**Phylum Chordata – Ch. 23** Updated 10 January 2012 -1-

Revised from 2011 Book (15th edition)

**See Table 23.1 for Traditional Divisions of 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)

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**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

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**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 -4-

 descendent of an ancestor that gave rise to both the

 cephalochordates and vertebrates

**C. Subphylum Vertebrata (Craniata)**

 1. Dorsal, hollow verve 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

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**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

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**Garstang's Hypothesis** of Chordata Larval Evolution - read pp. 96-97

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

Plan

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

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**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)

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**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

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**Evolution of Modern Fishes and Tetrapods -- read pp. 100-101**