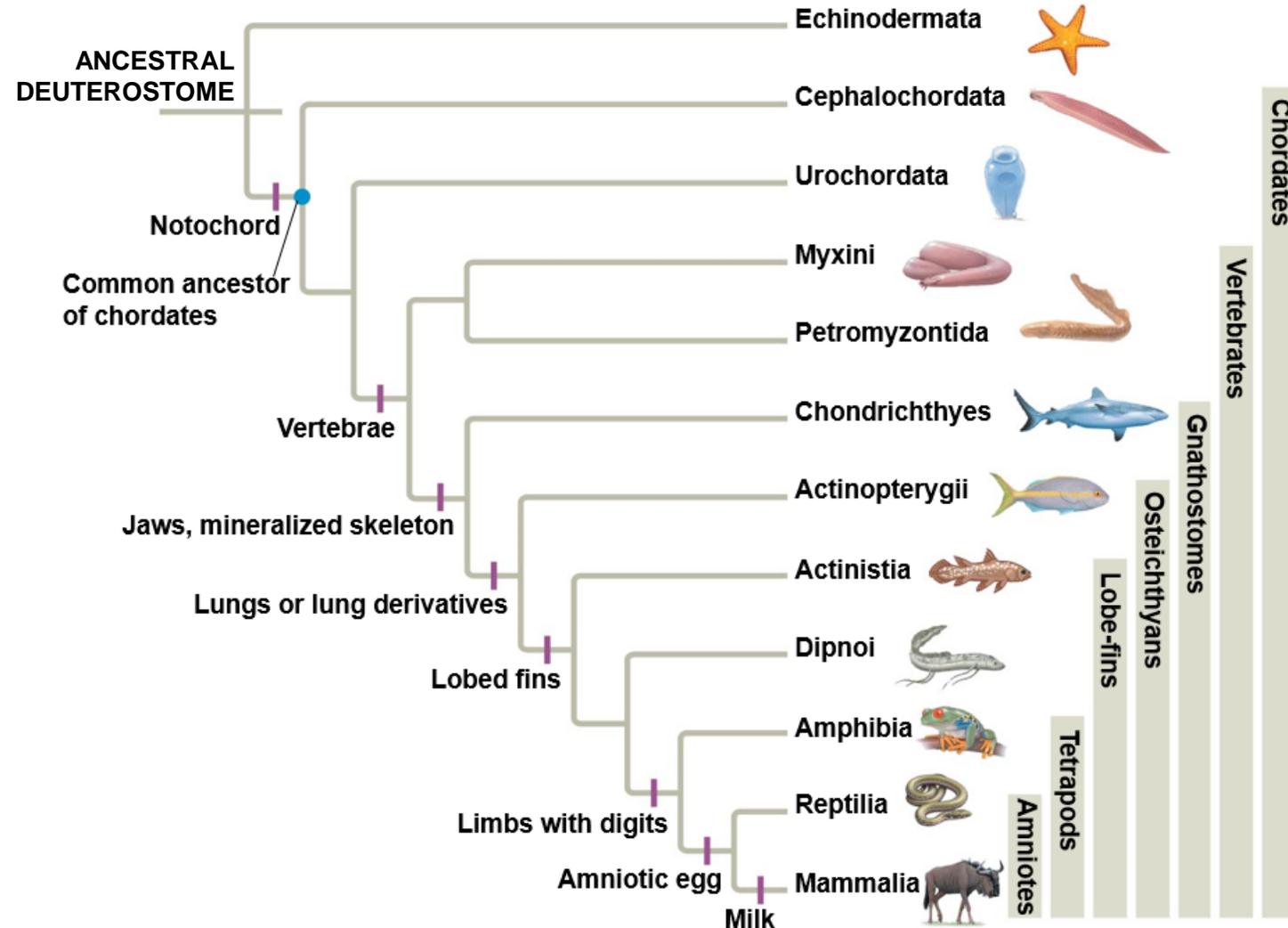


Lab 8: Chordates and Chondrichthyes

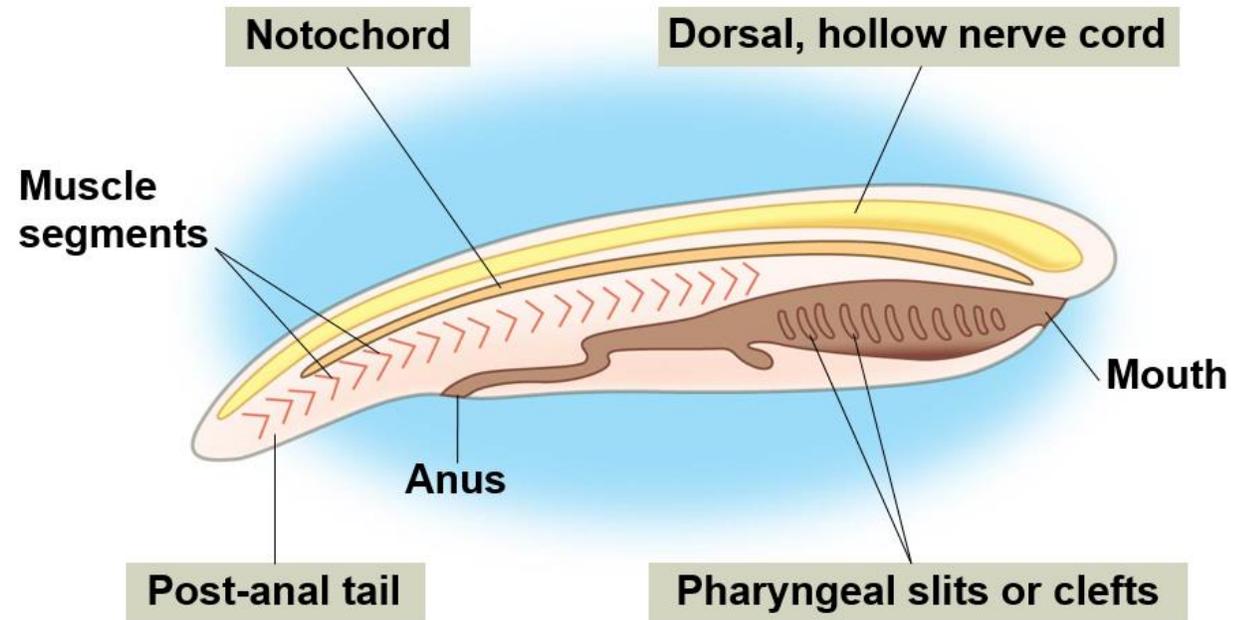
Phylum: Chordata

- ▶ Deuterostome development
- ▶ Bilateral Symmetry
- ▶ Segmented
- ▶ Coelomates
- ▶ Invertebrates and vertebrates
- ▶ Four distinct anatomical features
 - ▶ Notochord
 - ▶ Dorsal, hollow nerve cord
 - ▶ Pharyngeal gill slits
 - ▶ Muscular, post-anal tail



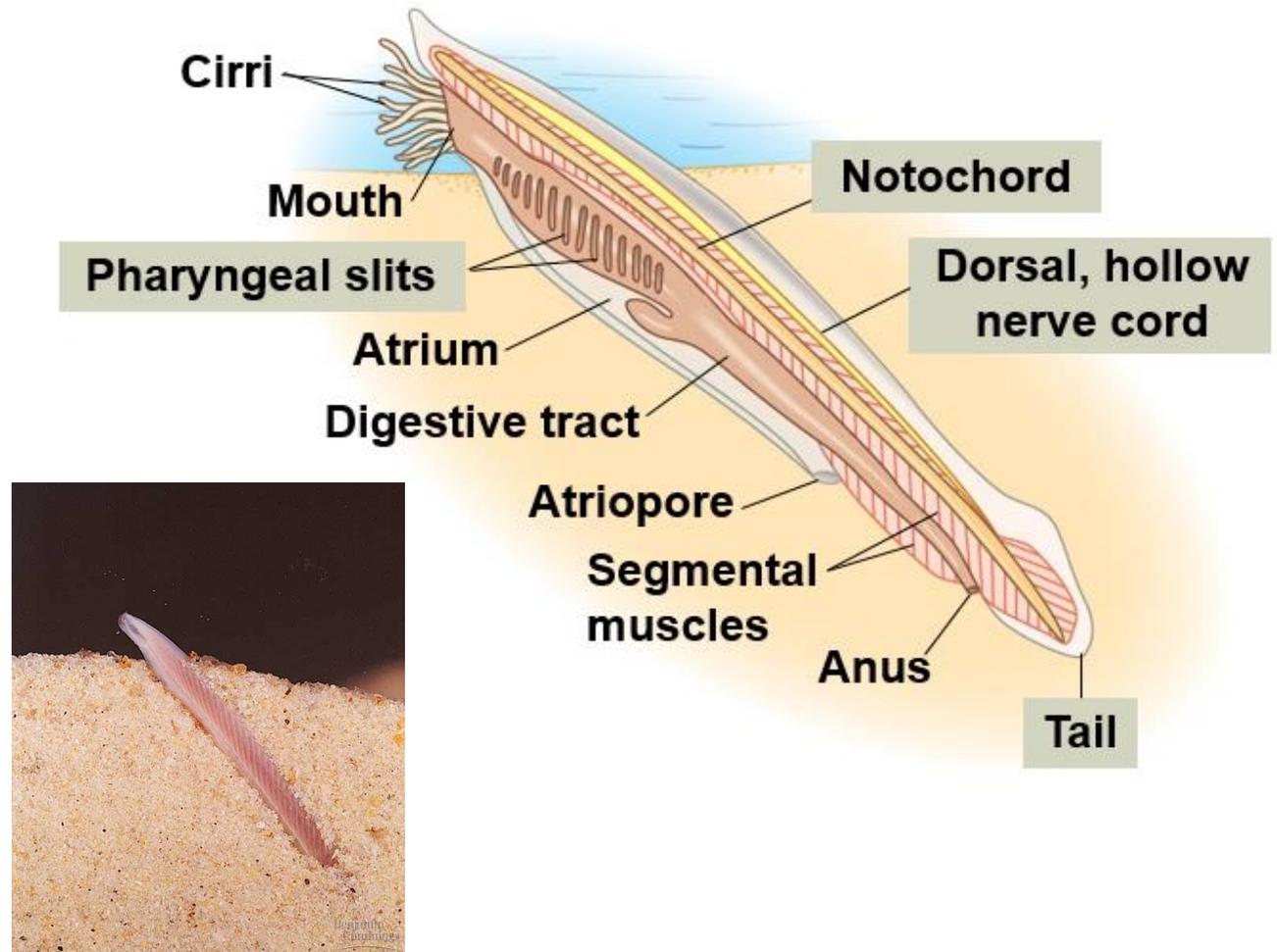
Chordata Characteristics

- ▶ **Notochord:** longitudinal, flexible rod that provides structural support, becomes disks between vertebrae in humans and other vertebrates
- ▶ **Dorsal, Hollow Nerve Cord:** develops into central nervous system
- ▶ **Pharyngeal Slits:** develop into gills in some vertebrates and part of the ear and neck in tetrapods
- ▶ **Muscular, Post-anal Tail:** used for locomotion in aquatic chordates, reduced during development in many species



Phylum Chordata, Subphylum: Cephalochordata

- ▶ Lancelets
- ▶ Contains all four chordate characters as an adult
- ▶ **Paedogenesis**: reproduction of immature or larval animals
- ▶ Metamorphosis



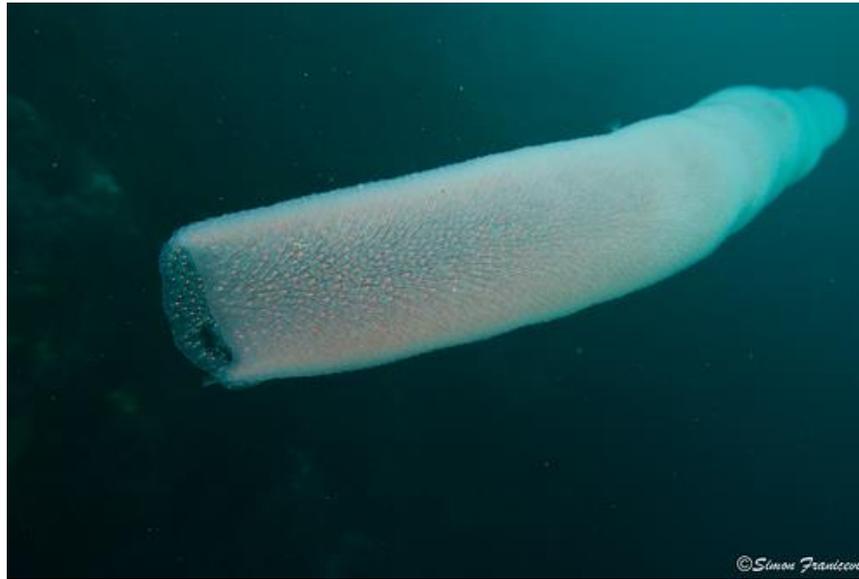


Phylum Chordata
Subphylum Cephalochordata
The Lancelet or Amphioxus

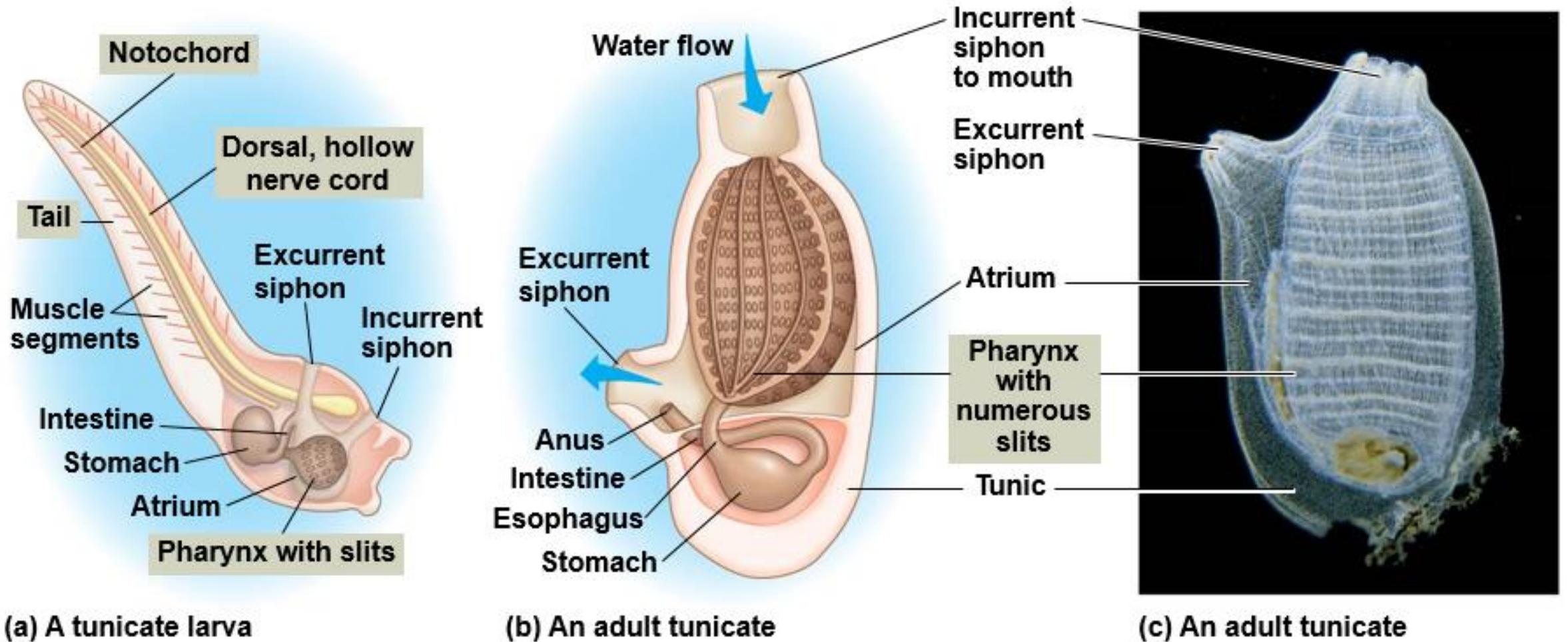


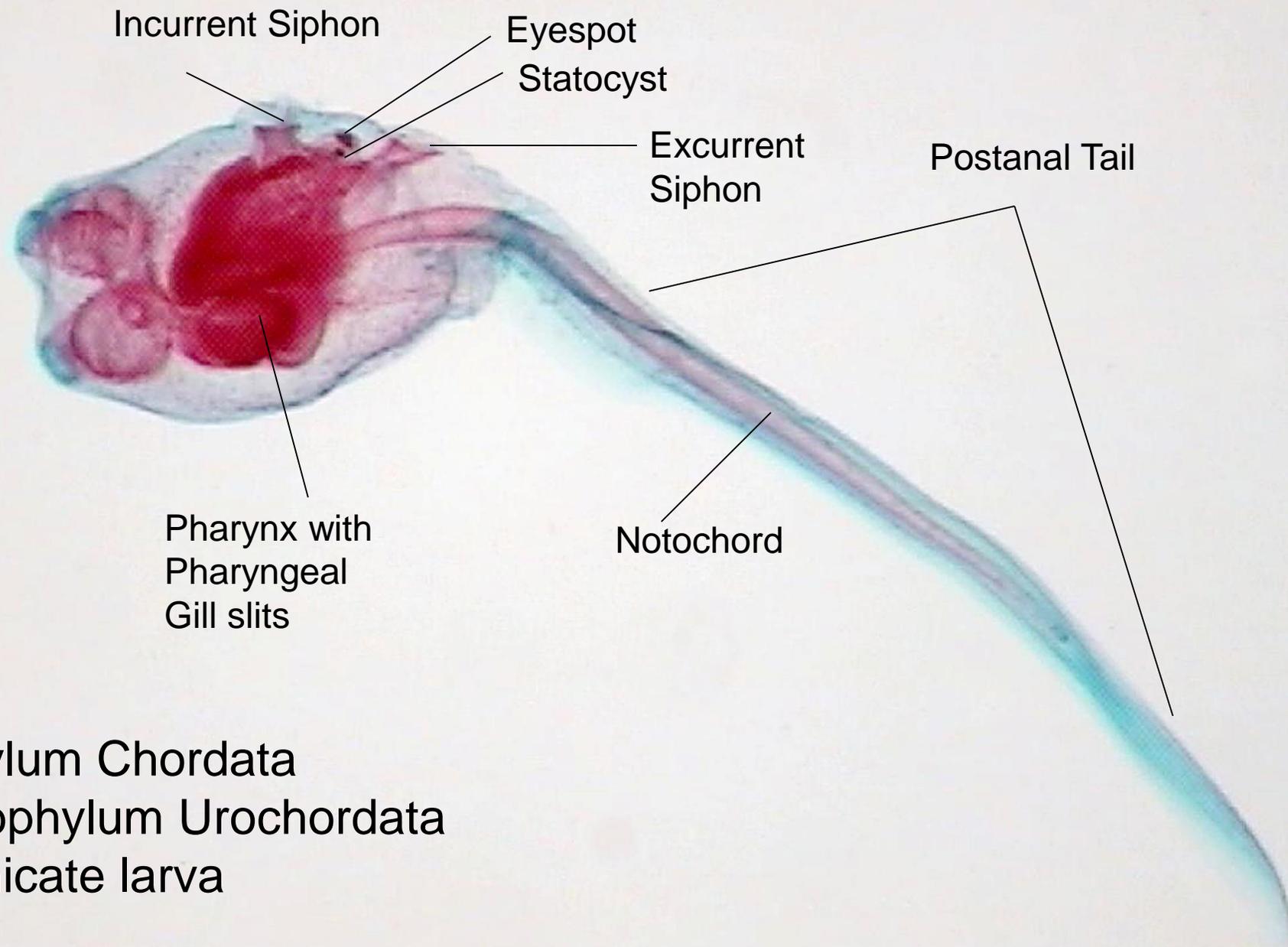
Phylum: Chordata, Subphylum: Urochordata

- ▶ Tunicates or sea squirts
- ▶ Sessile
- ▶ Closest relative to vertebrates
- ▶ Metamorphosis
 - ▶ Retains only pharynx with slits as an adult
 - ▶ Reabsorbed tail and notochord



Phylum: Chordata, Subphylum: Urochordata





Phylum Chordata
Subphylum Urochordata
Tunicate larva



Phylum Chordata: Tunicates



Tunicates, or "sea squirts" are common in all marine habitats, attaching themselves to virtually any fixed object on a coral reef. To feed, they constantly filter out bacteria and phytoplankton by passing a continuous stream of water through their body. The larger of the two openings is the mouth, or incurrent aperture, and the smaller is the excurrent aperture. The water stream is kept moving by the action of tiny cilia (hairs) that line the inside of the tunicate body. Waste products are also expelled through the excurrent aperture.



Phylum: Chordata, Subphylum: Vertebrata

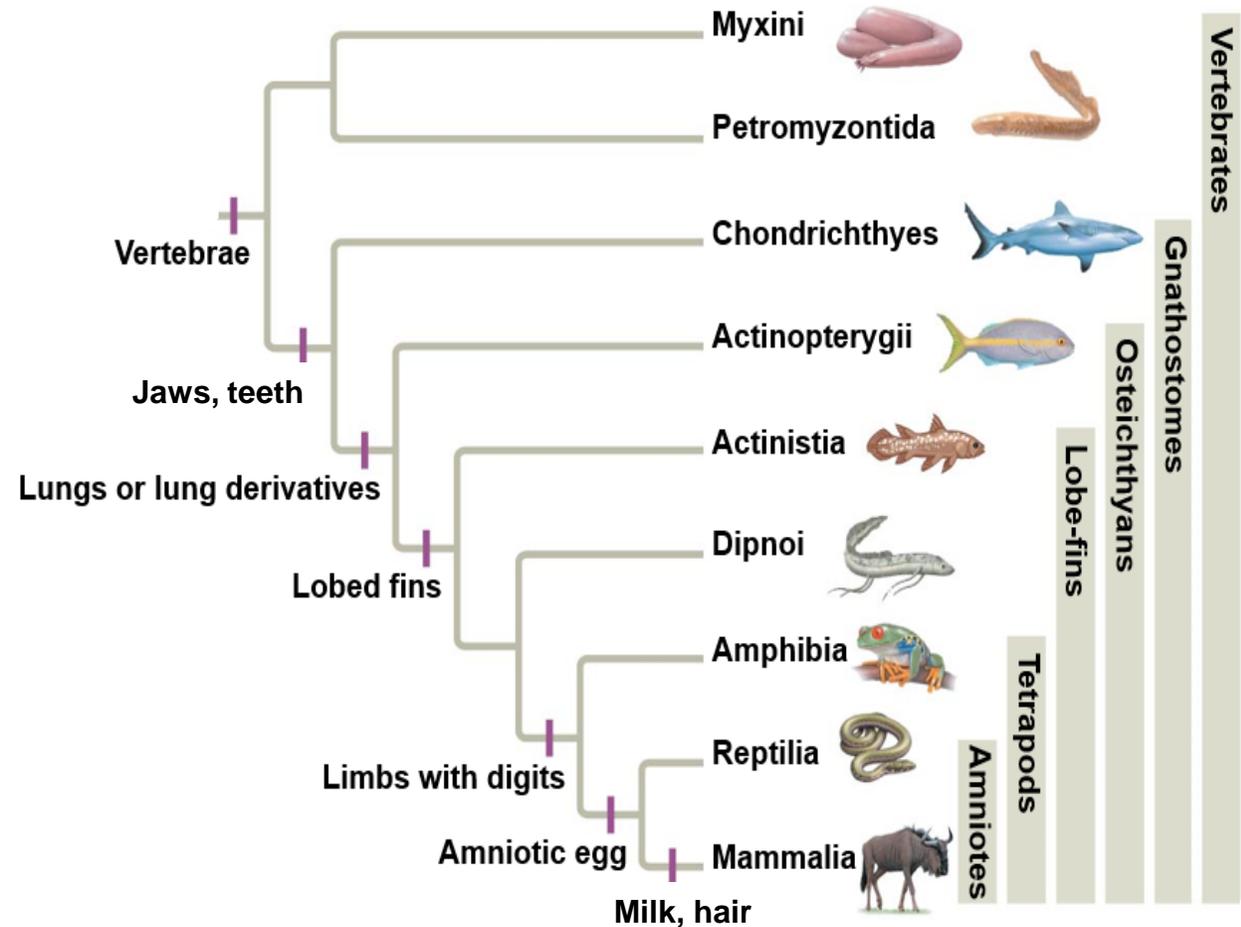
- ▶ Vertebrate column (backbone): flexible column stretching from the neck to the tail, made up of series of bones (vertebrae)
- ▶ Diverged 500 mya (Cambrian)
- ▶ Closed circulatory system
- ▶ Internal skeleton
 - ▶ Cartilage and/or bone
- ▶ Bilateral symmetry
- ▶ Well developed sensory organs and nervous system
- ▶ Highly develop brain enclosed in skull
- ▶ Respiratory system located near pharynx or throat
 - ▶ Gills or lungs



Vertebrate Phylogeny

Vertebrate Classes

- ▶ Agnatha – Hagfish and lampreys
- ▶ Chondrichthyes - Cartilaginous fishes
- ▶ Osteichthyes - Bony fishes
 - ▶ Sarcopterygii – Lobe finned fishes
 - ▶ Actinopterygii – Ray finned fishes
- ▶ Amphibia - Frogs, toads, salamanders
- ▶ Reptilia - Turtles, snakes, lizards, crocodilians, birds
- ▶ Mammalia - Mammals

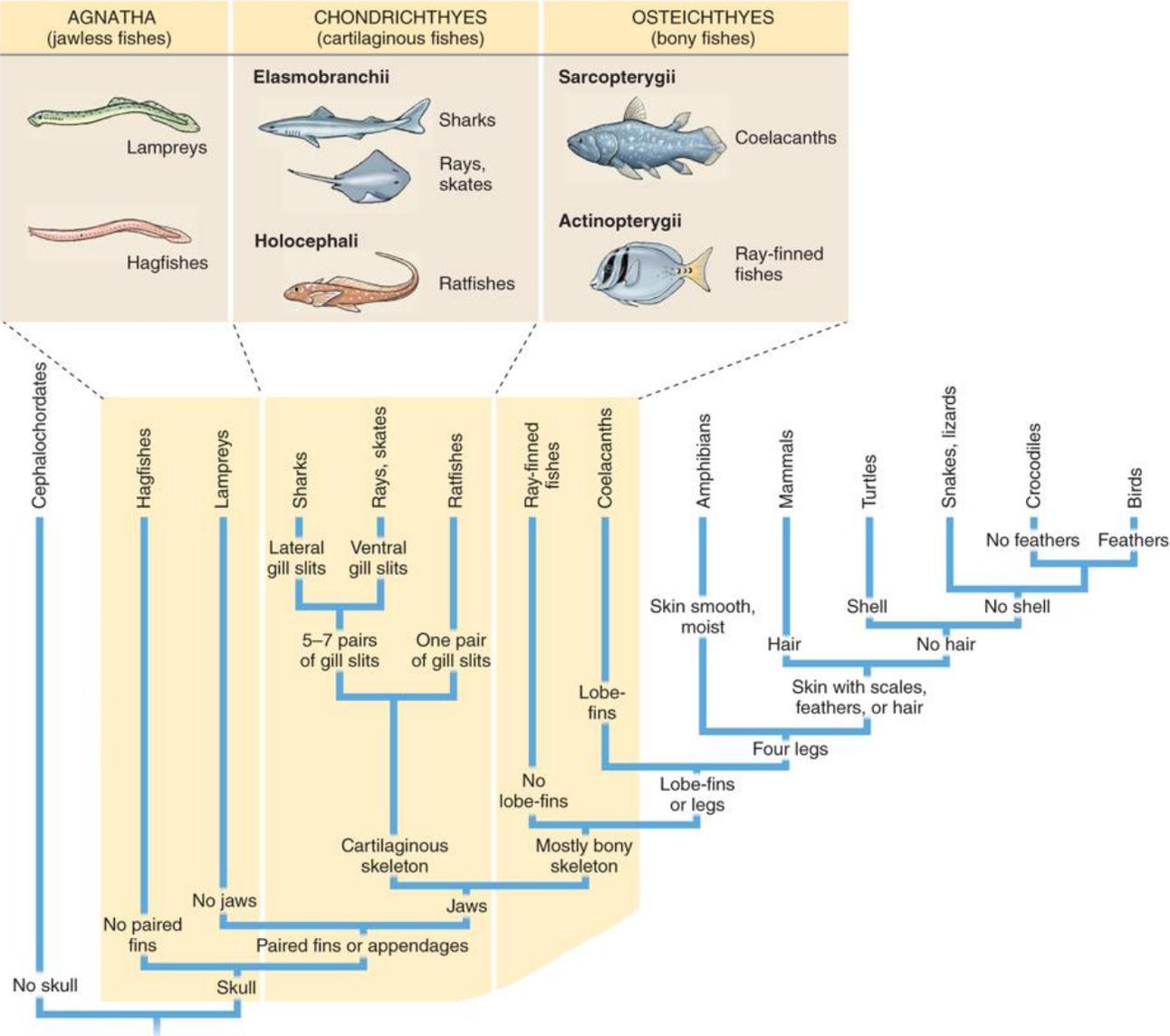


Major Groups of Fishes

Agnatha:
Jawless fishes

Chondrichthyes:
Cartilaginous fishes

Osteichthyes:
Bony fishes

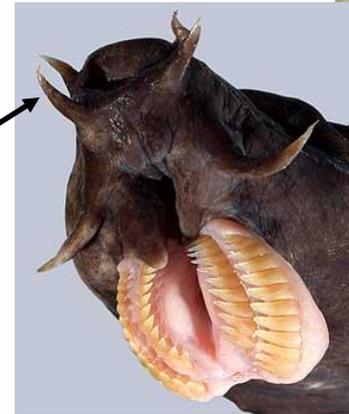


Agnatha

Hagfish

- ▶ Jawless
- ▶ Reduced vertebrae with cartilaginous braincase
- ▶ Marine scavengers
- ▶ Produce slime
- ▶ Lack scales and paired appendages
- ▶ Reduced brain, eyes, ears, and nasal opening
- ▶ Tie themselves in a knot to release slime or provide leverage when feeding

Barbels

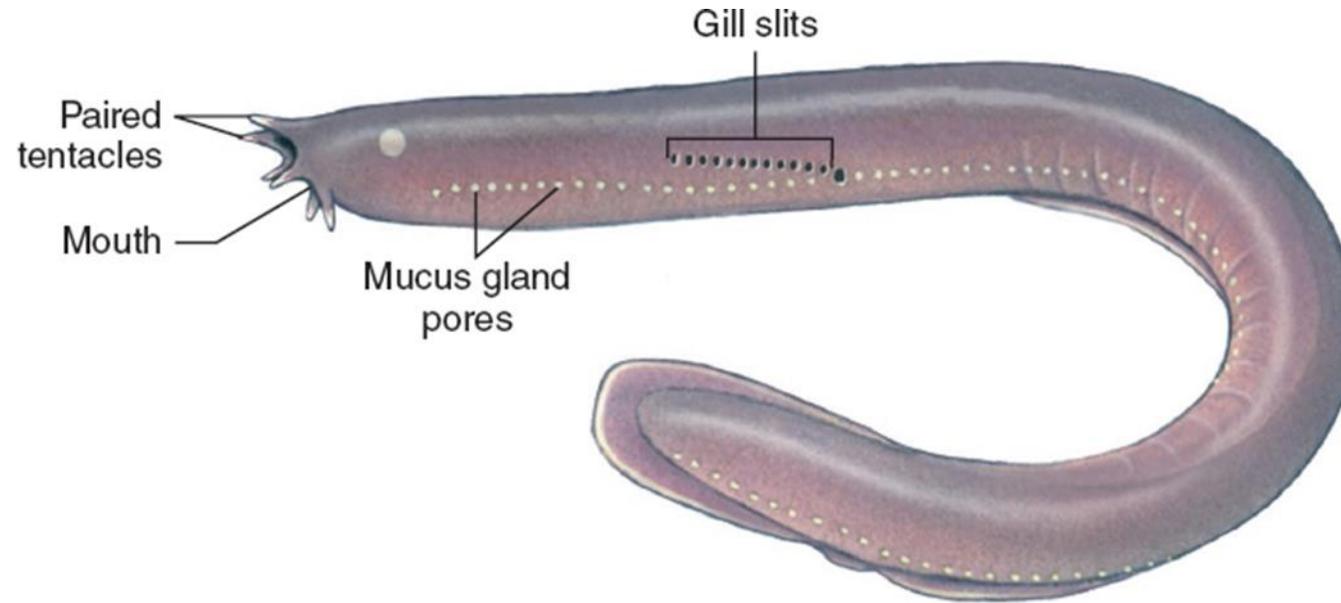


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Hagfish Slime

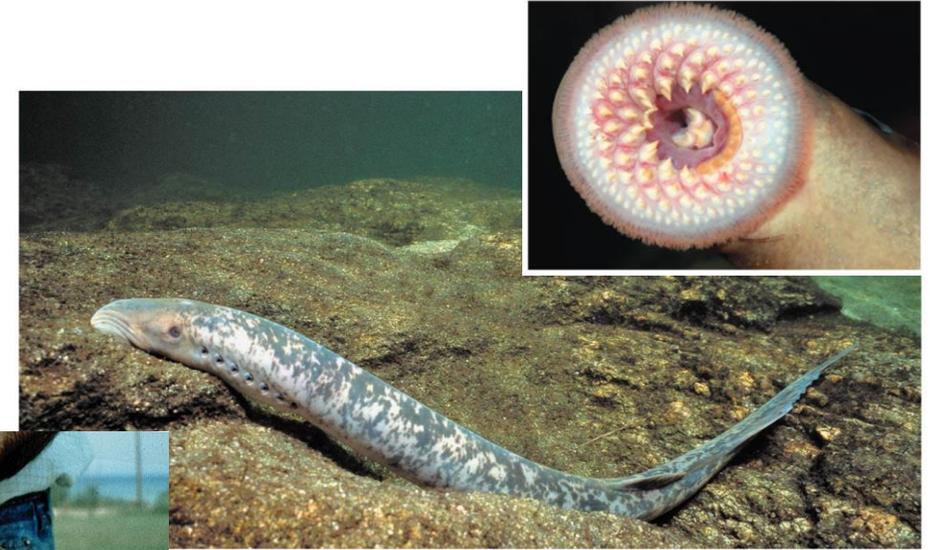
<https://youtu.be/BtaI8FdkVcA>



Agnatha

Lampreys

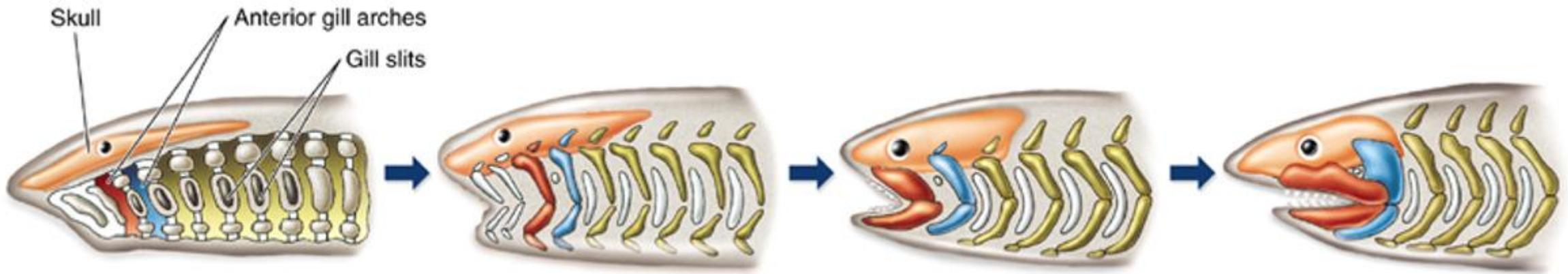
- ▶ Jawless
- ▶ Rudimentary vertebrae and cartilaginous skeleton
- ▶ Marine and freshwater
 - ▶ **Anadromous**: migrates to fresh water to spawn
- ▶ **Ammocoetes larvae**: filter feeders, buried in sediment
- ▶ Most are parasitic
- ▶ Lack scales and paired appendages



Evolution of Jaws

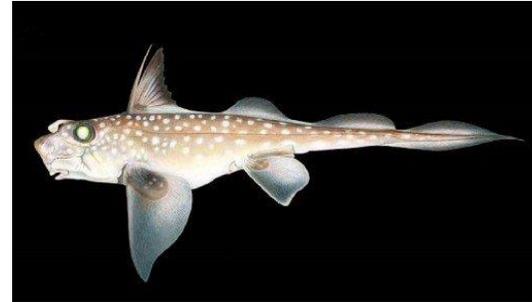


- ▶ Jaws likely developed from gill arches used in filter feeding
- ▶ Lead to the diversification of food types (carnivory and herbivory)
- ▶ Allowed for active defense from predators
 - ▶ De-emphasis on armored plates
 - ▶ Development of paired appendages



Class Chondrichthyes (kon-DRIK-thee-EEZ)

- ▶ Cartilaginous skeleton
- ▶ Placoid scales
- ▶ Teeth derived from placoid scales are not fused with jaw
 - ▶ Replaceable (every few days)
- ▶ Large, buoyant livers
 - ▶ Lack gas bladder or lungs
- ▶ Spiral valve intestine
- ▶ Highly developed sensory organs
- ▶ Internal fertilization



Class Chondrichthyes

Subclass Elasmobranchii

- ▶ Sharks (8 orders, ~360 species)
 - ▶ Most are large (> 1m)
 - ▶ Most are active marine predators
- ▶ Skates, Rays, Electric rays, Sawfish (4 orders, ~550 species)
 - ▶ Flattened bodies
 - ▶ Bottom dwelling predators



Subclass Holocephali

- ▶ Chimaera (rat fish) (1 extant order, ~50 species)
 - ▶ Feed on benthic invertebrates in deep ocean



Class Chondrichthyes, Subclass Holocephali

Chimaera (ratfish)

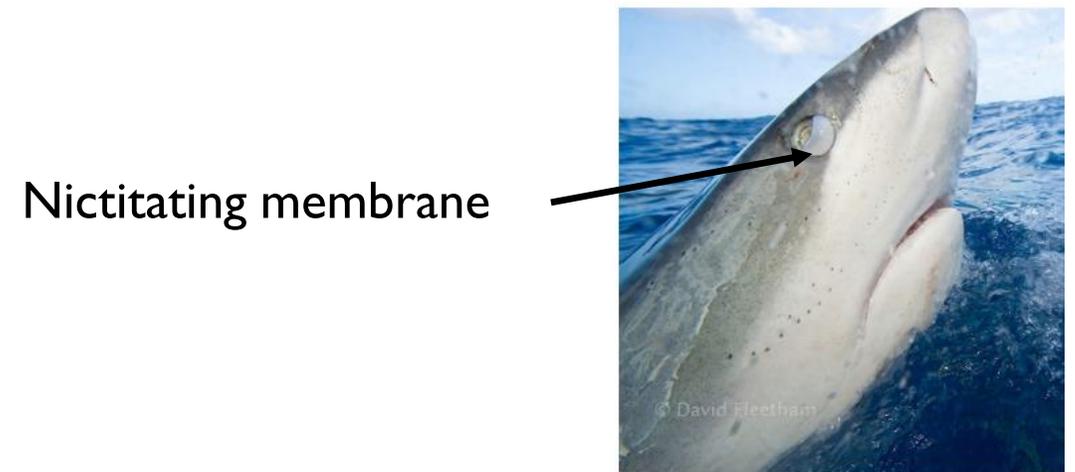
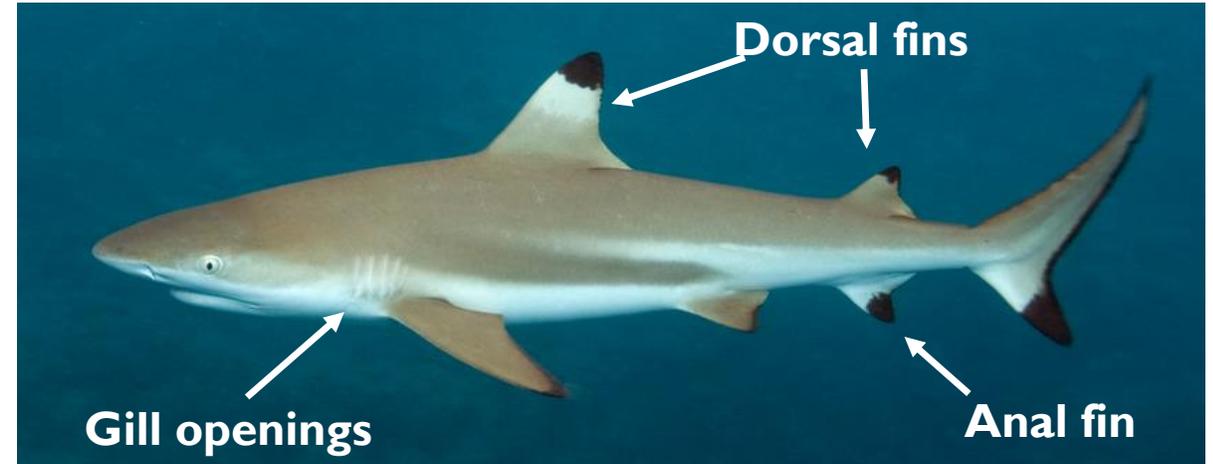
- ▶ Oviparous
- ▶ One pair of gill slits
- ▶ Upper jaw attached to braincase
- ▶ Teeth modified as crushing plates
 - ▶ Diet of benthic invertebrates
- ▶ Poisonous spine before first dorsal fin
- ▶ Move by flapping pectoral fins
- ▶ Lack scales



Class Chondrichthyes, Subclass Elasmobranchii

Sharks

- ▶ Almost exclusively marine
- ▶ Two dorsal fins, an anal fin, and 5 to 7 gill openings
- ▶ Heterocercal caudal fin
- ▶ **Nictitating membrane:** translucent third eyelid that protects the eye when feeding
- ▶ Elevated body temperature in some

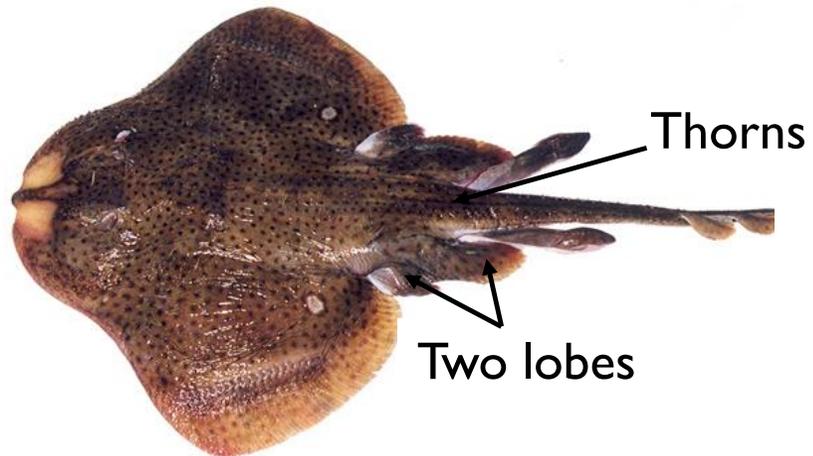


Class Chondrichthyes, Subclass Elasmobranchii

Most skates and rays are demersal, which means they live on the bottom. When buried in the sandy bottom, water enters through the spiracle and exits through the gills on their ventral side

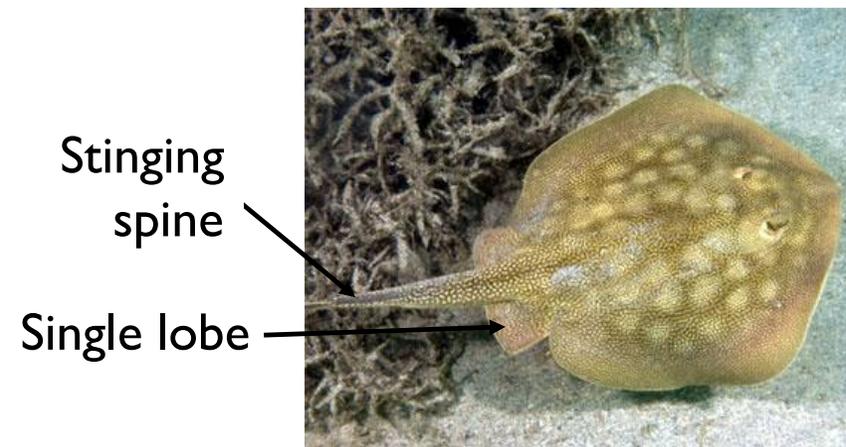
Skates

- ▶ Thorns on back
- ▶ No stinging spine
- ▶ Two lobes on pelvic fin
- ▶ Lay eggs (oviparous)



Rays

- ▶ No thorns on back
- ▶ Stinging spine
- ▶ One lobe on pelvic fin
- ▶ Live birth (viviparous)



Chondrichthyes Reproduction

Claspers of male s

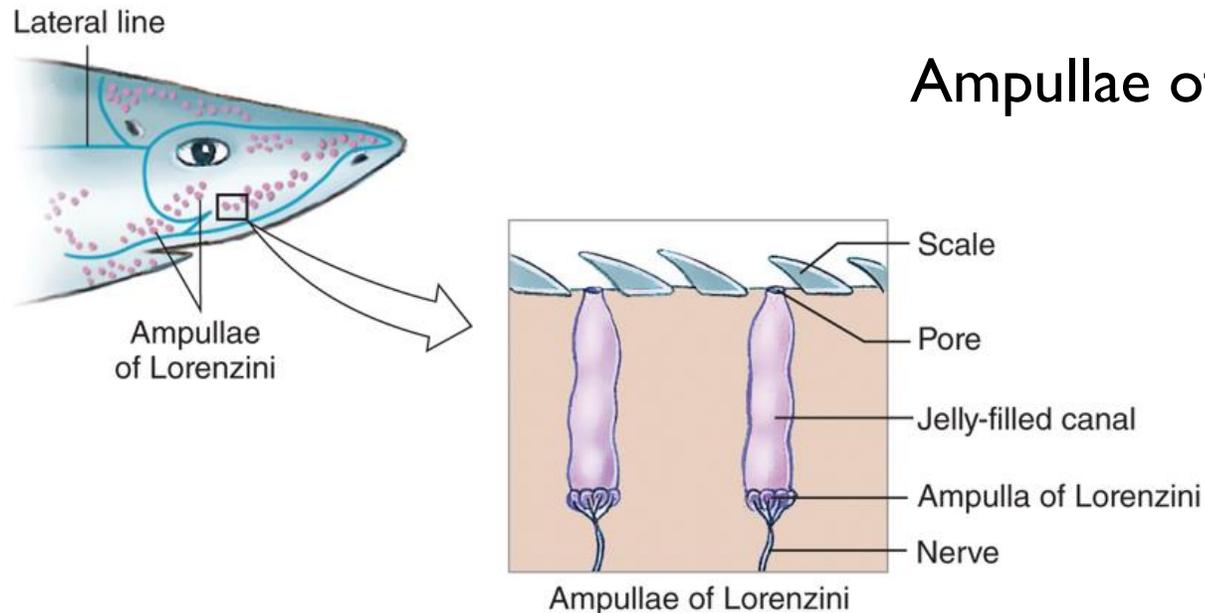
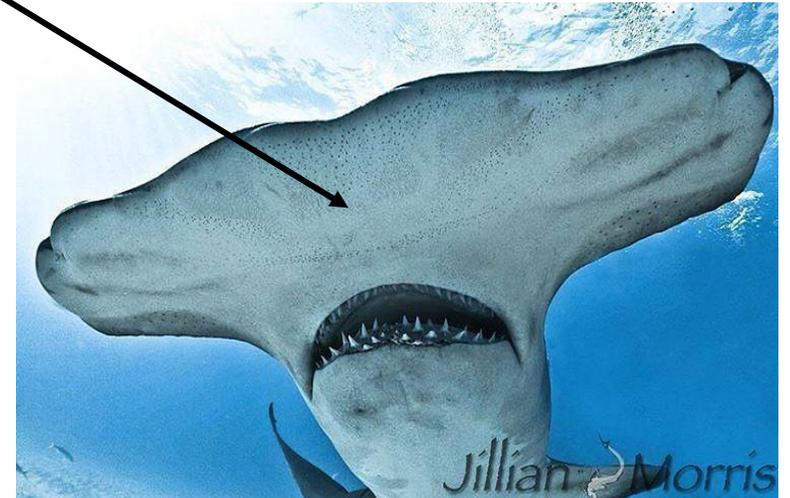
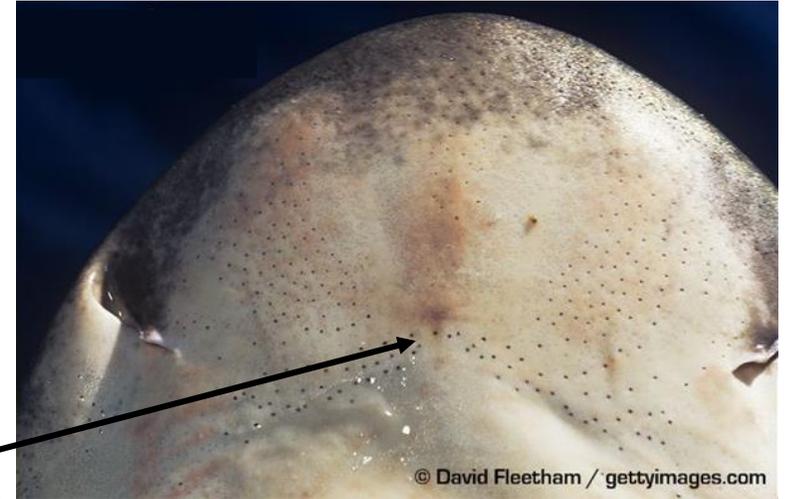


ca of female shark

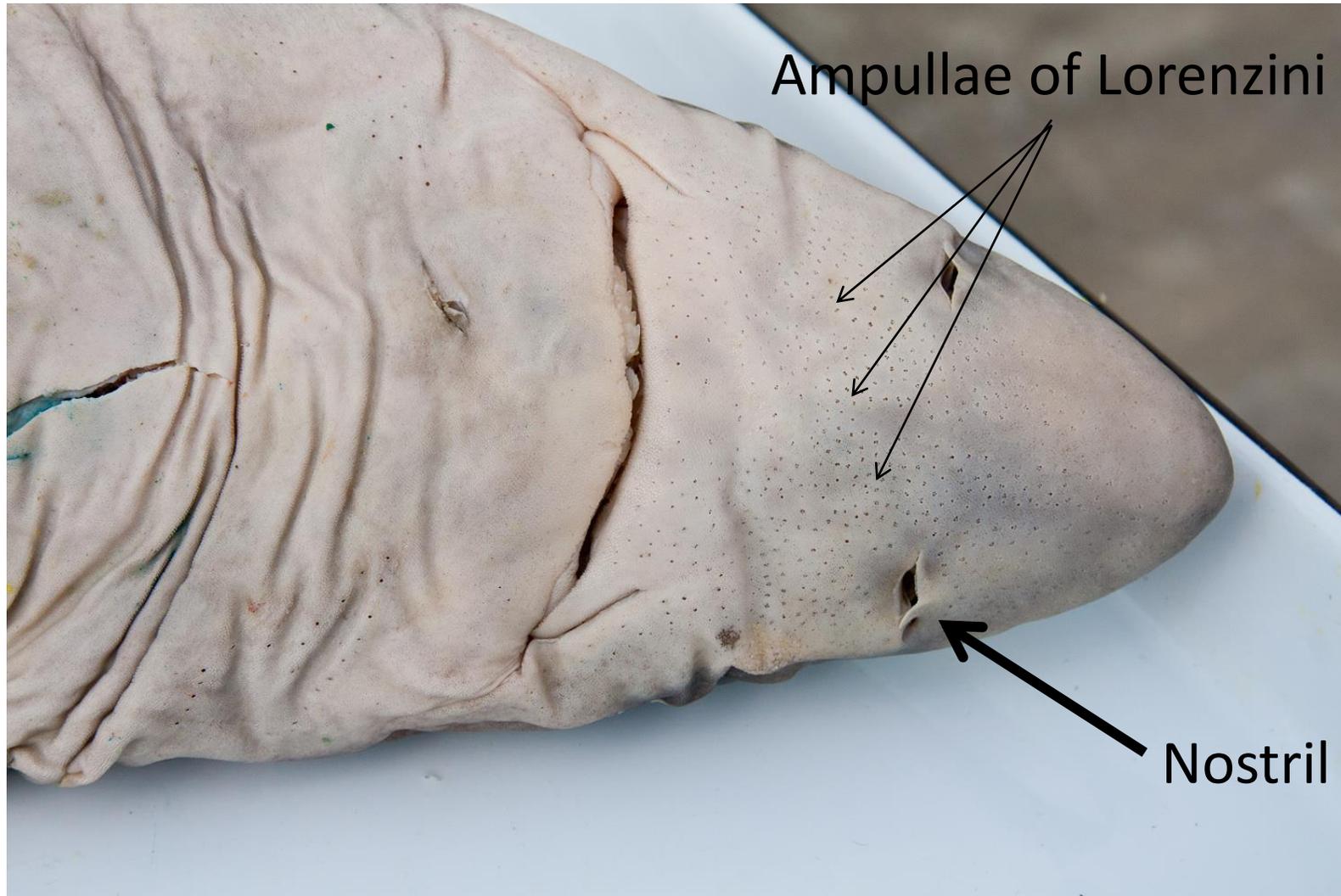


Ampullae of Lorenzini

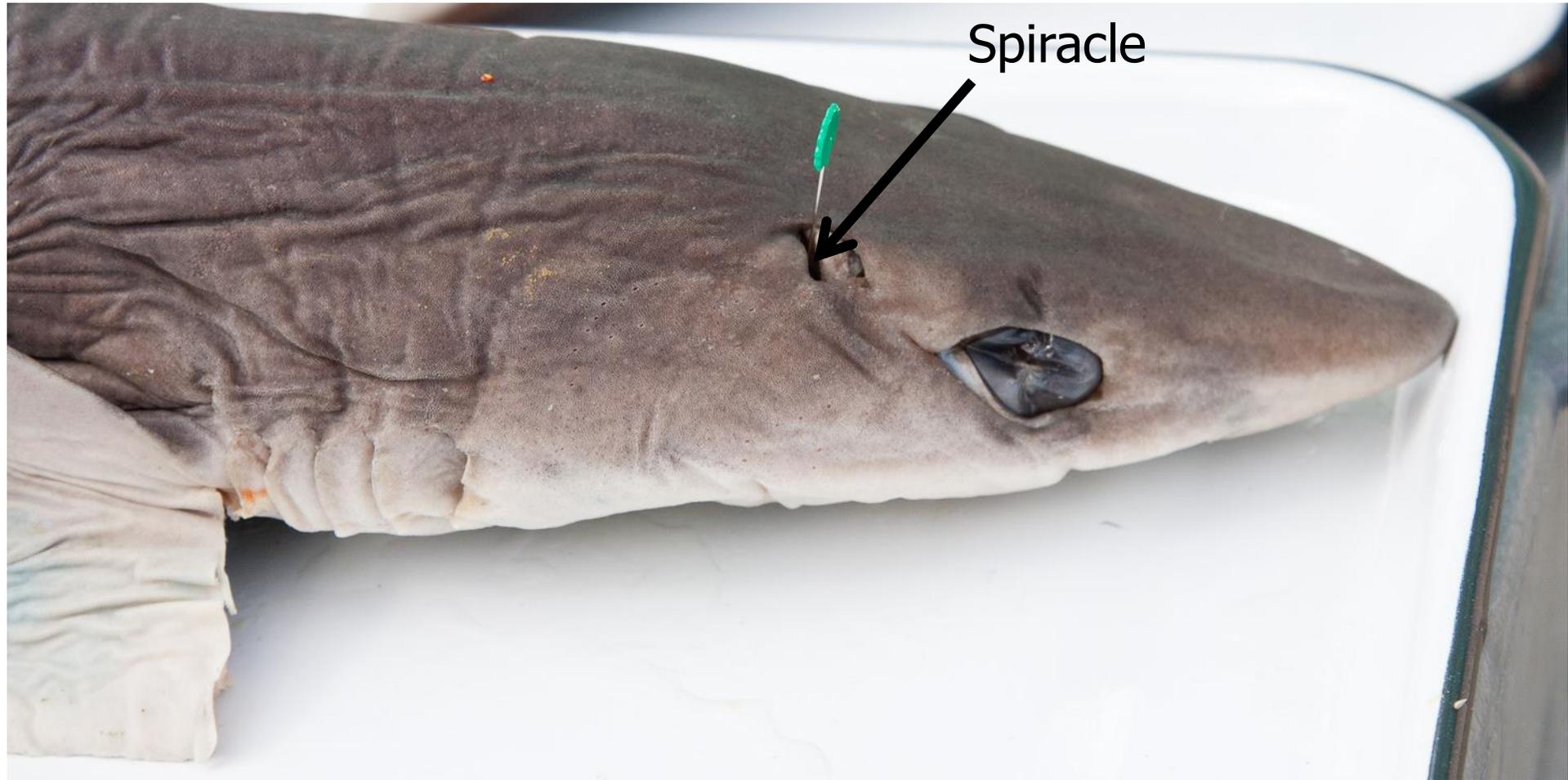
- ▶ **Ampullae of Lorenzini:** small, jelly filled pores that contain electroreceptors, which can sense the electric fields produced by other fish



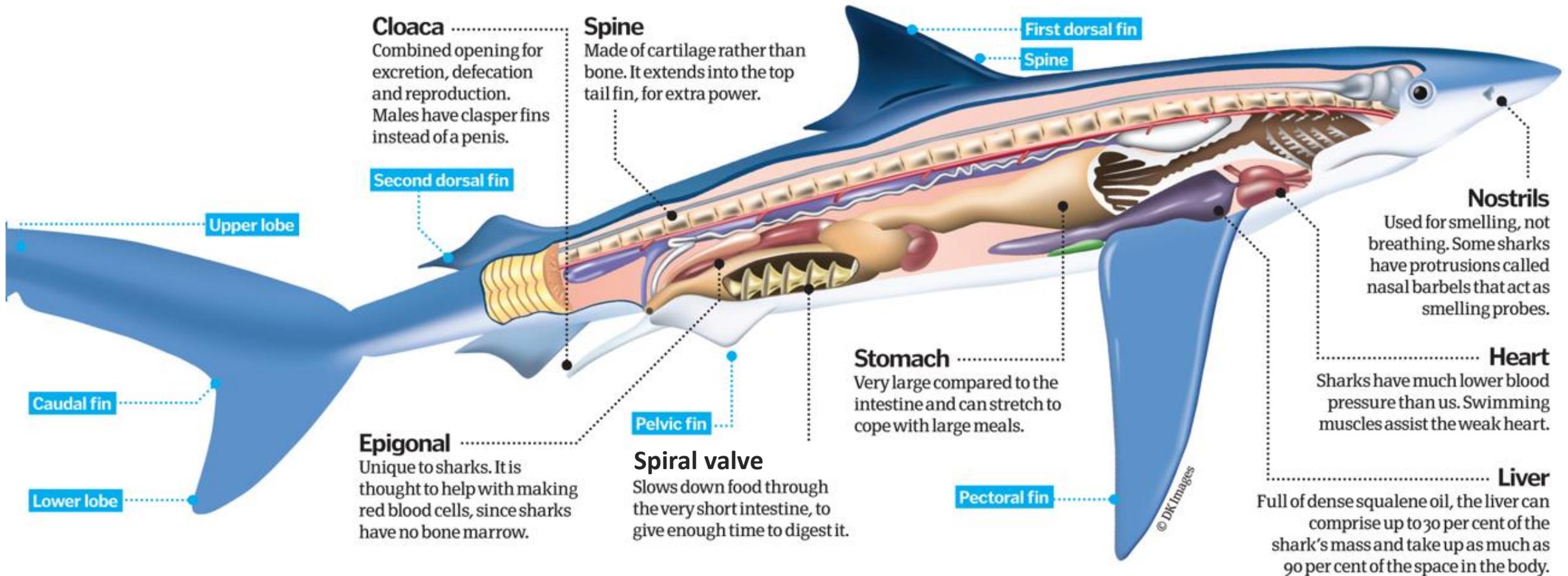
Anatomy of a Shark



Anatomy of a Shark



Anatomy of a Shark



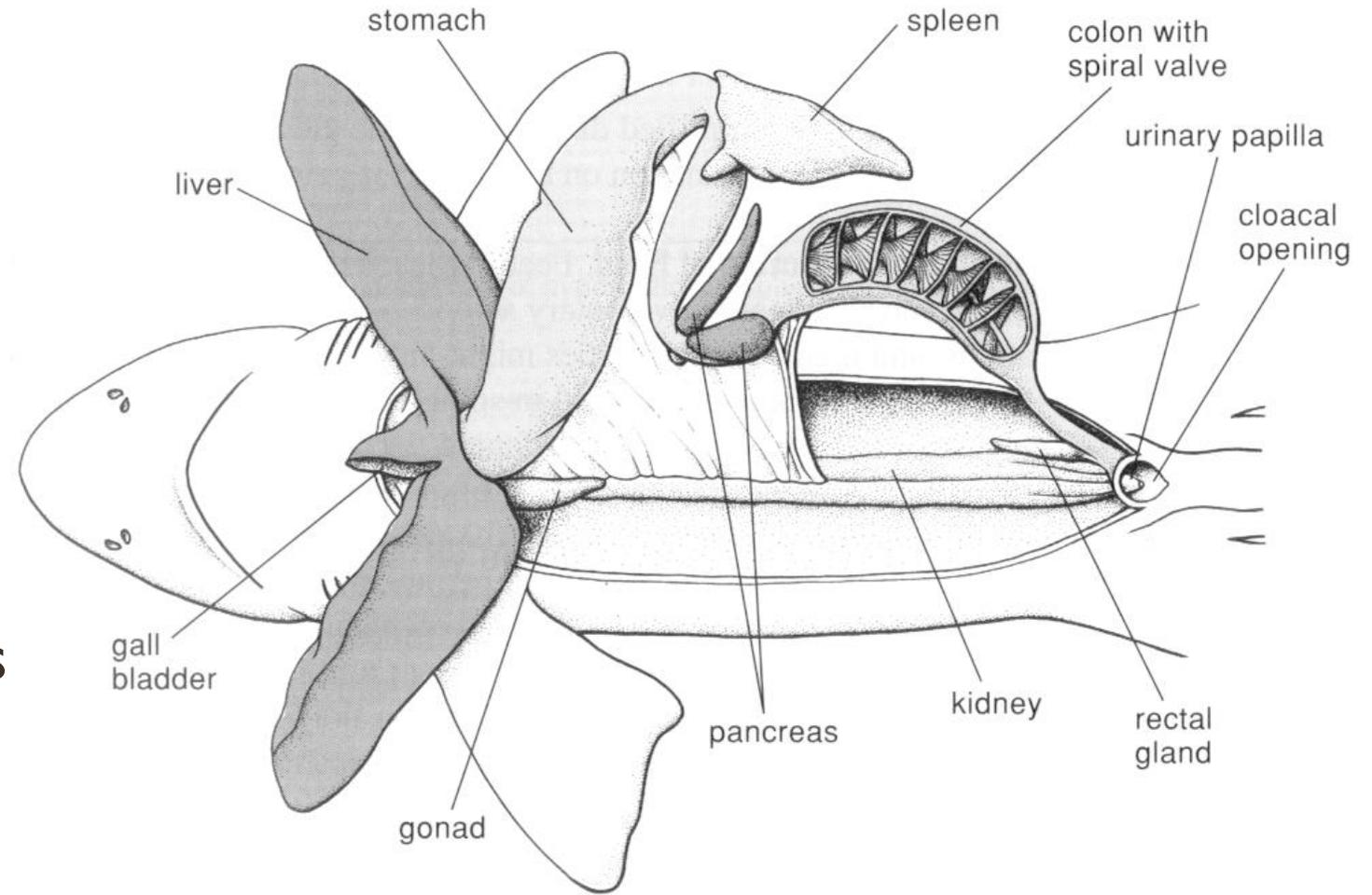
Anatomy of a Shark

▶ Liver

- ▶ Rich in lipids
 - ▶ Aids in buoyancy
- ▶ Produces bile
 - ▶ Emulsifies lipids

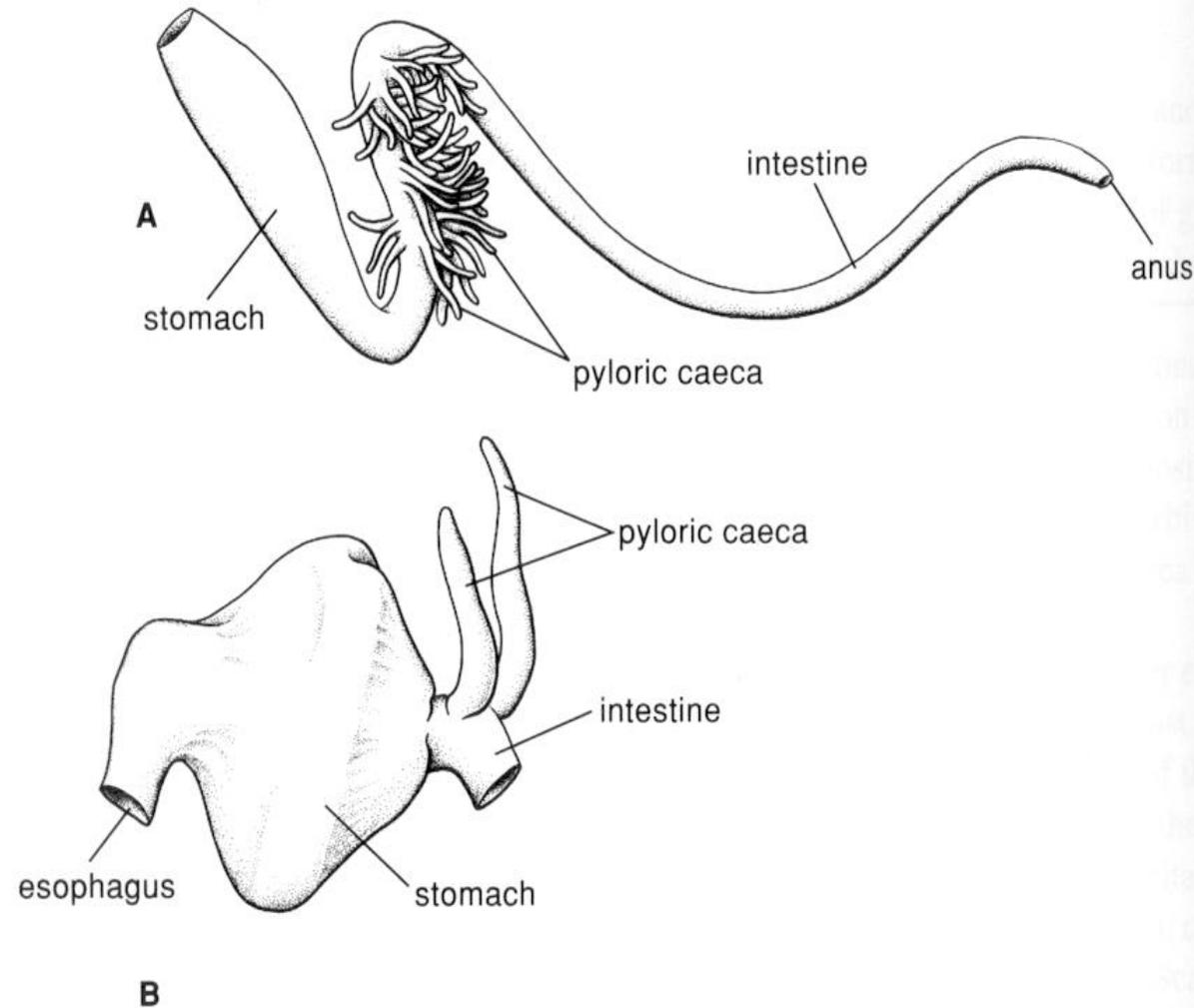
▶ Pancreas

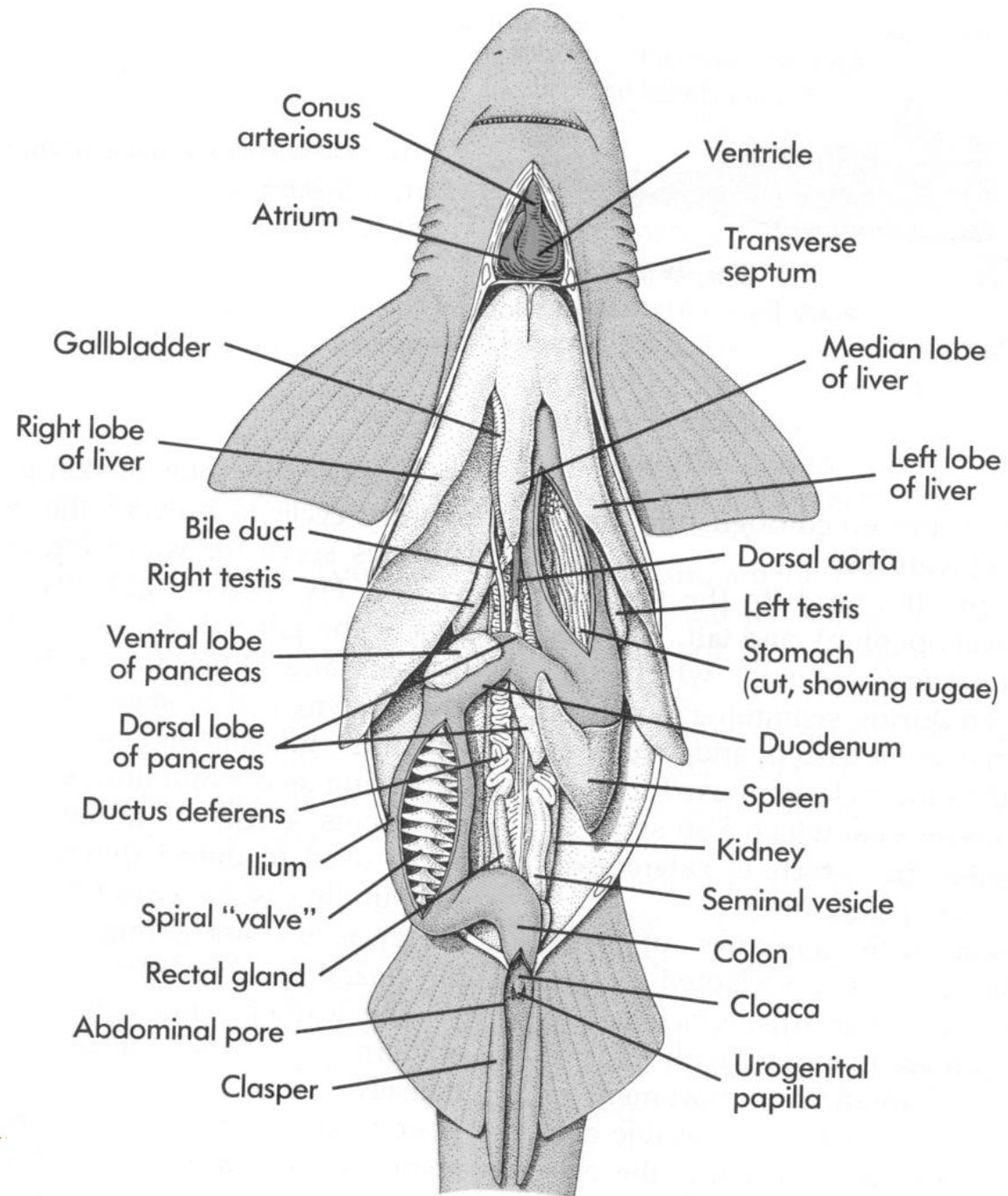
- ▶ Secretes digestive enzymes

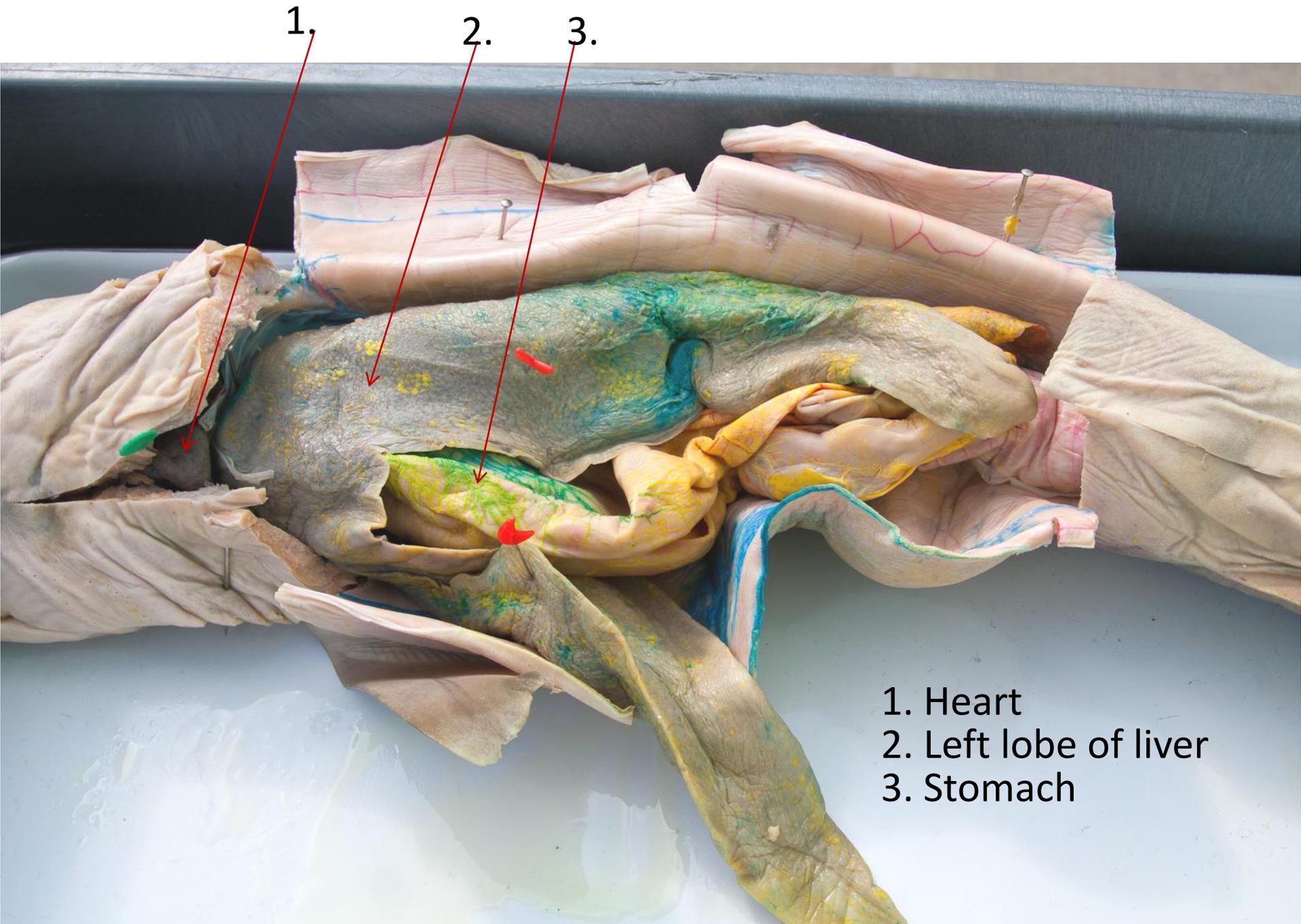


Anatomy of a Shark

- ▶ The esophagus is short and contains taste buds
- ▶ The stomach functions in storage
- ▶ Pyloric caeca secrete digestive enzymes.
- ▶ Carnivores have short intestines, herbivores have long intestines.
- ▶ The intestine functions in the digestion of nutrients

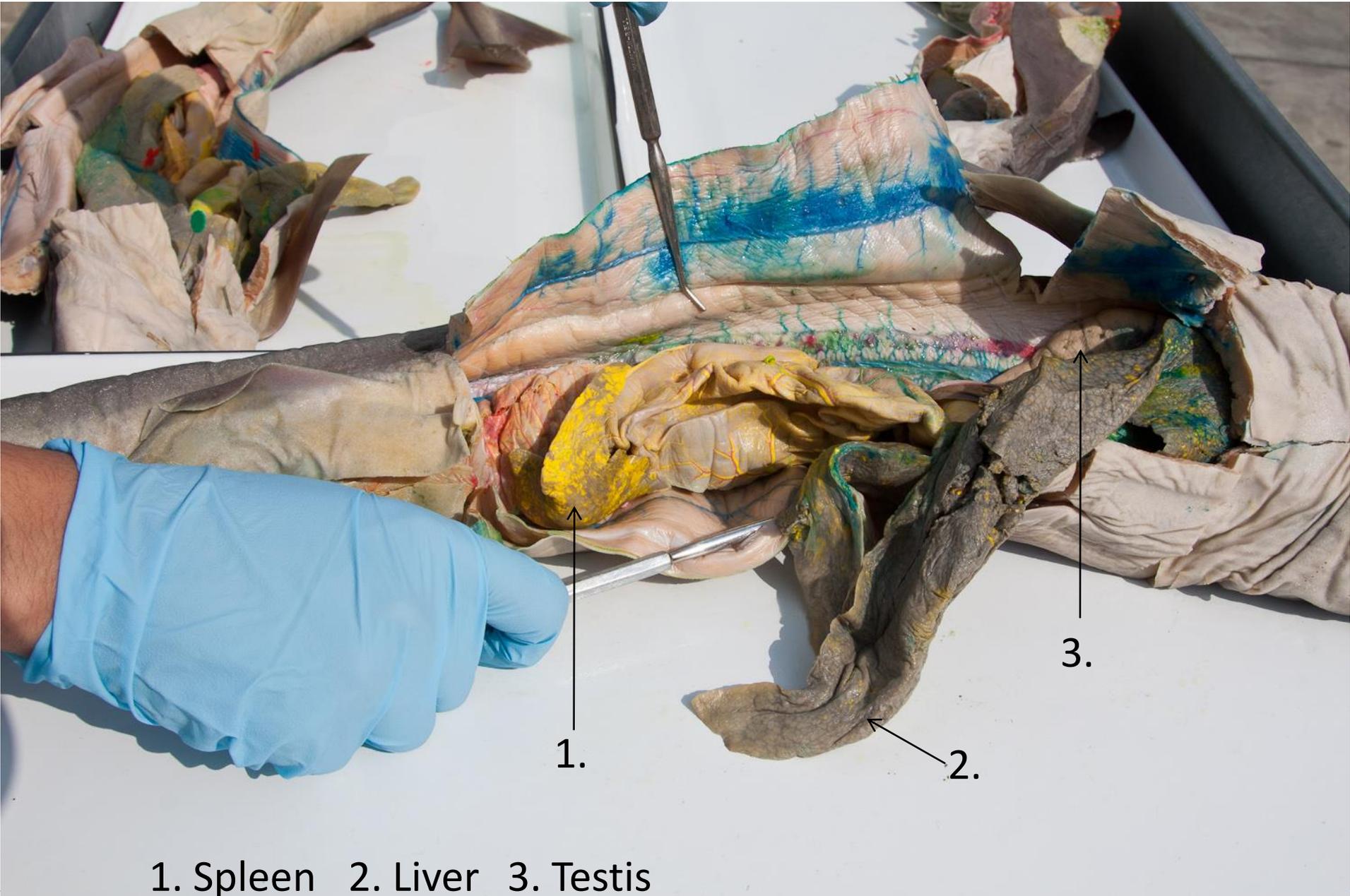






- 1. Heart
- 2. Left lobe of liver
- 3. Stomach





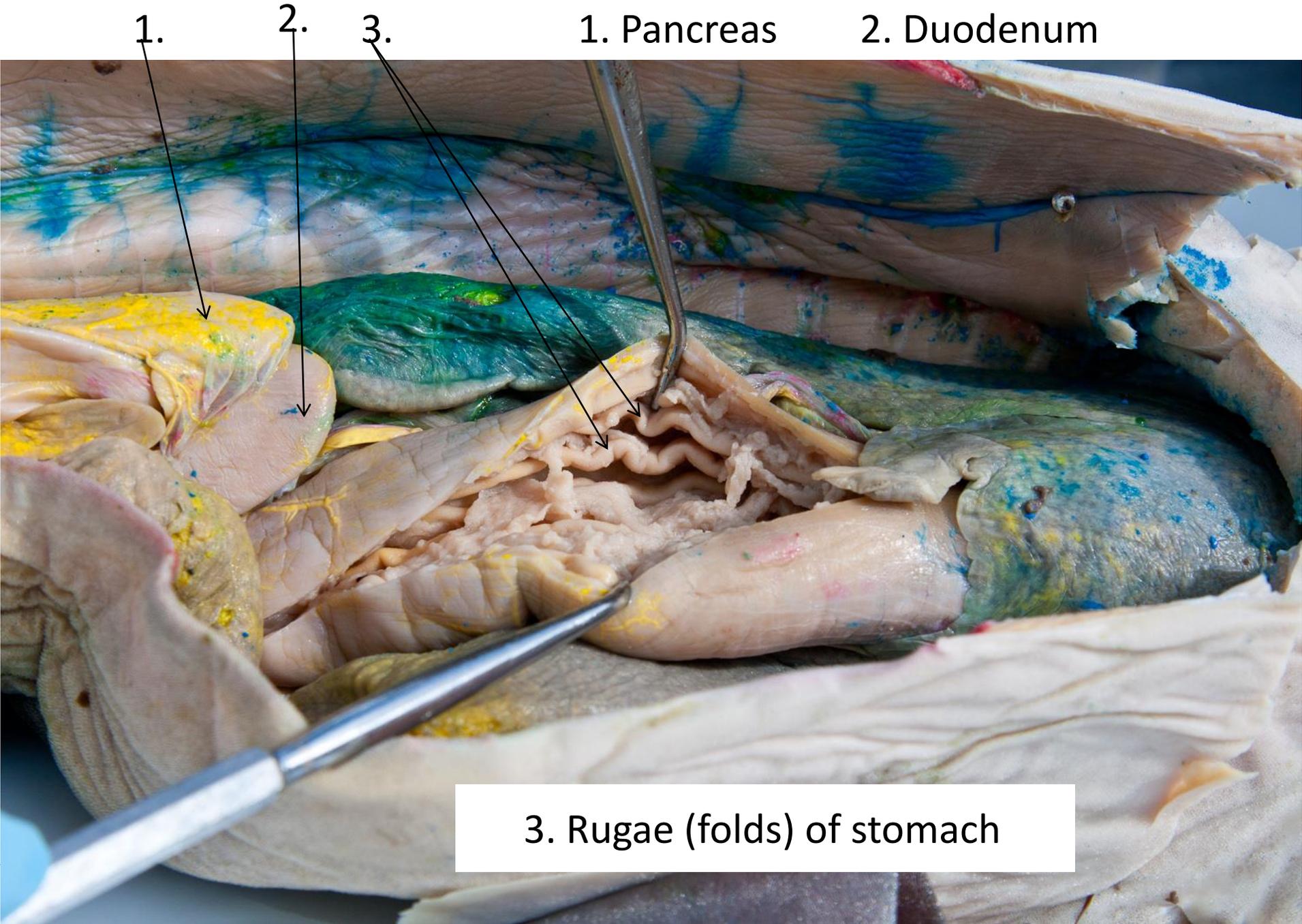


- 1. Pancreas
- 2. Ilium
- 3. Rectal gland
- 4. Pelvic fin
- 5. Cloaca



- 1. Stomach
- 2. Gall bladder





1.

2.

3.

1. Pancreas

2. Duodenum

3. Rugae (folds) of stomach

