

# **Topic: Chordata**

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## Phylum Chordata

### I. **Phylum Characteristics (\*\* means 4 main characteristics that set this phylum apart from other phyla)**

A. **Bilateral symmetry segmented**, 3 germ layers; well-developed coelom; some of the things the germ layers give rise to: (note these are just a few examples - each germ layer gives rise to more things than those listed below):

- **endoderm** - gives rise to epithelial lining of digestive tube; lining of respiratory system;
- **ectoderm** - epithelium, nervous system
- **mesoderm** - muscles, blood vessels, reproductive system

**B.\*\* Notochord** - have notochord at some stage in life cycle (rodlike, semirigid body of vacuolated cells which extends in most cases the length of the body between digestive tract and central nervous system); purpose of notochord is to stiffen the body

**C.\*\* Single, dorsal, tubular (hollow) nerve cord** (the anterior end is usually enlarged into a brain)

**D.\*\* Pharyngeal gill pouches** (sometime in life cycle); may or may not be functional

**E.\*\* Postanal tail** - may or may not persist

F. Segmented muscles (unsegmented trunk)

G. **Ventral heart** with dorsal and ventral blood vessels; closed circulatory system

H. Complete digestive tract

I. **Exoskeleton** often present (well-developed in some vertebrates)

J. Cartilage or bony **endoskeleton in most members** (vertebrates)

## II. Phylum Chordata

A. **Subphylum Urochordata (= Tunicata)** - "tail chordates" - tunicates or sea squirts - have non-living tunic on outside -2-

1. Notochord and nerve cord present in free-swimming larva, larva settles, becomes sessile filter feeder as adult and loses notochord and nerve cord
2. Pathway of water through sea squirt:

**incurrent siphon--> pharynx--> atrium--> excurrent siphon**

3. Sea squirts may be solitary, colonial, compound (where many individuals share tests; in some compound ones, each member has its own incurrent siphon, but excurrent siphon is common to the group)
4. Know parts of tunicate: Fig. 23.4
  - **tunic = test** -- composed mostly of cellulose- covers outside of animal
  - next is lining called **mantle**
  - incurrent, excurrent siphons
  - know how feeding occurs-- water enters into incurrent siphon -- goes to mouth -- to branchial sac (=pharynx)-- food particles get stuck on mucous coating that is on pharynx (endostyle secretes the mucus; it is a groove on midventral side of branchial sac); - mucous sheet is carried by cilia across the inner surface of pharynx to dorsal side-- picks up food-- goes down esophagus to stomach-- intestine-- anus-- out atrial cavity-- out excurrent siphon
  - **ventral heart** - they have reverse blood flow periodically; in their blood they have (in high amounts) the rare elements of vanadium and niobium -- unknown function
  - excretion - nephridium near intestine
  - in adult- notochord is gone
    - nervous system- few ganglia (on dorsal pharynx)
    - retain their pharyngeal gill slits
  - hermaphroditic (monoecious) - germ cells go out excurrent siphon into water- external fertilization
  - larva has all the characteristics of chordate - does

not feed, swims and settles down

- see Fig. 23.6 - ascidian development

**B. Subphylum Cephalochordata - marine lancelets (amphioxus = used to be old genus name, now it is the common name; Branchiostoma = current genus name) (Fig. 23.9)**

1. Have notochord; allows undulatory movements
2. Filter feeders
3. Cilia create currents moving water into mouth -- into pharynx through gill slits-- out atriopore (food particles are trapped in mucus and carried to intestine)
4. Circulation system is closed; no heart; blood is pumped forward in ventral aorta by peristaltic-like contractions of vessel wall-- then blood passes upward over branchial arteries (aortic arches) in gill bars to paired dorsal aortas (which then join to become 1 aorta)-- then to microcirculation-- blood then collects in veins-- back to ventral aorta; no hemoglobin or red blood cells; blood thought to transport nutrients but seems to play little role in gas exchange
5. Nervous system - hollow nerve cord above notochord
  - pair of spinal nerve roots emerge at each trunk muscle segment
  - "brain" is simple vesicle at anterior end of nerve cord
6. Senses - unpaired bipolar receptors at various places in body
7. Sexes separate (dioecious) - external fertilization (gametes go into atrial cavity and out atriopore)
8. Besides the 4 diagnostic chordate characteristics, amphioxus has several structural features suggesting the vertebrate plan:
  - liver diverticulum
  
  - cecum resembling a vertebrate pancreas in that it secretes digestive enzymes

- basic circulatory plan of advanced chordates
- segmented trunk musculature

9. Many zoologists consider amphioxus to be a living descendent of an ancestor that gave rise to both the cephalochordates and vertebrates

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**C. Subphylum Vertebrata (Craniata)**

1. Dorsal, hollow nerve cord has differentiated into brain, encased in a cranium (skull), and a spinal cord; present in adults and embryos of all species
2. Notochord in embryo replaced with a vertebral column of cartilage or bone in most adults (endoskeleton)
3. Pharyngeal gill slits found in all embryonic vertebrates, but only break through the body surface in fishes and larval amphibians
4. Post-anal tail at some stage in development
5. Sexes separate (usually)
6. Integument; epidermis (from ectoderm) and dermis (from mesoderm)
7. Has endoskeleton and attached muscles
8. Complete digestive tract and accessory organs
9. Ventral heart (2 to 4 chambers); closed circulatory system; red blood cells (RBC's), white blood cells (WBC's), and hemoglobin; paired aortic arches
10. Well-developed coelom
11. Paired kidneys
12. Brain - 5 vesicles (usually); 10-12 pairs of cranial nerves (autonomic nervous system- controls involuntary functions of internal organs)
13. Have endocrine system
14. Body plan -- head (some have neck), trunk, post-anal

tail, usually 2 pairs of appendages; coelom divided into pericardial space and general body cavity; mammals have thoracic cavity

15. Adaptations that have guided vertebrate evolution: -5-
- living endoskeleton (can get bigger, can support much muscle)
  - pharynx and efficient respiration
  - advanced nervous system
  - paired limbs

### **Ancestry and Evolution**

- candidates for the vertebrate ancestral stock:
  - they discarded annelid and arthropod ideas
  - early echinoderms, early hemichordates, or a common ancestor of both are probably ancestral to vertebrate stock;

they think so because they are Deuterostomes (i.e., mouth is second opening; anus is from blastopore); coelom is primarily enterocoelous (it is budded off from the archenteron of the embryo) in echinoderms; (chordates are schizocoelous); both have radially regulative cleavage; fossil echinoderms, the **Calcichordata** are filter feeders like primitive chordates

they think vertebrates arose gradually from a ciliated filter feeder (resembling protochordates)

- in the development to mobile vertebrate predatory lifestyle, the emergence of a distinct head was important - with the head came:

- a. improved nervous system with paired complex sense organs
- b. well-developed cranial skeleton, later jaws
- c. muscular buccal pump and effective gill circulation for efficient gas exchange

- amphioxus - used to be thought of as one possibility for main vertebrate ancestor, but adult does not have all the parts

### **Ammocoete Larva of Lamprey as a Model for Primitive Vertebrate Body Plan**

- we will go over this in lab -- know Fig. 23.13

## The Earliest Vertebrates: Jawless Ostracoderms

1. **Ostracoderms** - earliest vertebrate fossils-- found in late Cambrian (about 500 -600 million years ago) in US, Bolivia, Australia; were small, jawless
2. One of the earliest groups of ostracoderms -- were called **heterostracans** - they lacked paired lateral fins; probably were filter feeders, but were maybe predatory (had a brain, sense organs)
3. Later group was the **osteostracans (= cephalaspidiformes)** - had paired pectoral fins, well-developed armor, were bottom feeders (as were all ostracoderms)

## Early Jawed Vertebrates

- **Superclass Gnathostomata** - means "jaw mouth" (in contrast to **Superclass Agnatha** which means "jawless")
- first jawed vertebrates in fossil record (early Devonian, about 400 million years ago)-- called **Placoderms**; had jaws which allowed predation on large and active forms for food; jaws arose from the modification of the first 2 cartilages of gill arches