Chapter 32 & 33

Kingdom Animilia

- Over 1.5 million species
  - Estimated 73 million
- 35 Phylums
  - Over half are insects
- More similarities within animal genomes than other kingdoms

Characteristics

- Multicellular
- Lack of cell wall
- Sexual reproduction
  - mobile sperm
  - larger non-motile egg
- Nervous Tissue
  - Complexity
  - Responsiveness
- Hox Genes
  - Special clusters of genes associated with the planning of the body

Table 32.1 Common Characteristics of Animals

Characteristic	Example
Multicellularity	Even relatively simple types of animals such as sponges are multicellular, in contrast to the single-celled eukaryotic microorganisms called protists (see Chapter 28).
Heterotrophs	Animals obtain their food by eating other organisms or their products. This contrasts with plants and algae, which are autotrophs and essentially make their own food.
No cell walls	While plant, fungal, and bacterial cells are rigid because they possess a cell wall, animal cells lack a cell wall and are quite flexible.
Nervous tissue	The presence of a nervous system in most animals enables them to respond rapidly to environmental stimuli.
Movement	Most animals have a muscle system, which, combined with a nervous system, allows them to move in their environment.
Sexual reproduction	Most animals reproduce sexually, with small, mobile sperm uniting with a much larger egg to form a fertilized egg, or zygote.
Extracellular matrix	Proteins such as collagen bind animal cells together to give them added support and strength.
Characteristic cell junctions	Animals have characteristic cell junctions, called anchoring, tight, and gap junctions.
Special clusters of *Hox* genes	All animals possess *Hox* genes, which function in patterning the body axis (see Chapter 19).
Similar rRNA	Animals have very similar genes that encode for RNA of the small ribosomal subunit (SSU) rRNA.

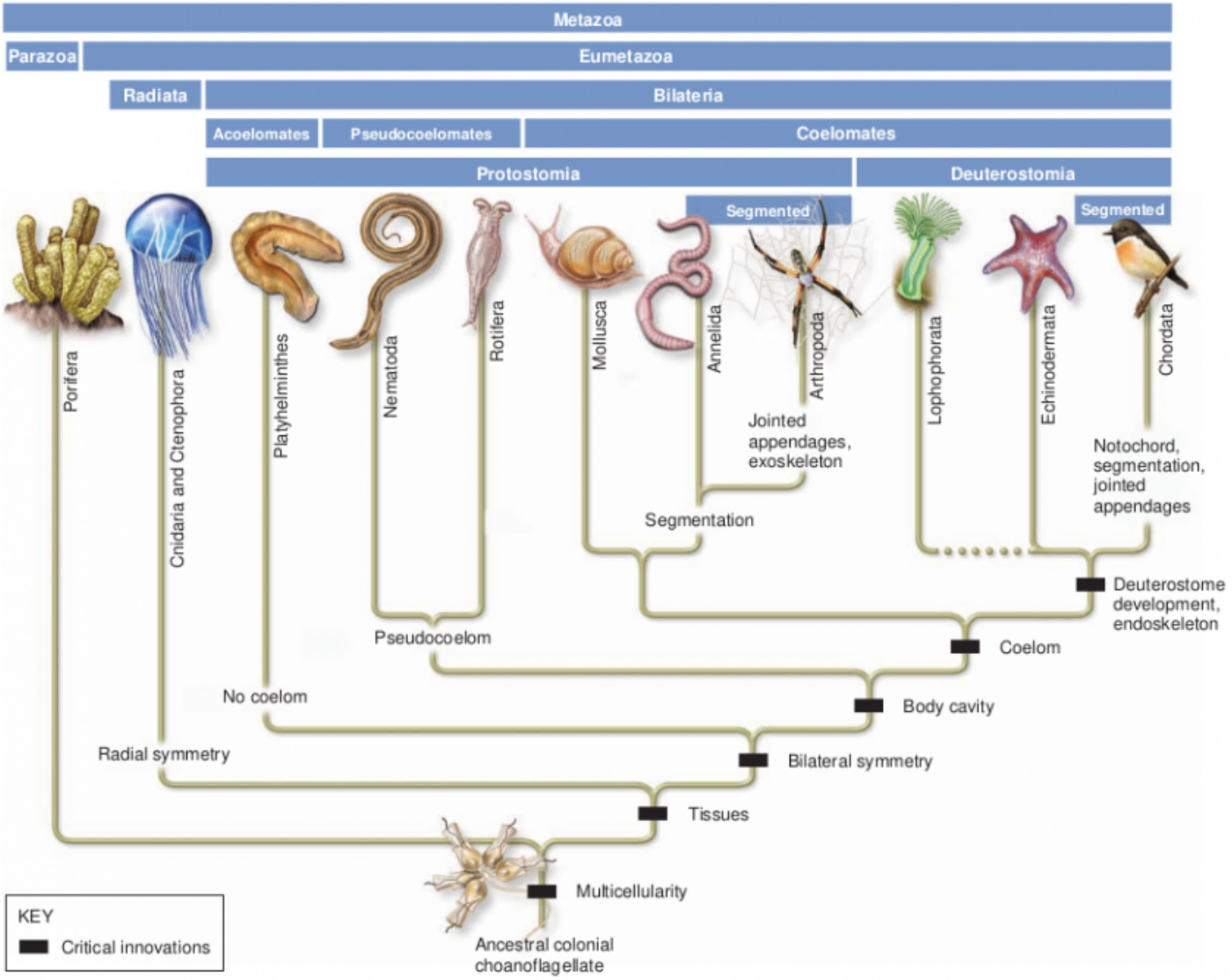


Figure 32.8 **An animal phylogeny based on body plans.** Though there are about 35 different animal phyla, we will focus our discussions here and in the next two chapters on the 11 groups with the greatest numbers of species. The dotted line represents the uncertainty of including the lophophorates with the deuterostomes.

Metazoans

- All animals
- Multicellular animals
- Paratoans
  - Sponges
- Eumetazoans
  - "true" multicellular animals

Classification/Systematics

- Old
  - Morphology
  - Embryonic Development
- Recent

- Molecular genetics

Body Plans

Morphological and Developmental Features

1. Body Symmetry
2. Number of tissue Layers
3. Patterns of Embryonic development

Symmetry

- Eumetazoa
  - Divided by symmetry
- Radiata
  - Radial symmetry
  - Often Circular or tubular
- Bilateria
  - Bilateral symmetry
  - Dorsal
    - Back
  - Ventral
    - Front
  - Anterior
  - Posterior
  - cephalization
    - enlarged head

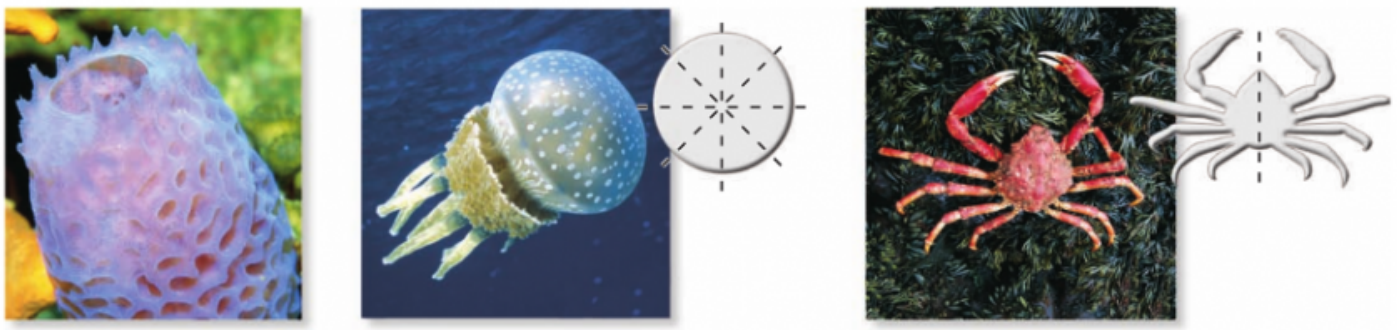


Figure 32.2 **Early divisions in the animal phylogeny.** Animals can be categorized based on **(a)** the absence of different tissue types (Parazoa; the sponges) or **(b,c)** the presence of tissues (Eumetazoa; all other animals). Further categorization is based on the presence of (b) radial symmetry (Radiata; the cnidarians and ctenophores) or (c) bilateral symmetry (Bilateria; all other animals).

Tissues

- Metazoa
  - all animals
  - divided on weather or not they have specialized tissues

- Parazoa
  - Porfera
    - sponges
    - may have distinct cell types
- Enmetazoa
  - more than one type of tissue
  - organs
  - all other animals

Germ Layers

- Radial
  - 2 layers
  - Diploblastic
    - endoderm
    - ectoderm
- Bilateral
  - 3 layers
  - Triploblastic
    - endoderm
    - ectoderm
    - mesoderm

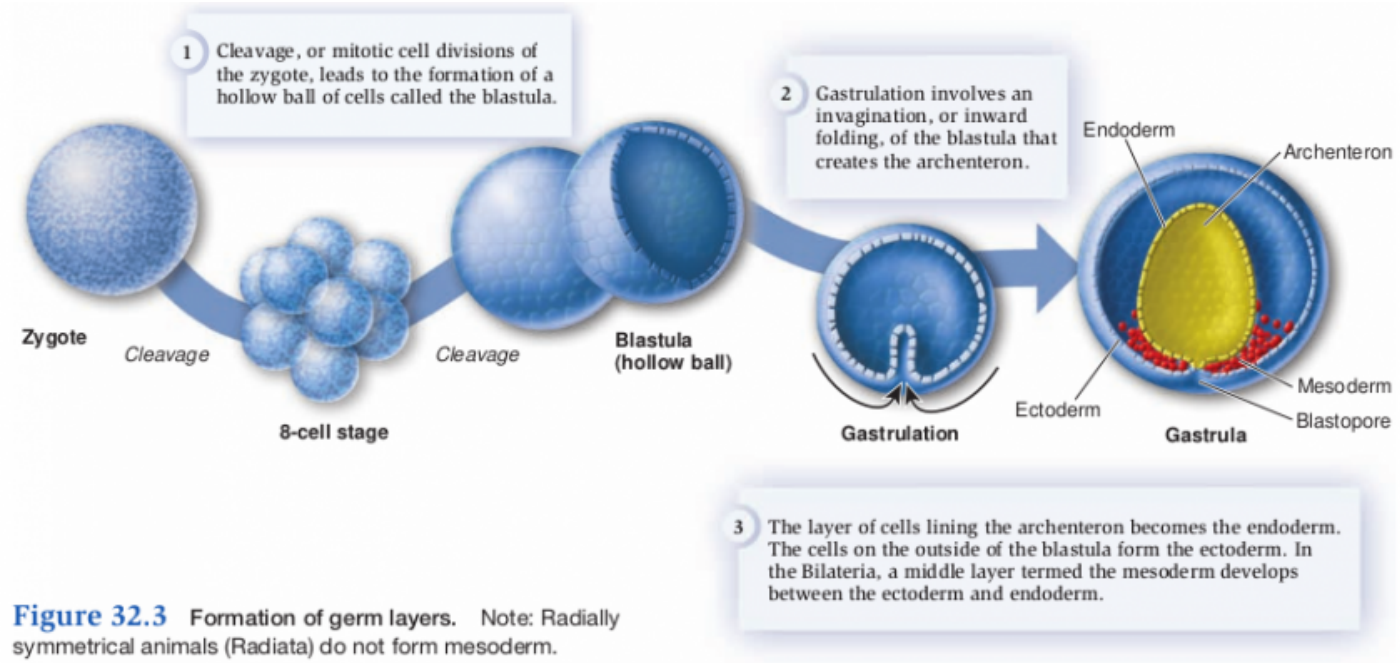


Figure 32.3 Formation of germ layers. Note: Radially symmetrical animals (Radiata) do not form mesoderm.

Embryonic Development

- Protostome
  - Blastopore becomes mouth
  - cleavage is determinate
    - fate of embryonic cells are determined early
- Deuterostome (second opening)

    - Blastopore becomes anus
    - cleavage is indeterminate
    - each cell produced by early cleavage can develop into a complete embryo

Other Morphological Characteristics

Used in classification

- Presence or absence or coelom
- Body segmentation

Molecular data suggest these features are unreliable in terms of understanding evolutionary history

Body Cavity

Coelom

    - a fluid-filled body cavity
- Coelomate or eucolemate
    - true coelom
    - coelom completely lined with mesoderm
- Pseudocoelom
    - coelom only partially lined with mesoderm
    - rotifers and roundworms
- Acoelomate
    - lack of a body cavity and instead have mesenchyme
    - flatworms

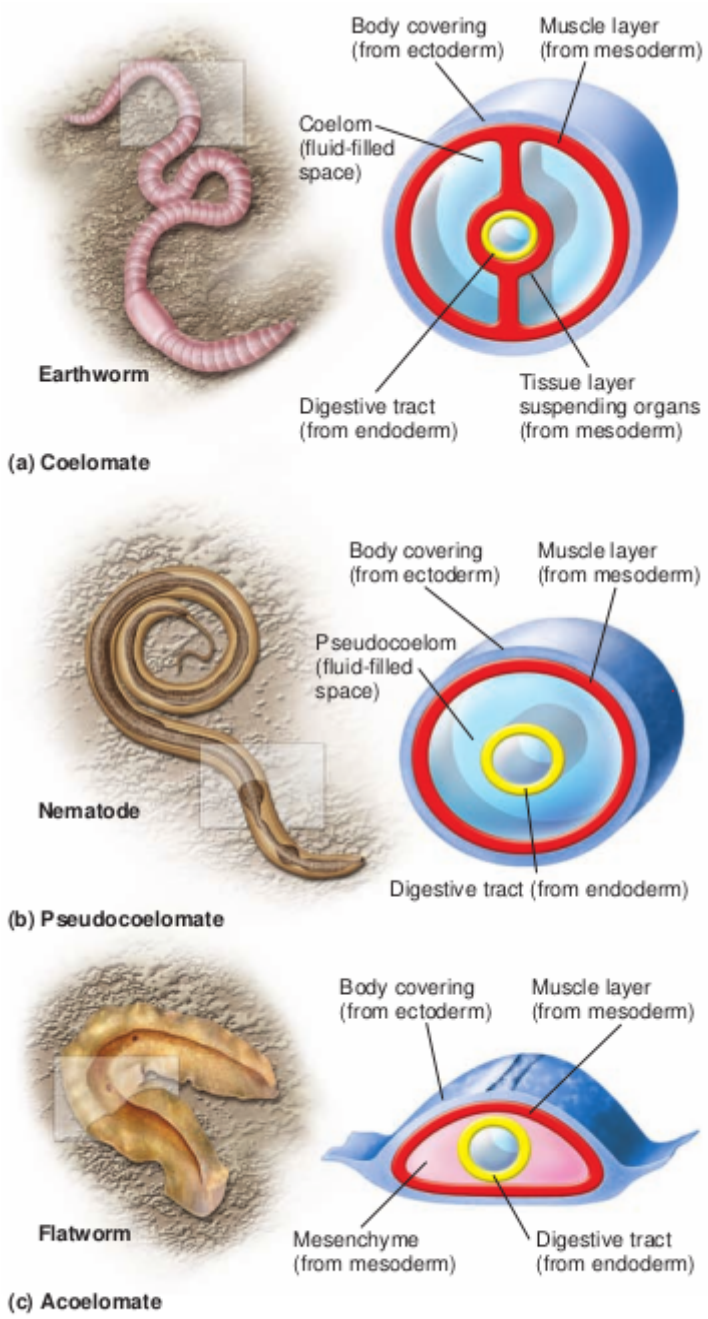


Figure 32.4 The three basic body plans of bilaterally symmetrical animals. Cross sections of each animal are shown on the right.

Flatworm has no mesoderm

Functions of the Coelom

- Cushions internal organs
- Enables movements and growth of internal organs independent of the body wall
- Fluid acts as a simple circulatory system

Segmentation

- Body may be divided into regions called segments
- occurs in annelid worms, arthropods, and chordates

- allows specialization of body region

Table 33.8 Summary of the Physical Characteristics of the Major Animal Phyla

Feature	Porifera (sponges)	Cnidaria and Ctenophora (hydra, anemones, jellyfish)	Platyhelminthes (flatworms)	Rotifera (rotifers)	Lophophorata (bryozoans and others)	Mollusca (snails, clams, squid)	Annelida (segmented worms)	Nematoda (roundworms)	Arthropoda (insects, arachnids, crustaceans)	Echinodermata (sea stars, sea urchins)	Chordata (vertebrates and others)
											
Digestive system	Absent	Gastrovascular cavity; ctenophores have complete gut	Gastrovascular cavity	Complete gut (usually)	Complete gut	Complete gut	Complete gut	Complete gut	Complete gut	Usually complete gut	Complete gut
Circulatory system	Absent	Absent	Absent	Absent	Absent; open; or closed	Open; closed in cephalopods	Closed	Absent	Open	Absent	Closed
Respiratory system	Absent	Absent	Absent	Absent	Absent	Gills	Absent	Absent	Trachae; gills; or book lungs	Tube feet; respiratory tree	Gills; lungs
Excretory system	Absent	Absent	Protonephridia with flame cells	Protonephridia	Metanephridia	Metanephridia	Metanephridia	Excretory tubules	Excretory glands resembling metanephridia	Absent	Kidneys
Nervous system	Absent	Nerve net	Brain; cerebral ganglia; lateral nerve chords; nerve net	Brain; nerve cords	No brain; nerve ring	Ganglia; nerve cords	Brain; ventral nerve cord	Brain; nerve cords	Brain; ventral nerve cord	No brain; nerve ring and radial nerves	Well-developed brain; dorsal hollow nerve cord
Reproduction	Sexual; asexual (budding)	Sexual; asexual (budding)	Sexual (most hermaphroditic); asexual (body splits)	Mostly parthenogenetic; males appear only rarely	Sexual (some hermaphroditic); asexual (budding)	Sexual (some hermaphroditic)	Sexual (some hermaphroditic)	Sexual (some hermaphroditic)	Usually sexual (some hermaphroditic)	Sexual (some hermaphroditic); parthenogenetic; asexual by regeneration (rare)	Sexual; rarely parthenogenetic
Support	Endoskeleton of spicules and collagen	Hydrostatic skeleton	Hydrostatic skeleton	Hydrostatic skeleton	Exoskeleton	Hydrostatic skeleton and shell	Hydrostatic skeleton	Hydrostatic skeleton	Exoskeleton	Endoskeleton of plates beneath outer skin	Endoskeleton of cartilage or bone

DO NOT worry about the number of species

Molecular views of Animal Diversity

- Scientist now use molecular techniques to classify animals
  - Compare similarities in DNA, rRNA, and Amino Acids
  - Closely related organisms have fewer differences than those more distantly related
- Advantages over morphological data in that genetic sequences are easier to quantify and compare
  - Example: A,T,G, and C in DNA

Genes used in Molecular Systematics

- Studies often focus on ribosomal RNA (rRNA)
  - Universal in all organisms
  - changes slowly over time
- Hox genes also studied often
  - Found in all animals
  - duplications in these genes may have led to evolution of body form

- Phylogenies constructed using rRNA and Hox genes are similar and often agree with those based on morphology

Invertebrates

- "without backbone"
- +95% of all species

Phylum Porifera

- Sponges
- lack tissues (organs)
- multicellular
- pores
  - filter H2O and food
- Invertebrates

Phylum Cnidaria

- Jelly fish, corals, anemones
- Diploblastic development
  - Two tissue layers
- Mesoclea
  - gelatinous covering
- Nerve net
  - interconnected nerve cells
  - no brain
- One opening with gastrovascular cavity
- Protostomes
- Invertebrates
- Radial symmetry
- Salt and fresh water
- Stingers

Phylum Ctenophora

- Comb jellies
- Same characteristics as Cnidaria
- Strictly salt water
- No Stingers

Phylum Platyhelminthes

- Flatworms, tapeworms, flukes
- Triploblastic
- Organs and organ systems
- Enhanced nerve net
  - 2 cerebral ganglia
- One opening with gastrovascular cavity
- Protostomes
- invertebrates
- bilateral symmetry
- Acoelomate

Phylum Rotifera

- rotifers
- pseudocoelomate
- Triploblastic
- Two openings
  - complete gut tract
  - alimentary canal
- Protostomes
- Corona
- simple brain
- invertebrates

Phylum Mollusea

- Snails, slugs, oysters, octopus, squid, clams, muscles
- Triploblastic
- Eucoelomate
- Complete gut tract
- Protostomes
- Invertebrates
- Three part Body
  - Foot
  - Visceral mass
  - Mantle
    - Many have outer shells

Phylum Annelida

- Segmented ring worms

- Triploblastic
- Eucoelomate
- Complete gut tract
- Protostomes
- Enhanced nervous system
- Invertebrates

Phylum Nematoda

- Roundworms
- Triploblastic
- Pseudocoelomate
- Complete gut tract
- Protostomes
- Invertebrates

Phylum Anthropoda

- Insects, crustaceans, spiders, ticks
- Highest diversity of animals
  - >1.5 million species
- Hardened Exoskeleton
- Protostomes
- Invertebrates
- Eucoelomate
- Triploblastic
- Complete gut tract
- Enhanced nervous system
  - Insects, in particular, have an enhanced brain
- segmented appendages

Phylum Echinodermata

- sea stars, urchins, sea cucumbers, sand dollars
- Triploblastic
- Eucoelomate
- Complete gut tract
- Deuterostomes
- Simple nervous system
- Endoskeleton
  - series of plates

Phylum Chordata

- Deuterstomes
- Complete gut tract
- Endoskeleton
- Few invertebrates
  - Mostly vertebrates
- Eucloemates
- Triploblastic

Four Critical Innovations of Chordate Body Design

1. Notochord
2. Dorsal, hollow nerve cord
3. Pharyngeal gill pouches
4. Post-anal tail

- These four features are exhibited at some point of life history/development
  - Only some Fishes exhibit all four

Notochord

- Cartilaginous supporting rod along the dorsal axis
- Replaced by jointed "backbone"
  - Vertebral column of hardened cartilage or bone

Dorsal, hollow nerve cord

- Expanded at the anterior end
  - Brian
- Enclosed/supported/protected by the Notochord

Pharyngeal gill pouches

- Gill slits
- pharynx
  - back of mouth cavity

Post-anal Tail

- Tail extends posterior of the anus

Humans

Notochord

- replaced by vertebrae
- only pieces left are the inter-vertebral discs between vertebrae

Nerve cord

- Dorsal, hollow with largest brain capacity (compared to body size)

Pharyngeal Pouches

- Embryonic Development
- 1 pair retained as Eustachian tubes

Post-anal Tail

- One vertebra as a tail bone (coccyx)

Subphylum Urochordata

- tunicates
- invertebrates
- ~3000 species
- Marine
- Filter feeders

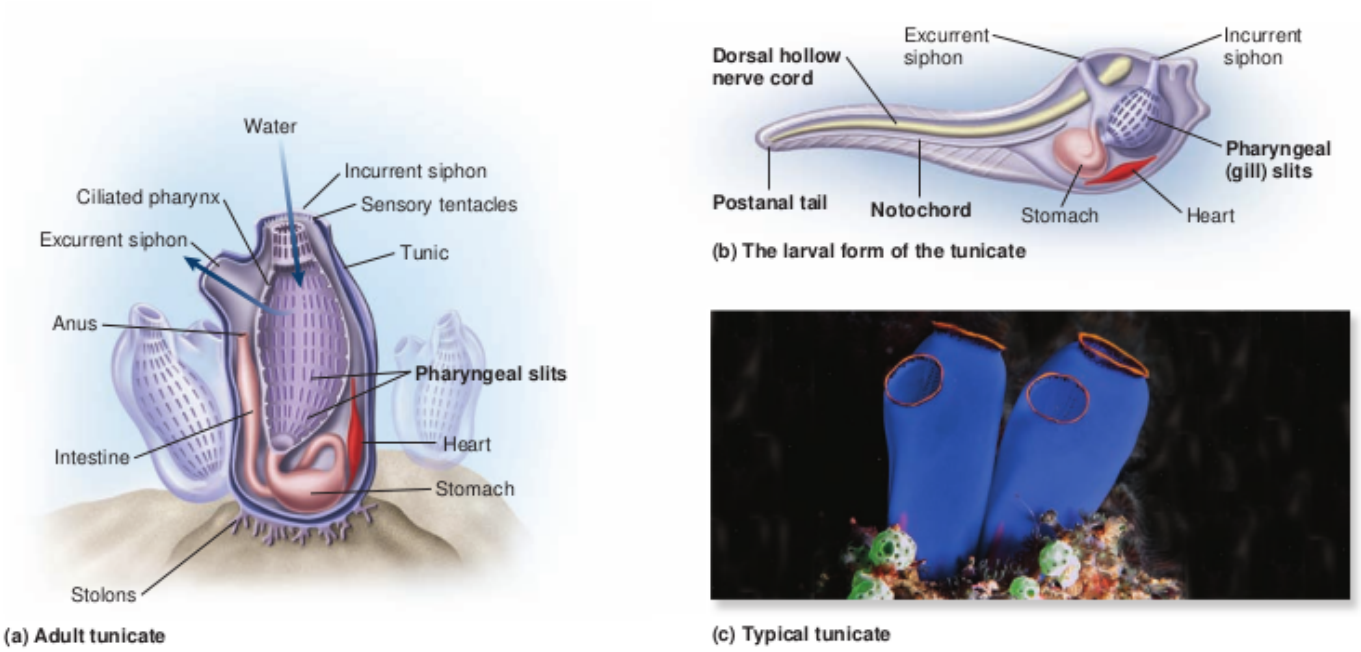
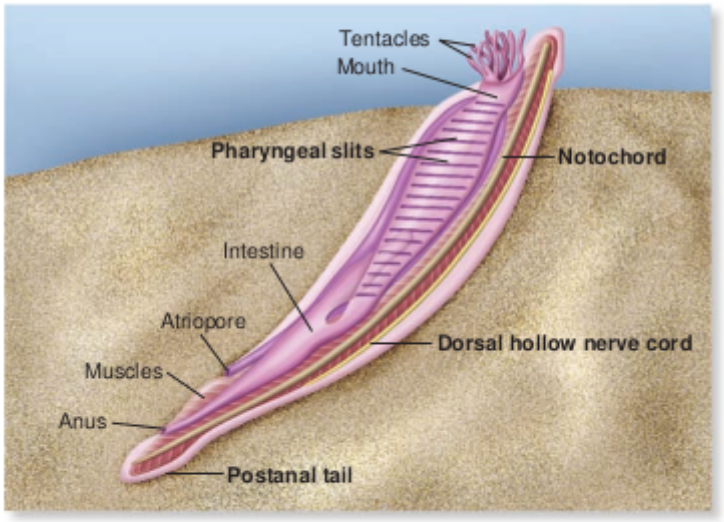


Figure 33.38 **Tunicates.** (a) Body plan of the sessile, filter-feeding adult tunicate. (b) The larval form, which shows the four characteristic chordate features, has been proposed as a possible ancestor of modern vertebrates. (c) The blue tunicate, *Rhopalaea crassa*.

Subphylum Cephalochordata

- Lancelets
- Invertebrates
- 25 species
- marine
- Filter feeders

(a) Lancelet in the sand



(b) Body plan of the lancelet

Figure 33.37 **Lancelets.** (a) A bladelike lancelet. (b) The body plan of the lancelet clearly displays the four characteristic chordate features.

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