **PINEAL SCALE:**

- Large median scale located on top of head.
- They have a light spot in the middle called the pineal eye.
- **The pineal eye functions:**
- **To register solar radiation by secretion of hormones.**
- It affects the animal thermoregulatory behaviour in exposing itself to sunlight.
- It is also thought to control reproduction.

## **TRUNK:**

- **The trunk is cylindrical and dorsoventrally flattened.**
- **The trunk bears the limbs.**
- **The limbs are well adapted for speed during running and climbing.**
- **The fore and hind limbs end in five digits with strong curved sharp claws.**
- **The forelimbs are smaller and shorter than the hind limbs.**
- **The forelimbs are placed at right angles to body.**

- **CLOACA:**

- **Just behind the hind limbs on the ventral side, is a transverse slit called the cloaca.**
- **There is a row of thickened scales around the slit called the Preanal pad.**
- **In males there is a hemipenis at each end of cloaca.**
- **The hemi penis is a dual penis which they use alternately while mating**
- **When not in use the hemipenis are contained within body creating a distinct bulge at the base of the tail.**

## • **TAIL:**

- **The tail extends from posterior end of trunk .**
- **It is relatively long and tapers from base.**
- **The tail is divided into base, middle and tip.**

## **FUNCTIONS:**

- **Fat is stored in the tail.**
- **Helps in maintaining suction to any surface.**
- **It provides support to lizard balance.**
- **In some species tail serves as a defensive structure, it breaks off when lizard is held by predator and lizard can escape.**

- **AUTOTOMY:**
- **Also called self amputation.**
- **The behavior where an animal sheds or discards one or more of its appendages usually as self defense mechanism to elude predators grasp or to distract the predator and allow escape.**
- **Agama does not appear to possess this mechanism necessary for tail shedding.**



## **ECOLOGICAL ADAPTATIONS:**

- **They are flexible animals that can easily adapt to changes in their environment.**
- **In the past they lived in the forest of Africa .**
- **When the forests began to disappear, agama managed to adapt to life in open spaces.**
- **Certain species of agama have adapted to life in both rural and urban areas.**

## **ADAPTATIONS:**

- 1. They are nocturnal and come out to hunt for food at night.**
- 2. Tail breaks off easily when grabbed by prey, the tail is also used as fat storage for times when there is not much food for them to eat (desert species).**
- 3. They have dry scaly skin an effective adaptation to life on land. Desert lizards have scales on skin that allow dew to collect on skin and slowly run towards mouth. This is a water source in arid deserts.**
- 4. Lizards have well developed limb with five toes ending in claws for climbing, digging holes for laying of eggs and running on land.**

## **ADAPTATIONS:**

**5. Lizards evolve different sizes and shapes to adapt to their habitat.**

**Lizard living on islands without large predators grow to very large sizes.**

**Lizard that live in competitive environment with little food have smaller sizes.**

**6. Camouflage that helps them to blend in with the environment.**

**Display of colors are used in attracting mates.**

**Some of them have ability to adjust colors due to temperature fluctuation and this is called METACHROMATISM.**

**At cool temperatures lizard becomes darker. Dark colours increase heat.**

**At high temperatures colors become lighter. Lighter colours reflect heat.**

**7. They carry out thermoregulation by orientation of body to sun's angle.**

**When lizard needs to increase temperature, it turns body towards strongest ray of sun.**

**If it needs to cool off it turns away from the sun.**

**Some bury themselves in sand to escape the heat of the top layer of sand of sand and the direct sunlight.**

8. The hemipenis allows for internal fertilization.

9. An improvement on the more necessary sense organs namely the eyes, ears and nose,

Reptiles have a more developed brain than amphibians.

10. The neck allows the lizard to move its head independently of its body so that it can watch its prey without moving.

# REPRESENTATIVE OF AVES

## THE PIGEONS

Pigeons are birds with a small head, plump body, short legs and smooth feathers (Smooth and compact plumage).

They are birds that belong to the family Columbidae.

# MODIFICATION FOR FLIGHT

Birds have become highly modified due to aerial life.

## **A). Morphological adaptations:**

Body form: fusiform form or spindle shaped.

Body covered with feathers.

Contour feathers make body streamlined and reduce friction to the minimum.

Feathers make body light.

Feathers hold considerable blanket of enveloping air around the body and add much to its buoyancy.

## **A). Morphological adaptations:**

- Feathers insulate body perfectly and prevent loss of heat which enables a bird to endure intense cold at high altitudes and maintain constant temperature.
- Feather forms broad surface for striking the air.
- Fore limb transformed into unique & powerful propelling organ the wings.
- Mobile neck & beak.
- Extreme mobility of long and flexible neck for reaching food.
- Bipedal locomotion – The anterior of body becomes modified for flight & posterior part of body becomes modified for movement on land.



## **A). Morphological adaptations:**

- To support the entire body weight the hind limbs occupy a somewhat exterior position on trunk & become more stable.
- Perching – The hind limbs are specialized for perching.
- Short tail bears a tuft of long tail feathers or rectrices which spread out in a fan like manner & serves as a rudder for flight.
- They also assist in steering lifting & counter balances during flying & perching.

# MODIFICATION FOR FLIGHT

## **Muscle development:**

The action of wings is controlled by flight muscles which are greatly developed.

## **Flight muscles include:**

Pectoralis major - Powerful down stroke of the wings is caused by these immense muscles.

Pectoralis minor – Raising or elevation of the wing caused by this muscles.

## **Lightness and rigidity of endoskeleton:**

- The skeletal frame work of flying birds is very stout and light. Most of the bones are pneumatic filled with air spaces and provided with a secondary plastering to make them rigid.
- The rate of metabolism in birds is very high. Food requirements are great & digestion is rapid
- The dense elastic & complicated lungs are supplemented by a remarkable system of air sacs which grow out from lungs and occupy all available space between internal organs, even extending to the cavities of hollow bone.
- Air sacs reduce specific gravity of the bird and also facilitate complete aeration of the lungs.

## **Blood system:**

- They have efficient circulatory system because rapid metabolism requires large oxygen supply to the tissues.
- The heart is large, powerful & efficient.
- The high & constant body temperature enables the birds to take flights at high altitudes & also facilitates activeness in every season.

## **Excretory system:**

- The excretory system is specialized for flight in 3 ways
- Efficient water absorbing organs
- No urinary bladder & semisolid urine is immediately excreted out, not retained long in the body

# The Brain:

- Avian brain is highly developed consisting of well-developed centers of equilibrium, muscular coordination & instinct.
- Ovary & oviduct of one side (right-side) are preserved and this reduces the weight of body.

## **Distribution:**

**They are a widely distributed family of bird.**

**Cosmopolitan in distribution, that is found almost anywhere on earth.**

**Every country in the world except Antarctica has pigeons or doves.**

## **Habit:**

**They exist in domestication and in the feral state in cities and towns throughout most of the world.**

**(Feral means existing in a wild or untamed state, or returning to an untamed state from domestication).**

## **Pigeons and Doves:**

- **They are closely related to doves.**
- **Pigeons and doves belong to the family Columbidae and have many similar features.**

## **Differences:**

- **Doves typically have smaller bodies than pigeons.**
- **Doves have bigger tails than pigeons.**
- **Doves have pointed tails and pigeons have rounded tails.**
- **Doves are wild while pigeons are urban.**
- **Doves are white while pigeons are grey.**

- **Pigeons are fruit and seed eaters.**
- **They are unlike most other birds because both male and female produce milk for young.**
- **The milk is called crop milk and contains higher level of protein and fat than milk produced by mammals.**



# CLASSIFICATION

**Kingdom : Animalia**

**Phylum : Chordata**

**Class : Aves**

**Order : Columbiformes**

**Family : Columbidae**

**Genus : *Columba***

**Species : *livia***

**Common Name: Common pigeon**

**Rock dove**

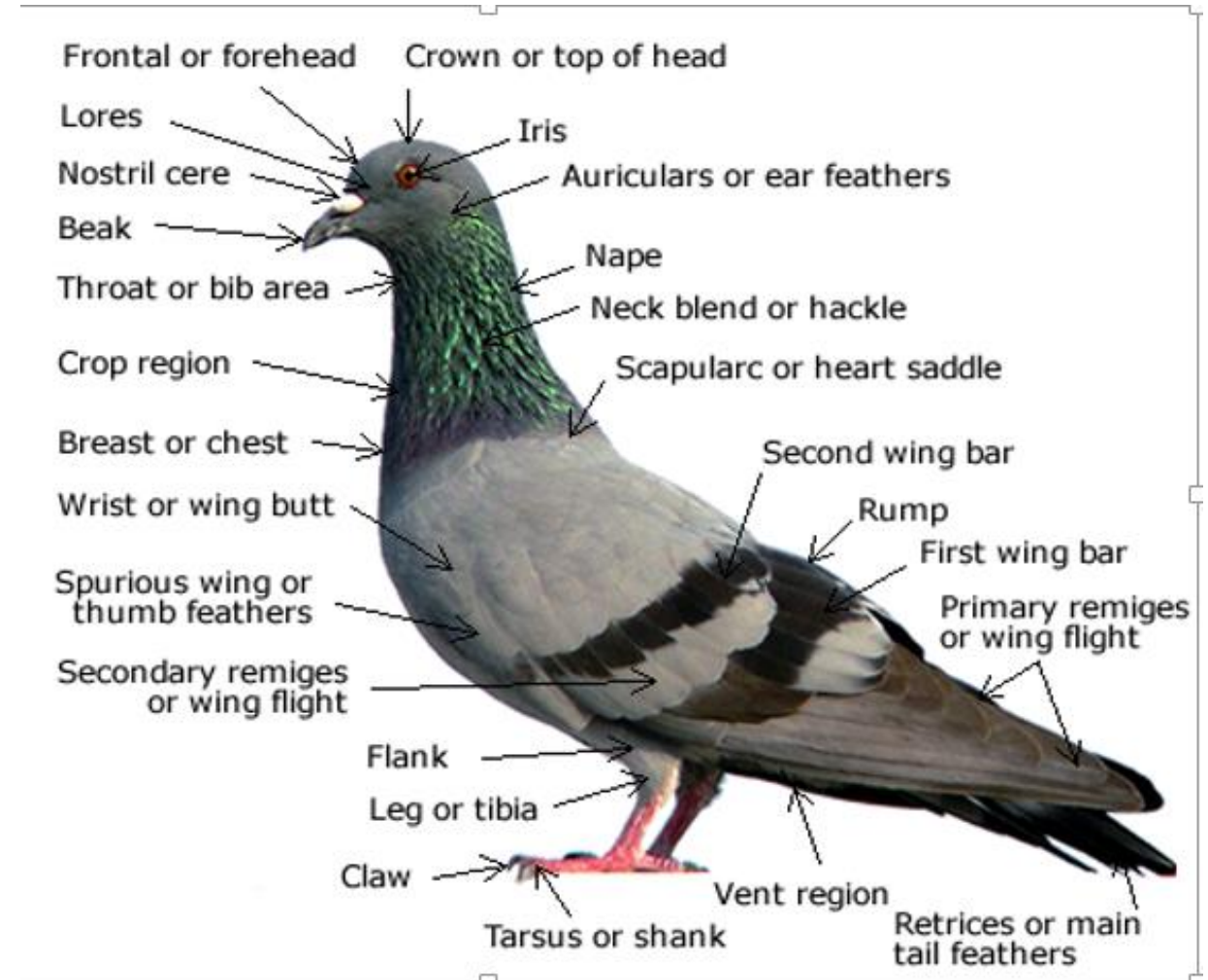
# EXTERNAL FEATURES:

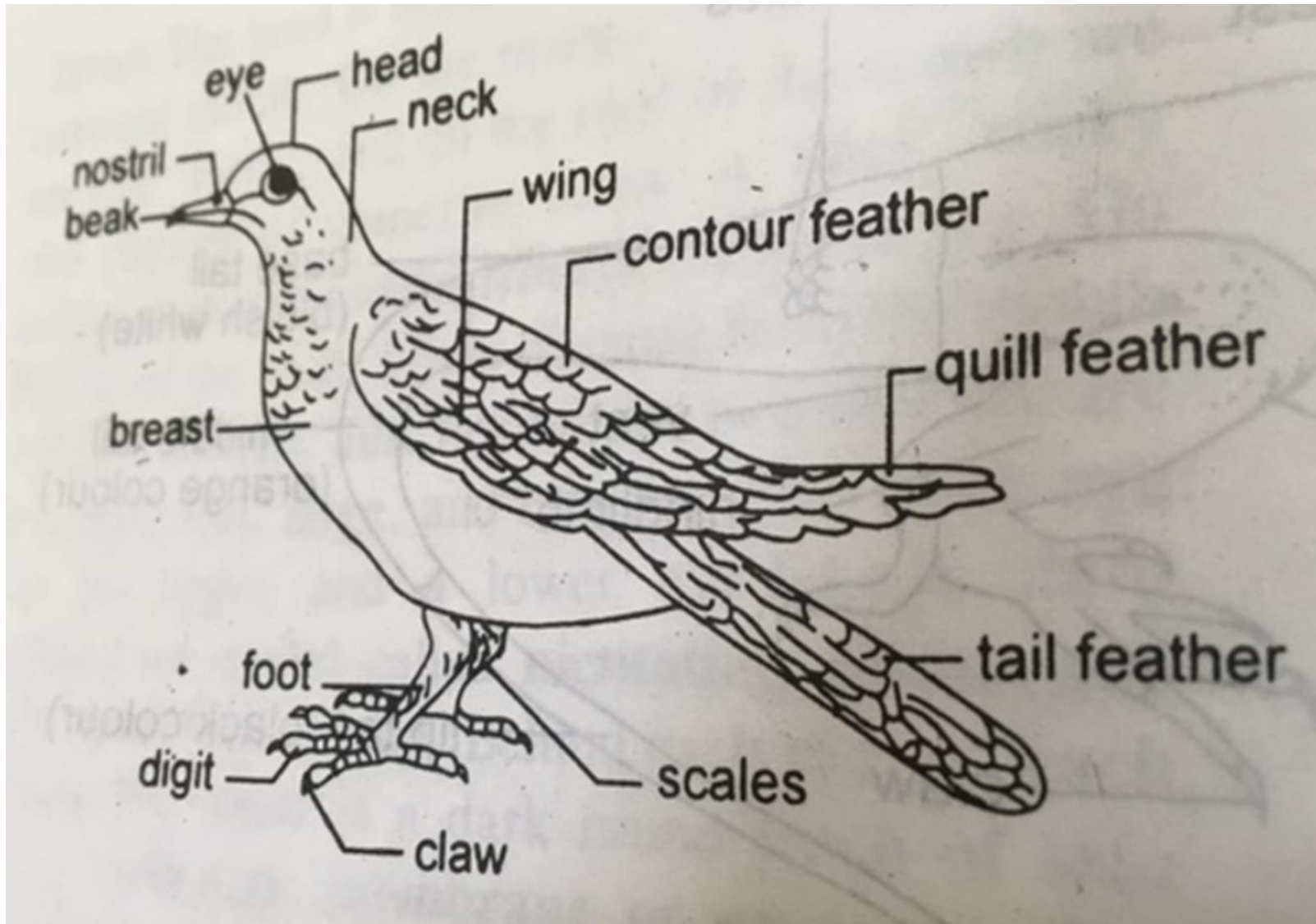
## SIZE:

- About 30 cm long.

## BODY:

- The body is streamlined and boat shaped.
- The body is covered with feathers except feet and beak.

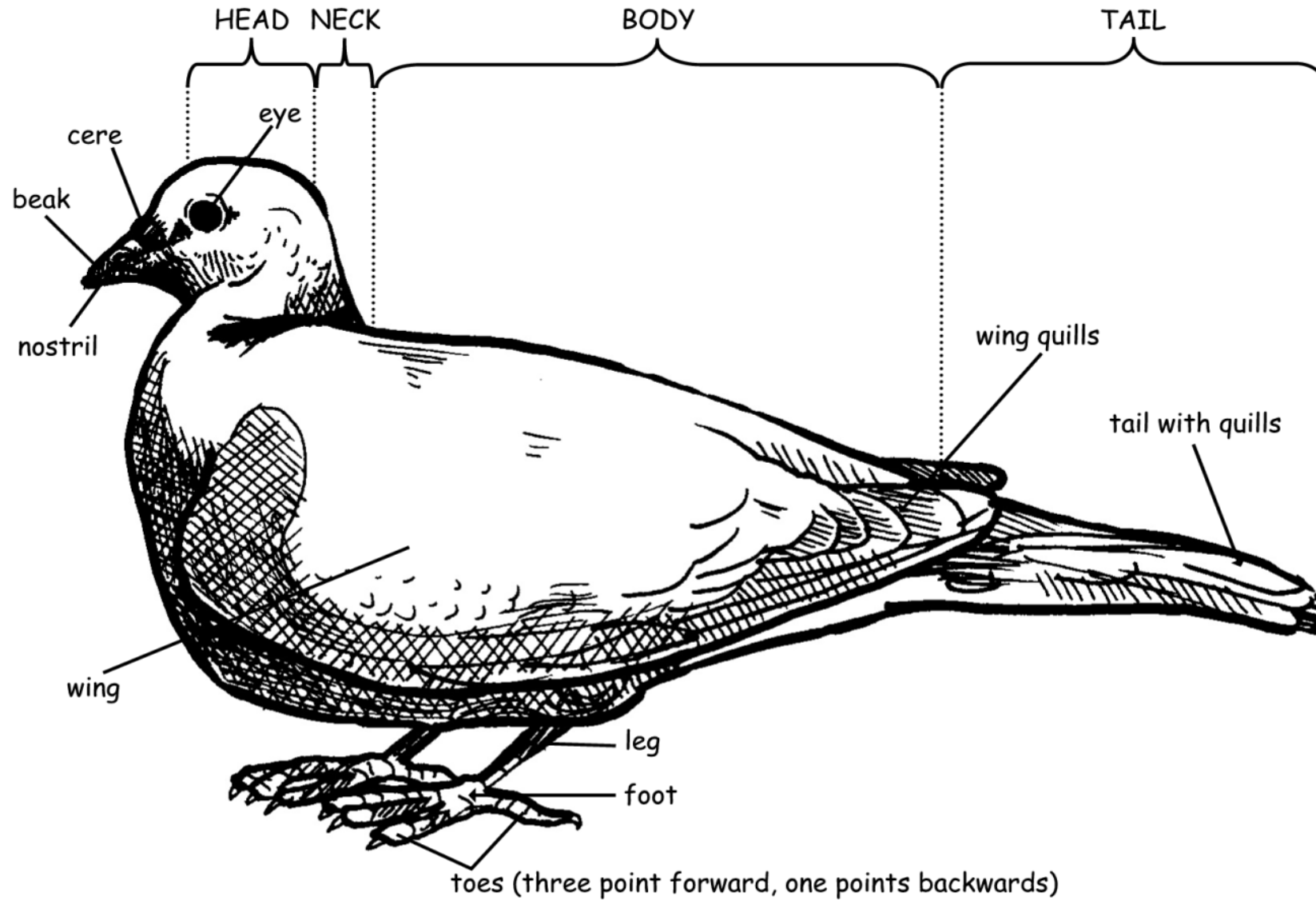




The external features of a pigeon (*Columba livia*)

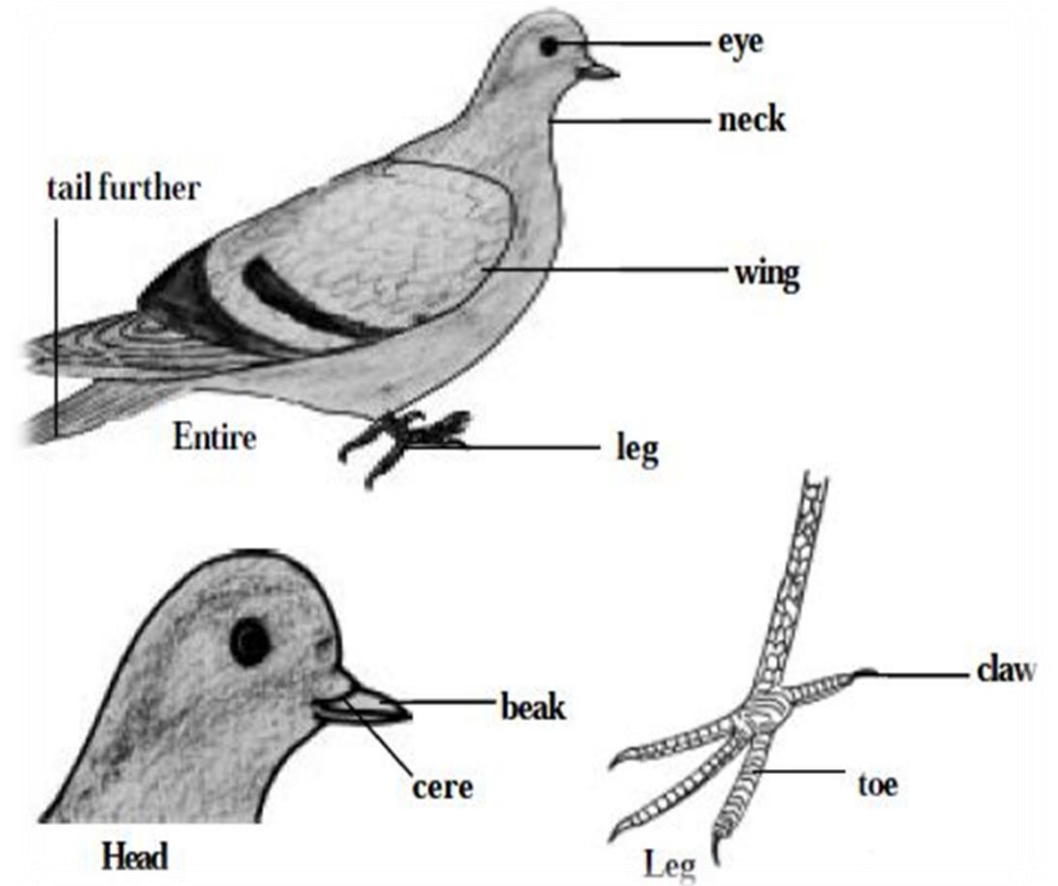
# BODY DIVISION:

The body is divided into a small head, a neck, compact trunk and tail.

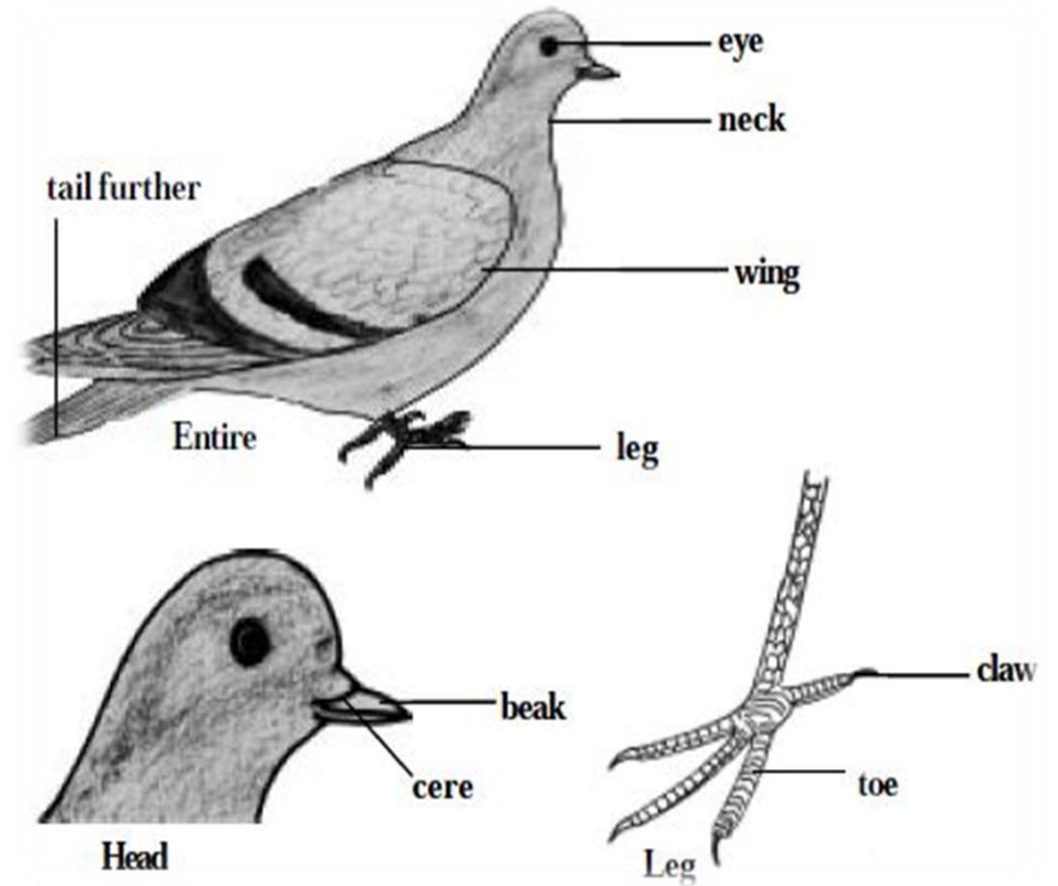


# HEAD:

- The head is small and round.
- The lower and upper jaws are modified to form a beak or bill.
- The beak is pointed horny and tough.
- On the upper portion of the jaw are two small slits the nostril.
- There are two large round eyes.
- Each of the eyes lies on one side of head.



- Each eye has an upper and lower eyelid and a nictitating membrane which can be drawn to cover eye ball.
- The nictitating membrane helps to keep the eye moist and clean.
- The ear openings lie behind and below the eyes but are hidden by feathers.
- Each of the ear opening leads by a short tube to the ear drum.



## **NECK:**

- **The neck is fairly long and flexible.**
- **The bird can therefore twist its head in all directions giving it a wide range of vision.**

## **THE TRUNK:**

- **The trunk is oval and compact.**
- **It tapers towards the neck and tail, giving the body a streamlined shape.**
- **The trunk consists of the forelimbs and the hind limbs.**
- **The forelimb is Z-shaped and modified to form wings.**

- **The wings are folded neatly against side of body when bird is at rest but are stretched out when bird is in flight.**
- **The hindlimbs are two in number and are not entirely straight, they are bent slightly.**
- **The front of each hindlimb is covered with scales.**
- **Each foot has four digits with one pointing backward and three forward.**
- **Each digit ends in a strong and sharp claw.**

## **CLOACA:**

- **Located a little distance from the leg on the ventral side.**



## **TAIL:**

- **It has a short tail.**
- **On the dorsal side of the tail is a small gland, the preen or oil gland,**
- **The gland supplies oil for keeping feathers glossy and water proof.**
- **The oil also prevents the beak from becoming brittle.**
- **Certain pigeons do not have this oil gland.**

## **FEATHERS:**

- **These are epidermal structures which cover the entire surface of birds.**
- **Feathers do not grow on all parts of skin.**

## **FUNCTION OF FEATHERS:**

- 1. They form a flexible, light but resistant covering.**
- 2. They are used to insulate body as they trap large pockets of air among them.**
- 3. They protect from rain as they are water proof.**
- 4. They are used in flight.**

## **TYPES OF FEATHERS:**

**Quill feathers.**

**Contour or covert feathers.**

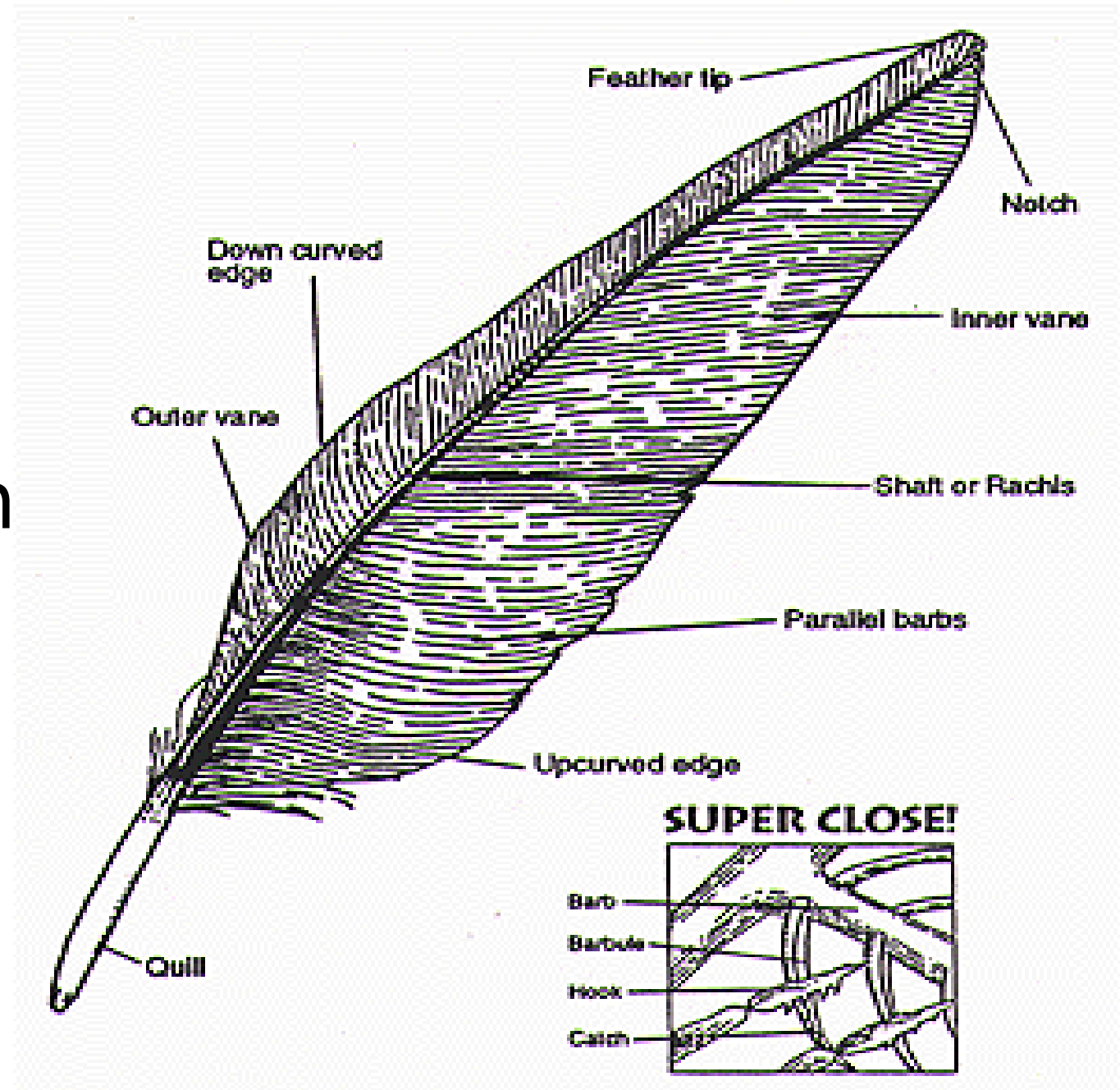
**Down feathers.**

**Filoplumes.**

**Bristle feathers.**

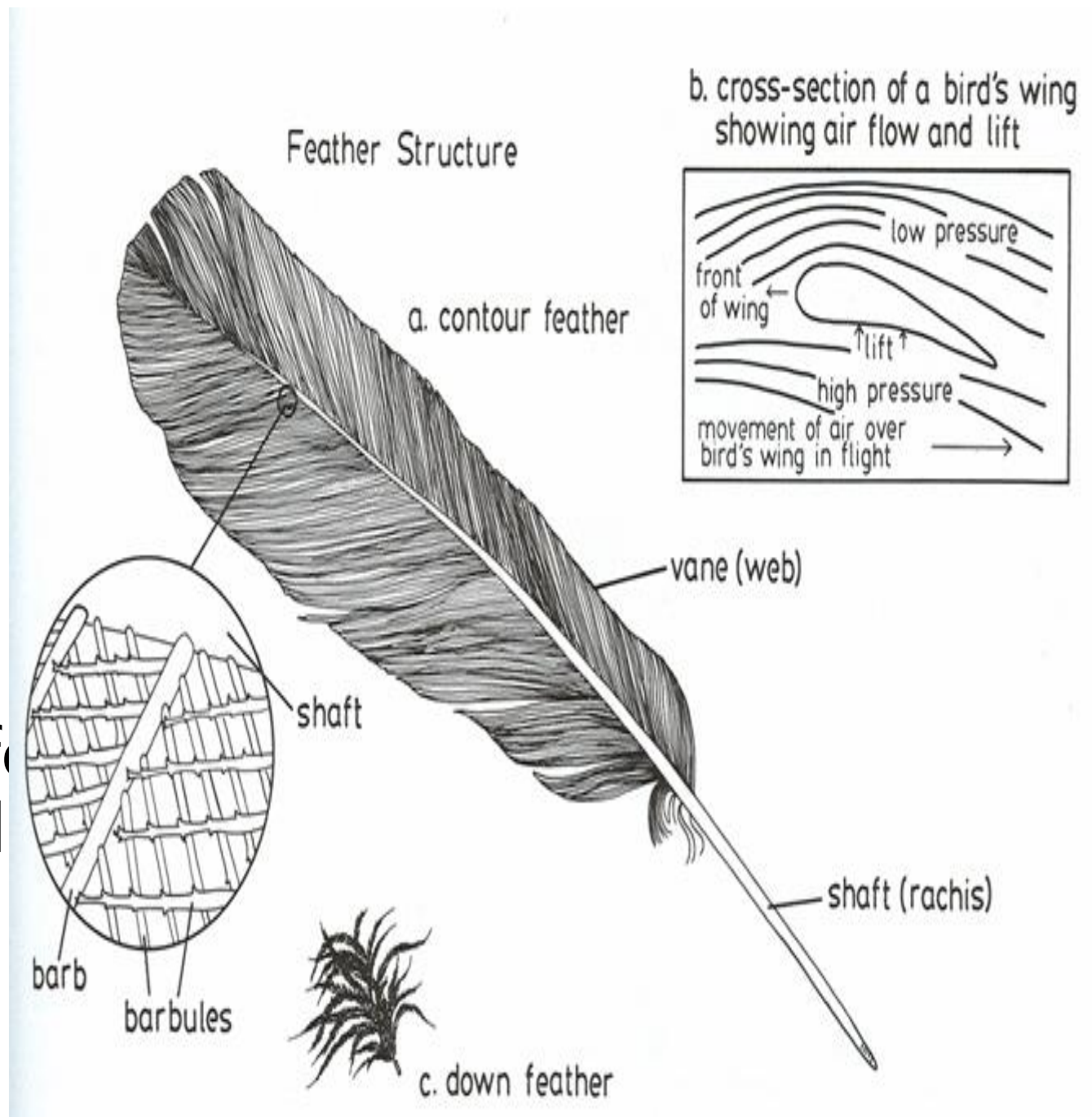
# Quill feather

- They are found on wings and tail.
- They are used for flyin



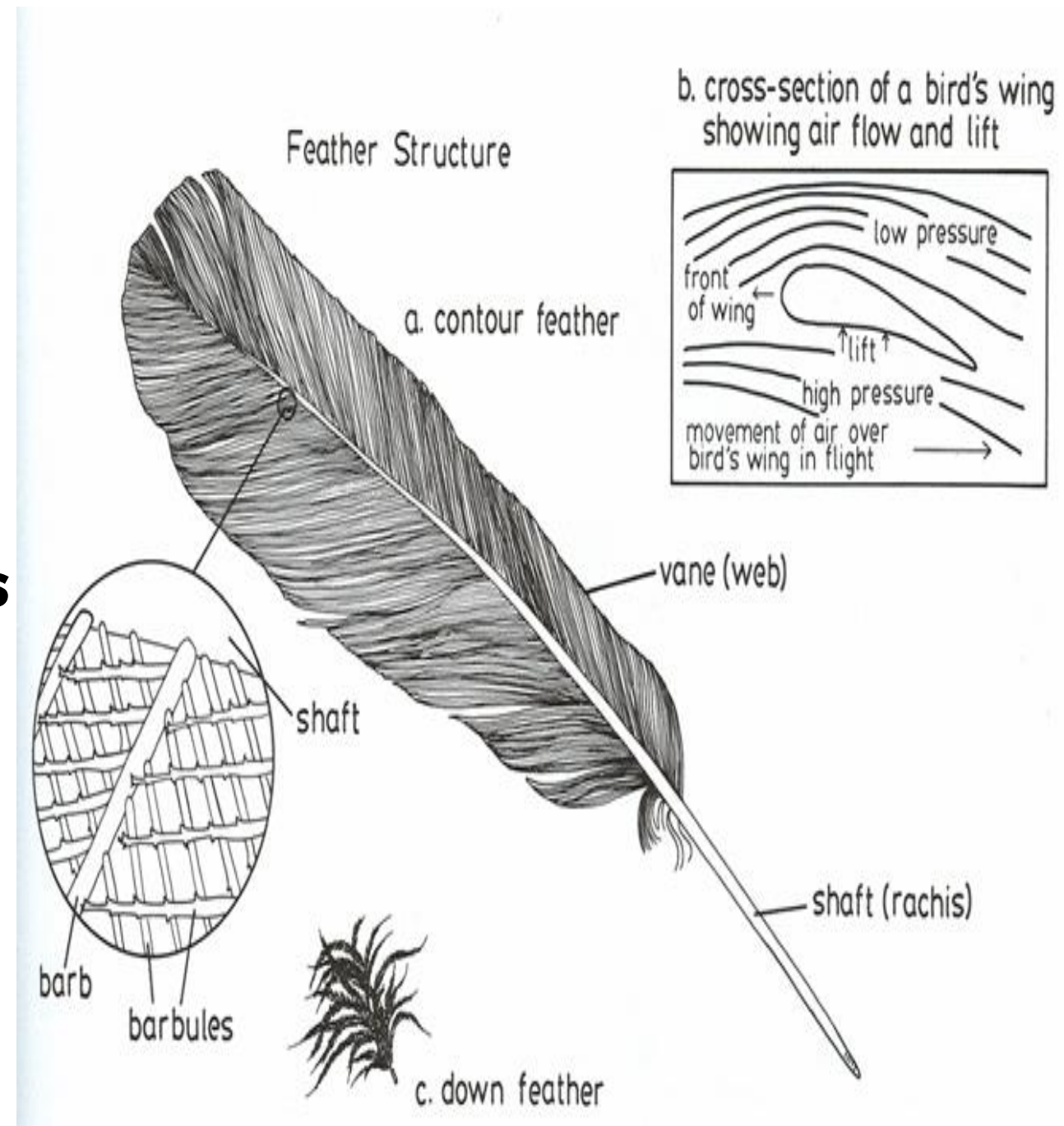
# CONTOUR AND DOWN FEATHERS:

- They are also known as the covert feathers.
- They are smaller than quill feathers.
- They make a light covering for most of the body of the bird (Breast)



## Down feathers:

- **They are soft and fluffy.**
- **They are found beneath the quill and covert feathers.**
- **Most of the feathers in young birds are down feathers.**
- **Because they are soft and bushy they are used in insulation.**

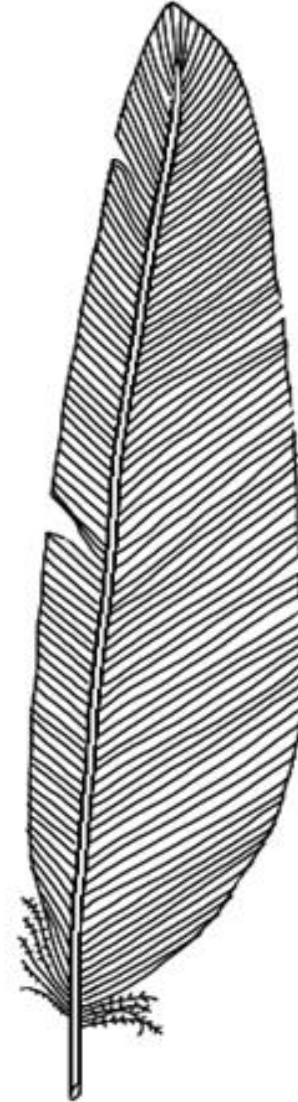


# FILOPLUME AND BRISTLE FEATHERS

## Bristle feathers:

- Small specialized hair like feathers.
- Found around the eyes and nostrils.
- They help to prevent foreign bodies from the eyes and nostrils.

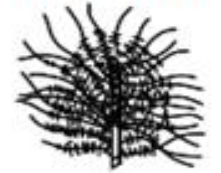
Contour feather



Plumule



Chick down



Filoplume



Bristle



## Bristle feathers:

- **Small specialized hair like feathers.**
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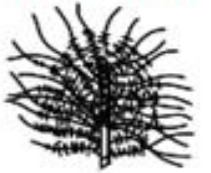
Contour feather



Plumule



Chick down



Filoplume



Bristle



# REPRESENTATIVE OF MAMMALS

*Rattus rattus*

(Commonly called the  
black rat)

**DISTRIBUTION:** All  
continents of the earth.  
They are native to India.

**HABIT:**

Nocturnal.

Climbers.



# CLASSIFICATION

- **Kingdom : Animalia**
- **Phylum : Chordata**
- **Class : Mammalia**
- **Order : Rodentia**
- **Family : Muridae**
- **Genus : *Rattus***
- **Species : *rattus***

# EXTERNAL FEATURES:

- A long tailed rodent.

## SIZE:

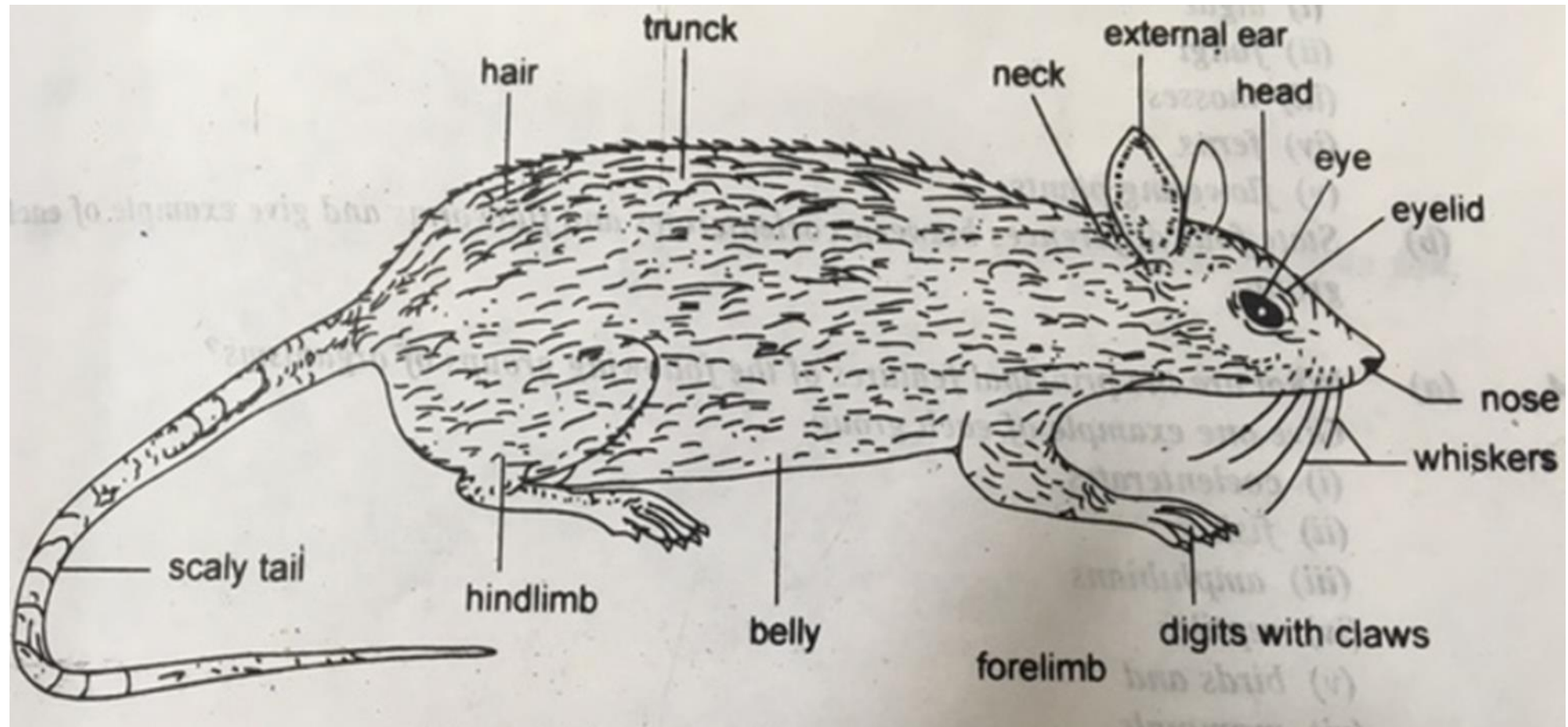
- Head-body length size is 14-23cm.
- Tail length is between 17-28cm.
- Body weight of 75-230g.
- Males are longer and heavier than females.

## BODY:

- The body is long and slim but broader towards posterior part.
- Entire body is covered with greyish dark hairs.

# BODY DIVISION:

The body is divided into head, neck, trunk and tail.



**The external features of a black rat**

## **HEAD:**

- **The head is pointed and consists of mouth, nose, eyes and external ears (The external ear is making a first appearance).**

## **MOUTH:**

- **The mouth is bound by an immovable upper and moveable lower jaw.**
- **Both jaws are bounded by upper and lower lips.**
- **The mouth is opened and closed by the down and upward movement to the lower jaw.**

## **TEETH:**

- **The upper and lower jaw contains different kinds of teeth (heterodont), specialized for different functions.**

## **TONGUE:**

- **The tongue is attached to the floor of the buccal cavity.**
- **It is muscular.**

## **THE NOSTRILS:**

- **They are located above the mouth and are two in number**
- **On either side of the nose are the whiskers.**
- **They are long and strong hairs.**
- **They are sensitive to touch and help the rat to move freely at night.**

## **EYES:**

- **The eyes are located a little farther from the nose.**
- **The eyes are protected by nictitating membrane and eyelids.**

## **EARS:**

- **Further from the eyes are the external ears called the PINNAE.**
- **They are located one on each side of head.**

## **NECK:**

- **This connects the head with trunk.**

## **TRUNK:**

- **It carries four muscular limbs.**
- **Each side of the trunk has one forelimb and one hindlimb.**
- **Forelimbs are shorter than hindlimbs.**
- **Each limb ends in five digits (toes) with claws.**
- **Underneath the trunk is the belly.**
- **In female adults there are two rows of mammary gland on each side of the belly.**
- **Each mammary gland ends up in a teat.**

## **TRUNK:**

- **The teat is where the young ones obtain milk when newly born.**
- **Just below the tail is the anus.**
- **The genital organs are located below the anus.**
- **The male genital organ consists of testes and penis.**

## **TAIL:**

- **The tail is nearly longer than the body.**
- **The tail is covered with scales**
- **It helps the animal in balancing during movement.**



## **ECOLOGICAL ADAPTATIONS:**

- 1. The small size allows it to squeeze through small openings and escape from predators.**
- 2. The hair or fur keeps it warm in cold temperatures.**
- 3. They have whiskers that help them in gathering information about the environment.**
- 4. They use the tail for balance (They balance on ropes wrapping their tails around the rope).**
- 5. The dentition affords them access to a variety of food and shelter.**
- 6. They are nocturnal and become more active at night.**
- 7. They are opportunistic omnivores (They take advantage of whatever food is available).**

## **ECOLOGICAL ADAPTATIONS:**

**8. They live in packs and groups which make them more secure and protected.**

**9. They are skilled climbers and swimmers.**

**10. They are very prolific, producing 3-5 litters in a year.**

- Each litter contains 1-16 young.**
- A Single female can produce 56 young.**
- At age 12-16 weeks females can reproduce.**
- While still suckling a litter female can conceive.**

## **ECOLOGICAL ADAPTATIONS:**

11. They show parental care and construct nests of grass and twig often in roof of houses (That's where they got the name roof rat).

12. They are very aggressive.

13. They can survive in a wide variety of habitats and take advantage of shelters and resources provided by vacant buildings.