

Ministry of Higher Education and Scientific Research  
University of Baghdad  
College of Science  
Department of Biology



# Practical

## Comparative Anatomy of Chordata

### 2020-2021

المرحلة الرابعة - الدراساتين الصباحية والمسائية  
الفصل الدراسي الثاني

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# Lab1:Classification of chordate:

Phylum Chordate includes **53000** species of animals, they all characterized by:

- 1- Dorsal hollow nerve cord.
- 2- They Contain notochord.
- 3- Pharyngeal gill pouch and gill slits.
- 4- endostyle
- 5- postanal tail

# Classification of Phylum: chordate

## A. Protochordata (Acraniata)

### 1- Subphylum: Hemichordata

Ex: *Dolichoglossus kawalveskii*

### 2- Subphylum: Urochordata

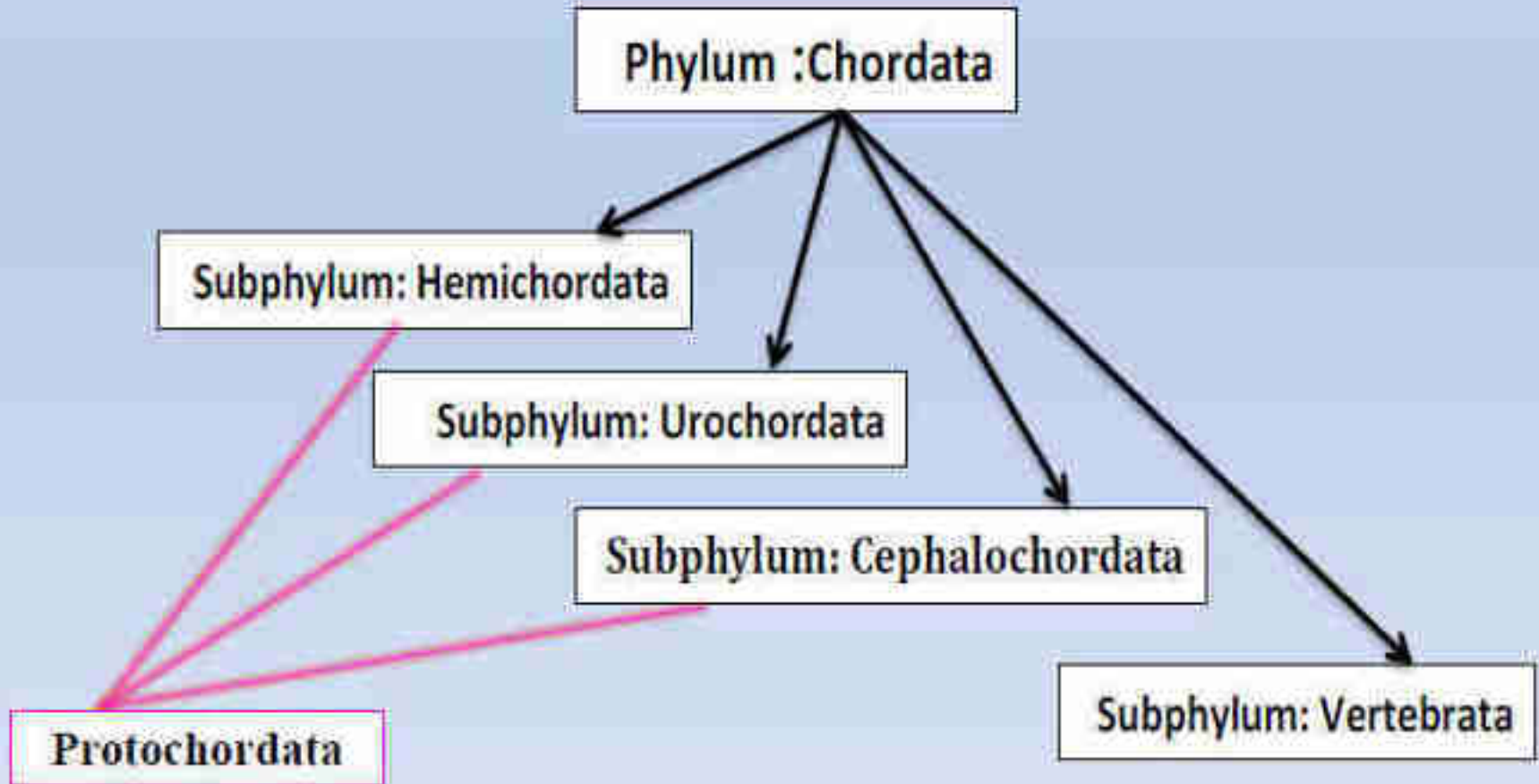
Ex: *Molgula*

### 3- Subphylum: Cephalochordata

Ex: *Branchiostoma lanceolatum*

## B. Vertebrata (Craniata).

# Classification of Chordates



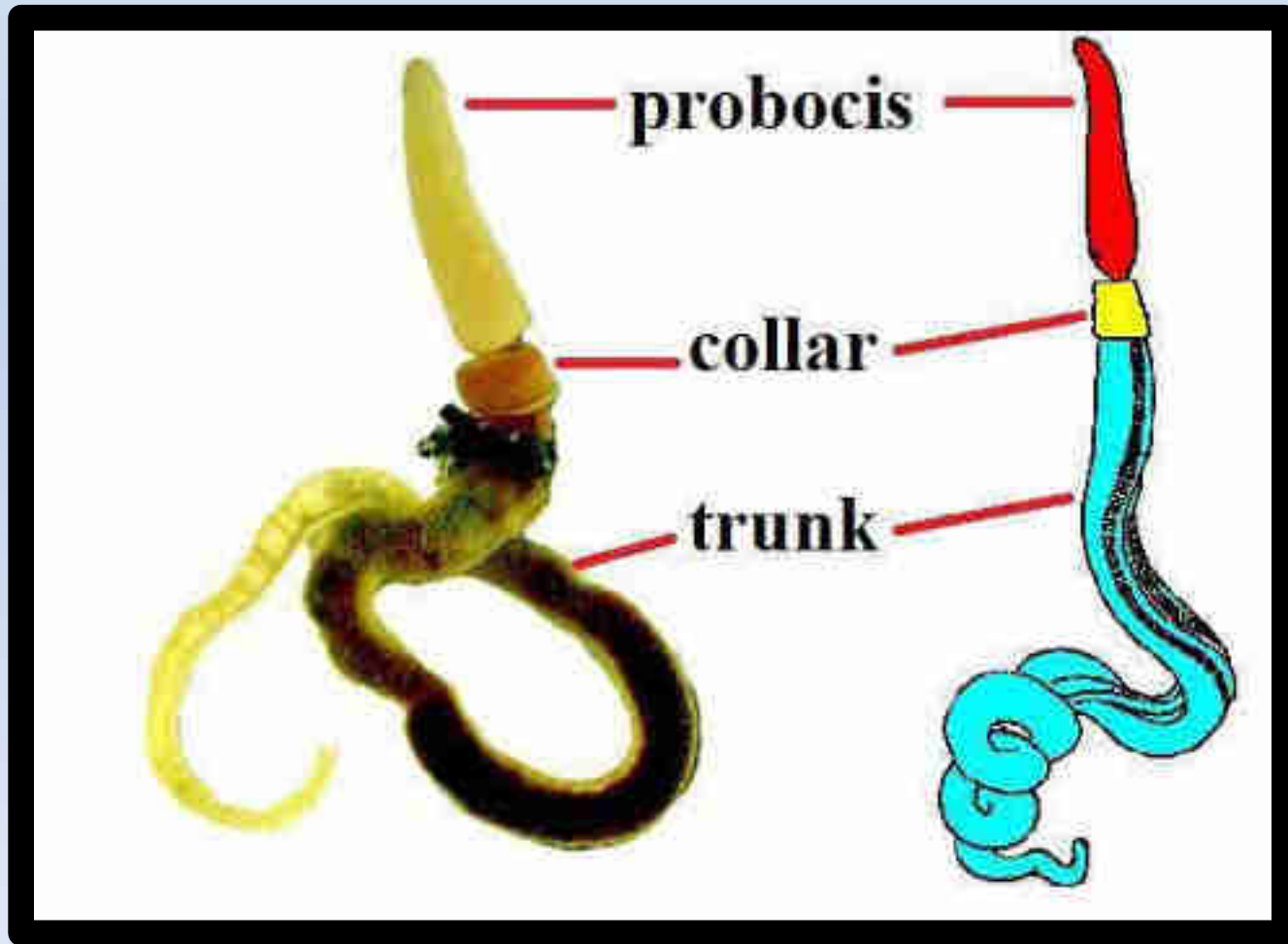
## **General characteristics of protochordata**

- Exclusively marine.
- Relatively small sized animalsCranium or brain box, jaws, vertebral column and paired appendages are absent.
- Dorsal tubular nerve cord, gill slits and notochord are usually present.
- Sexes may be separate or united.
- Solitary, colonial, free living, pelagic, burrowing or tube like living forms

Phylum: chordate Protochordata (Acraniata)

Subphylum: Hemichordata

Ex: *Dolichoglossus kawalveskii*



## **General Characteristics of hemichordates**

- The name Hemichordata refers to the presence of a short notochord, reduced to half the size (hemi – half; chorde – cord). This structure is present in the anterior region of the animal, the proboscis
- Exclusively marine and soft-bodied forms
- Body is divisible into proboscis, collar and trunk
- Numerous paired gill slits are present.
- Fertilization is external.







**Phylum: Chordate Protochordata (Acraniata)**

**Subphylum: Urochordata**

**Ex: *Molgula manhatensis***



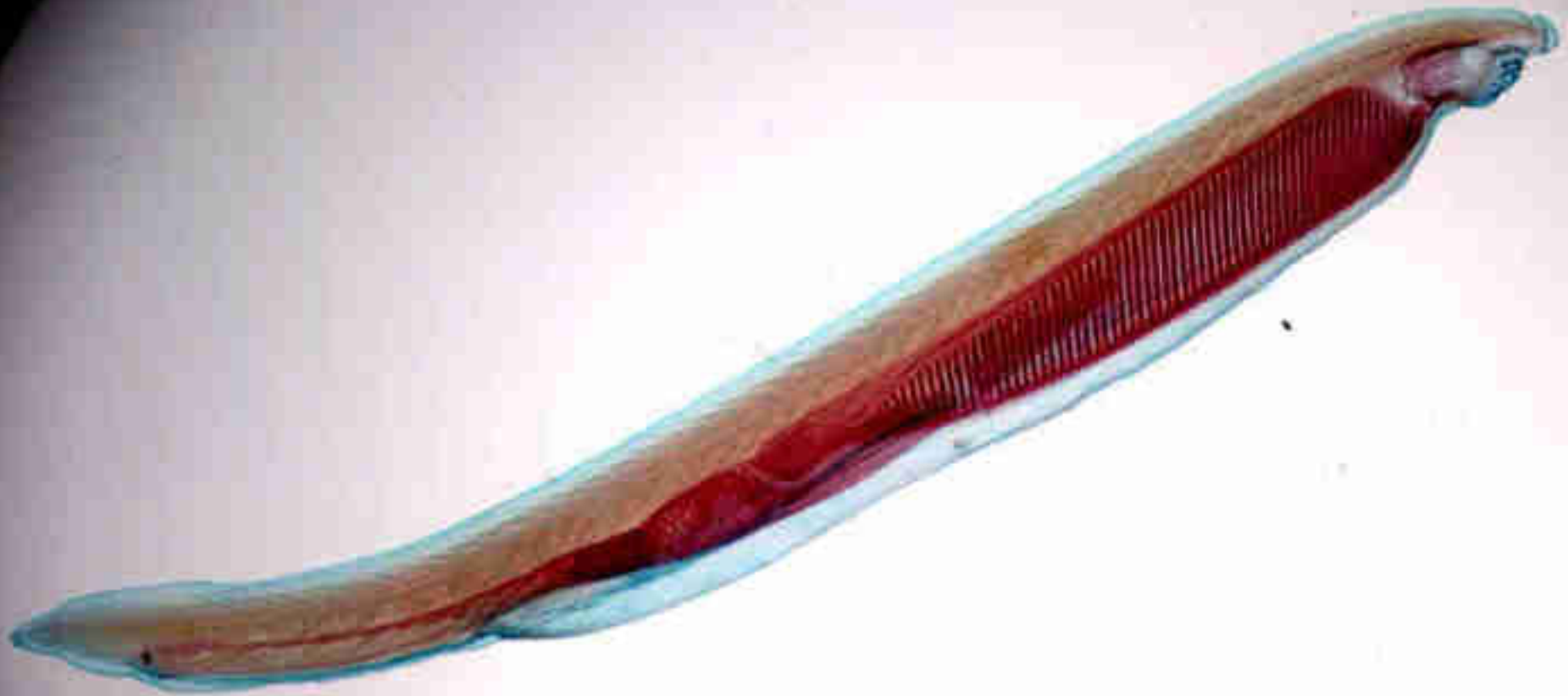
## General characteristics of Urochordata

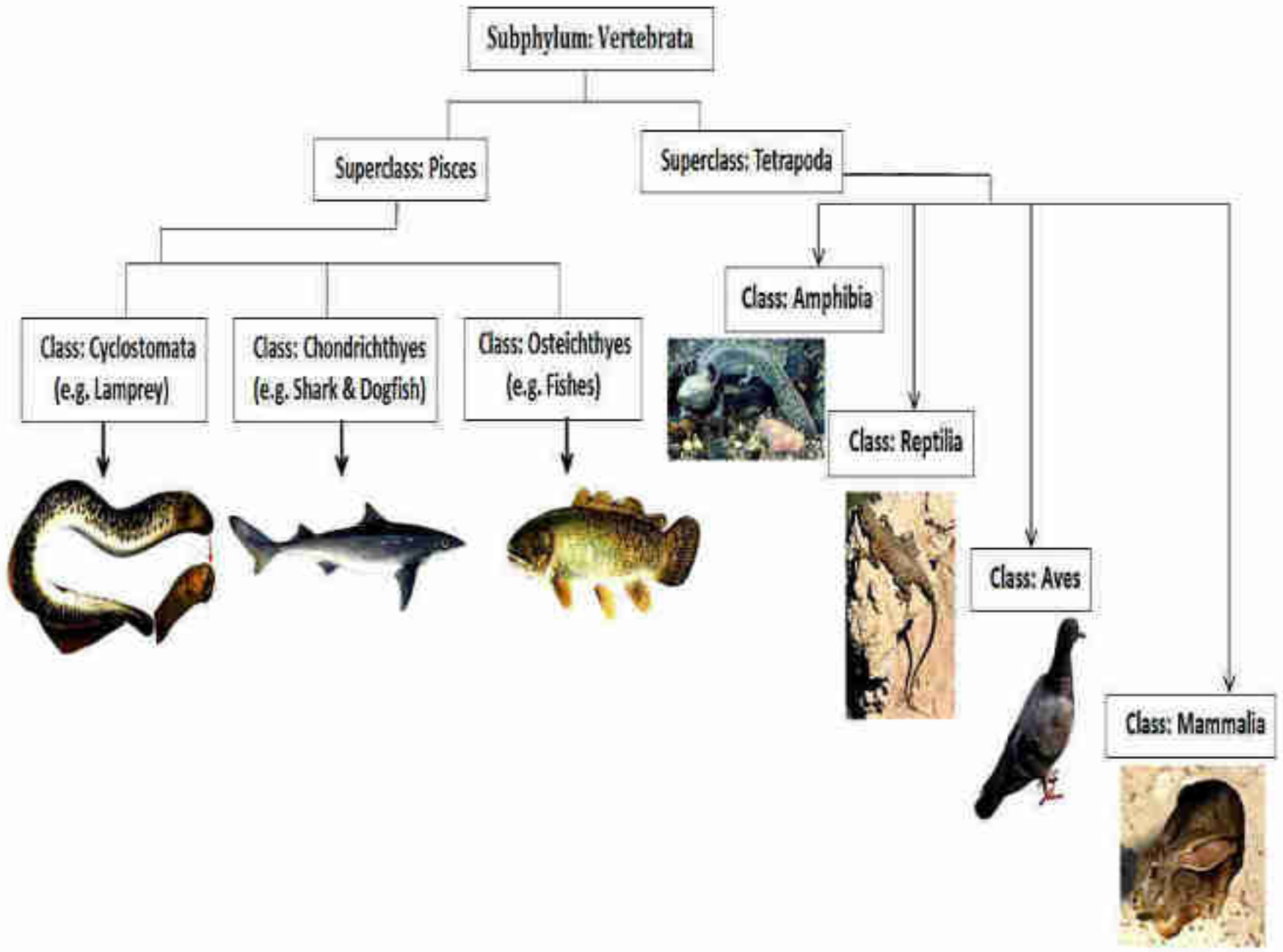
- Urochordata is the term used to refer to the presence of a notochord in the tail region.
- The notochord is restricted to the tail region of the larval forms of urochordates and is absent in the adults.
- Tunicata is the other name of this subphylum Urochordata, due to the presence of an outer leathery covering called tunic or test in the adult. Exclusively marine and commonly known as sea squirts.
- Solitary or colonial. Body is covered by a cuticular tunic or test in adult stage.
- Dorsal tubular nerve cord is present in the larval forms while degenerates in the form of small ganglion in adults. A numerous gill slits are present.
- Sexes are united that is hermaphrodite. Heart is ventral, simple and tubular.

Phylum: chordate Protochordata (Acraniata)

Subphylum: Cephalochordata

Ex: *Branchiostoma lanceolatum*





**Subphylum: Vertebrata**

**Superclass: Pisces**

**Superclass: Tetrapoda**

**Class: Cyclostomata  
(e.g. Lamprey)**

**Class: Chondrichthyes  
(e.g. Shark & Dogfish)**

**Class: Osteichthyes  
(e.g. Fishes)**





**Subphylum: Vertebrata**

**Superclass: pisces**

**Class: Chondrichthyes**

***Ex : Squalus acanthias***





Subclass : Eutheria

Order: Lagomorpha

*capensis arabicuEx : Lepus*



# Lab.2

## THE INTEGUMENTARY SYSTEM

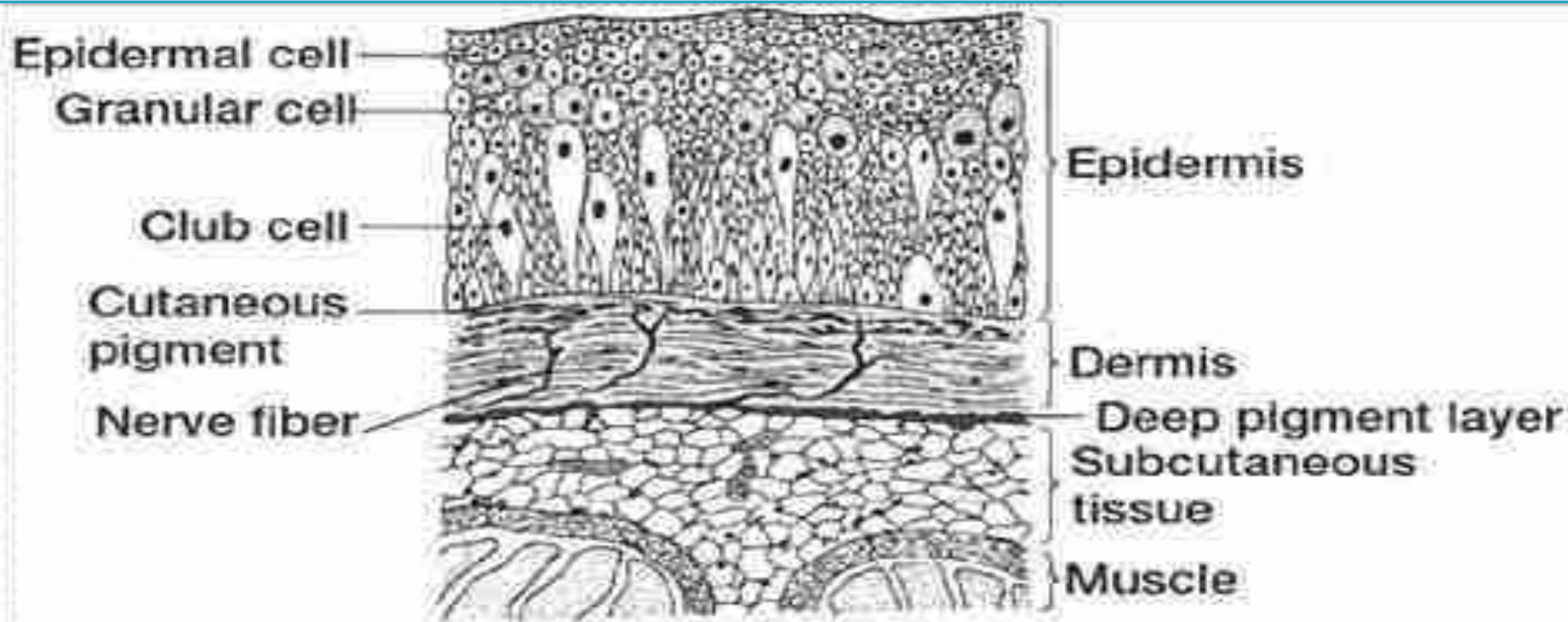
### Skin and its Derivatives

**Edit By**  
**Dr. Sura A. Munaf**

## 2. Cyclostomata (lamprey)

In, the surface of the skin is smooth, with no scales.

- The epidermis consists of several cell layers squamous epithelium), that actively secrete a thin cuticle, Granular cells, and The club cell.
- The dermis is a thin layer of connective tissue



### 3. Chondrichthyes( Shark)

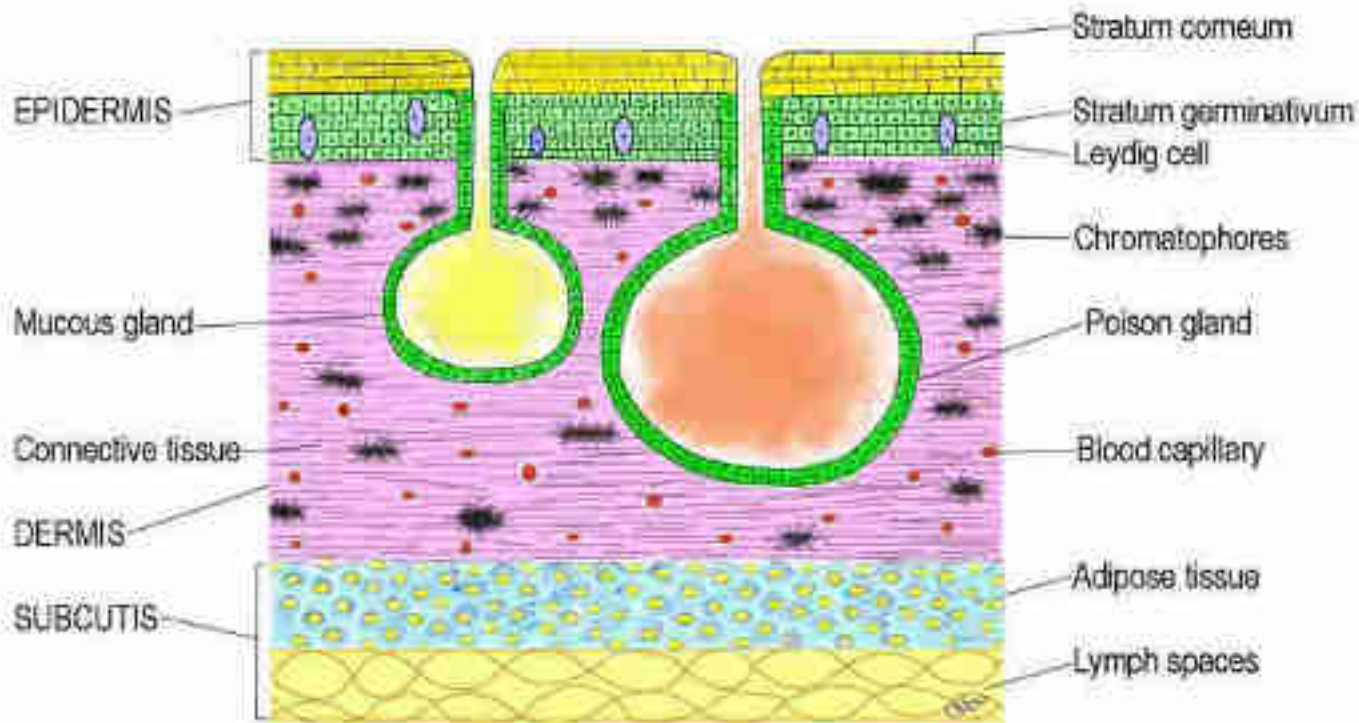
- The epidermis is composed of many layers of similar epithelial cells and goblet cell.
- Dermis is less vascularized and has no layers.
- In some deep-sea fishes photophores are present.
- Placoid scales are present.





## 4. Amphibia:

- The epidermis has 5 to 7 layers of cells.
- mucous glands which are numerous and smaller, and poison glands are less numerous and larger
- The dermis is two-layered, an outer loose and inner compact
- Dermis is richly vascularized.

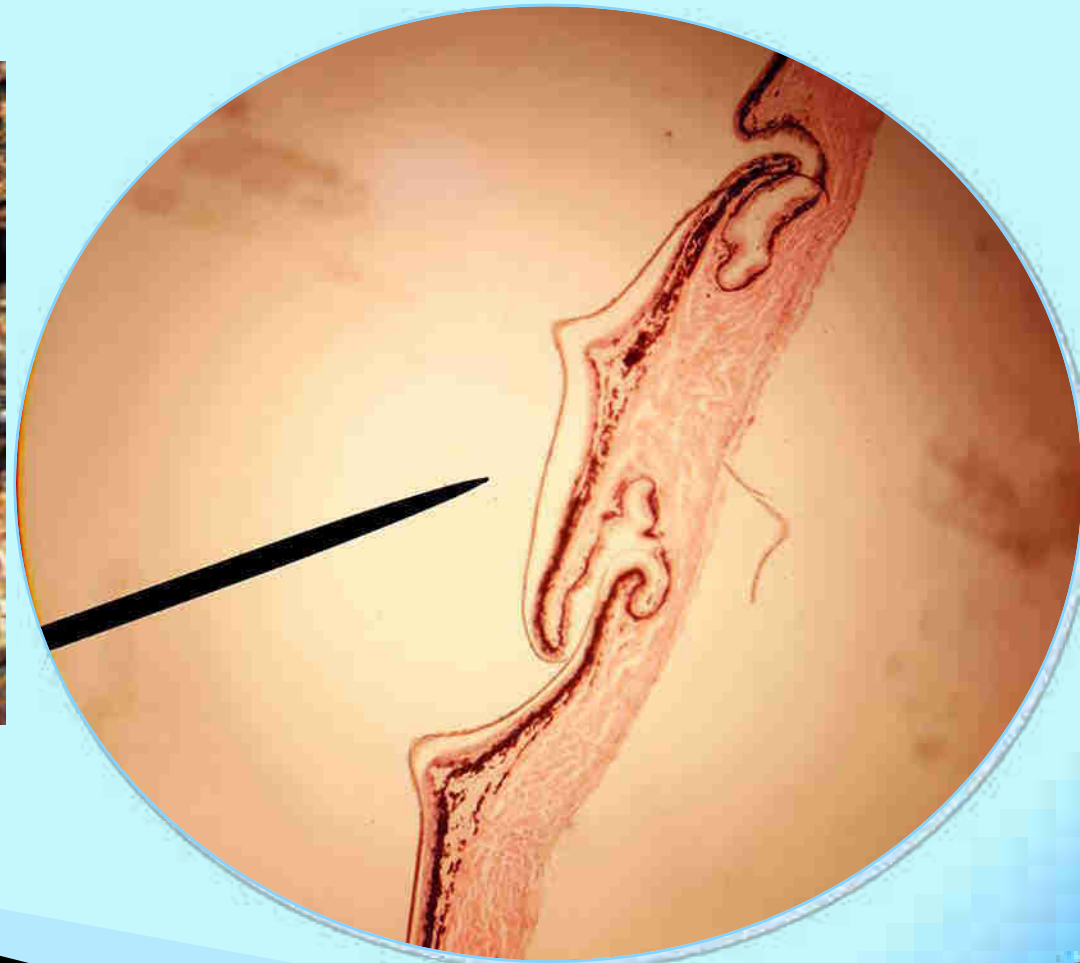


**VERTICAL SECTION OF SKIN OF FROG**



## 5. Reptilia:

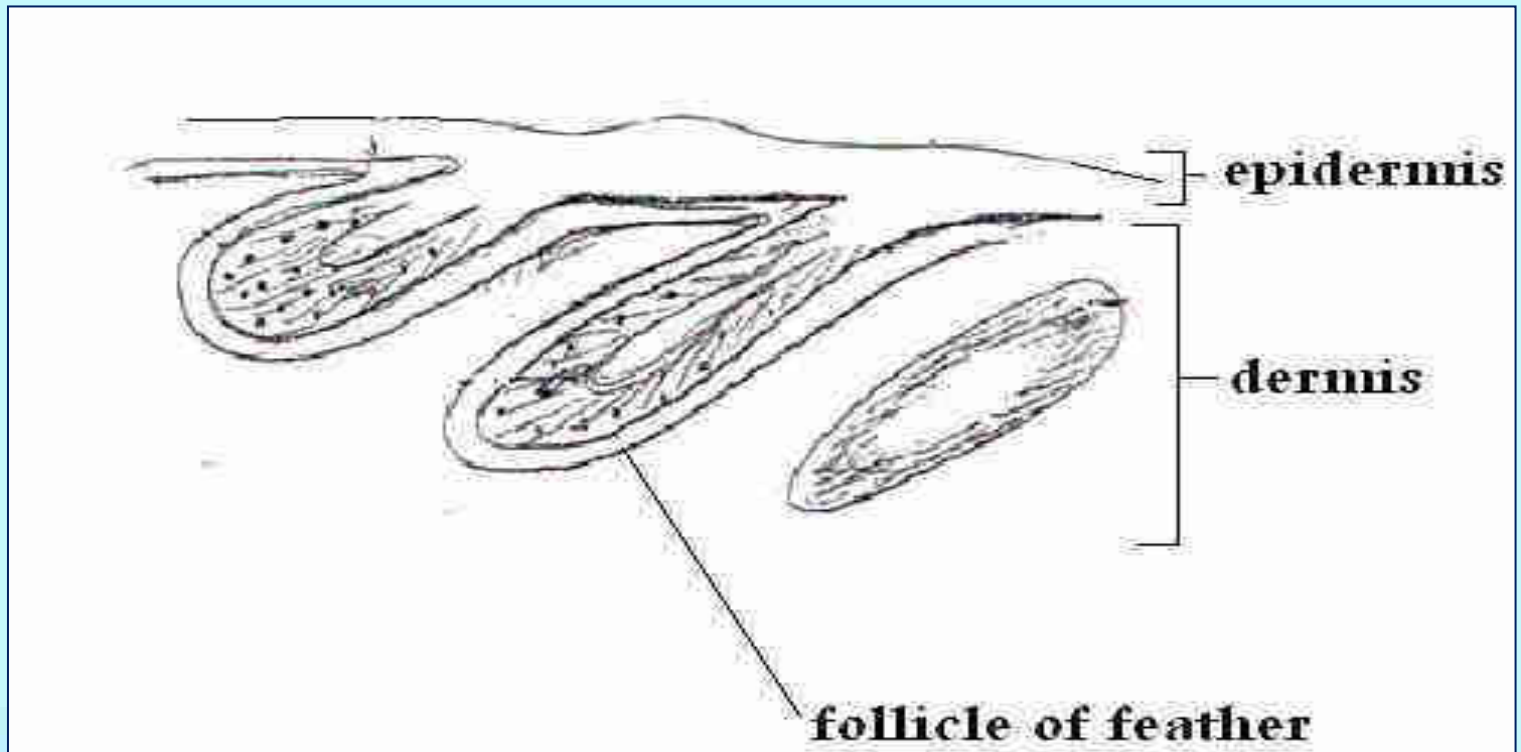
- The epidermis covered with horny epidermal scales to adapted to the life on dry land.
- The skin is dry or contain very scarce gland.
- The dermis consists of connective tissue.





## 6. Aves:

- The epidermis is thin layer and posses feather:
- The dermis is thicker and contain follicle of feather.
- No glands except the uropygial gland in the tail used to preen its feathers.
- The dermis consists of connective tissue.



## **6. Skin of Mammalia**

➤ **The epidermis is thicker than dermis and consist of five layers :-**

- **Stratum corneum**
- **Stratum lucidum.**
- **Stratum granulosum.**
- **Stratum spinosum.**
- **Stratum germinativum. (Be Smiley to Gain Love & Confidence)**

➤ **The dermis consists of two layers:-**

- **Outer layer: Loose connective tissue.**
- **Inner layer: compact connective tissue**

➤ **The skin of mammals contains some glands like sebaceous gland and sweat gland, and the color of skin refer to presence of melano cell in the epidermis.**

Lab.3

# DERIVATIVE OF SKIN

## ➤ **1.Epidermal derivative :**

➤ Scales in Reptiles and birds.

➤ Horns: the hollow horn in cattle ( ox ,goat and sheep)

➤ Claws, Nail & Hoof: it found in amniotes (reptilian ,birds &mammals) ,

➤ Feathers: there are three principal types .

➤ Hair in mammals

## ➤ **2-Dermal derivatives:-**

➤ Scales of fish

➤ The external skeleton of Turtle

# 1. MAMMALS EPIDERMAL DERIVATIVES

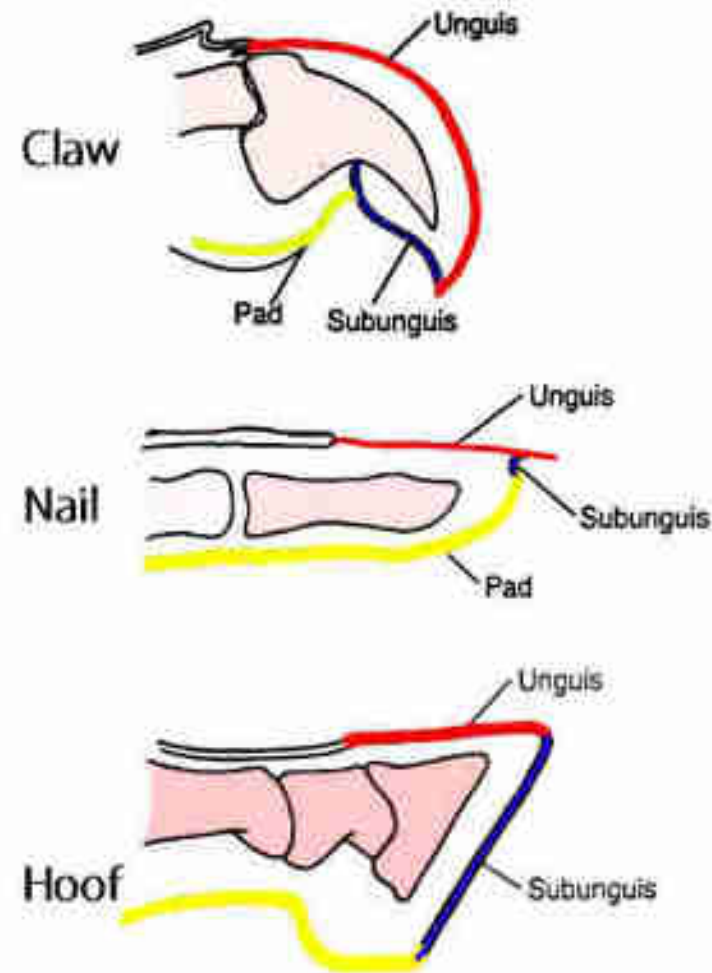
- **HAIR:** shaft, bulb, root
- **NAILS:** lunula, nail bed root
- **CLAWS:** cats, monkeys, etc.,
- **HOOVES:** ungulates ; cow, goat, etc.
- **Horns:** ungulates ; cow, goat, etc.

# MAMMALS EPIDERMAL DERIVATIVES

## 4: Claws are present in amniotic classes

### The claw consists of two parts:

- The dorsal **unguis** made of keratin, growth and is arranged in layers at an oblique angle
- Ventral **subunguis** is the soft and flaky



# MAMMALS EPIDERMAL DERIVATIVES

## 5: Horn and Antler



### Antlers ...

- Are shed & re-grow
- Are made of bone
- Have branches or "points"
- Antlers belong to the cervids. That includes all deer, elk, moose and caribou



### Horns ...

- Are permanent
- Are made of (keratin)
- Have no branches or "points"
- Horns belong to the bovids: animals such as sheep, goats, cows, and bison





## 2-Birds epidermal derivatives:

- **Beak** for preening, nesting, food
- **Feather** for insulation, flight, and body counter
- **Claws** in
- **Scales** in bird & reptilian



## Lab.4

# Classification

Kingdom: Animalia

Phylum: Chordata

Subphylum: Cephalochordata

Species: *Branchiostoma lanceolatum*

Common name: Amphioxus or Lancelet



# External Morphology

- The body is **elongated**, fish like, semi-transparent and laterally compressed. It measures about 5-7 centimetres in length
- The body of the amphioxus is divided into two parts: The **trunk** and **tail**. The head is absent.
- The paired fins are absent, but unpaired fins such as a **dorsal fin**, running along the whole length, a caudal fin, around the tailed a **ventral fin**, are present.

- The trunk bears three openings: the **mouth**, **atripore** and **anus**.

The anterior end of trunk is called **rostrum**.

- The mouth lies below the rostrum. It leads into **oral hood** formed by dorsal and lateral projections of the body. The edge of the oral hood is provided with 10 - 11 pairs of **oral cirri** or **tentacles**. These cirri help in filter feeding and draw water current towards pharynx.

- The oral hood encloses a cup shaped buccal cavity called **vestibule**.
- The **anus** lies at the base of caudal fin on the ventral side.
- The **atripore** is a small mid-ventral aperture situated in front of the ventral fin.



# Internal Anatomy

- The dorsal **nerve cord** lies above and supported by a muscularized rod or notochord that extending from the anterior to the posterior end of the body.
- The body is covered by a thin external **cuticle** secreted by the simple epithelial epidermis.
- Beneath the skin and visible through it are sixty pairs of **myotomes** which alternate with one another along the two sides of the body. These myotomes are greatly thickened along the dorsal side of the body. Each myotome is V-shaped and separated by **myosepta**.

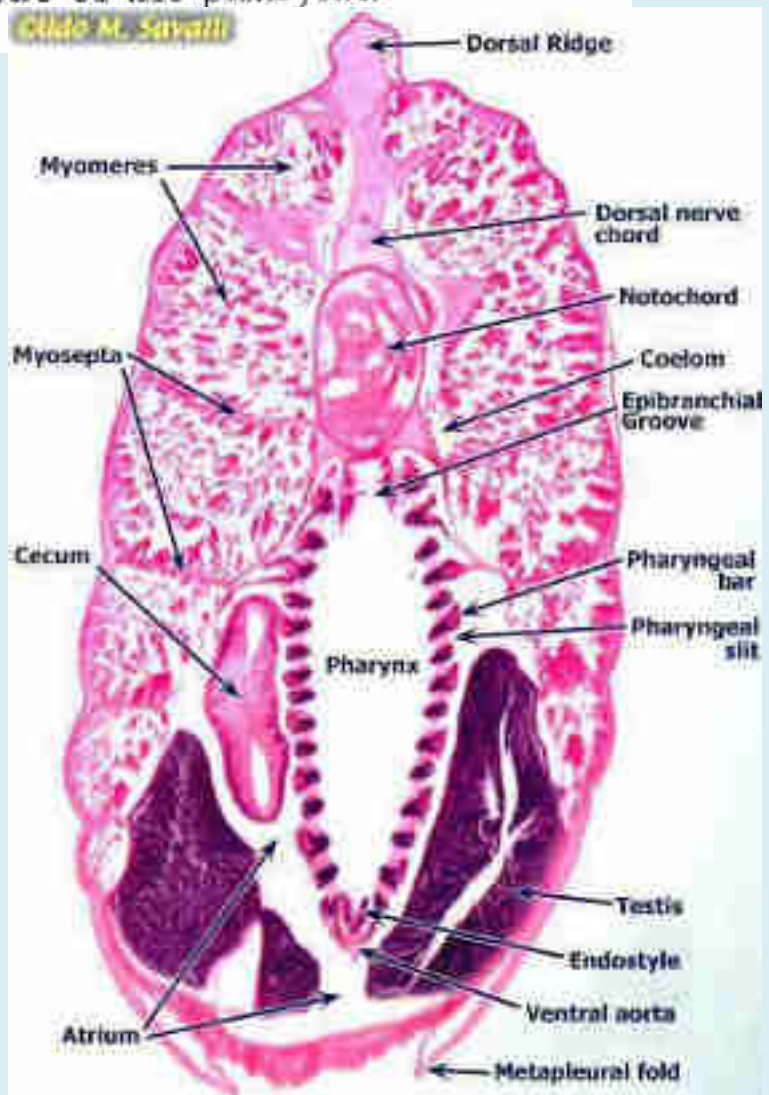
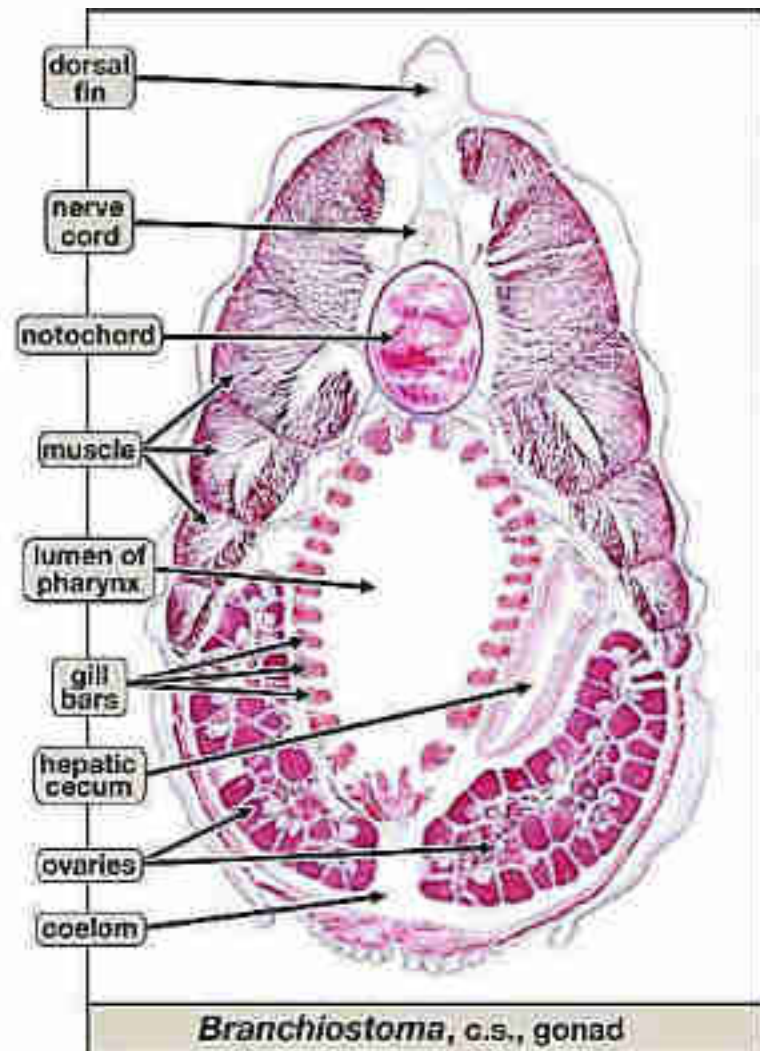
- There are no true vertebrae.
- The wall of pharynx is perforated by over 100 **pharyngeal slits** or "**gill slits**", which are used to strain food particles out of the water. These slits are separated by oblique bars called **primary and secondary gill bars**. Primary gill bars are connected to each other by cross-bars or **synapticulae**.
- The **atrial chamber** which surrounds the elongated pharynx is formed by the union of paired lateral folds which meet in the mid-ventral line of the body. Such a structure seems to be an adaptation to the sand-burrowing habit of the adult animal.



- Ninety pairs of **nephridia**, limited to the gill-region, open into the atrial cavity.
- The nervous system is tubular and dorsal. The **brain** is a simple vesicle and the nerves are of two kinds, **dorsal** (sensory and motor) and **ventral** (motor). Sense organs are also poorly developed.

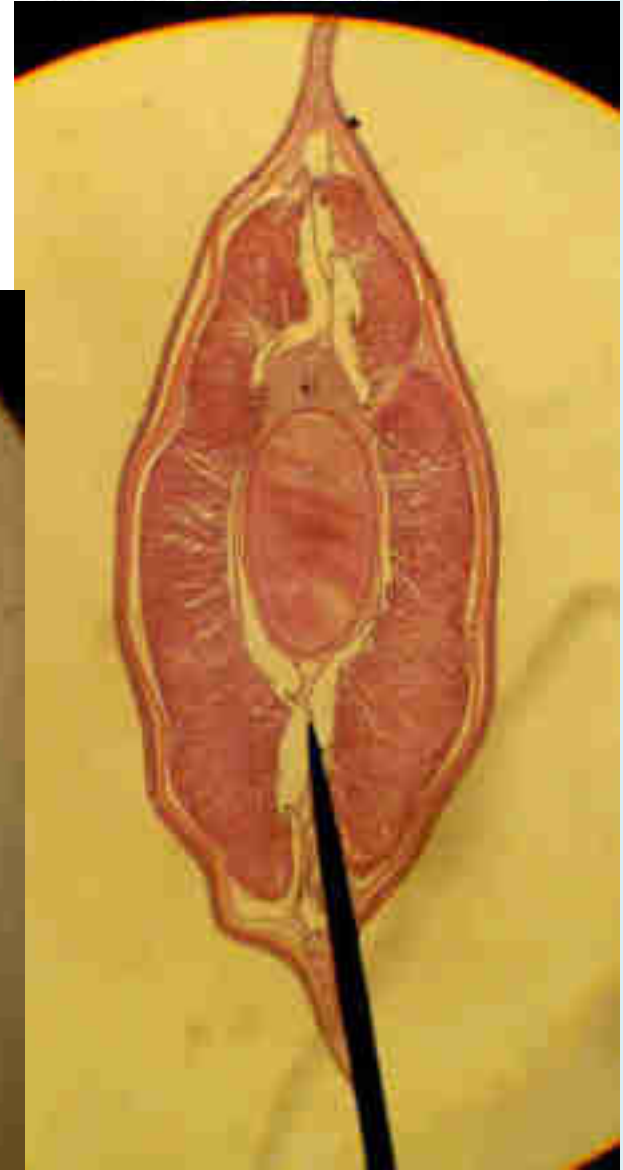
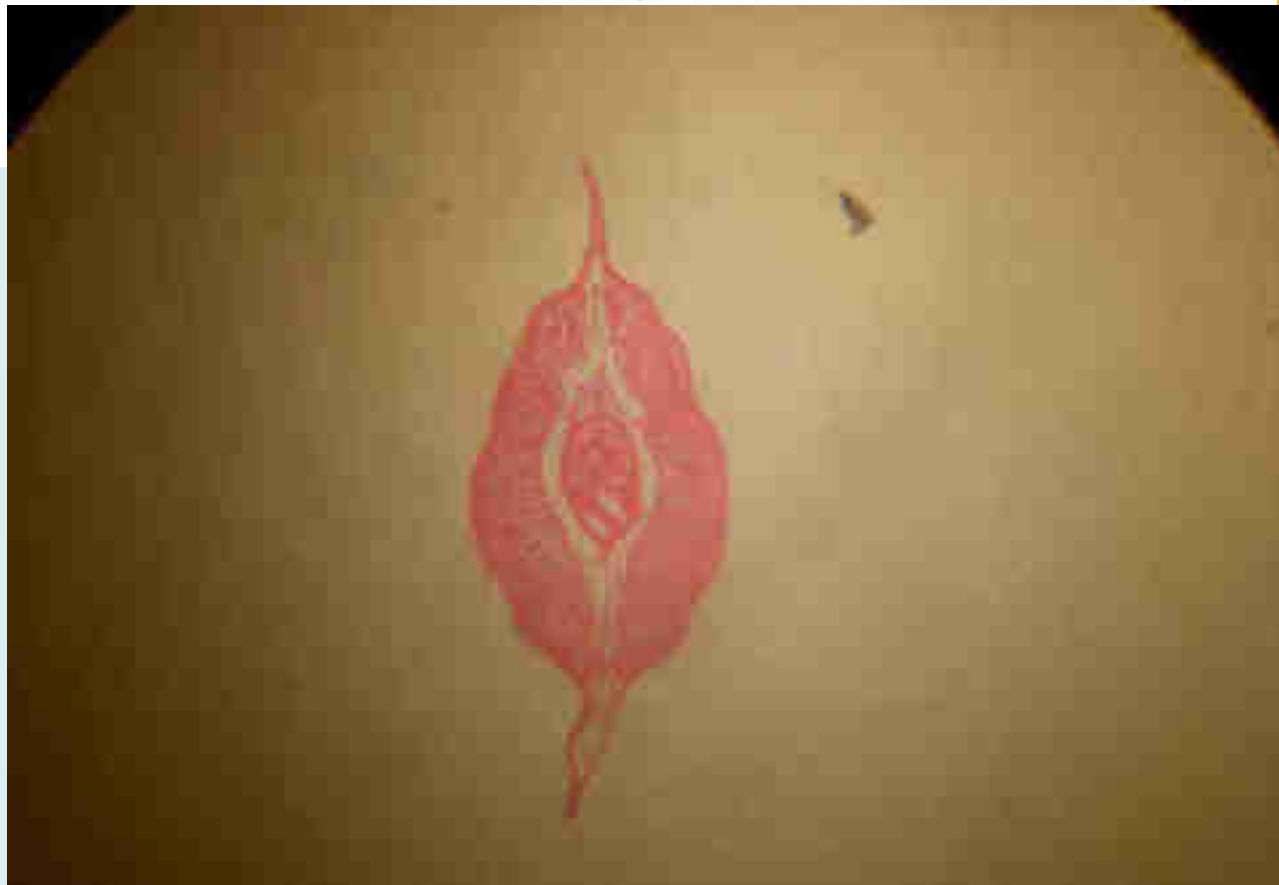
# C.S. of pharyngeal region

- Notochord, nerve cord, pharynx with gill bars.
- The gonads, one pair in the section on each side of the pharynx.



# C.S. of tail region

- The dorsal lobe and ventral lobe of caudal fin.
- Myotome and myoseptum.
- Caudal artery and caudal vein.



## Lab.5

### Classification

Kingdom: Animalia

Phylum: Chordata

Subphylum: Vertebrata

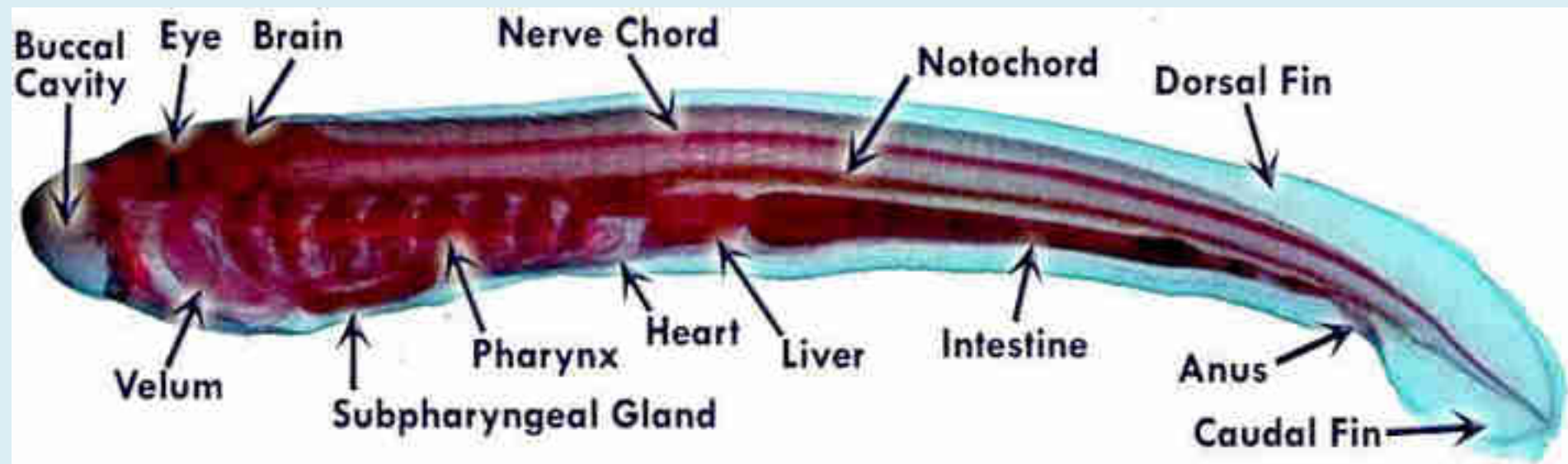
Class: Cyclostomata

Species: *Petromyzon marinus*

Common name: Sea lamprey.





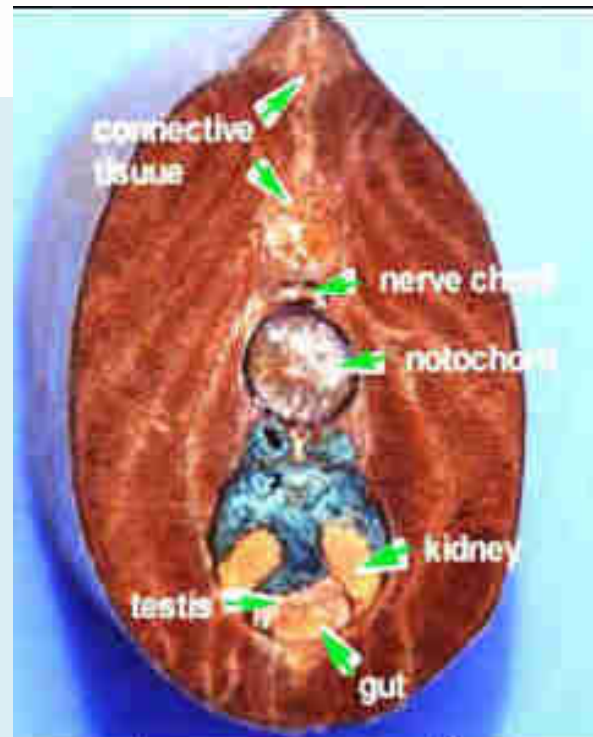




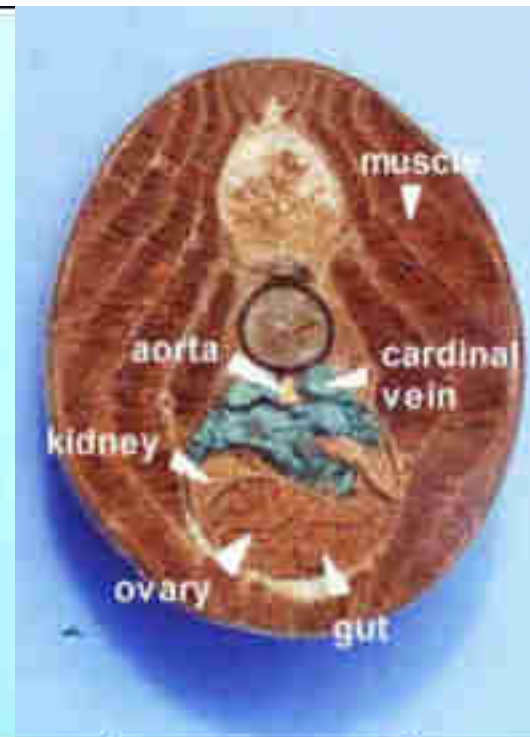
### 3. C.S. in Posterior Trunk Region

This section shows:

Dorsal fin, notochord, nerve chord, myotomes, two posterior cardinal veins and dorsal aorta in between them. Gonad (testes, ovary), liver, kidney and intestine (where as small tube ventral to gonad) may be shown.



Lamprey cross section  
(male)



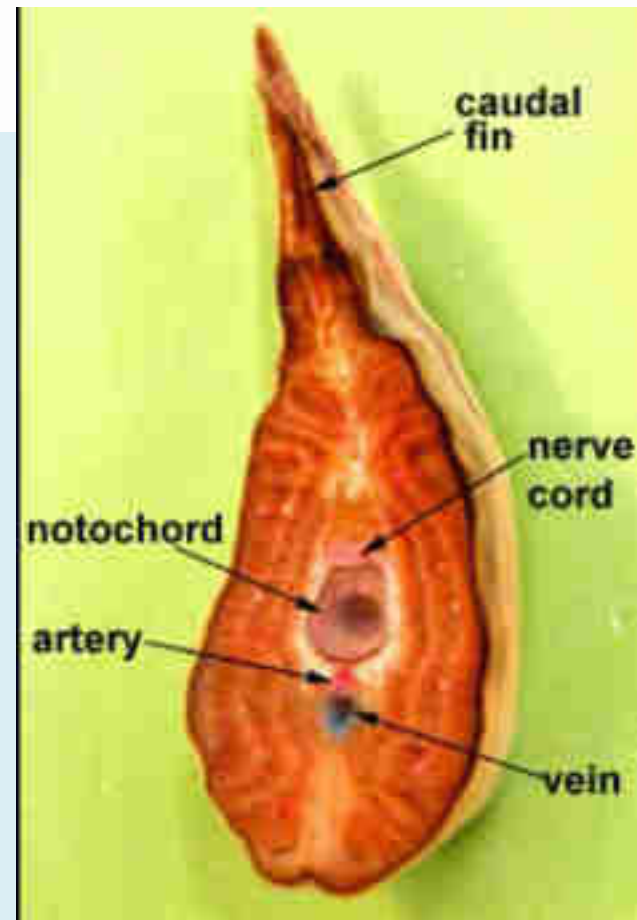
Lamprey cross section  
(female)



## 4. C.S. in Tail Region:

This section shows:

**Notochord, nerve chord, myotomes, myoseptum, caudal artery, caudal vein and caudal fin.**



## The Ammocoete Larva

- The ammocoetes, which closely resembles cephalochordates such as *Branchiostoma* (amphioxus).
- The larvae live in freshwater streams, burrow in sediments, and are filter feeders utilizing phytoplankton. They live two to six years before metamorphosing into parasitic adults.
- At the anterior end of the head a large **oral hood** expands to form the the adult buccal funnel. The hood is covered by **buccal cirri** (= **oral papillae**), which are easily seen with magnification. The posterior wall of the hood is the **velum**, a vertical, muscular, transverse partition covered by larger **buccal cirri**. The cirri play a role in selecting or rejecting food by the filter feeding ammocoetes. The large **mouth** is an opening in the center of the velum. The oral hood has **upper and lower lips**.
- The **gill pouches** are eight pairs in number and this larva has a spherical **gall bladder** as a part of digestive system.

## Lab.6

# *Squalus acanthias* (Dogfish)

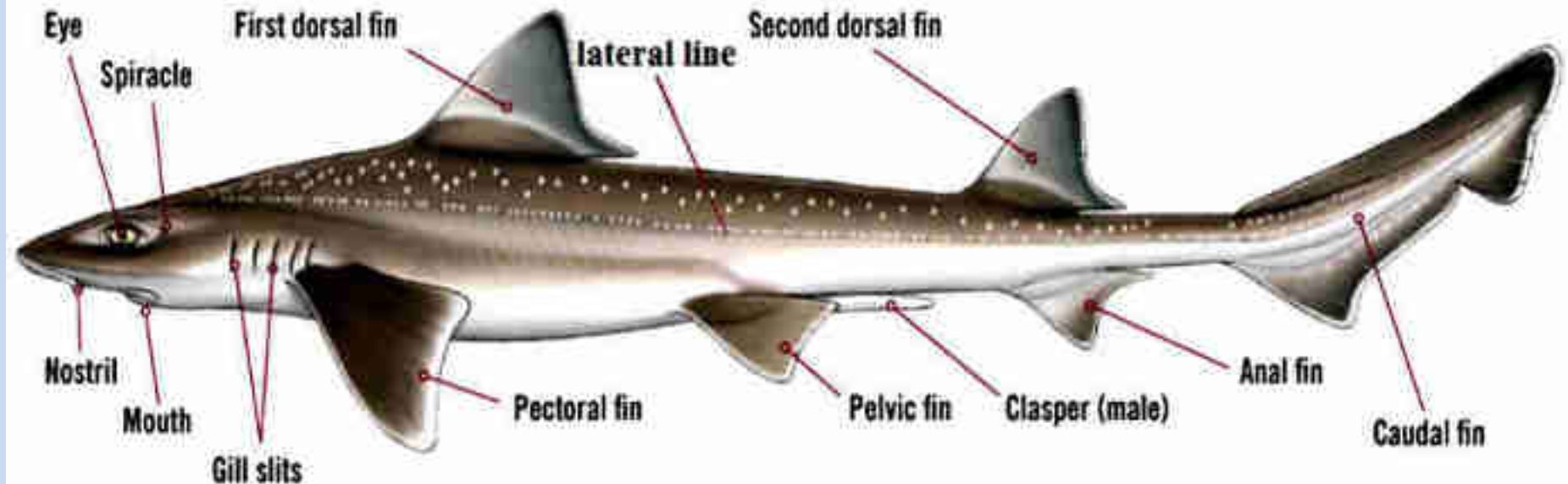
**Kingdom:** Animalia **Phylum:** chordate

**Subphylum:** Vertebrata

**Super class:** Pisces

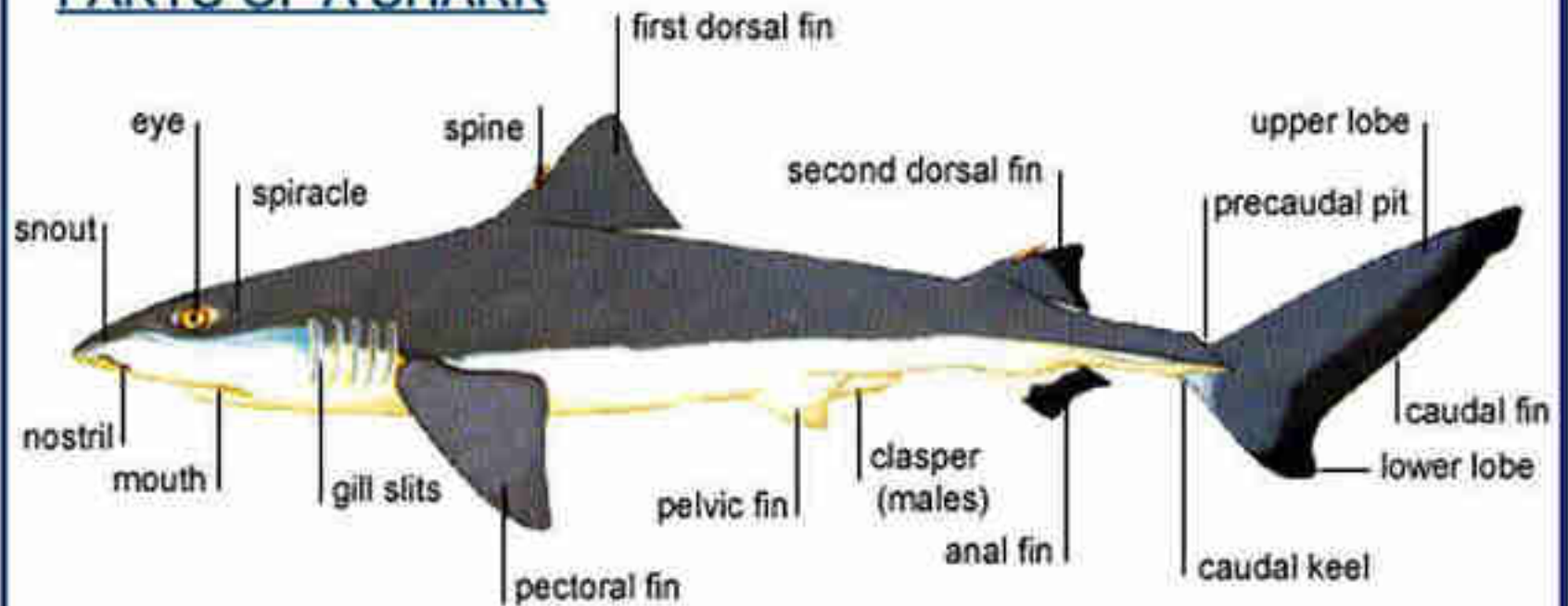
**Class:** Chondrichthyes

**Ex:** *Squalus acanthias* (Dogfish)



- **Caudal fin** is divided into two lobes: a larger dorsal lobe and a smaller ventral lobe. This type of tail is known as heterocercal tail.
- Large **spiracle** openings are located posterior and dorsal to the eyes.
- Most sharks have five external **gill slits** located on their sides behind the mouth and in front of the pectoral fins.
- Males have stout, grooved copulatory organs called **claspers** on the inner side of their pelvic fins. During copulation, one of the claspers is inserted into the oviduct of the female.
- The **cloacal opening** located on the ventral surface between the pelvic fins.
- The **muscles** are arranged in W-shaped bundles called **myomeres**.

## PARTS OF A SHARK

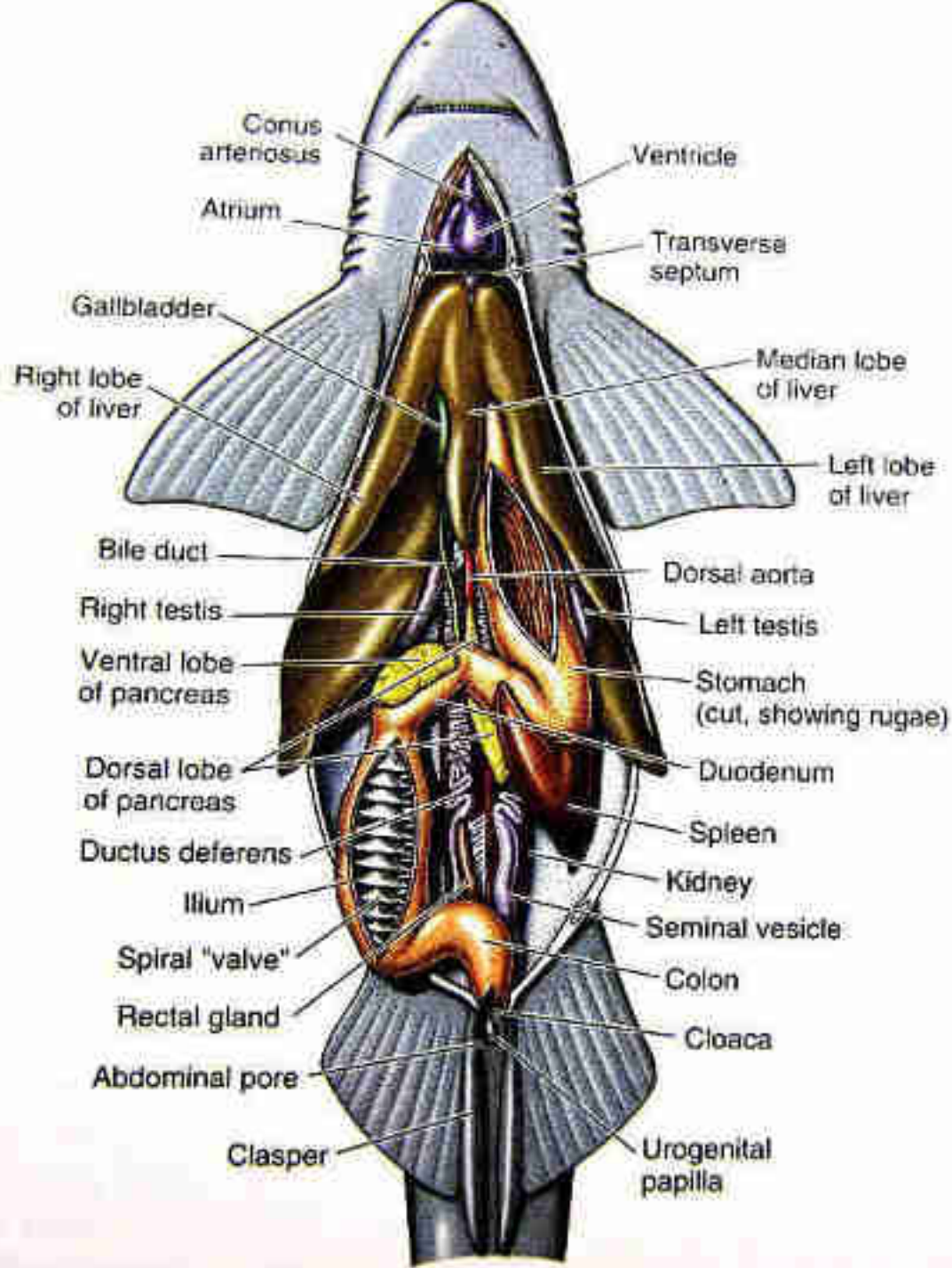


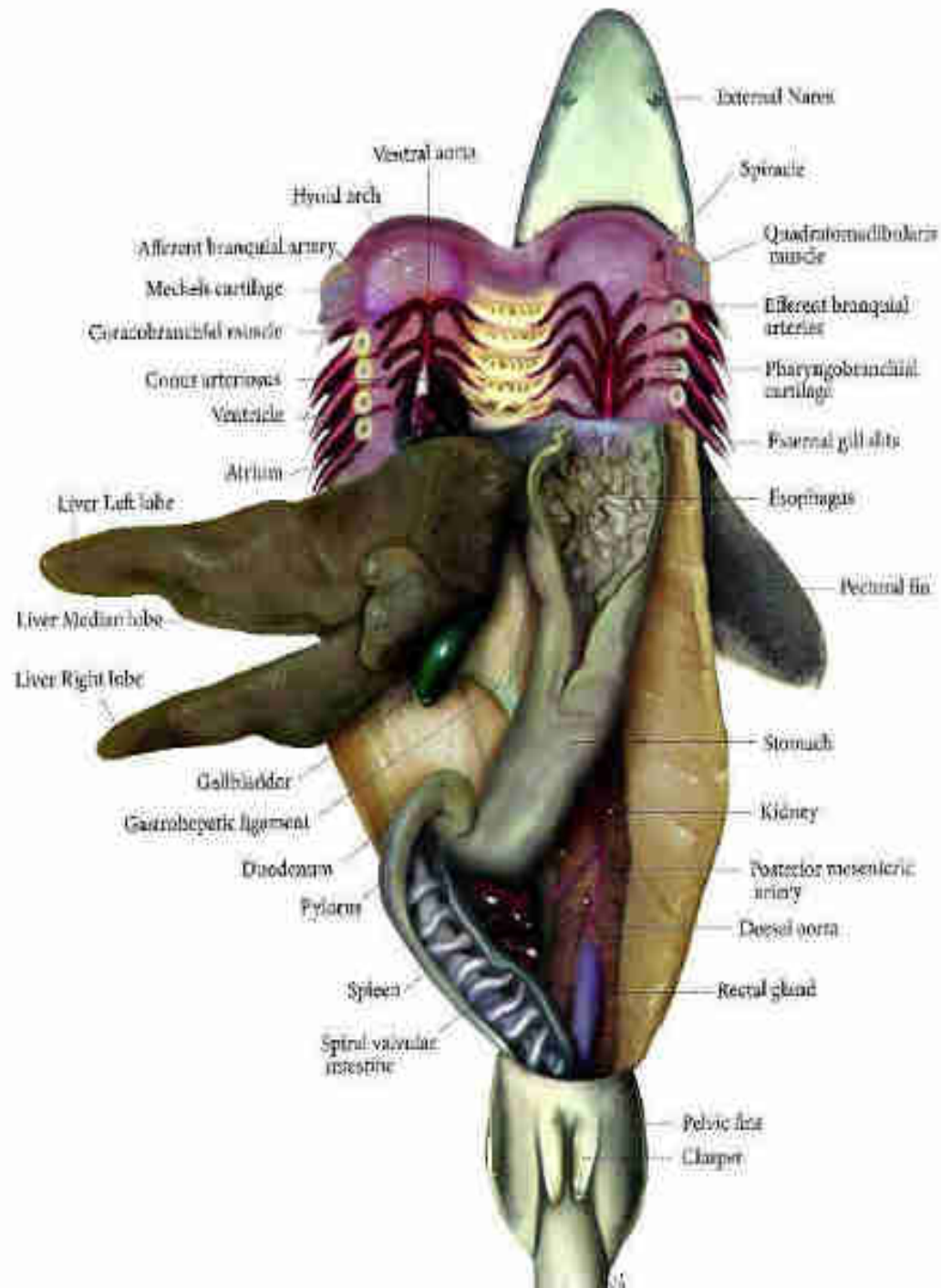


# Digestive System

- The **buccal cavity** extends from the mouth opening to **pharynx**.
- The **esophagus** is the thick muscular tube extending from the top of the cavity connecting the oral cavity and pharynx with the stomach.
- The esophagus leads into the "J"-shaped **stomach**. The upper portion is the cardiac region, and the lower portion is the pyloric region.
- The dark, triangular-shaped **spleen** is located near the posterior end of the stomach.
- The **duodenum** is a short "U"-shaped portion of the small intestine.
- The **pancreas** is located on the duodenum and the lower stomach.
- The **ileum** is the second, and much larger, portion of the small intestine. It follows the duodenum and its outer surface is marked by rings.







# Lab. 7: Common Carp

**Kingdom: Animalia**

**Phylum: Chordata**

**Subphylum: Vertebrata**

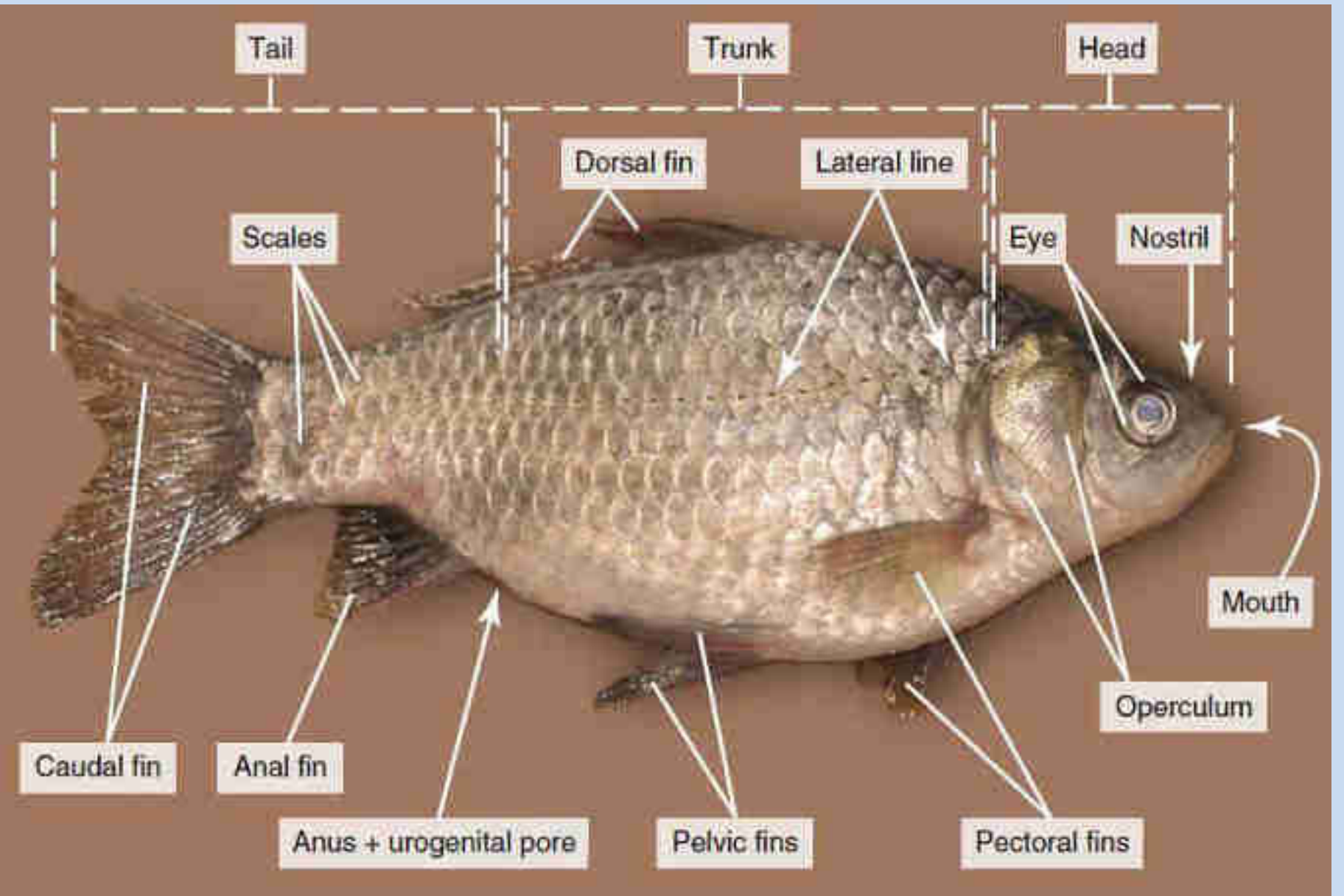
**Class: Osteichthyes**

**Ex.: *Cyprinus carpio***



## **External Feature:**

- The body of a fish is divided into a head, trunk and tail.
- The main skeletal element is the vertebral column, composed of articulating vertebrae which are lightweight yet strong.
- The head is relatively small. The lips are thick and can be extended.
- Males are usually distinguished from females by the larger ventral fin.
- The main external features of the fish, the fins. They are supported by the muscles which compose the main part of the trunk.
- Carp are characterized by their deep body and serrated dorsal spine.
- This species is omnivorous, feeding on aquatic crustaceans, insects, worms, aquatic plants, algae and seeds
- The tail has two, rounded but deep lobes. Males have a slightly larger fin on their bellies, but otherwise males and females look very much alike.





## Digestive System

- The esophagus in bony fishes is short and expandable so that large objects can be swallowed. The esophagus walls are layered with muscle
- The stomach is a bent muscular tube in a "U" or "V" shape. Gastric glands release substances that break down food to prepare it for digestion.
- At the end of the stomach, many bony fishes have blind sacs called pyloric caeca. The pyloric caeca are an adaptation for increasing the gut area; they digest food.
- The pancreas secretes enzymes into the intestine for digestion.
- Difference between a small intestine and a large intestine is indistinguishable.
- The digestive system terminates at the anus.



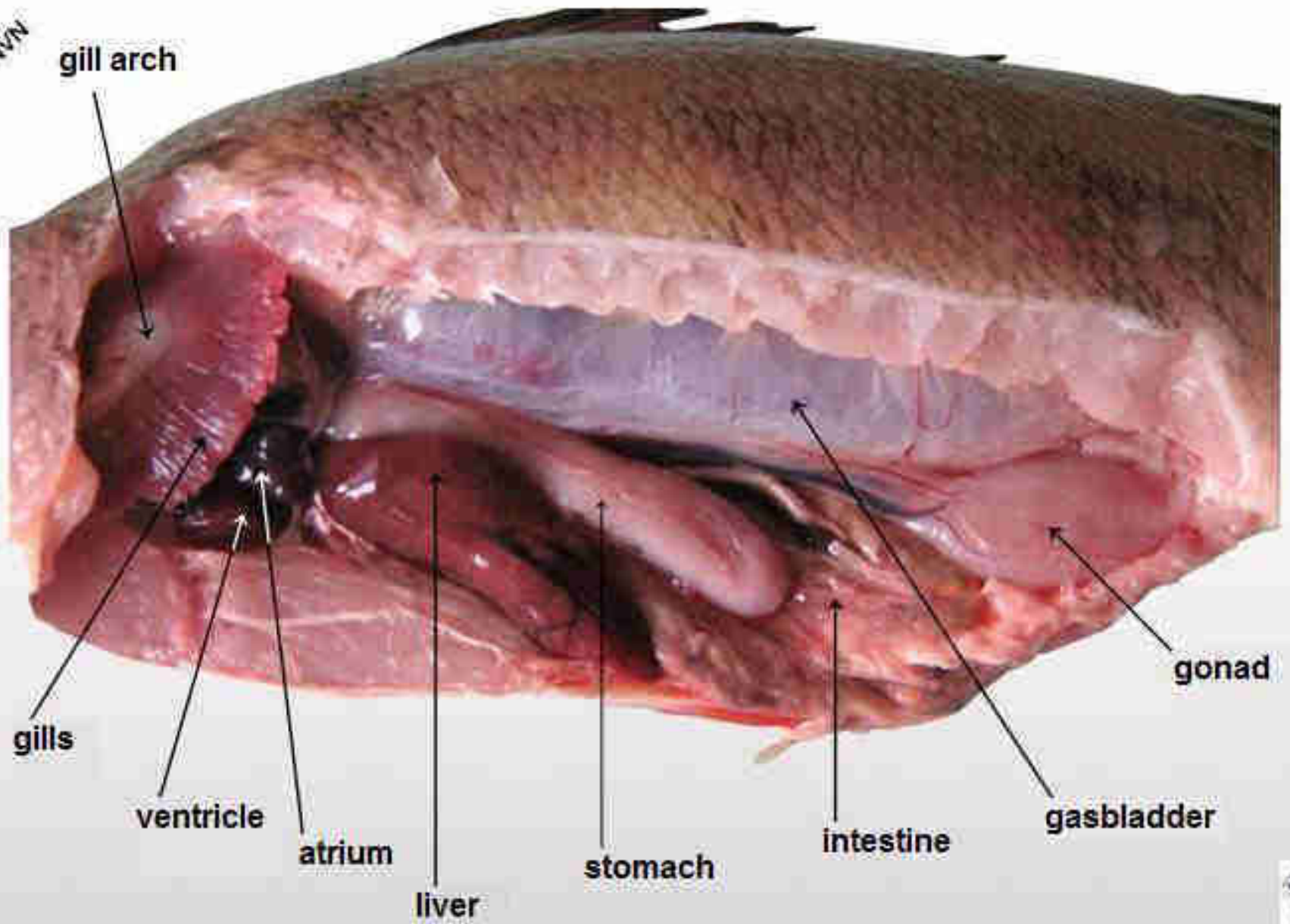
## **Circulatory System**

- **The circulatory system is quite simple. It consists of a heart, blood and blood vessels.**
- **The heart is located behind and below the gills and enclosed by pericardial membrane or pericardium.**
- **The heart consists of an atrium, a ventricle, a thin-walled structure called sinus venosus and a tube called bulbus arteriosus.**
- **Blood from the body enters the sinus venosus, moves into the atrium, then into the ventricle. From the ventricle it enters the conus arteriosus, and then goes to the gills for gas exchange.**

## **Respiratory System**

- **Water enters the gill chamber through a fish's mouth and exits through gill openings under the operculum.**
- **Blood flowing through the gill filaments absorbs oxygen from the water.**
- **The swim bladder is located in the body cavity and is derived from an outpocketing of the digestive tube. It contains gas (usually oxygen) and functions as a hydrostatic, or ballast, organ.**

Marie ENVN



# Lab: 8

## Classification

**Kingdom:** Animalia

**Phylum:** Chordata

**Subphylum:** Vertebrata

**Superclass:** Tetrapoda

**Class:** Amphibia

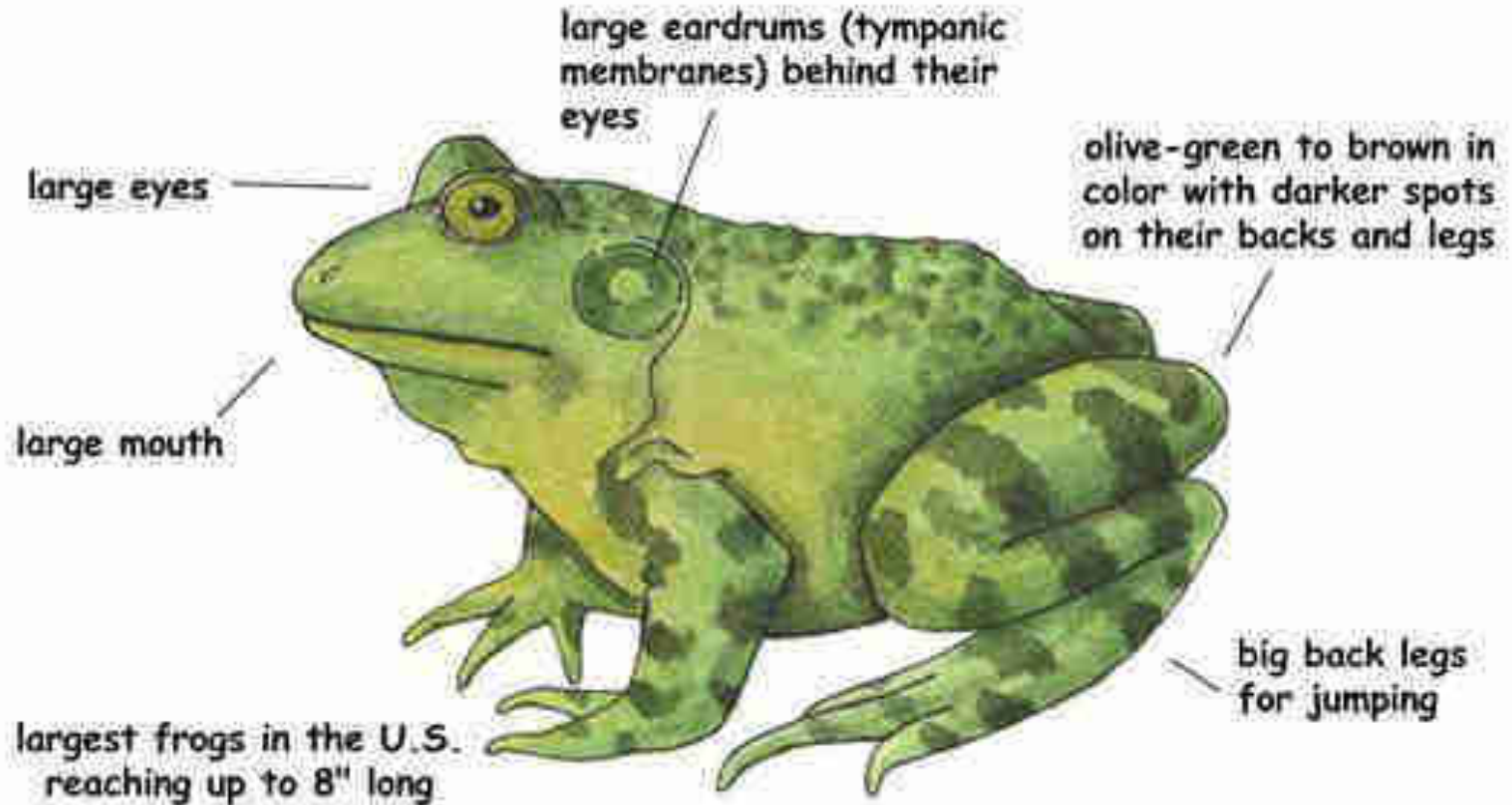
**Order:** Anura

**Ex.:** *Rana ridibunda*



# American Bullfrog

*Rana catesbeiana*





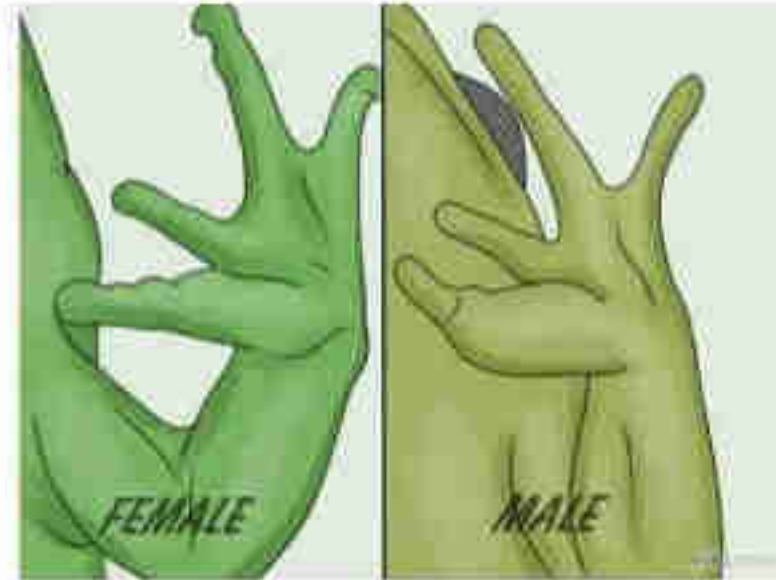


# Determine if your frog is a Male or Female



Copulatory pad of male frog

Fore limb of frog



The sex of a frog may be determined externally by examining the **thumb pads** on the front feet. The thumb pads of males are enlarged at the base as in the drawing on the right.

## **The Digestive System:**

- ✓ **The mouth opening is lead to buccal cavity.**
- ✓ **The esophagus is cylindrical, short (because of the absence of the neck region) and open into stomach.**
- ✓ **The stomach is a muscular curved sac, it has two ends: a cardiac and a pyloric end, which leads into the intestine.**
- ✓ **The intestine is long. Small intestine consists of the duodenum and ileum. Large intestine consists of rectum and opened to the cloacae.**
- ✓ **The following accessory glands connected with the digestive system: liver 3 lobes ( with gall bladder) and pancreas,.**

# *Frog Heart*

*Aortic Arches*

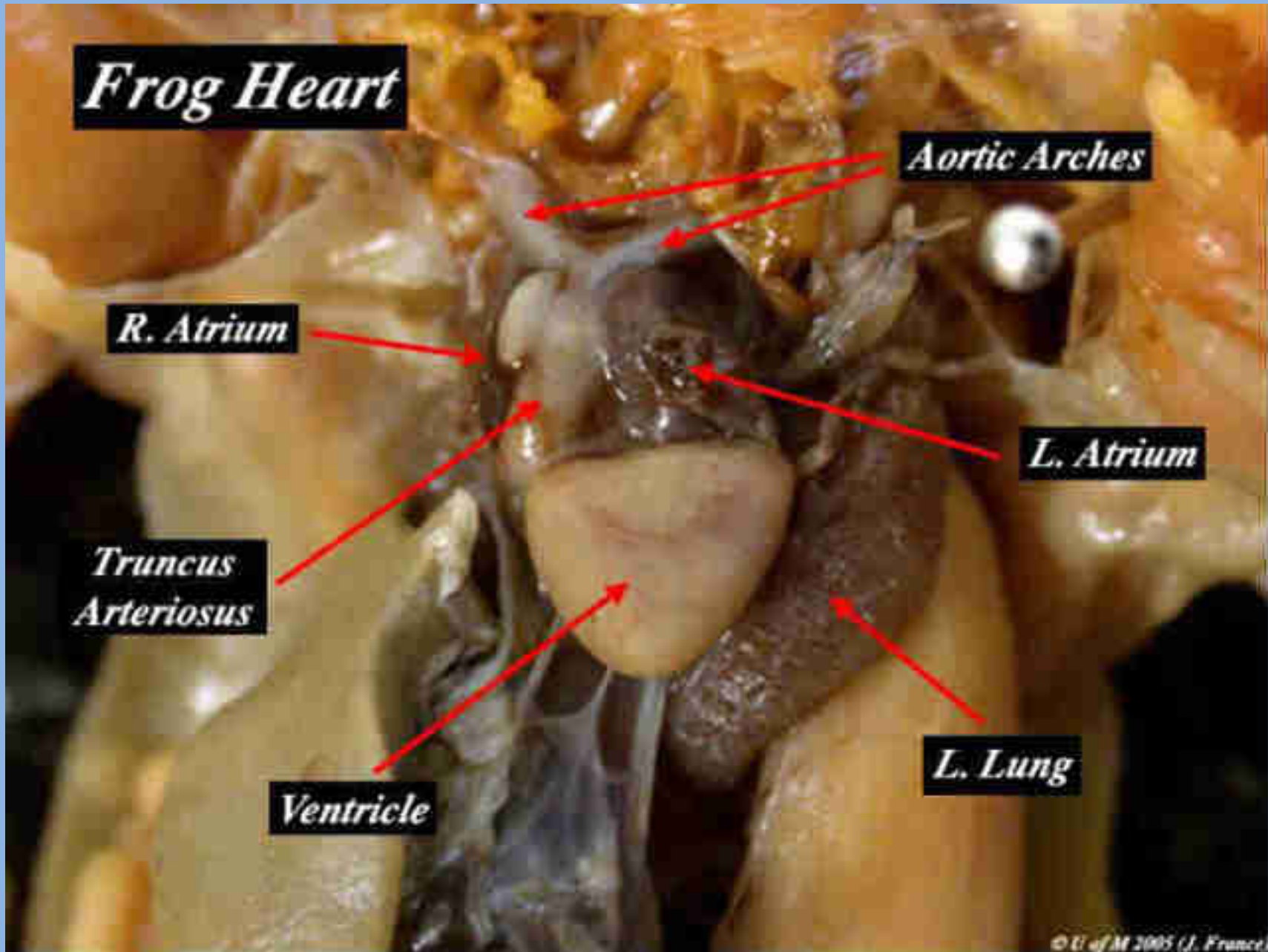
*R. Atrium*

*L. Atrium*

*Truncus Arteriosus*

*L. Lung*

*Ventricle*



# Lab: 9



## Classification

**Kingdom: Animalia**

**Phylum: Chordata**

**Subphylum: Vertebrata**

**Super class: Tetrapoda**

**Class: Reptilia**

**Order: Chelonia**

**Species: Testudo graeca (Turtle)**

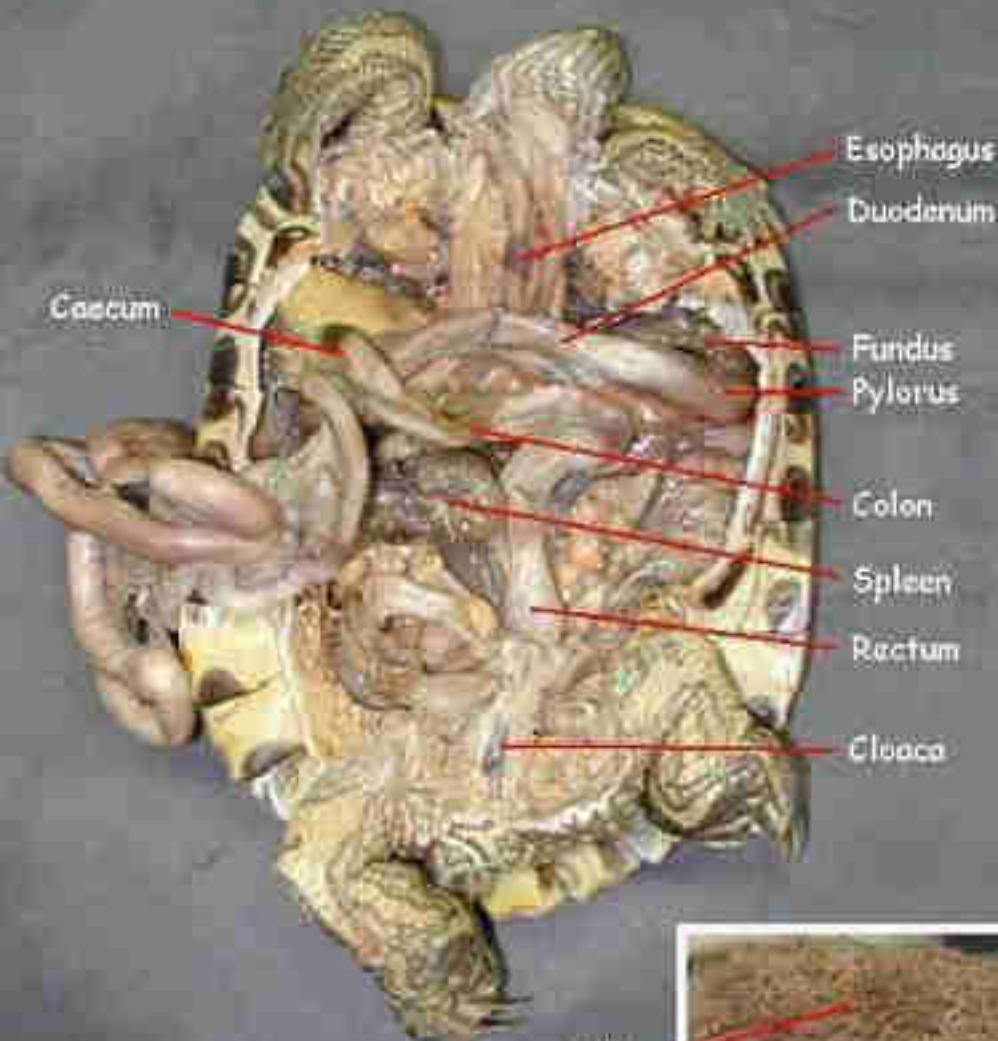
## External Morphology

- Turtles have a **head**, **tail** and **four legs** projecting from a broad **bony shell**.
- The head, legs, and tail are covered by **horny scales**, and the feet have **horny nails**.
- They have conspicuous **eyes** placed well forward on the upper sides of head.
- The eyes are provided with upper and lower **eye lids**, and additional eye lid at anterior corner.
- There is no ear on the outside of a turtle's body. But the **eardrum** is covered with head or neck scales.
- They use their **jaws** to cut and handle food. Instead of teeth, a turtle's upper and lower jaws are covered by horny ridges, similar to a bird's beak.







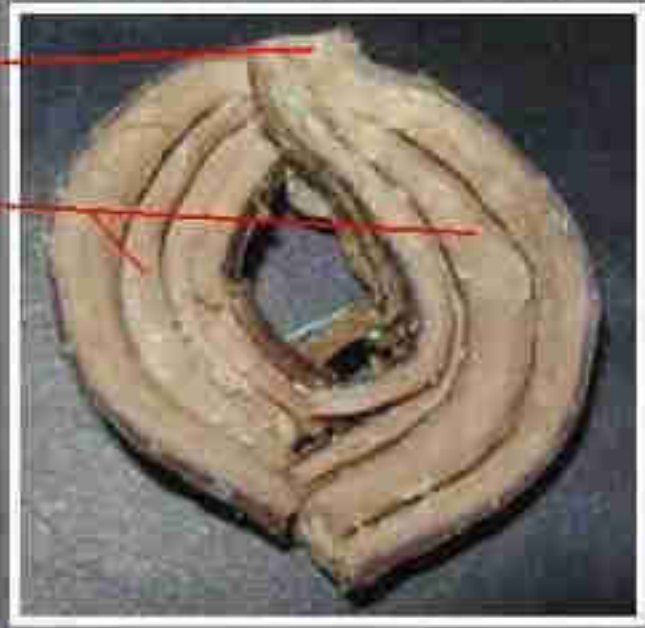


Inferior esophageal wall



Stomach interior (fundic region)

Opening to esophagus  
 Rugae



villi



Interior wall of small intestine



Trachea

Bronchi

Lungs

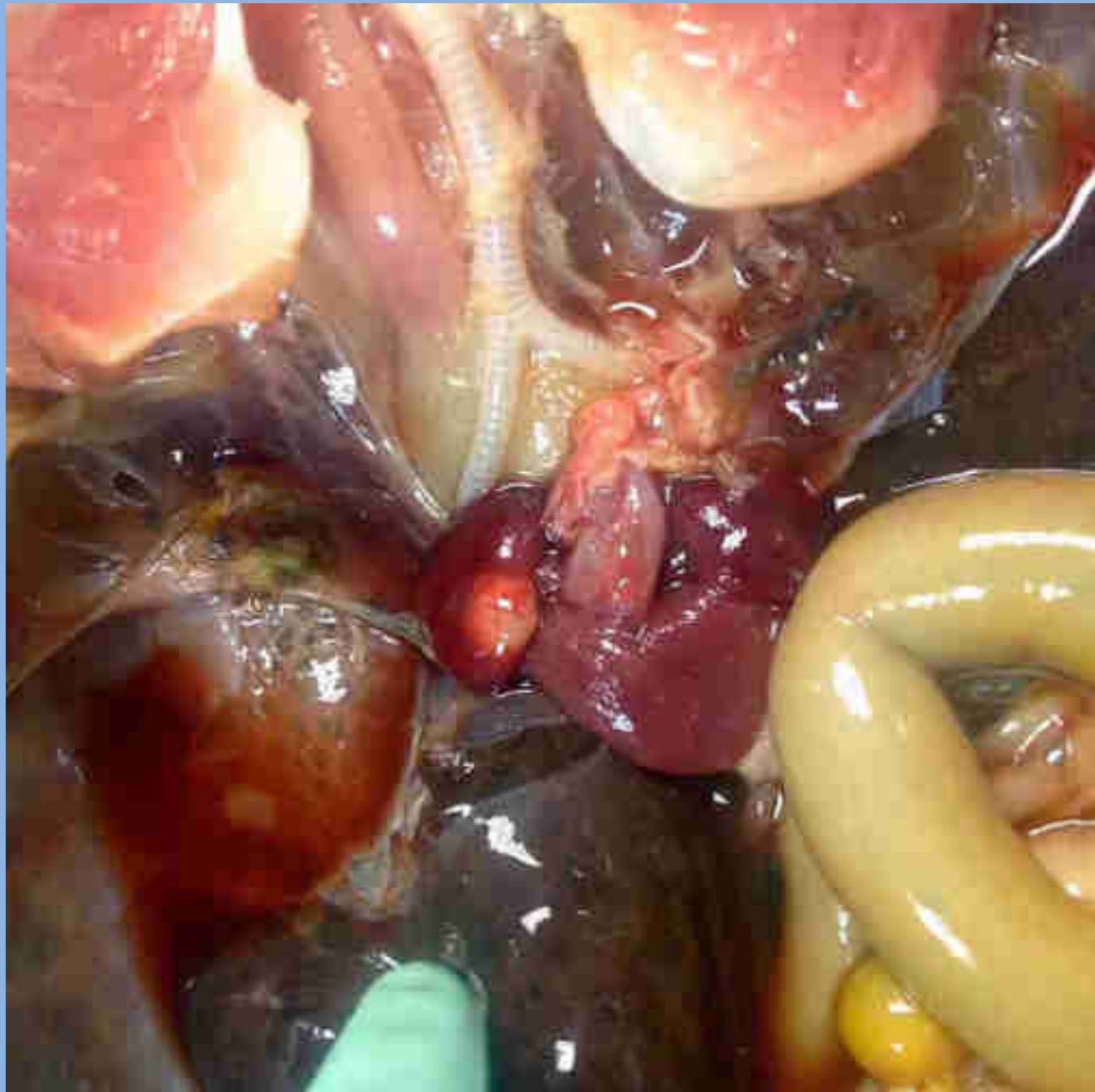


Close up of right lung

Lung interior



Faveoli





# Lab.10

## Classification

**Kingdom: Animalia**

**Phylum: Chordata**

**Subphylum: Vertebrata**

**Super class: Tetrapoda**

**Class: Aves**

**Scientific name: *Columba livia* (pigeon)**

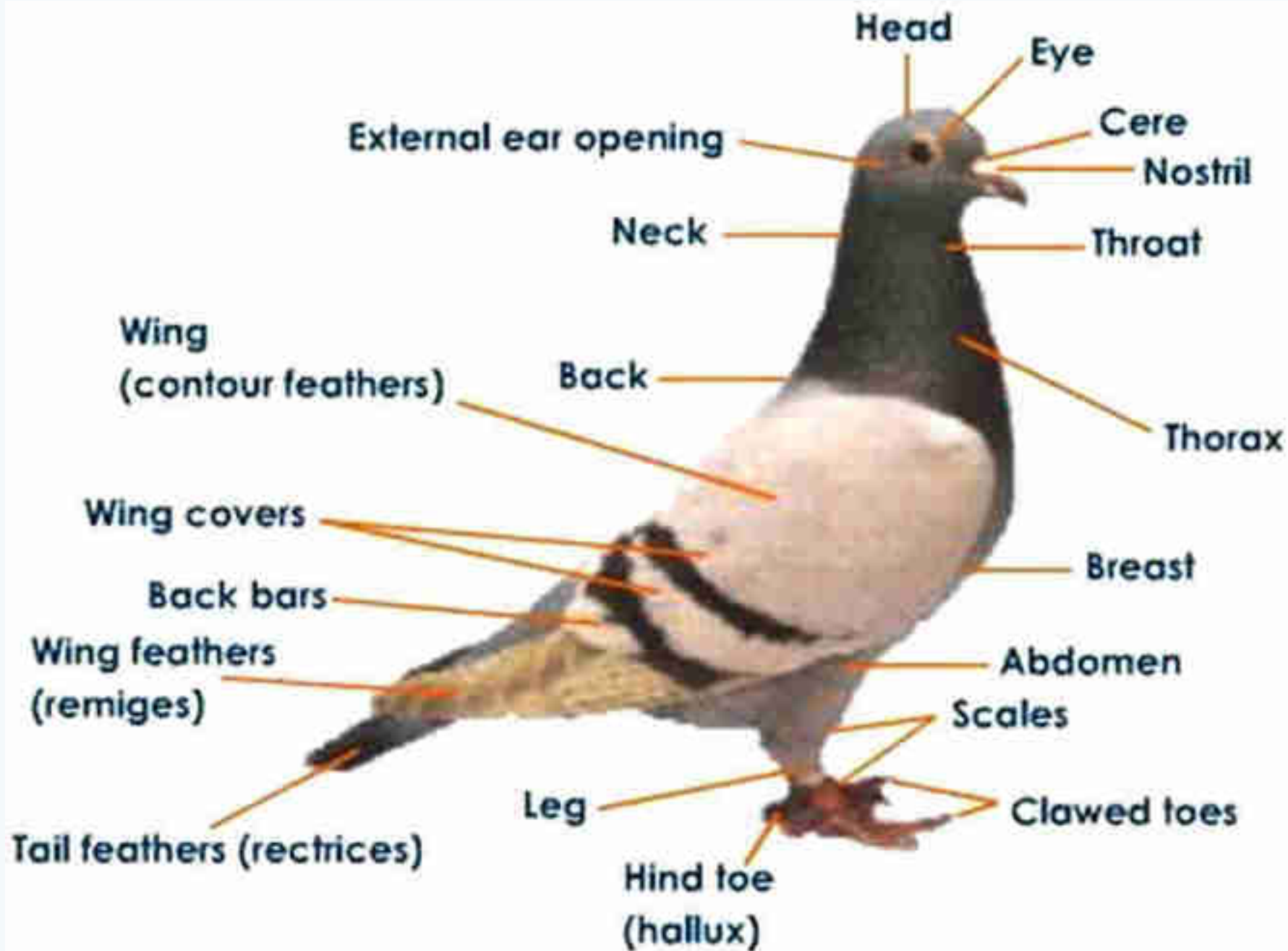


## External feature:

- Feather cover almost the whole body except the beak and feet .the body consists of head ,neck ,trunk and tail.
- **head**, the strong, horny, straight beak, at the base of which is a naked swollen portion of sensitive skin forming the cere. the two nostrils are obliquely situated in the cere ,each eye surrounded by three eye lids an upper a lower and a nictitating membrane ,posterior of the each eye ,there is an external auditory aperture.



- **The neck** is long, flexible, and can bent to form S shape
- **The trunk** is divided into a large thorax and small abdomen. Keel projects mid-ventrally which can be felt.
- **The tail** is short on the dorsal surface of the tail there is an oil or pyjeal gland , used by the bird to preen its feathers .
- The fore limbs are modified into wings.



# Respiratory System

- The **nostrils** are generally at the base of the upper mandible.
- Air passes to the **glottis** to enter the **larynx**.
- The **trachea** connects to the **syrix**, at the **tracheal bifurcation**.
- The **bronchi** connect the **syrix** to each **lung**.

**Air sacs: which are membranous extension of the two bronchi , nine air sacs are found:**

- 1. Cervical air sac:** two in number and lie at the base of neck.
- 2. Interclavicular air sac:** single and lies between the two clavicles.
- 3. Anterior thorax air sacs:** two in number.
- 4. Posterior thorax air sacs:** two in number.
- 5. Abdominal air sac:** are the largest air sac and two  
in number