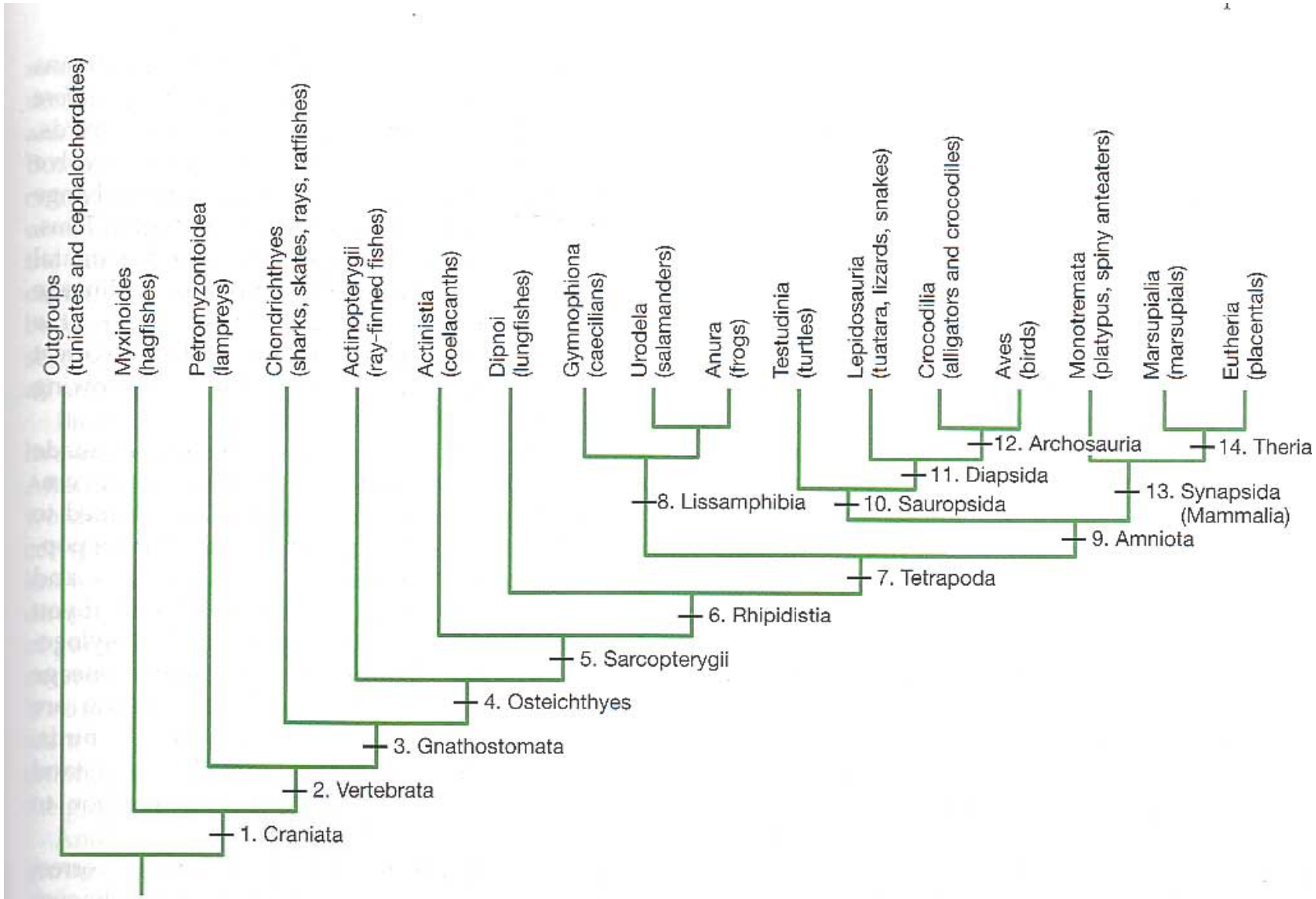
Early Vertebrates

Readings in Chapter 2, 3, and 7.

Using the Tree of Life Web Project

- www.tolweb.org
  - A project to put the entire tree of life, a phylogeny of all life, on the web.
  - Biologists world-wide contribute phylogenies to the project, thus building the tree and making the information accessible to everyone.
- Animal Diversity Web; http://animaldiversity.ummz.umich.edu



▲ **Figure 1–4** Phylogenetic relationships of extant vertebrates. This diagram shows the probable relationships among the major groups of extant vertebrates. Note that the cladistic groupings are nested progressively; that is, all placental mammals are therians, all therians are synapsids, all synapsids are amniotes, all amniotes are tetrapods, and so on.

Kingdom: Animalia
Phylum: **Chordata**

By Phil Myers

Members of this Phylum

- Chordates are defined as organisms that possess a structure called a **notochord**, at least during some part of their development. The notochord is a rod that extends most of the length of the body when it is fully developed. Lying dorsal to the gut but ventral to the central nervous system, it stiffens the body and acts as support during locomotion.
- Other characteristics shared by chordates include the following (from Hickman and Roberts, 1994):
  - Notochord;
  - single, dorsal, hollow nerve cord, usually with an enlarged anterior end (brain);
  - pharyngeal pouches present at some stage of development;
  - tail projecting beyond (posterior to) the anus at some stage of development;
  - bilateral symmetry;
  - segmented body, including segmented muscles; **MYOMERES**
  - three germ layers and a well-developed coelom;
  - ventral heart, with dorsal and ventral blood vessels and a closed blood system
  - complete digestive system
  - bony or cartilaginous endoskeleton usually present.

- **Contributors**

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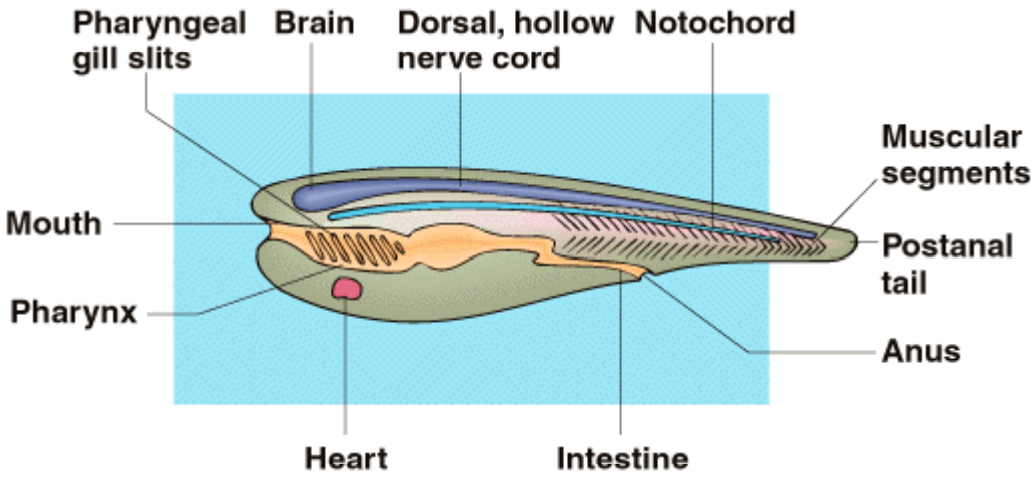
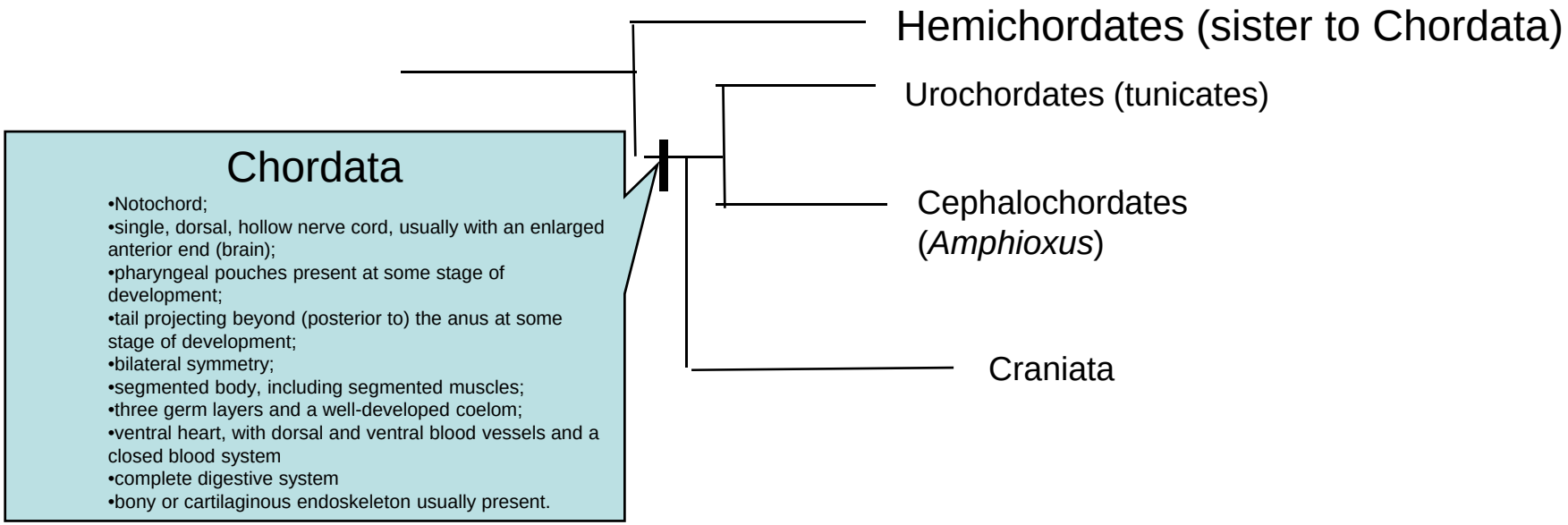
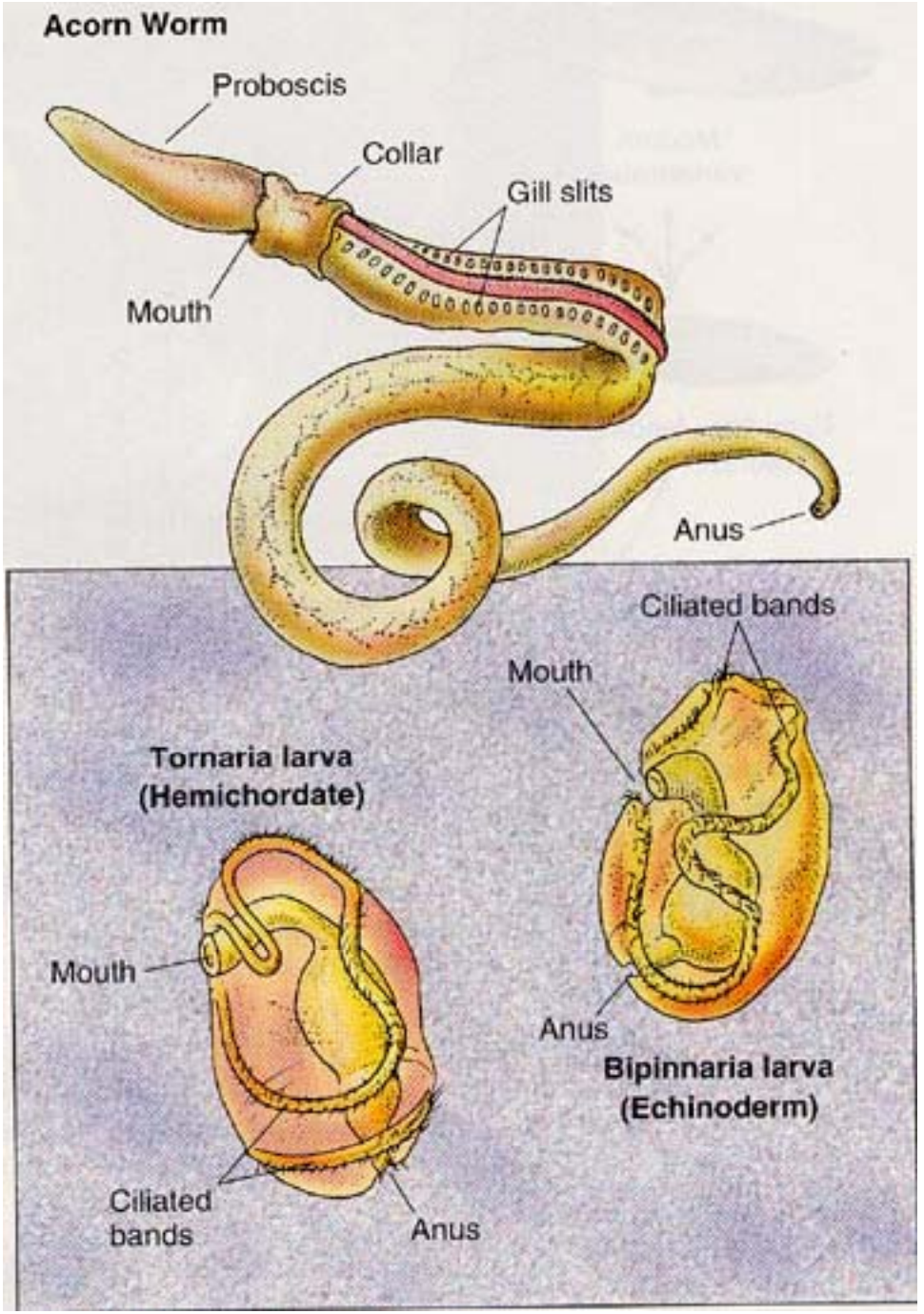

Pharyngeal gill slits
Brain
Dorsal, hollow nerve cord
Notochord
Muscular segments
Mouth
Postanal tail
Pharynx
Anus
Heart
Intestine

Phylum Hemichordata

- The sister taxon to the Phylum Chordata
- Hemichordates are filter feeders that possess pharyngeal slits.
- The hemichordates include Acorn worms which are marine invertebrates that filter-feed and live in U-shaped burrows in the sediment.



- acorn worm.


Acorn Worm
Proboscis
Collar
Gill slits
Mouth
Anus
Ciliated bands
Mouth
Tornaria larva
(Hemichordate)
Mouth
Anus
Bipinnaria larva
(Echinoderm)
Ciliated
bands
Anus

Hemichordata (Acorn worms)

This tells you something about acorn worms:

- http://www.susanscott.net/OceanWatch2001/aug17-01.html

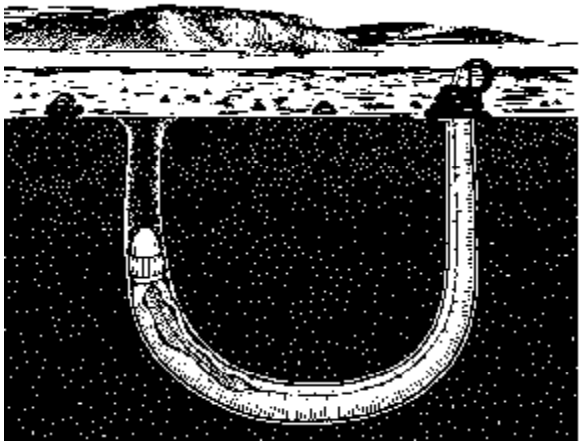
SusanScott.net, “An acorn worm isn't much more than a thin, cylindrical bag with a head and collar resembling an acorn. But just because it's simple doesn't mean it's trivial. Acorn worms are considered evolutionarily advanced because they bear gill slits like sharks and rays.

Gill slits are a big deal because they aren't found in any other invertebrate. Therefore, the humble little acorn worm may be the link between animals with backbones and animals without.

There are about 70 species of acorn worms in the world, but people rarely see any of them. Some build and live in U-shaped burrows; others tend to burrow continuously, parallel to the surface. Still others hide beneath stones or seaweed.

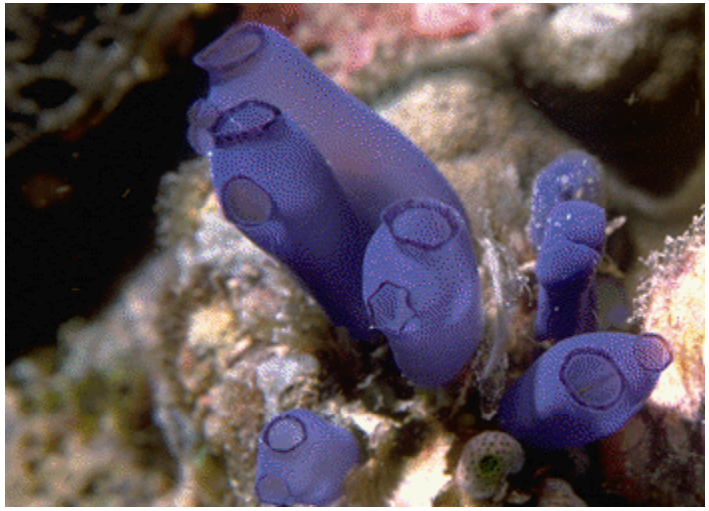
Besides being buried or hidden, these worms are not often seen even when dug up. That's because the creature's body walls are so thin that the weight of the sand inside them bursts the walls when the worm is handled.

Acorn worms are full of sand because they are its vacuum cleaners.”



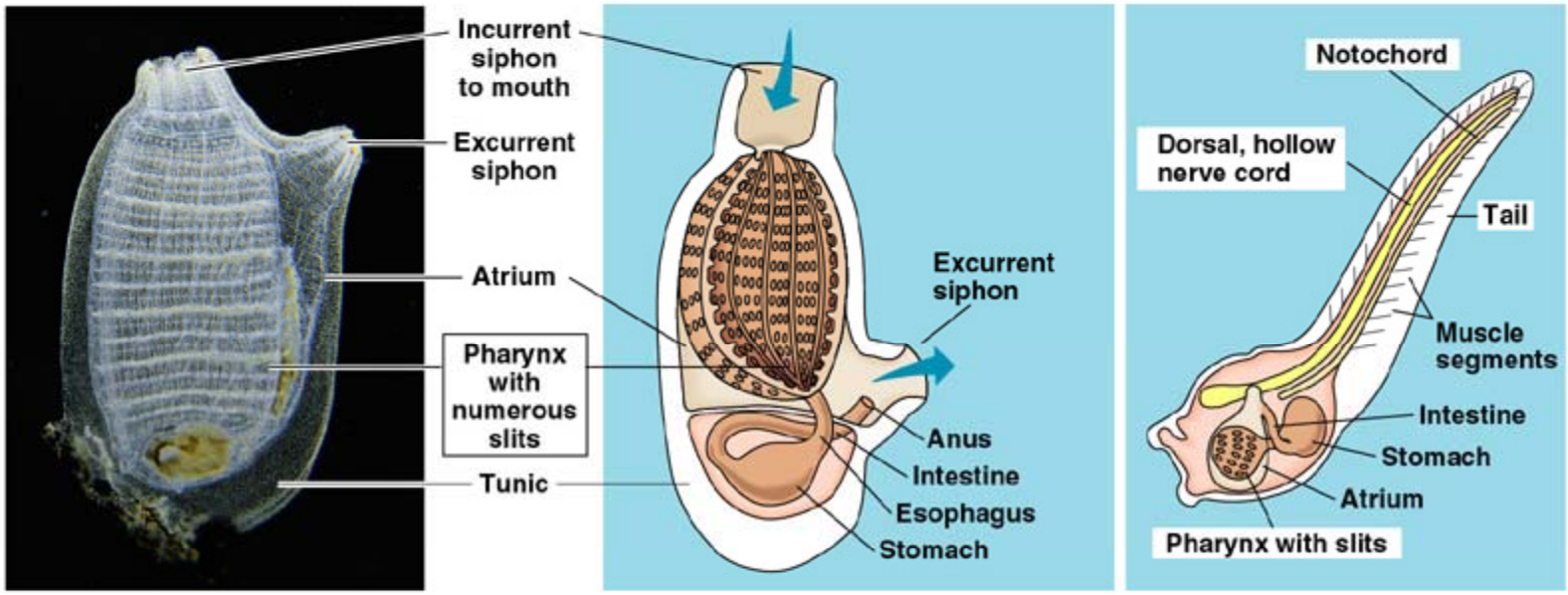
Urochordates: The clade that is sister to Vertebrates + Cephalochordata

http://www.youtube.com/watch?v=90AAN2PWAtk



http://www.emc.maricopa.edu/faculty/farabee/biobk/a_urochordate.gif

- Urochordates: Tunicates (sea squirts)
  - Know they exist
  - Know their phylogenetic placement
  - Be familiar with Figure 2-2 in your book.
  - Why know them?
    - Their larvae have characteristics that are shared with all chordates
    - Tail and notochord are lost during metamorphosis

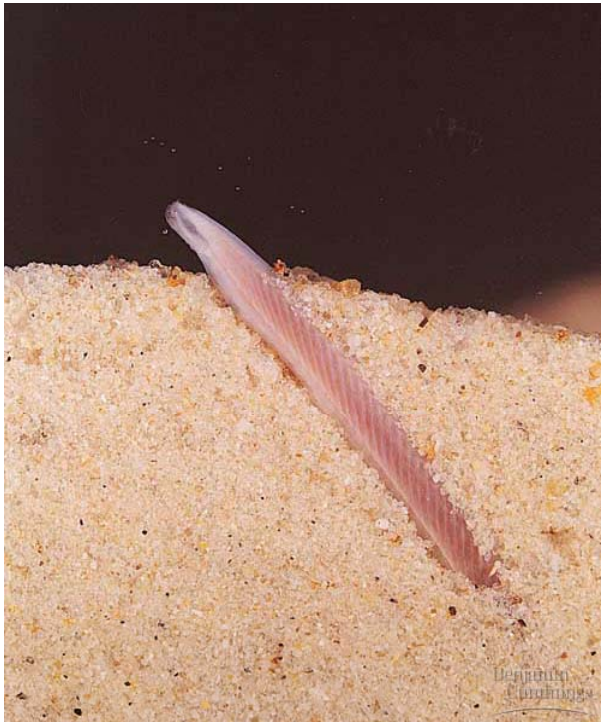


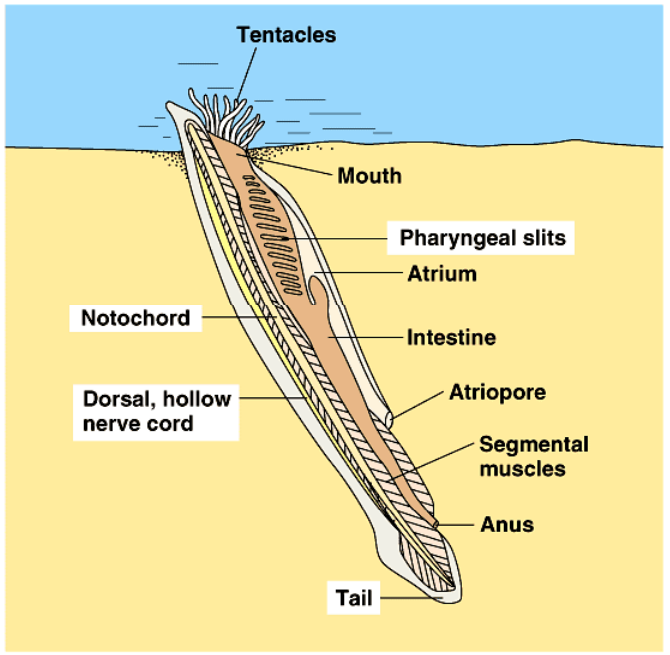
Cephalochordata: genus *Amphioxus* (lancelets)

- Know they exist
- Know their phylogenetic placement
- Why know them?
  - Their larvae have typical chordate characteristics that are shared with all chordates
- Anything interesting about them?
- Be familiar with Figure 2-2 in your book.
- Amphioxus swim like fish, and this is because they have myomeres, a feature of vertebrates.

"Today, amphioxus may be extremely common in shallow sandy environments: at Discovery Bay, Jamaica, up to five thousand individuals per square meter of sand have been reported. In some parts of the world, amphioxus are eaten by humans or by domestic animals; they are important food items in some parts of Asia, where they are commercially harvested."

http://www.ucmp.berkeley.edu/chordata/cephalo.html





(a)

Craniata

- Monophyletic group that contains Hagfishes+Vertebrata
- Hagfishes are sister to Vertebrata

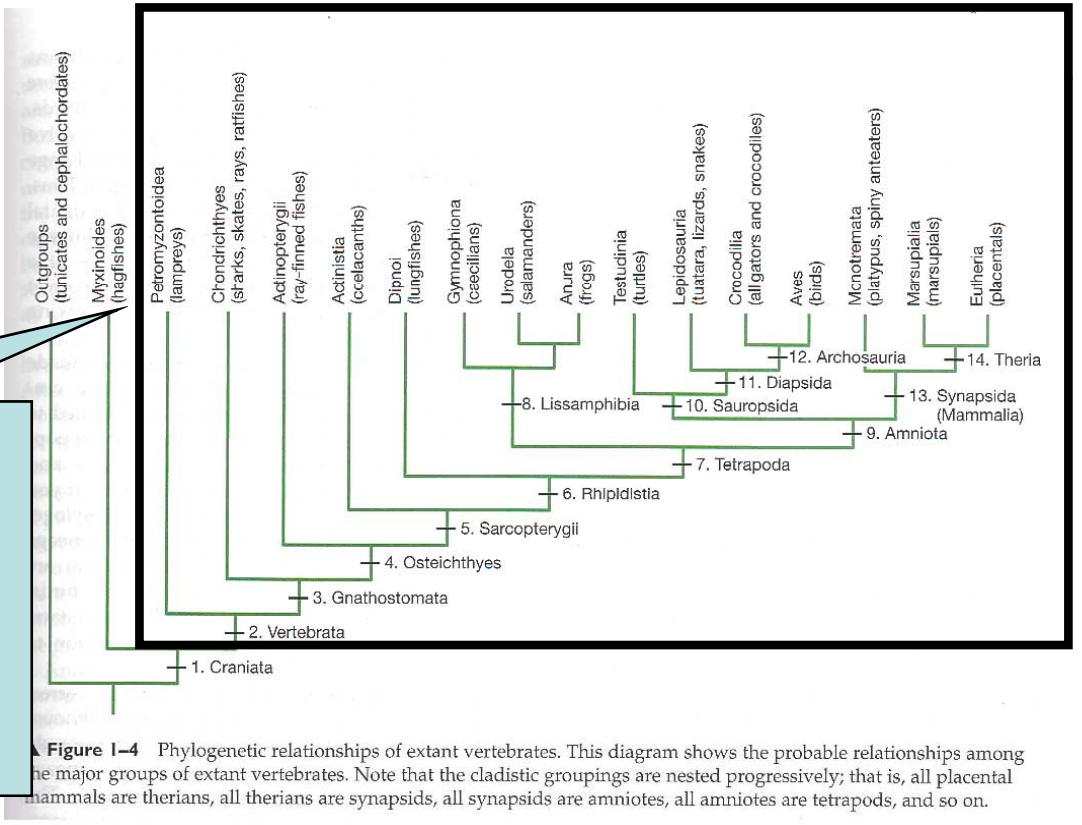


Figure 1–4 Phylogenetic relationships of extant vertebrates. This diagram shows the probable relationships among the major groups of extant vertebrates. Note that the cladistic groupings are nested progressively; that is, all placental mammals are therians, all therians are synapsids, all synapsids are amniotes, all amniotes are tetrapods, and so on.

The square encloses the monophyletic Vertebrata; Hagfishes are sister to Vertebrata; together, these clades are Craniata

Craniata

- Monophyletic group that contains Hagfishes+Vertebrata
- Hagfishes are sister to Vertebrata

- All craniates possess:
  - head skeleton that encases anterior end of notochord;
  - brain with 3 regions;
  - paired kidneys;
  - gill bars made of cartilage;
  - neural crest tissue

Myxiniformes (hagfish, all marine)

- Know they exist
- Know their phylogenetic placement
- They do NOT have vertebrae
- They Do have cartilaginous skeleton
- They ARE non-vertebrate craniates

…“They have the peculiar habit of tying themselves into knots in order to shed their slime coat and make a new one.”

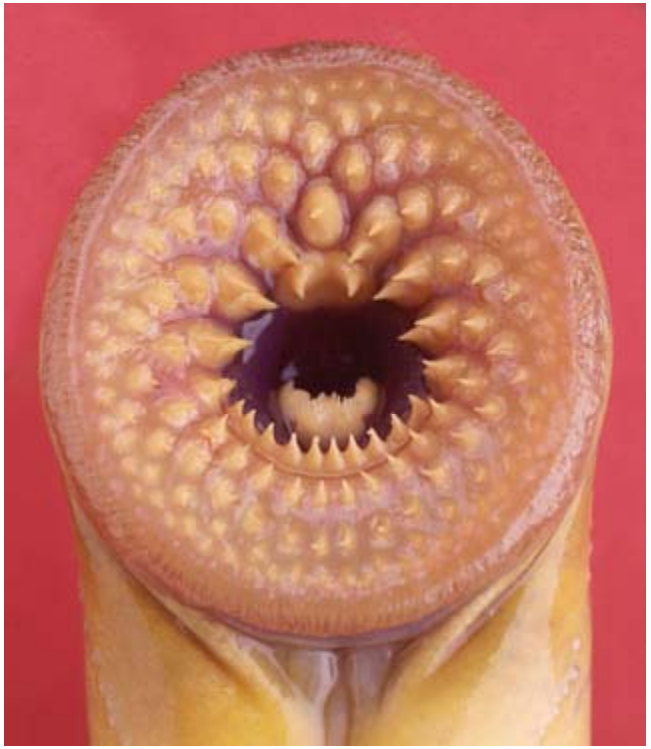
Hagfish sliming video:
http://www.youtube.com/watch?v=Bb2EOP3ohnE

http://docs.lib.noaa.gov/OEDV/ODS2005/Images/Album%20I/Deep%20Scope%2005%208_23%20log%20Disgusting%20hagfish.JPG

Vertebrates defined

- All vertebrates share:
  - Serially arranged vertebrae
  - Vertebrae form around notochord and encircle the nerve cord.
  - Vertebral column replaces notochord
  - **All vertebrates share the derived feature of a cranium.**

Vertebrata: Agnathans, jawless fishes



Characters:

- 1) Jawless
- 2) No paired fins
- 3) Early forms had external bony armor (exoskeleton)

- Geological range: Cambrian to Recent

Vertebrata: Agnathans, jawless fishes

- Petromyzontoidea (lampreys)
  - The sister group to all other vertebrates
- Lamprey characteristics.
  - 1) Skin naked
  - 2) Body elongate, eel-like
  - 3) Some species are anadromous (spawn up rivers like salmon)
  - 4) Ammocoete larvae

Compare and contrast vertebrates to non-vertebrates

Table 2.1 from your book (page 23)