**Chapter 13: Phylum Chordata**

**Introduction**

The phylum **Chordata** consists of three subphyla:

1. **Urochordata**

2. **Cephalochordata**

3. **Vertebrata** (Craniata)

The urochordates and the cephalochordates are only represented by marine forms.

**Subphylum Cephalochordata**

The cephalochordates are illustrated by **amphioxus** (*Branchiostoma lanceolatum*), and are burrowing forms living in the sand in shallow water around the world's land masses. They lack appendages and possess a body with a short transverse axis. Both the anterior and posterior extremities are pointed. Our interest in this organism is essentially to recognize it and locate the five classical chordate characteristics. Look at a whole mount under the dissecting microscope (Fig. 13.1). From this you should be able to see the five classical chordate characteristics which are:

**1. Dorsal hollow nerve cord**

**2. Pharyngeal slits**

**3. Notochord**

**4. Postanal tail**

**5. Endostyle**

The five features above occur sometime in the life of all chordates. In amphioxus, they are all present in the adult; this is unusual in the chordates. The organism is, therefore, very useful in our study of chordates. Three characteristics are best seen in cross-sections. We will be concerned only with these three characteristics and not the total morphology of the organism.

The available slides of amphioxus have four representative cross-sections through the body, the most anterior section being to the left. In at least the three last sections, the dorsal tubular nervous system and notochord are present. The former is dorsal to the latter. Close inspection will reveal a lumen in the nerve cord. Find the **dorsal hollow nerve cord** and **notochord** in the last three sections. Use your text if necessary. Usually the second section contains the pharynx and the **pharyngeal slits**. This organ is in a large cavity, the **atrium**, ventral to the notochord. The organ is composed of small blocks of tissue, which collectively surround a lumen. The spaces between the blocks are the **pharyngeal slits.** As in most other lower chordates, the pharyngeal slits are exits for water taken into the pharynx from the mouth. They also provide spatial proximity between the oxygen-carrying water and the blood capillaries in the walls of the pharynx.



**Figure 13.1.** Labeled micrograph of a whole mount of Amphioxus.

Also be sure to study the amphioxus woodcuts and the microscope slides. Note that the woodcuts are colored according to the classical embryological colors: blue for ectoderm, red for mesoderm, and yellow for endoderm. Recognize the germ layer from which each chordate structure originates.

**Subphylum Urochordata**

The adult of this organism, the sea squirt, does not look like most chordates (Fig. 13.2). They are sessile as adults, and retain only the **pharyngeal slits** and **endostyle** from the five chordate characteristics. The slits are numerous, and go through a large pharyngeal basket, which is housed in the atrium. Look at the plastic mount and the slides provided. The organism can be identified by two external openings, the **incurrent** and **excurrent siphons**. Look for these and the pharyngeal slits. Observe a preserved tunicate for siphons.

To see the other two chordate characteristics, we must look at the larval stage (Fig. 13.3). This is a tadpole-like organism. Look at the slide (*Amaroecium* tadpole), and notice the presence of two longitudinal structures in the tail. One of these is the **notochord**. Its presence in the tail-only is responsible for the name of the subphylum. The **nerve cord** is dorsal to the notochord, and extends into the anterior portion of the body.



**Figure 13.2.** Labeled micrograph of a whole mount of anadult urochordate.



**Figure 13.3.** Labeled micrograph of a whole mount of a urochordate larva.

**Subphylum Vertebrata (Craniata)**

* Vertebrae replace notochord as a supporting structure
* Vertebrae surround nerve cord
* Notochord remains or is replaced by centrum of vertebra

**Agnatha:** jawless fish

**Class Myxini**: hagfish and slime hag (have cranium, but no vertebrae)

**Class Petromyzontida**: lampreys

* + Circular mouth, no jaws
  + No paired appendages
  + Cartilaginous vertebrae incomplete
  + More than five pharyngeal slits

Lamprey: this organism possesses a circular, toothed, mouth that is adapted to its feeding habits of attaching to fish, rasping a hole in the scale covering, and feeding on the muscles. Observe this mouth in the preserved specimen and the plastic mount sagittal section of the anterior body. Laterally and posterior to the mouth, are several paired openings. These are actually openings from the gill pouches and there is a one-to-one correspondence between the more internal pharyngeal slits and the openings from the gill pouches.

In the sagittal section and in the cross-section embedded in plastic, the dorsal tubular nervous system and notochord can be seen in their usual relationship.

Ammocoetes: lamprey larva. Its name sounds a good deal like amphioxus, and its appearance is not unlike that of the cephalochordate. The cross-sections of ammocoetes are arranged similarly to those of amphioxus. Look through all the sections for the **nerve cord** and **notochord**. Compare cross-sections of amphioxus and ammocoetes through the pharyngeal region. Be able to identify the **gill slits** and the **endostyle.**

**Superclass Gnathostomata**: “jaw mouth” – jawed organisms

**Class Chondrichthyes**: sharks, rays, skates, chimaeras

* + Cartilaginous skeleton
  + Five pharyngeal slits plus a spiracle
  + Skull of one piece called a chondrocranium
  + Two pairs of paired appendages (pectoral, pelvic)
  + Paired jaws
  + **Placoid** scales in the integument

**Subclass Elasmobranchii**: sharks, skates, and rays

**Subclass Holocephali**: chimaeras

Ovoviviparity: The young of sharks hatch in the body of the maternal parent and are born as fully-living organisms. Look at the provided specimens of young dissected from the uterus of the mother. Notice the attached yolk sac.

**Clade Osteichthyes**:

* + Bony skeleton
  + Teeth usually fused to jaws
  + Swim bladder or lung often present

**Class Actinopterygii**: ray-finned fishes

* + - Paired fins supported by rays without a lobed portion

**Subclass Neopterygii**

**Infraclass Holostei**

* + - * **Order Lepisosteiformes**: gars – seven living species
        + Multilayered and interlocking **ganoid scales**
        + Elongated jaws
        + Look at the mounted gar hung on the wall on the western end of DW Reynolds on the first floor. In addition, we have two dried specimens and a skull available for examination in the lab.
      * **Order Amiiformes**: bowfin – single species
        + Mobile maxilla
        + **Cycloid scales**
        + Observe the bowfin skull and specimen.

**Infraclass Teleostei**

* + - * **Superorder Elopomorpha**
        + Have specialized larva called leptocephalus (“leafy head”) larva
        + Most are marine
        + Eel-like in morphology
        + **Cycloid scales**
* **Superorder Ostariophysi**
  + - * + **Weberian apparatus** – small bones that connect gas bladder to inner ear
        + Males have nuptial tubercles – composed of epidermal cells;
      * **Superorder Acanthopterygii** 
        + Modified protrusible jaws
        + Many have upturned mouths
        + **Ctenoid scales**

**Class Sarcopterygii**: lobe-finned fishes

* + - Fins have lobes with large heavy bones for support.
    - Lung often present

**Clade Tetrapoda – vertebrates with four limbs**

**Class Amphibia**

* + Scaleless, moist glandular skin
  + Four appendages for locomotion on land
  + Substantial musculature in appendages, not just at the base as in fins
  + Three-chambered heart
  + Can raise or lower head--two articulations with skull (occipital condyles) and vertebral column

**Order Caudata**: salamanders

* + - Well-developed head, trunk, and tail

**Order Anura**: frogs and toads

* + - Fused head and trunk; tailless
    - Hind legs adapted to jumping

**Order Gymnophiona**: caecilians (no specimen)

* + - Lacks limbs, snake-like

**Class Reptilia**

* + Scaled, virtually glandless skin
  + Amniotic eggs
  + Three-chambered heart (except crocodilians, which have four chambers)

**Clade Diapsida**

* + - Two temporal openings in the skull

**Order Testudines**: turtles

* + - * Body enclosed by upper shell (**carapace**) and lower

shell (**plastron**)

**Superorder Lepidosauria**

**Order Squamata**: lizards and snakes

* + - * Skin of plates or scales that is shed periodically

**Suborder Lacertilia**: lizards

* + - * + Eyelids and external ear openings
        + Legs usually present

**Suborder Serpentes**: snakes

* + - * + No eyelids or external ear openings
        + Legs vestigial or absent

**Order Sphenodonta**: tuataras

**Superorder Archosauria**: ruling reptiles

**Order Crocodilia**: crocodiles and alligators

* Elongate, massive skull
* Sprawling body form
* Four-chambered heart

**Order Saurischia**: “lizard hip”

**Suborder Theropoda**: “wild beast foot”

* *Tyranosaurus rex* and *Velociraptor*
* Birds descended from this suborder\*

**Clade Synapsida**: mammal-like reptiles

**Order Pelycosauria**: Carboniferous and Permian synapsids

* *Diametrodon*
* Therapsids descended from this group

**Order Therapsida**: Permian and Triassic synapsids

* Living mammals descended from this group

**Class Aves\***

* + Feathers over body, scales on legs
  + Anterior appendages modified into wings for flying
  + Bill present, no teeth

**Subclass Archaeornithes**: “long, old tail” - *Archaeopteryx*

**Subclass Neornithes**: “short, new tail”

**Superorder Paleognathae**: “old jaw” – ratites (e.g. ostrich,

emus, kiwis)

**Superorder Neognathae**: “new jaw” – all the rest (e.g. ducks,

shorebirds, owls, woodpeckers, raptors, songbirds, etc.

**Class Mammalia**

* + Body with hair and skin glands
  + Female with functional mammary glands
  + Lower jaw is a single bone called a dentary (mandible)
  + Teeth diversity: heterodont dentition

**Subclass Prototheria**: egg-laying mammals

**Order Monotremata**: platypus

**Subclass Theria**: viviparous mammals

**Infraclass Metatheria**: marsupials

**Infraclass Eutheria**: chorio-allantoic placenta

**Order Insectivora**: shrews and moles

**Order Chiroptera**: bats

**Order Primates**: monkeys and humans

**Order Cingulata**: armadillos

**Order Pilosa**: sloths and anteaters

**Order Lagomorpha**: rabbits

**Order Rodentia**: rodents

**Order Carnivora**: carnivores

**Order Hyracoidea**: hyraxes

**Order Proboscidea**: elephants

**Order Sirenia**: manatees

**Order Perissodactyla**: odd-toed ungulates

**Order Artiodactyla**: even-toed ungulates, whales, hippo