

Cyclostomata – an overview

DBS 402B.2

Presidency University, 2016

Chordata

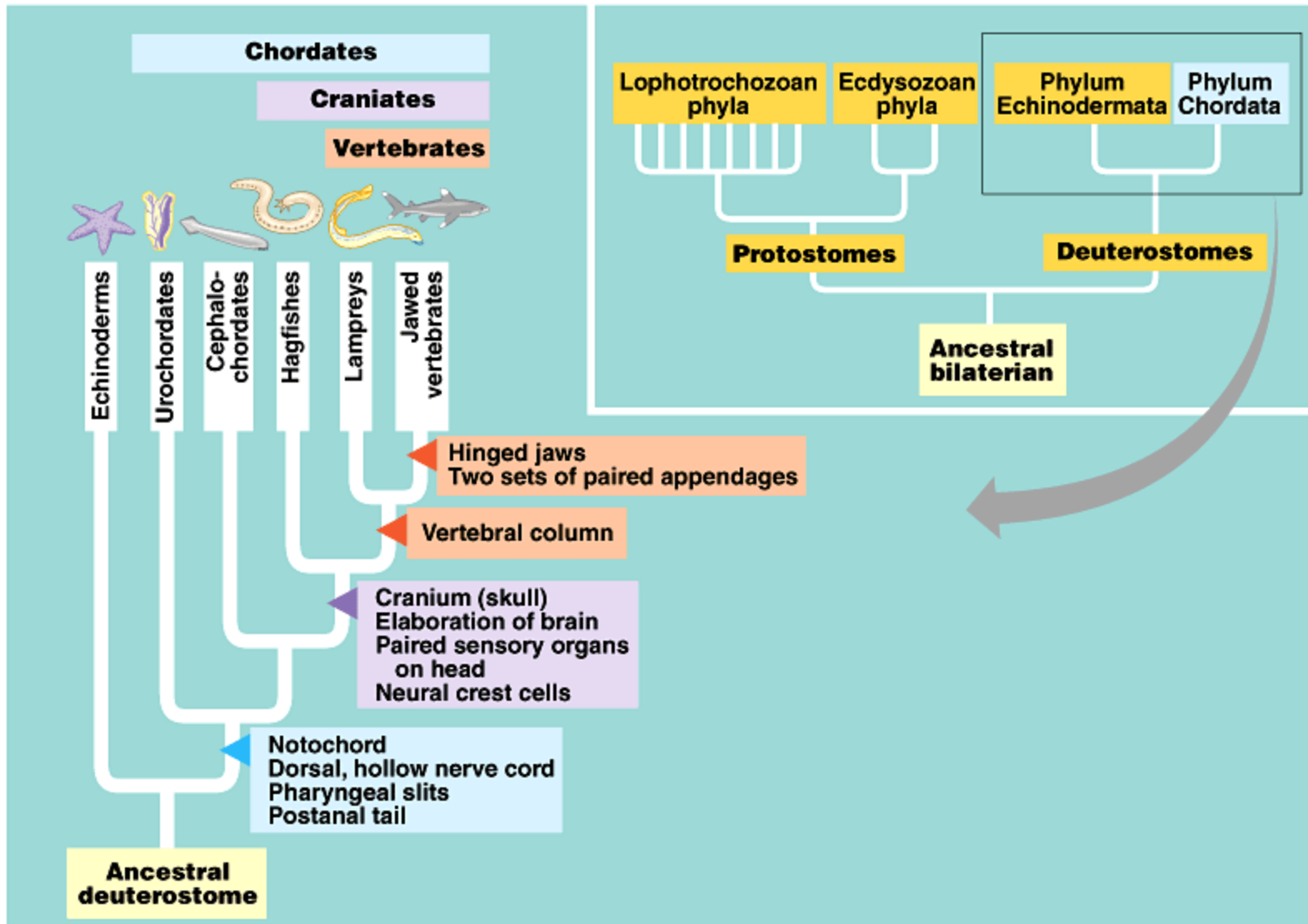
- Fish evolved from primitive Chordates
 - Dorsal, hollow nerve chord
 - Notochord
 - flexible dorsal rod for support
 - present at some stage in all chordates (usually in embryonic development)
 - remnant present in adults of many fishes: sharks, rays, sturgeons
 - Pharyngeal gill slits
 - present in embryos of all vertebrates

Chordate classification

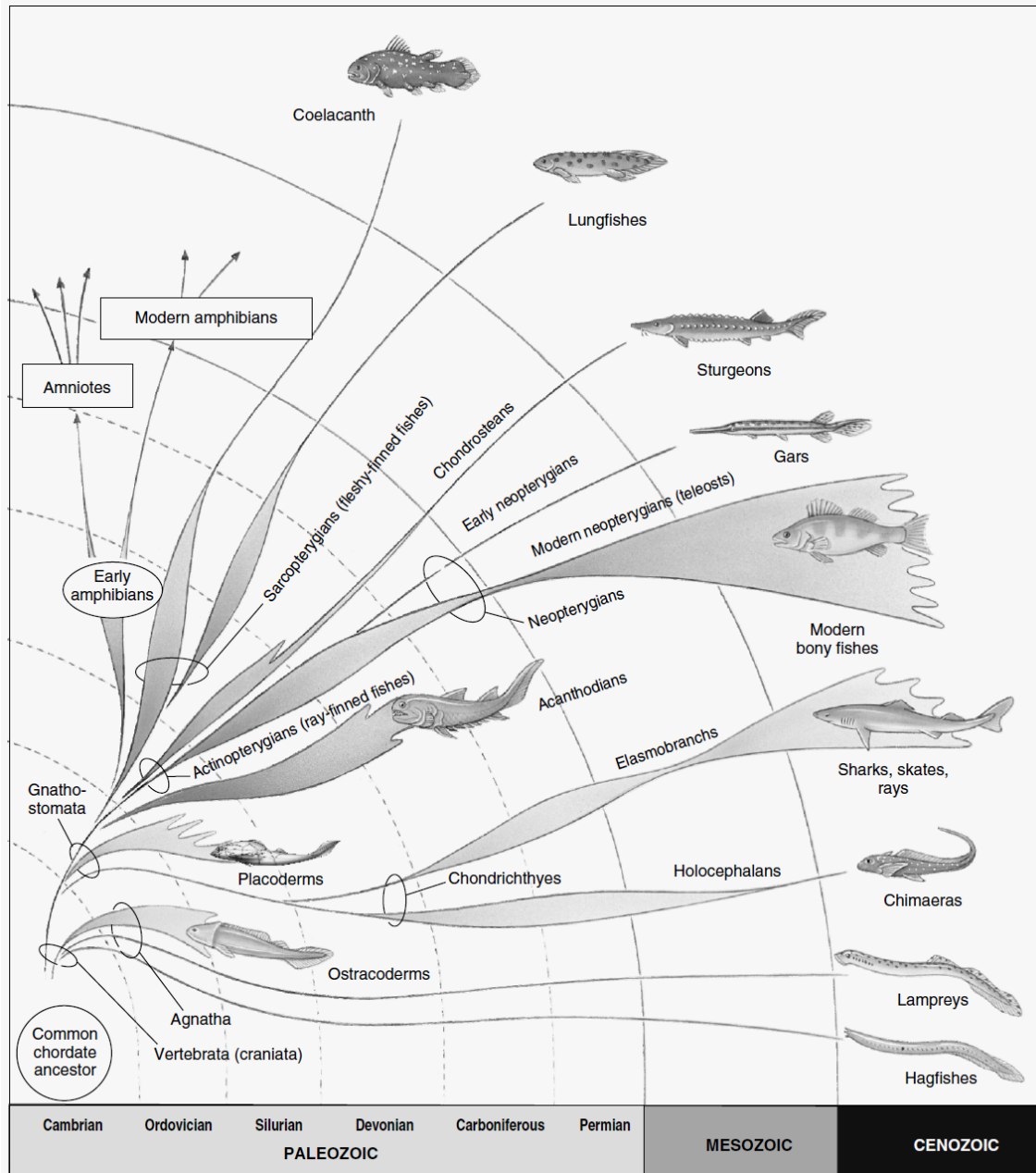
- Phylum: Hemichordata
- Phylum: Chordata
 - Subphylum: Urochordata
 - Subphylum: Cephalochordata
 - Subphylum: Vertebrata
 - Class: Cephalaspidomorphi
 - Class: Myxini
 - Class: Chondrichthyes
 - Class: Osteichthyes
 - Class: Amphibia
 - Class: Reptilia
 - Class: Aves
 - Class: Mammalia

[{Miller-Harley} {Kardong placed Hemi, Uro and Cephalochordates into a group called 'Protochordates'}]

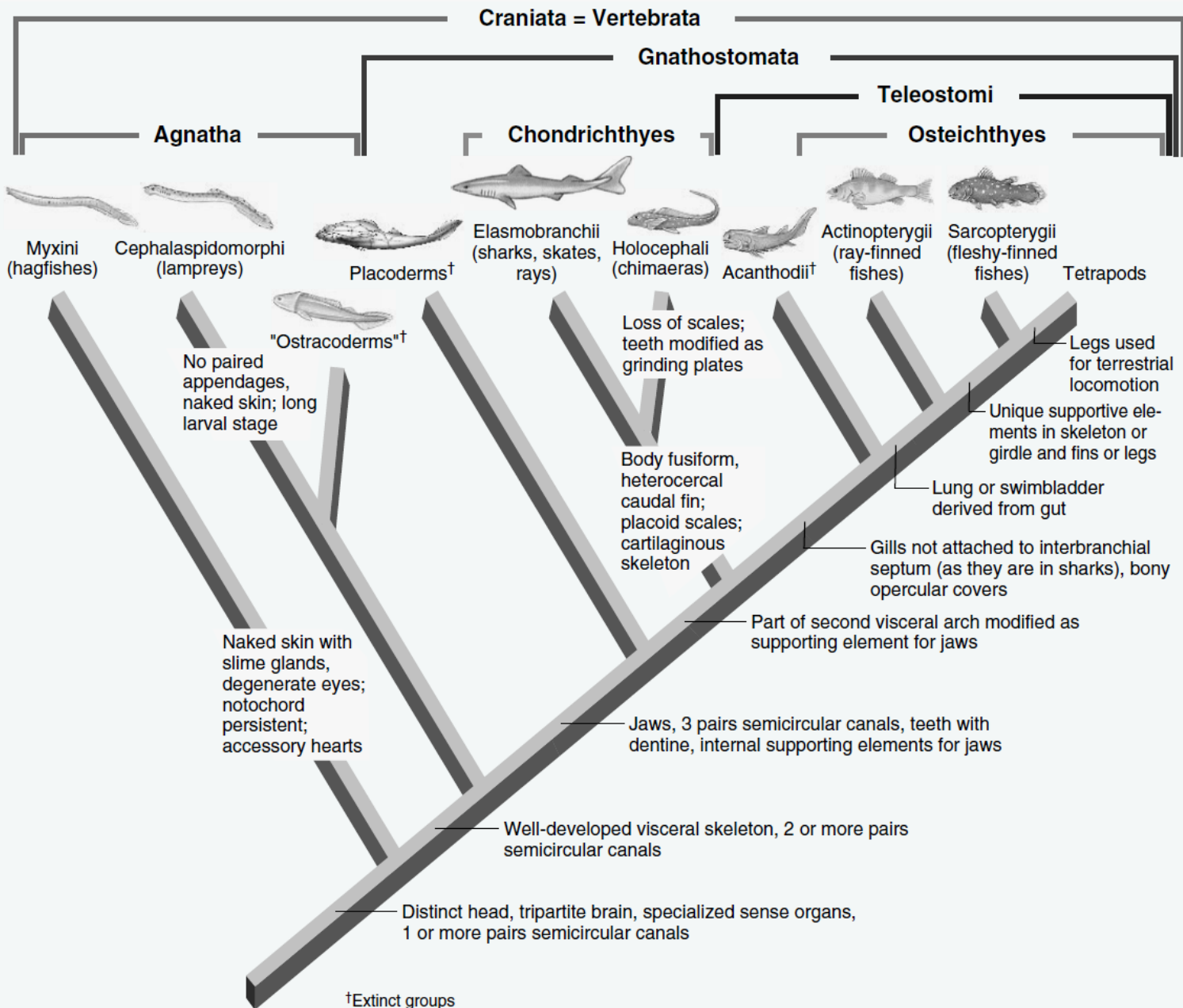
Vertebrate evolution



A little zoomed in

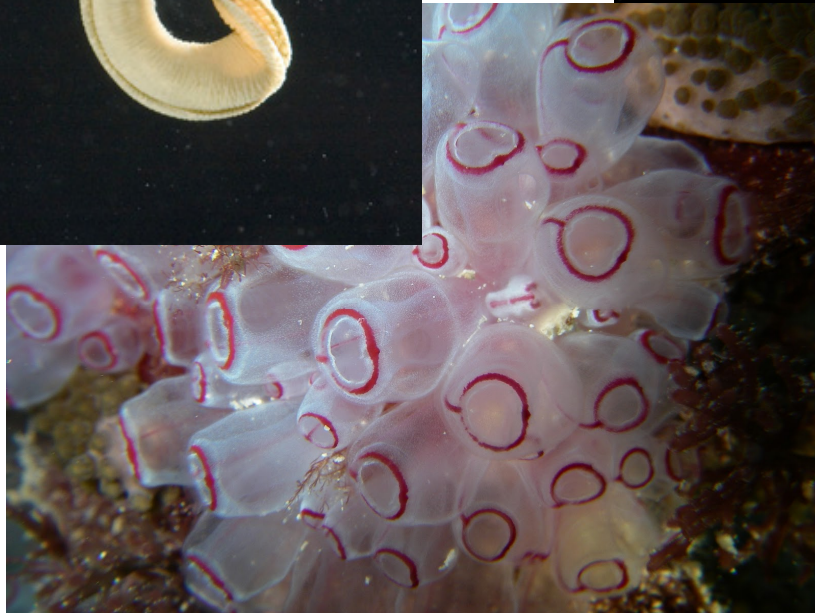


Same things in cladogram



Other chordates

- Hemichordata: *Balanoglossus*
 - Urochordata: *Ascidia*
- Cephalochordata: *Branchiostoma*



Craniates

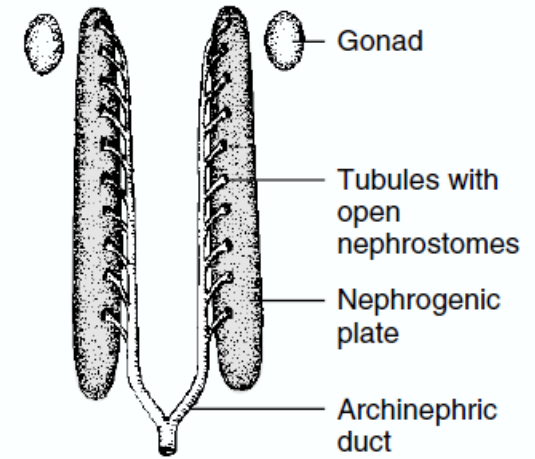
- Agnathes: lampreys & hagfishes



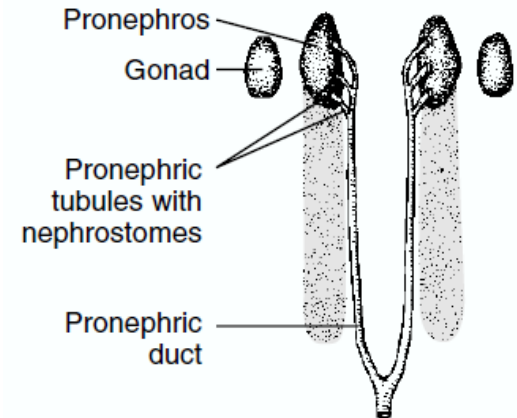
Hagfishes

- Hagfishes live buried in the sand and mud of marine environments as a scavenger. When hagfishes find a suitable fish, they enter the fish through the mouth and eat the contents of the body, leaving only a sack of skin and bones.
- In hagfishes lateral neural cartilages are found only in the tail. While reminiscent of neural arches, it is unclear whether they represent primitive vertebrae, vestigial vertebrae, or entirely different structures. Anteriorly, only an incomplete cartilaginous sheath covers the notochord in hagfishes.
- Four chambered heart. Hagfishes have three additional sets of accessory hearts along their venous system: the portal heart, cardinal hearts and caudal hearts.
- Hagfishes lack a stomach. Food passes through the pharynx and oesophagus into a straight intestine, which opens into the cloaca.

Continued



(a) **Archinephros:** Kidney found in embryo of hagfish; this is the inferred ancestral condition of the vertebrate kidney.



(b) **Pronephros:** Functional kidney in adult hagfish and embryonic fishes and amphibians; fleeting existence in embryonic reptiles, birds, and mammals

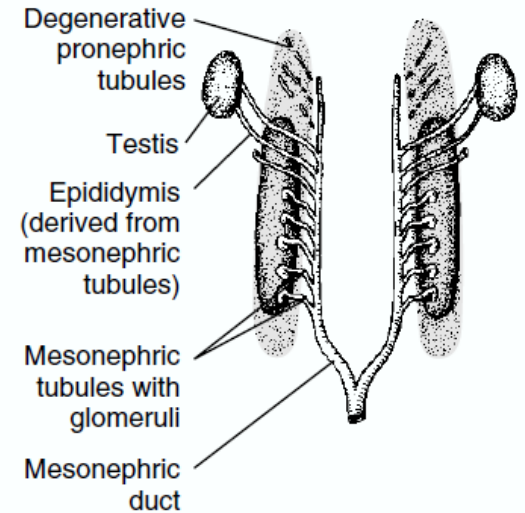
- Hagfish body fluids have salt concentrations similar to that in sea water (= isotonic); their physiology is similar to invertebrates. Hagfish embryos possess a primitive kidney known as an archinephros. It is replaced by a pronephric kidney, which forms from the anterior portion of the nephrogenic mesoderm and functions as the adult kidney in hagfishes.
- Very little is known about hagfish reproduction and smallest hagfishes look like adults.
- Ovaries and testes occur in the same individual, but only one is functional; so hagfishes are not practising hermaphrodites.

Lampreys

- Most adult lampreys prey on other fishes, and the larvae are filter feeders. The mouth of an adult is suckerlike and surrounded by lips and teeth that have sensory and attachment functions.
- Lampreys need freshwater, even saltwater lampreys spawn in freshwater. Ammocoete larvae grow from 7 mm to about 17 cm over three years. During later developmental stages, the larvae metamorphose to the adult over a period of several months.
- Cartilages supporting the mouth parts and the gills are suspended from the skull, which is little more than a trough plate of cartilage on which the brain rests.
- Although a true vertebral column is lacking in jawless fishes, paired lateral neural cartilages are located on top of the notochord lateral to the spinal cord in lampreys. These cartilaginous segments are the first evolutionary rudiments of a backbone, or vertebral column.

Continued

- Four chambered heart.
- Lampreys don't have stomach either.
- Lampreys can live in both sea water and fresh water. In the ocean, they prevent osmotic water loss by having a tough skin, by using salt-excreting cells in their gills to rid themselves of salt absorbed in their gut, and by reabsorbing water in their kidneys. In fresh water, the kidneys excrete large amounts of excess water while retaining essential proteins and salts.
- In lampreys, the anterior portion of the nephrogenic mesoderm forms a pronephric kidney and the posterior portion forms an opisthonephric kidney



(c) Mesonephros (Opisthonephros):
Functional kidney of adult lampreys,
fishes, and amphibians; transient function
in embryonic reptiles, birds, and mammals

Nut shell

Characteristics

Dorsal fin
Pre-anal fin
Eyes
Extrinsic eye muscles
Lateral-line system
Semicircular canals
Barbels
Intestine
Spiral valve intestine
Buccal funnel
Buccal glands
Nostril location
Nasohypophyseal sac
External gill openings
Internal gill openings

Cranium
Branchial skeleton
Vertebrae (cartilaginous)
Pairs of spinal nerves per
body segment
Kidney

Osmoregulation
Eggs
Cleavage of embryos

Lampreys

One or two
Absent
Well developed
Present
Well developed
Two on each side of head
Absent
Ciliated
Present
Present
Present
Top of head
Does not open into pharynx
7
United into single tube
connecting to oral cavity
Cartilaginous
Well developed
Neural cartilages
Two

Mesonephros

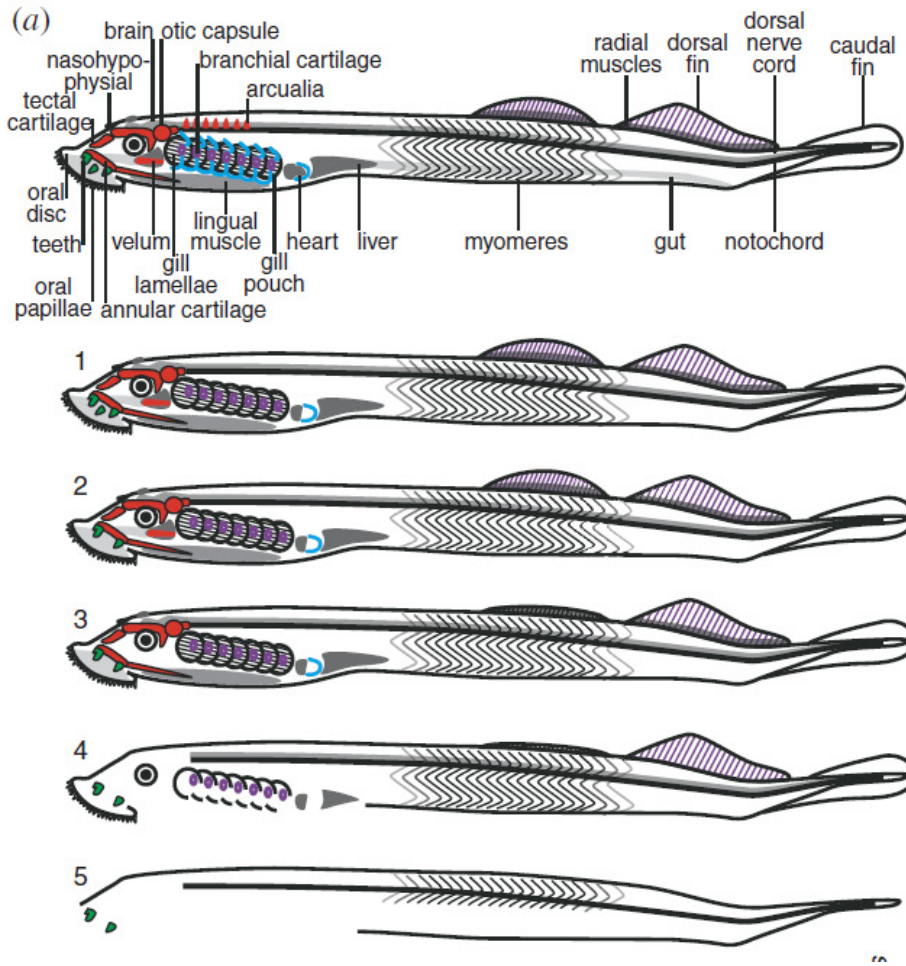
Hyper- or hypoosmotic
Small, without hooks
Holoblastic

Hagfishes

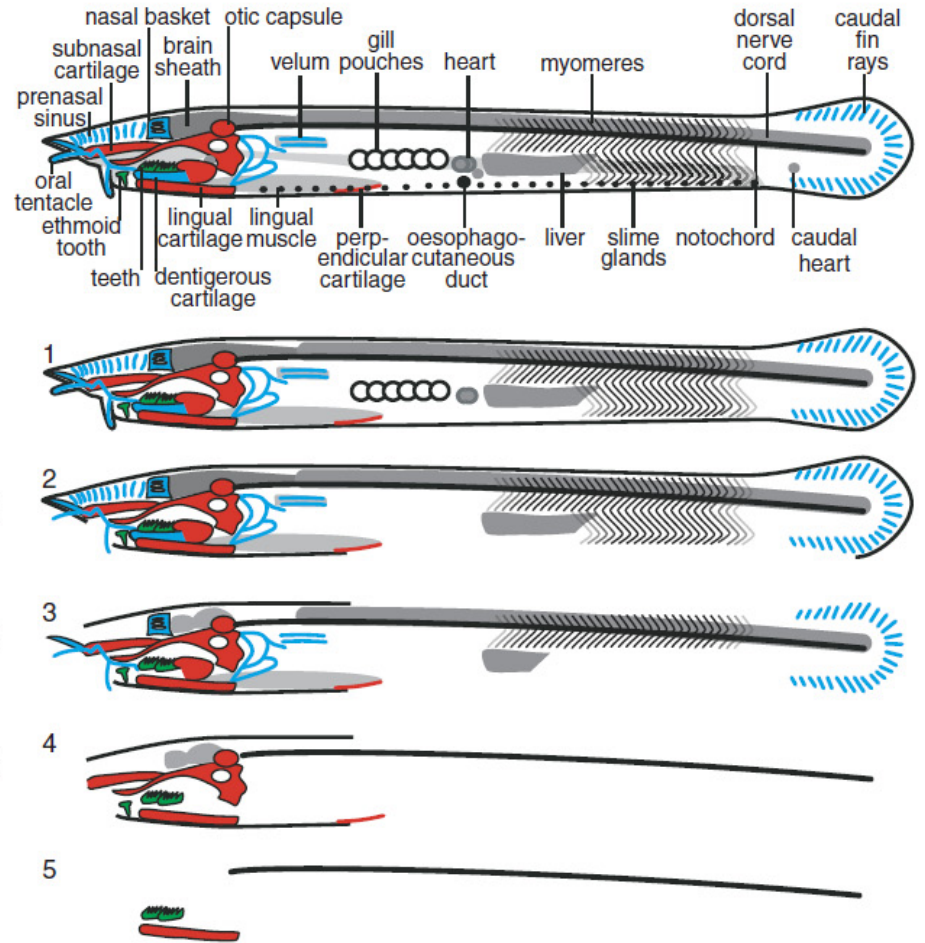
None
Present
Rudimentary
Absent
Degenerate
One on each side of head
Three pairs
Unciliated
Absent
Absent
Absent
Front of head
Opens into pharynx
1 to 14
Each enters directly into
pharynx
Poorly developed
Rudimentary
Neural cartilages only in tail
One

Pronephros anterior,
mesonephros posterior
Isosmotic
Very large, with hooks
Meroblastic

The ones



Lamprey

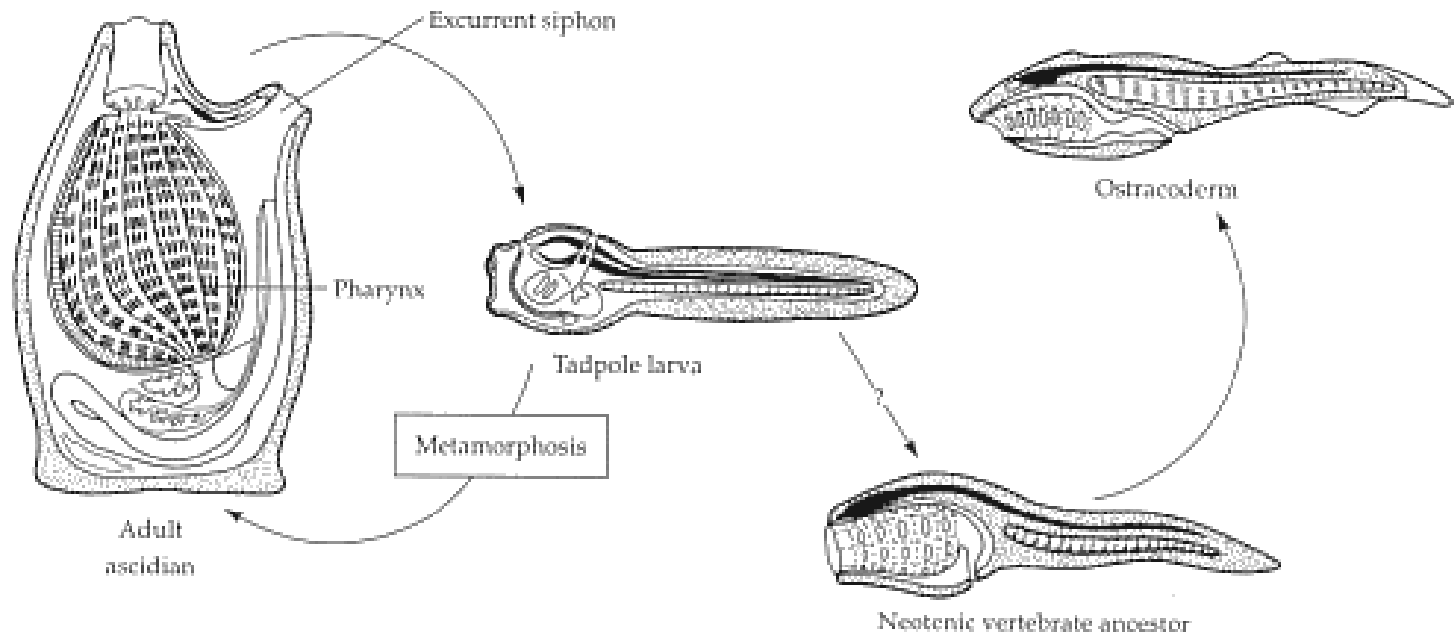


Hagfish

The question

- How do you get from uro to cephalo to craniate?
- Neoteny = retention of larval features into the adult stage
 - Stages:
 - ancestors (tunicates?) had:
 - sessile adult stage
 - free swimming larval stage for dispersal
 - larval stage became more active; more vertebrate-like
 - eventually, larvae capable of reproduction evolved (= neoteny)

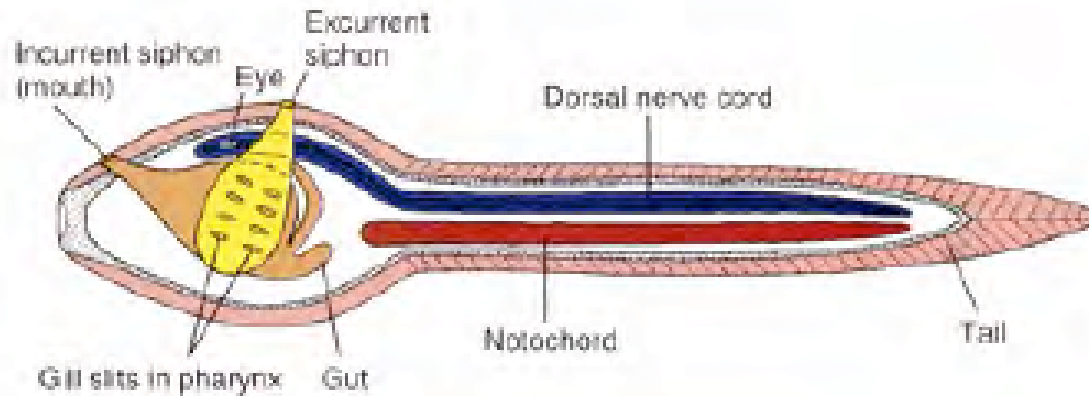
The Garstang hypothesis



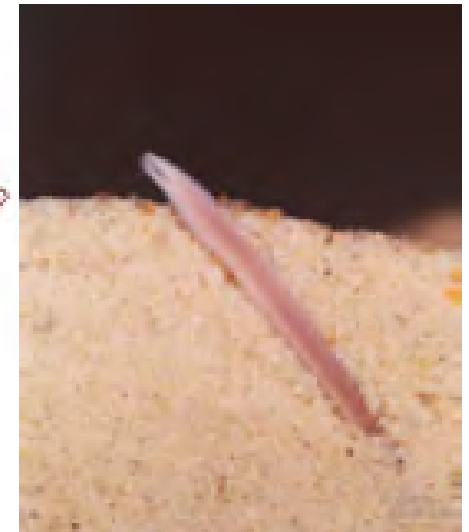
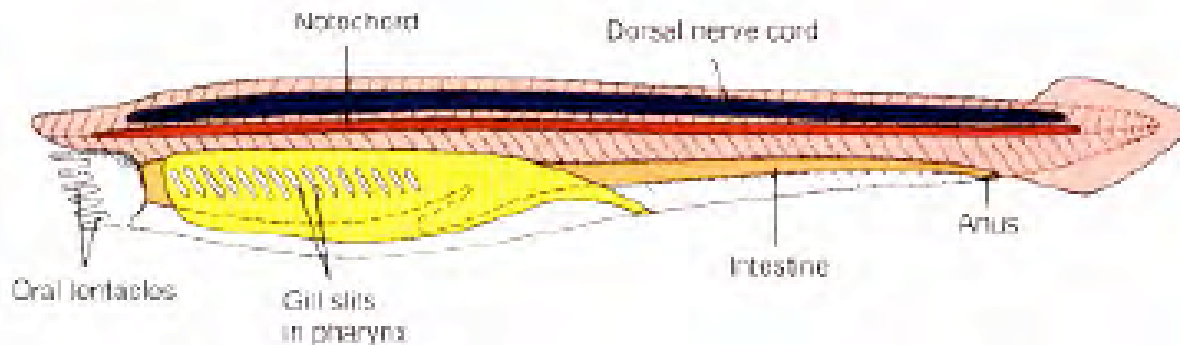
- Modern Ascidians (Subphylum Urochordata) typically have a motile tadpole larva that undergoes metamorphosis to a sessile adult. The tadpole has the typical characteristics of Chordata, including a notochord, pharyngeal gill slits, and a post-anal tail. According to the Garstang Hypothesis, development of sexual maturity in a non-metamorphosing lineage of tunicates might provide the immediate proto-chordate ancestors of more typical chordates such as Amphioxus (Subphylum Cephalochordata), or even of early Vertebrata (Ostracoderms) as shown here. Development of sexual maturity in a larval form is an example of Progenesis (Garstang called the process Neoteny, which today is used for a different but related differential growth phenomenon).

In an image

Ascidian “tadpole” larva



Lancelet (adult Cephalochordate)



Table

Table 1 : Differences between Petromyzon and Myxine

Petromyzon (Lamprey)	Myxine (Hagfish)
1. Lamprey lives in sea as well as in rivers.	Hagfish is exclusively marine.
2. Lamprey has two median fins.	Dorsal fin is like a thin and narrow membrane which extends from the middle of body and extends upto anus.
3. Barbels are absent.	Mouth is surrounded by three or four pairs of barbels.
4. Mouth is at the base of buccal funnel and is surrounded by cartilaginous lips.	Mouth is terminal. Lips are soft.
5. Lips have conical teeth.	Cartilage and teeth or denticles are absent.
6. Buccal funnel is present.	Buccal funnel is absent.
7. Nasal opening is single and median. It opens in the nasohypophysial sac. its posterior end is closed.	Nasal opening is ventral and situated in front of mouth. Nasohypophysial sac opens into buccal cavity.
8. Pineal area is present.	Pineal area absent.
9. Eyes are well-developed.	Eyes are subcutaneous and poorly developed and non-functional.
10. Branchial basket is well developed.	Branchial basket is poorly developed.
11. Branchial sacs and branchial openings are seven pairs.	Branchial sacs 6-14 pairs. There is only one branchial aperture in <i>Myxine</i> .
12. Brain is better developed. The head is distinct.	Brain is less developed. The head is indistinct.
13. Membranous labyrinth has utriculus, sacculus and two semicircular canals.	Membranous labyrinth is simple and without a sacculus.
14. Spinal nerves have distinct dorsal and ventral roots.	The dorsal and ventral roots are present but not very distinct.
15. Kidneys form a compact mass.	Kidneys are separate.
16. Urinogenital sinus is present. There is a pair of genital apertures.	Urinogenital sinus is absent. There is only one genital aperture.
17. Intestine has a typhlosole and a valve similar to spiral valve.	Intestine is without typhlosole and spiral valve but intestinal wall has longitudinal ridges .
18. Development includes ammocoete larva .	Development is direct in <i>Bdellostoma</i> i.e. with larva.
19. Lamprey gets attached to the under-surface of bony fishes and scarpes their flesh.	Hagfish gets attached to the gills of fishes, enters their body cavity and eats their visceral organs and muscles.

Ref

- Miller Harley
- Linzey
- Rastogi