Lesson 2
Craniate/Vertebrate Characteristics

◊ **Lesson Outline:**

- ♦ Protostomes versus Deuterostomes
- ♦ The Chordate Body Plan
- ♦ Craniate Characteristics
- ♦ Vertebrate Characteristics
- ♦ Origin of the Chordates

◊ **Objectives:**
At the end of this lesson you should be able to:

- ♦ Distinguish between prototomes and deuterostomes
- ♦ Describe the features of the basic chordate body plan
- ♦ Describe the characteristics common to all craniates
- ♦ Describe the characteristics that distinguish craniates and vertebrates
- ♦ Describe the origin of the Chordates

◊ **References:**
- ♦ Chapter 1 and 3 (read only)

◊ **Reading for Next Lesson:**
- ♦ Chapter 4

Chordate Body Plan

Despite the tremendous diversity within the animal kingdom, there are only a few different types of body plan

Large numbers of animals are descendent from common ancestors and the common ancestry determines much of the basic similarity in body organization

Thus, all chordates have a common body plan that is unique to this group.

Other plans include: Coelenterate Body Plan
Flatworm Body Plan
Round Worm Body Plan
Annelid Body Plan
Arthropod Body Plan
Molluscan Body Plan
Ecinoderm Body Plan
Chordate/Vertebrate Body Plan

There are departures from each plan (parasites for instance) raising questions about "Why" and "How" they have occurred.

Protostomes vs Deuterostomes *(not in textbook)*

The chordates are descended from ancestors that were distinguished by the fact that at some point in their development they were bilaterally symmetrical and had a coelom or body cavity.

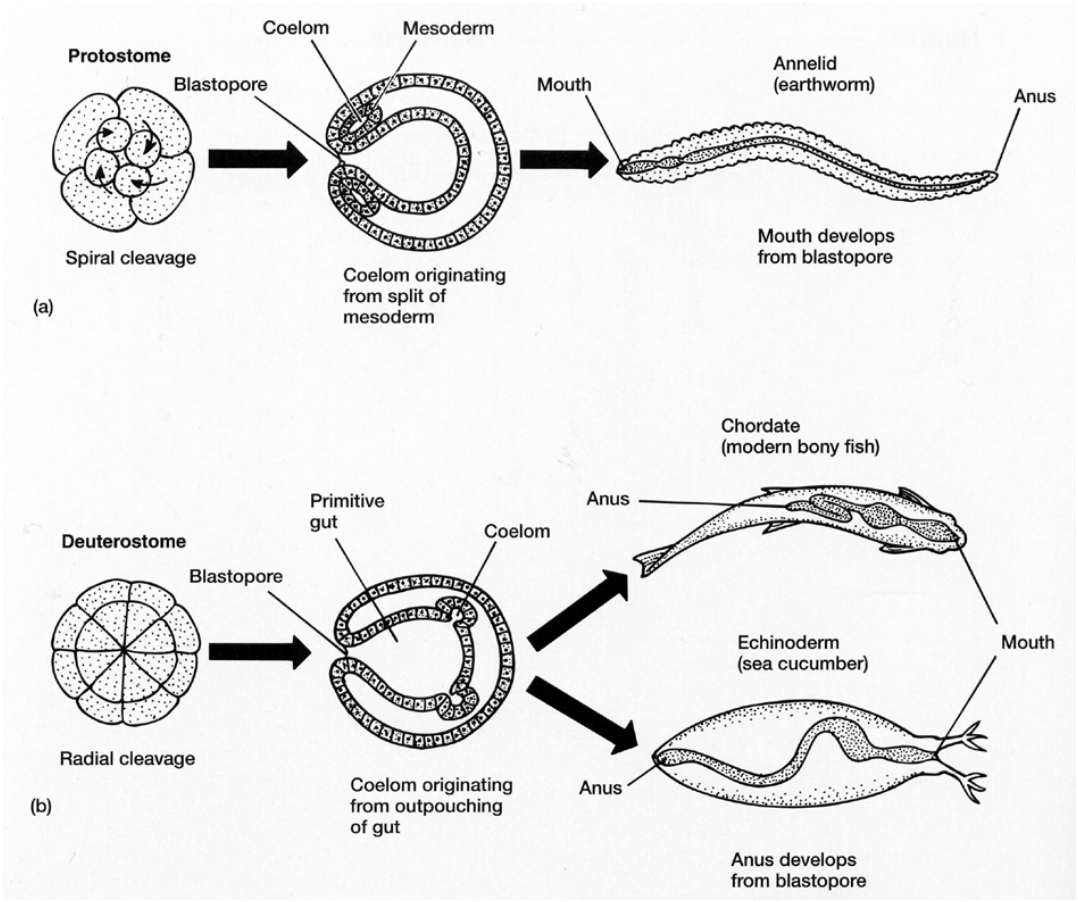
Within the coelomates two distinct and independent evolutionary lines are present.

One line is the protostomes, which includes the molluscs, annelids, arthropods and many smaller groups.

The other line is the deuterostomes which includes the echinoderms, protochordates and chordates

The division into these two groups has been made based on embryonic characteristics. There are four important ones:

- the dividing cell mass demonstrates spiral cleavage in the protostomes but radial cleavage in the deuterostomes
- the blastopore forms the mouth in the protostomes but the anus in the deuterostomes
- the coelom forms from splitting the mesoderm in protostomes but from an outpocketing of the gut cavity in the deuterostomes
- the skeleton forms from outer endodermis in the protostomes but from inner mesoderm in the deuterostomes.



Classification

Kingdom Animalia

- Phylum Chordata
  - Subphylum Urochordata
  - Subphylum Cephalochordata
  - Subphylum Craniata / Vertebrata
    - Hagfish (craniates without vertebrae)
    - Vertebrata (craniates with vertebrae)

Note:

Some authors equate craniates with vertebrates (and include hagfish in the vertebrates) - others do not.

Chordate characteristics (text pg 2)

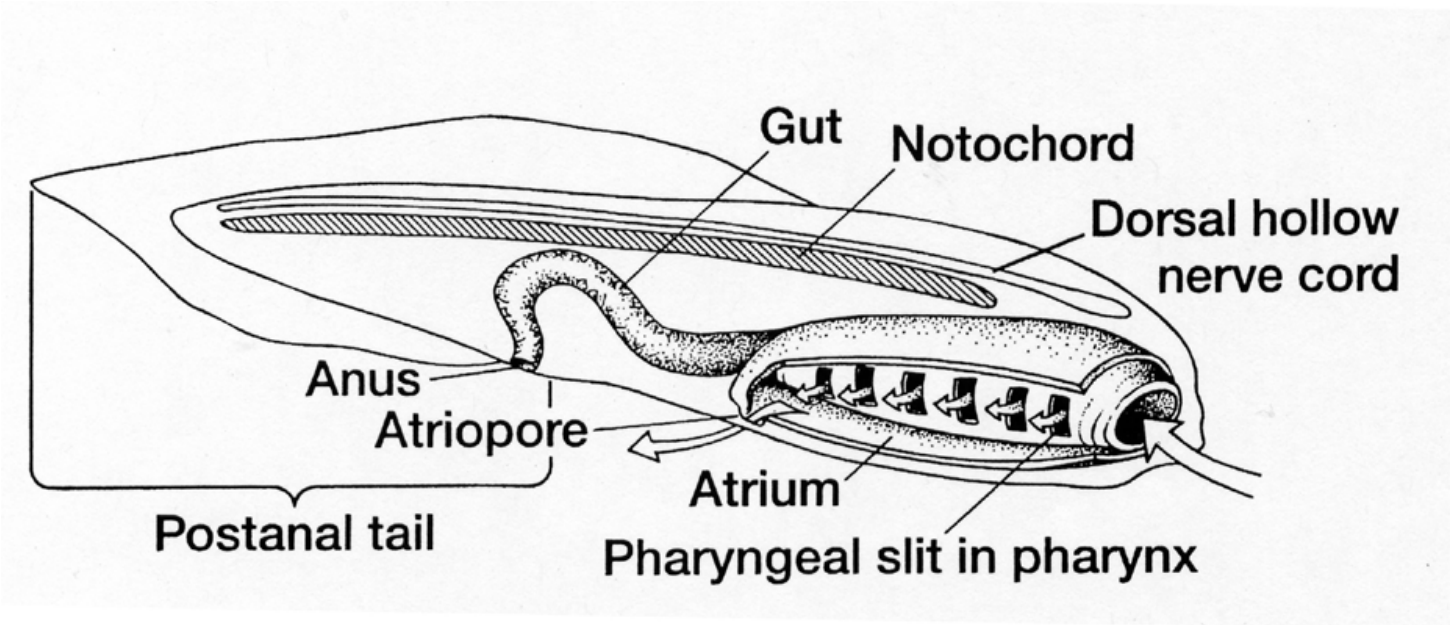
All chordates share a common body design similar in four (or five) fundamental features:

- notochord
- dorsal, tubular (hollow) nerve cord
- postanal tail
- endostyle
- pharyngeal slits

Note:

All authors consider the notochord, dorsal hollow nerve cord and postanal tail to be chordate characteristics. Some also include the endostyle, some include the pharyngeal slits and some include both.

The endostyle is a glandular groove in the floor of the pharynx



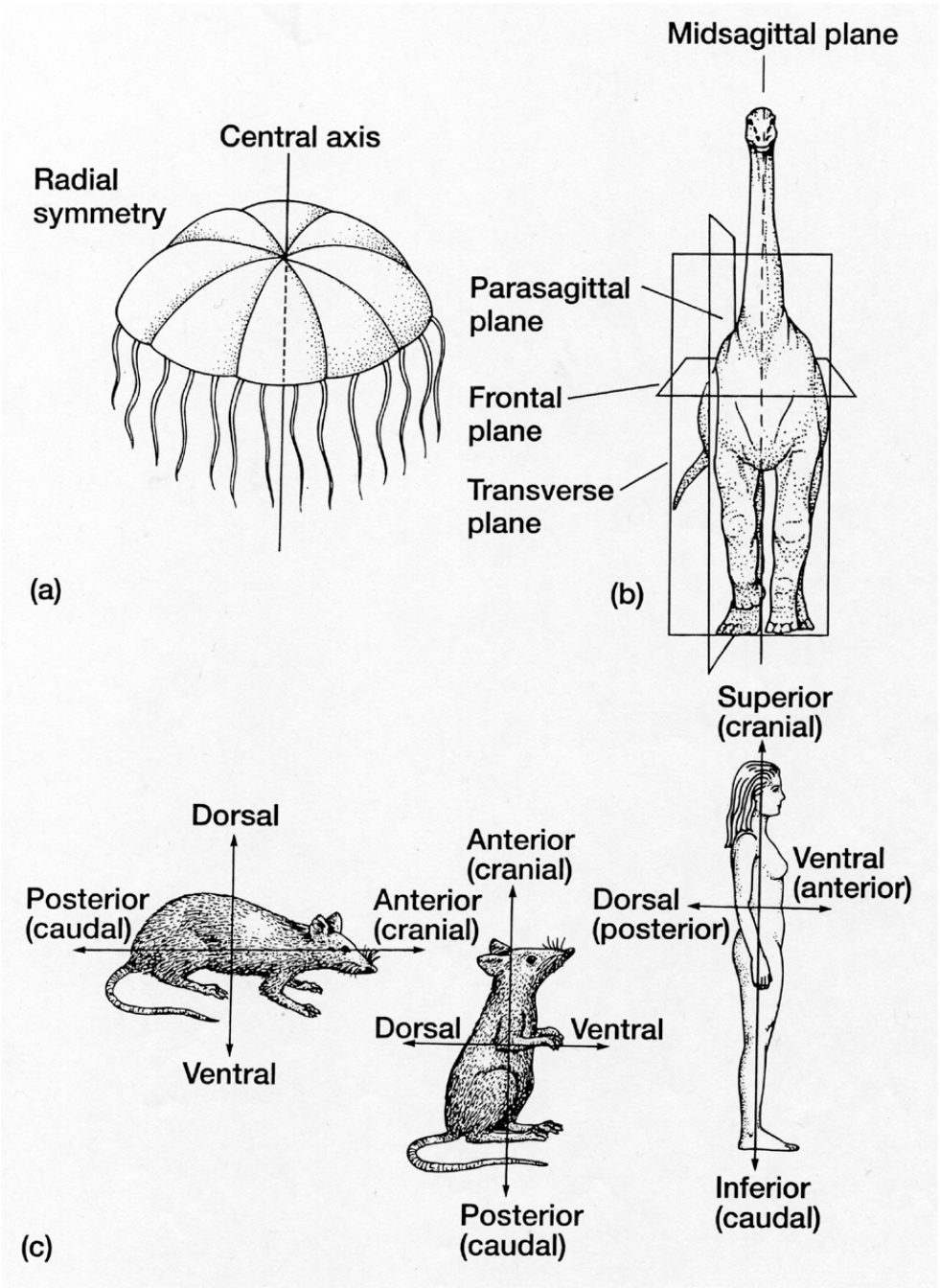
The Craniate Body: General Plan *(pp2-5)*

All craniates are bilaterally symmetrical

Radial versus bilateral

Dorsal, ventral	anterior, posterior
medial, lateral	rostral, caudal
superior, inferior	distal, proximal

frontal, transverse (cross) sagittal (parasagittal)



Metamerism / Segmentation

Craniates exhibit serial repetition of structures in the longitudinal axis of the body. This is commonly seen in craniate embryos but not commonly seen in adult structures other than the vertebral column and the segmental muscles of the trunk.

Craniate Characteristics: *(pp5-9)*

Notochord = a slender rod that develops from mesoderm that lies dorsal to the coelom but beneath and parallel to the nerve cord. This gives the phylum its name. It appears as an embryonic structure in all chordates but is replaced by the vertebral column in the vertebrates.

Pharyngeal Slits = The pharynx is the anterior chamber of the digestive tract. At some point during development in all chordates, the walls of the pharynx are penetrated by a longitudinal series of openings which connect to the outside (singly or via a single opening from a common vestibule or atrium). In many it is overgrown and disappears before the embryo is born or hatched.

Dorsal, Hollow Nerve Cord = This is derived from ectoderm by invagination giving rise to a hollow, fluid filled structure that lies dorsally above the gut. In most invertebrates, not only does the nerve cord form from migration of cells, it forms ventrally below the gut and is solid.

Postanal Tail = The last unique feature is the posterior elongation of the body extending beyond the anus. It is usually used for locomotion and contains the notochord and segmental musculature.

These characteristics may be present only briefly during development, or they may persist into the adult stage. Together they are a suite of characteristics that distinguish them from all other phyla. Remember they are also bilaterally symmetrical, contain a coelom and show segmentation.

Other Craniate Characteristics

In addition to the basic chordate characteristics, craniates also exhibit: *(pg 5)*

- a cranium
- *a three part brain*
- *a neural crest and its derivatives*
- *paired external sense organs*
- *cartilage*

Other characteristics of craniates include: *(pgs 9-11)*

- Integument
- Respiratory Mechanisms
- Coelom
- Digestive System
- Urogenital System
- Circulatory System
- Muscles
- Sense Organs

These are the systems that we will cover in detail shortly

Vertebrate Characteristcs
Vertebrates are further characterized by *(pg 5*)

a vertebral column
two semicircular canals
electroreception
a lateral line system

Origin of Chordates - Chordate Phylogeny

Origin lies amongst the invertebrates - but where?

The origin of the vertebrates is still unsettled and controversial. Their origin certainly lies somewhere amongst the invertebrates but the question is where? Many theories have been put forward and we will briefly look at the most recent theory supported by Ken Kardong.

Within the early chordates, the basic body plan was established, pharyngeal slits, notochord, dorsal hollow nerve cord, endostyle and post-anal tail.

The pharyngeal slits in extant vertebrates serve to separate suspended food particles from the water as well as to extract oxygen and excrete carbon dioxide. Oxygen is required to oxidize food substances to obtain ATP from metabolism and carbon dioxide is the primary waste product of this process. All three processes are related (obtaining and metabolizing food and excreting waste).

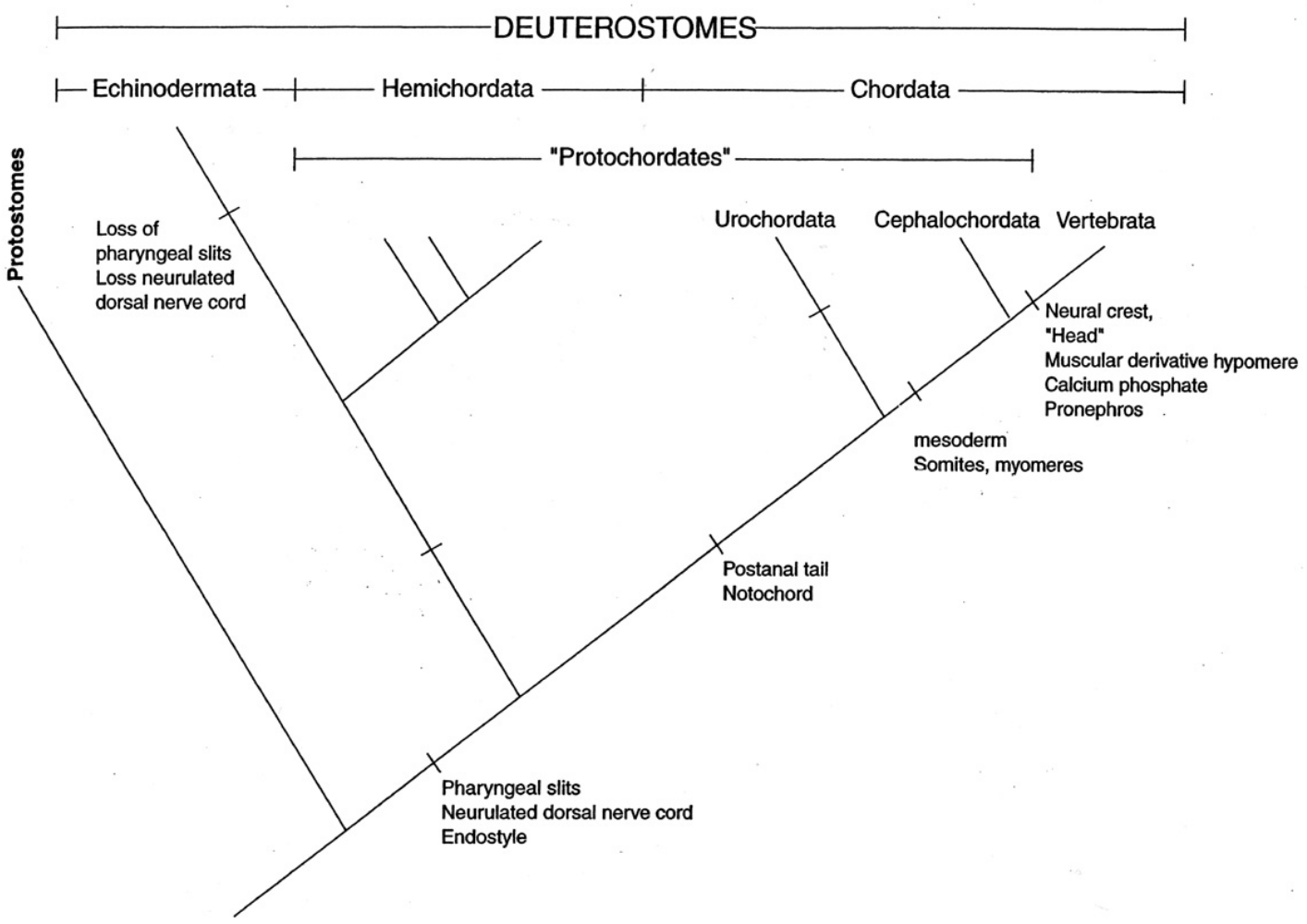
As animals grow, filter feeding becomes replaced by active feeding which requires locomotion. Effective locomotion requires large muscle mass and a coordinated nervous system. It also requires a stiff body upon which to generate force and a large surface (the postanal tail).

Thus the basic chordate body plan is seen as a response to increasing size and the need for active predation.

What gave rise to these features?

Kardong's Theory

The most current theories now not only employ anatomical and embryological data but also employ new molecular data obtained from DNA analysis. This data would suggest that the ancestor of the vertebrates first gave rise to two groups. One group ultimately gave rise to both the echinoderms and hemichordates while the other group gave rise to the urochordates, cephalochordates and vertebrates.



Thus, vertebrate evolution has tended to progress from:

sessile groups to active groups
filter feeding to active feeding involving muscular action
soft body support to bony support

This appears to have occurred through paedogenesis and led to increased locomotion and activity. A return to a sessile life style is rare amongst the vertebrates although it does occur.