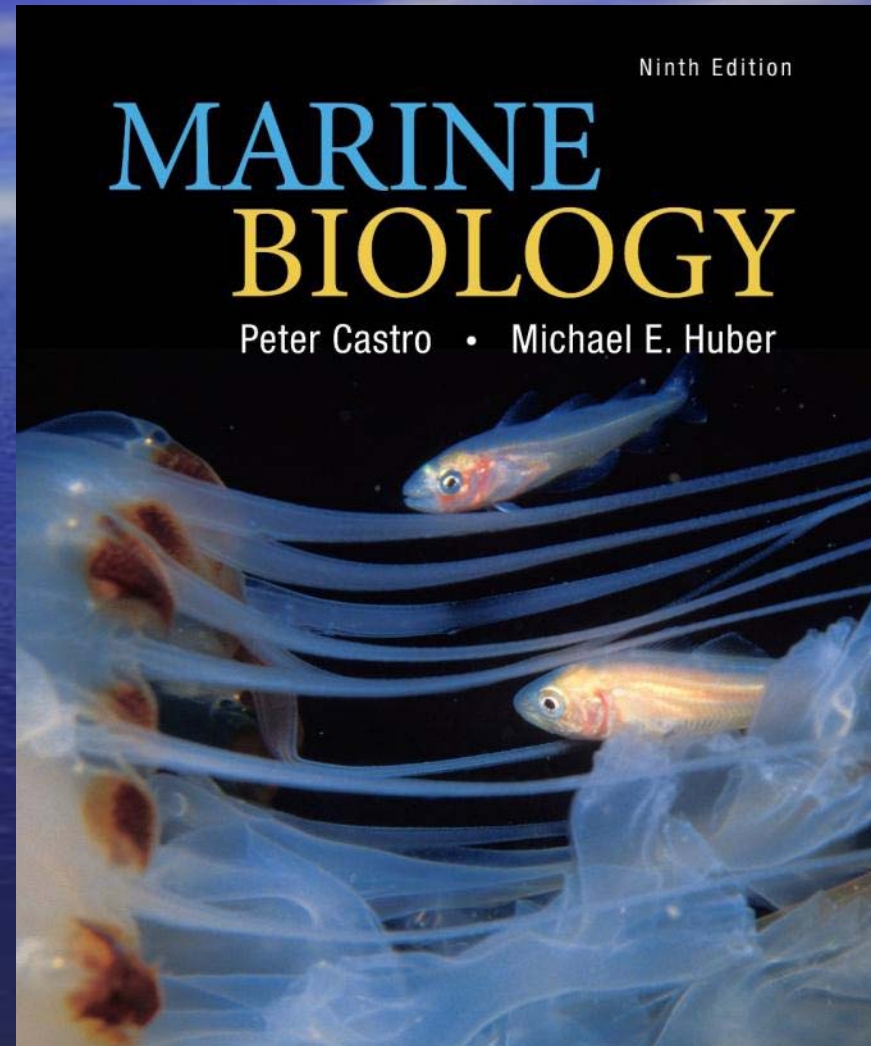
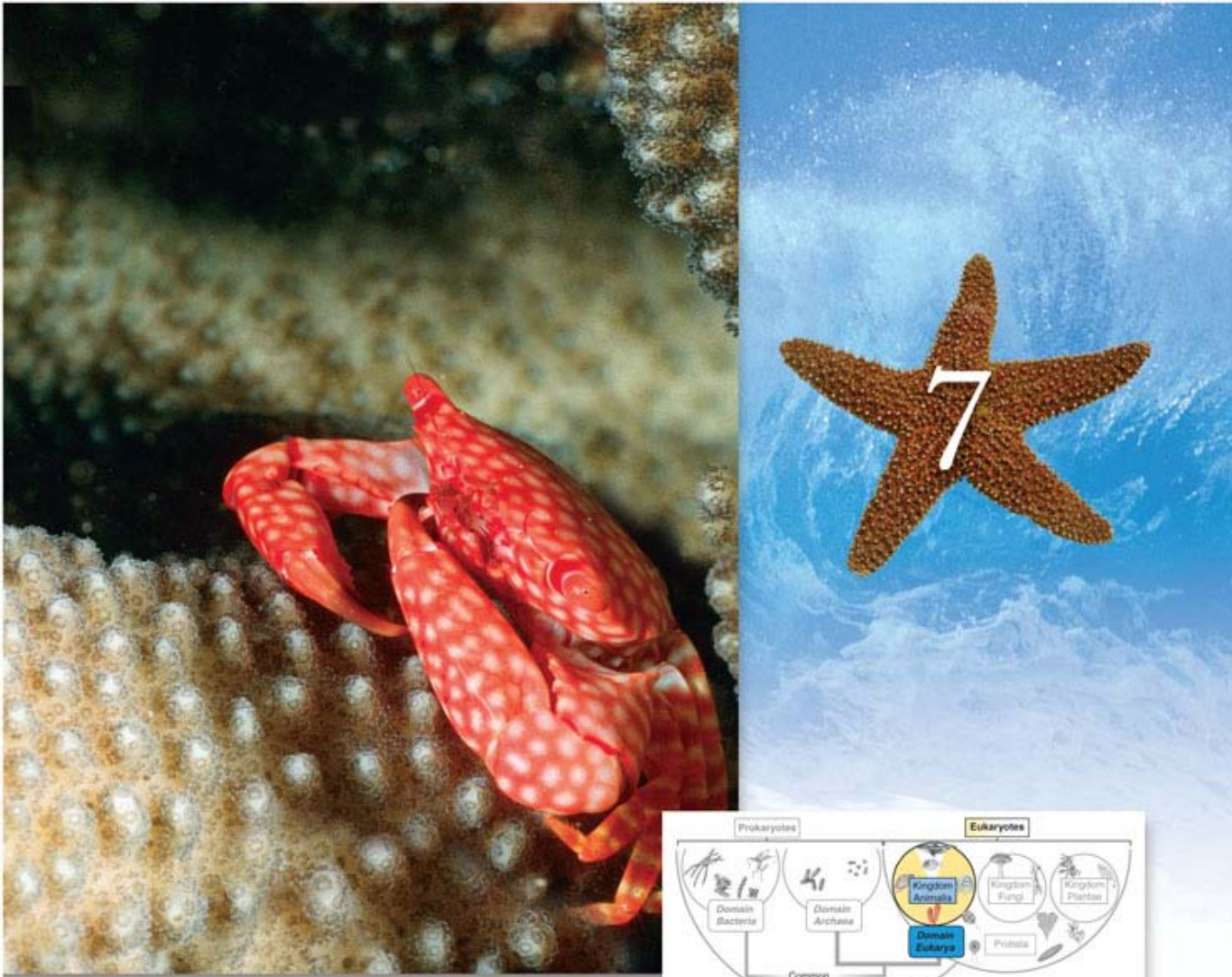


# Chapter 7

## Marine Animals Without a Backbone







# Invertebrates

- Animals without a backbone are known as invertebrates. Those with a backbone are called vertebrates.
- About 97% of animals are invertebrates.
- All major animal groups have representatives in the marine community.
- Several animal groups are exclusively marine.

# General Characteristics of Animals

- Multicellular, diploid organisms with tissues, organs or organ systems in most
- Heterotrophic
- Require oxygen for aerobic respiration
- Reproduce sexually, or asexually, or both
- Most are motile at least during some portion of the life cycle
- Animal life cycles include a period of embryonic development



# General Characteristics of Animals

- Basic body structure:
  - Symmetry (body plan)
    - Radial - round; equal parts radiate out from a central point (ex: sea star)
    - Bilateral - organism can be divided into right and left halves that are more or less equal (ex: marine mammals)
    - Asymmetry - having no symmetry (ex: sponge)

# Major Phyla of Marine Invertebrates

1. Sponges
2. Cnidarians
3. Flatworms
4. Ribbon worms
5. Nematodes
6. Annelids
7. Sipunculans
8. Echiurans



# Major Phyla of Marine Invertebrates

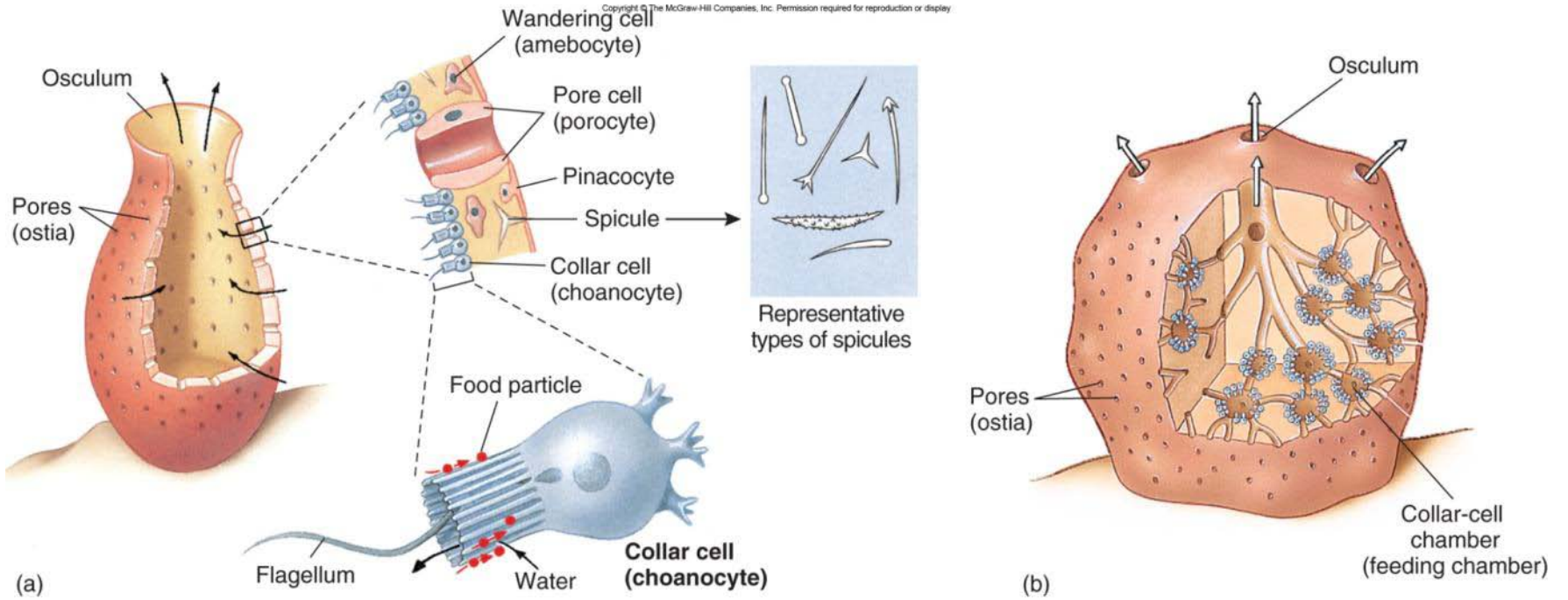
9. Mollusks
10. Arthropods
11. Bryozoans
12. Phoronids
13. Brachiopods
14. Arrow worms
15. Echinoderms
16. Hemichordates
17. Tunicates
18. Lancelets

# Invertebrates

- **Porifera: The Sponges**
- **Characteristics of Phylum:**
  - All sponges are sessile (non-motile and living attached) and some encrust on hard substrate.
  - Numerous tiny pores (ostia) exist in the body to allow water to pass through the sponge.
  - This water movement is required to allow sponges to filter feed (a type of suspension feeding) on plankton and dissolved organic matter in the water.
  - Water flow is also essential to carry metabolites (waste) away from cells and to carry gametes.
  - A diagram of two typical sponge body plans is shown in Fig. 7.1, pg. 116.



Figure 7.1



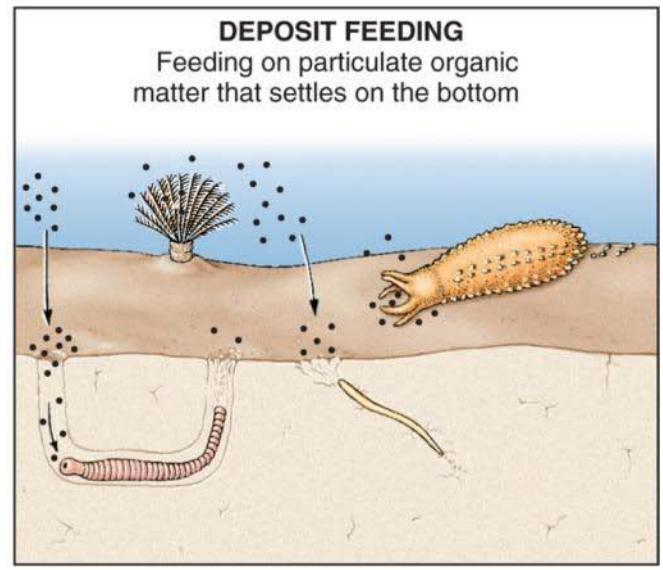
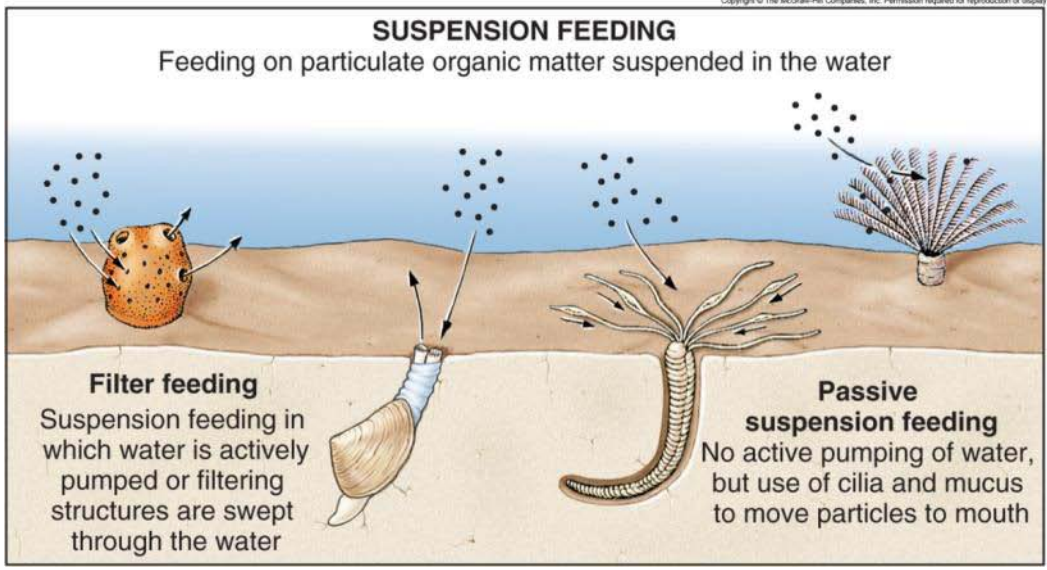
# Invertebrates

- **Porifera: The Sponges**
- **Characteristics of Phylum:**
  - Asymmetric body with no true tissues or organs.
  - Mostly marine
  - Varying size, shape, and color
  - Solitary or colonial
  - Regeneration capability
  - Filter feeders



Figure 7.3

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# Invertebrates

- **Porifera: The Sponges**
- **Types of Cells:**
  - Choanocytes (or collar cells) –
    - line interior canals of the body;
    - flagella on the choanocytes create a water current that brings more food particles into the body
    - "Collars" on choanocytes traps food particles.



# Invertebrates

- **Porifera: The Sponges**
- **Types of Cells:**
  - Pinacocytes- these flattened cells cover exterior of body.
  - Porocytes- cells with a pore to allow water to pass into body

# Invertebrates

- **Porifera: The Sponges**
- Structural support:
  - Spongin is a support protein
  - Spicules are support structures made of silica or calcium carbonate.
  - These spicules have a variety of shapes from simple rods to star-shaped (examples of spicules shown in Fig. 7.1, pg. 116)



# Invertebrates

- **Porifera: The Sponges**
- **Modes of Reproduction –**
  - Asexual budding- fragmentation of a cluster of cells from original sponge can begin growth in a new area.
  - Sexual- sperm are released into surrounding water (broadcast spawners) to be picked up by a nearby sponge and directed to egg .
  - Most sponges are hermaphroditic (possess male and female reproductive parts).

Figure 7.2

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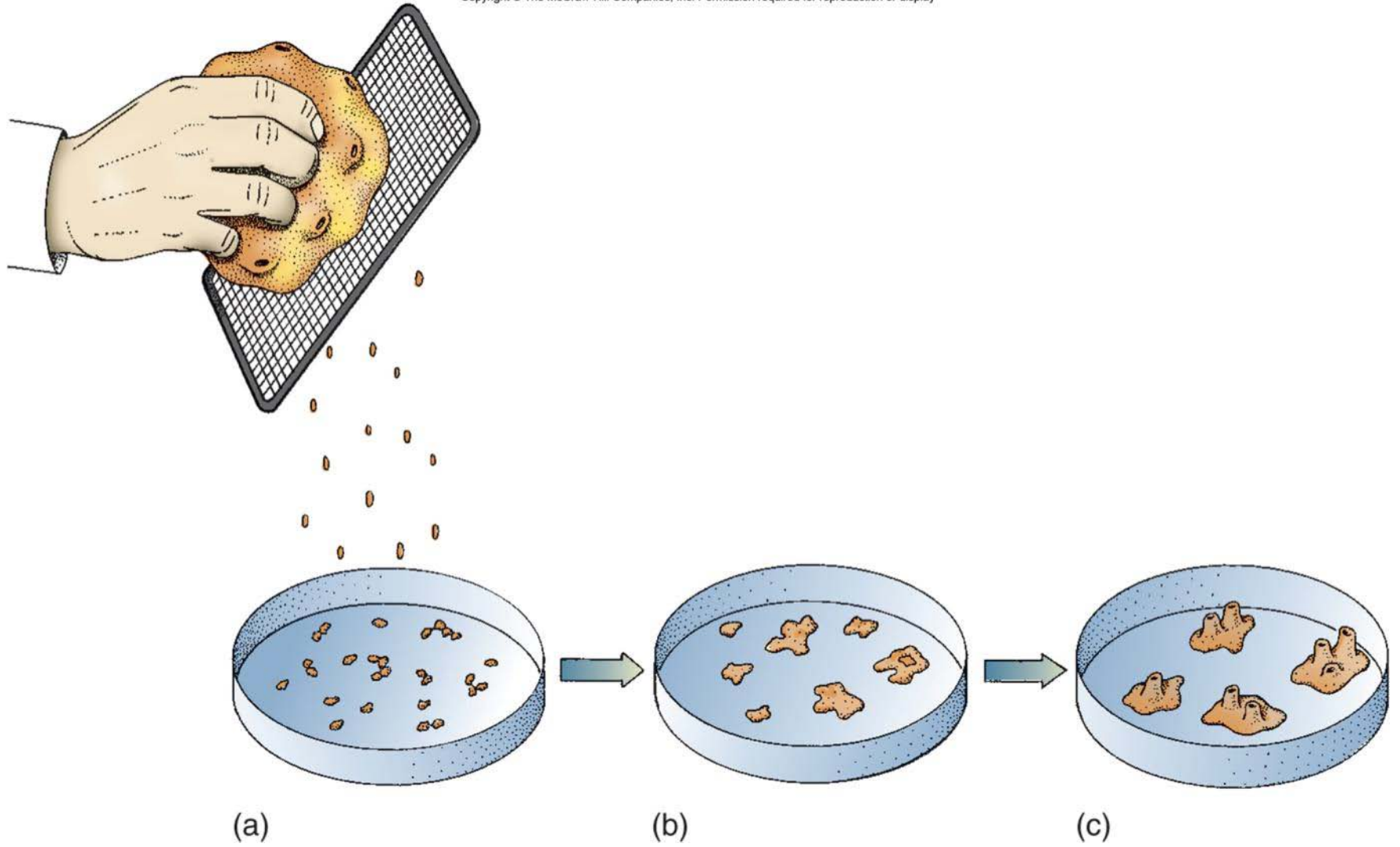




Figure 7.4

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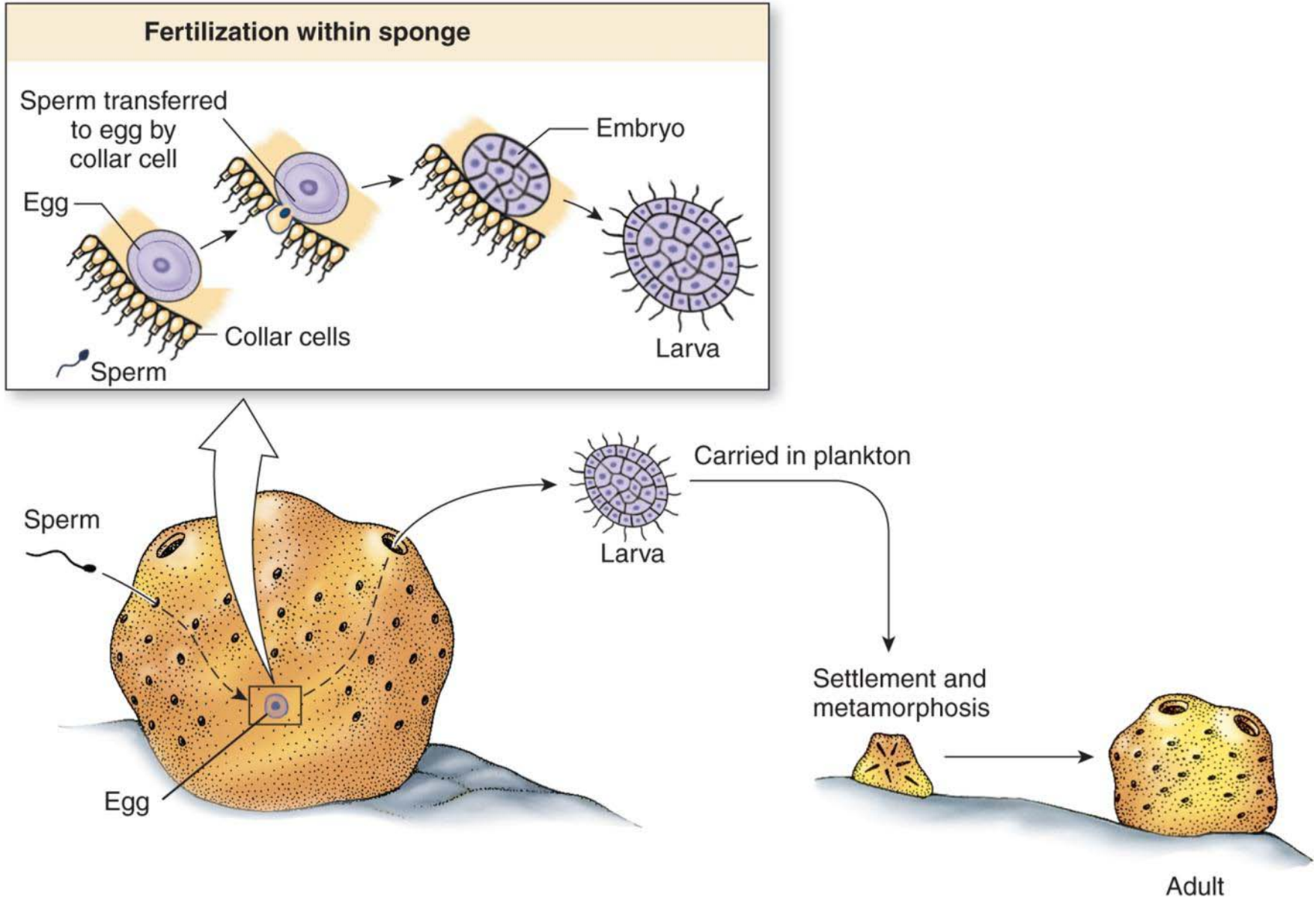


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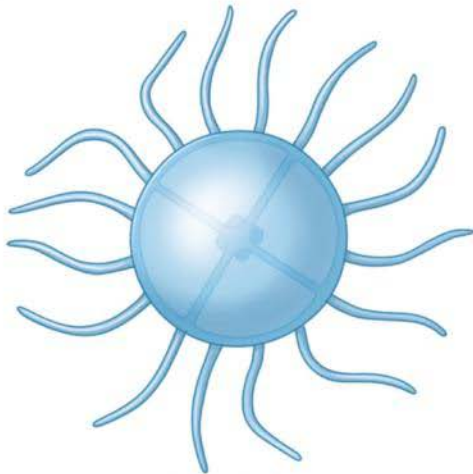
# Invertebrates

- **Cnidarians: Stinging animals**
- **Characteristics of Phylum:**
  - Radial symmetry
  - Mostly marine organisms, about 10,000 species known
  - Two body forms exist :
    - Medusa – free floating form which is transported by water currents, mouth with surrounding tentacles are positioned downward
    - Polyp – sessile, attached form with mouth and tentacles are positioned upward
  - Two tissue layers are present-
    - Epidermis covers body surface
    - Gastrodermis lines internal body cavity and is specialized for digestion

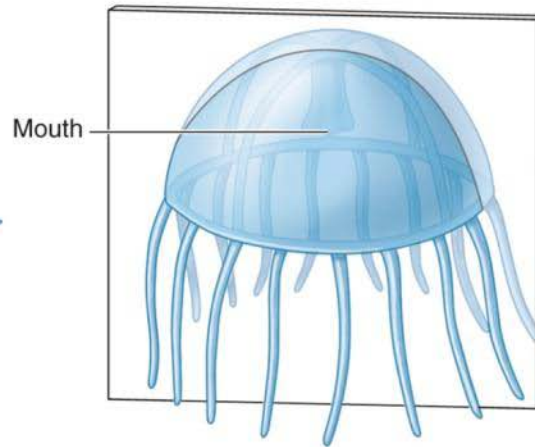
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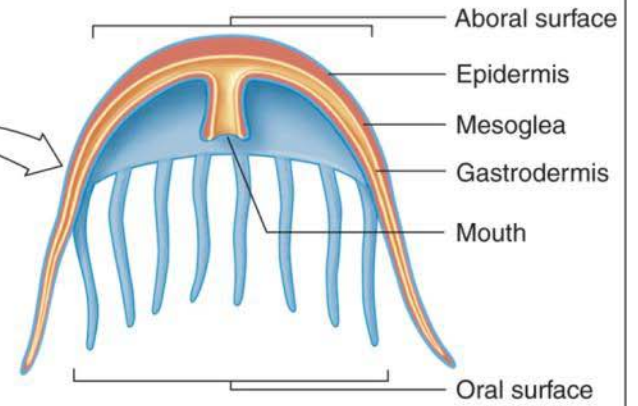
MEDUSA



Aboral view

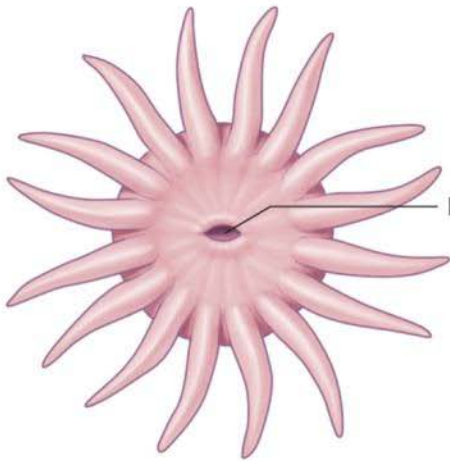


Lateral view

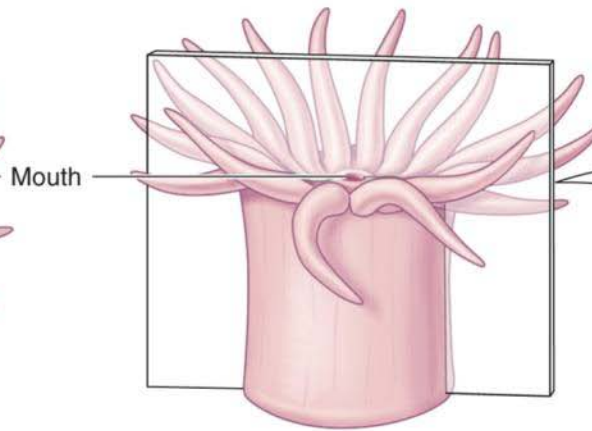


Sectional view

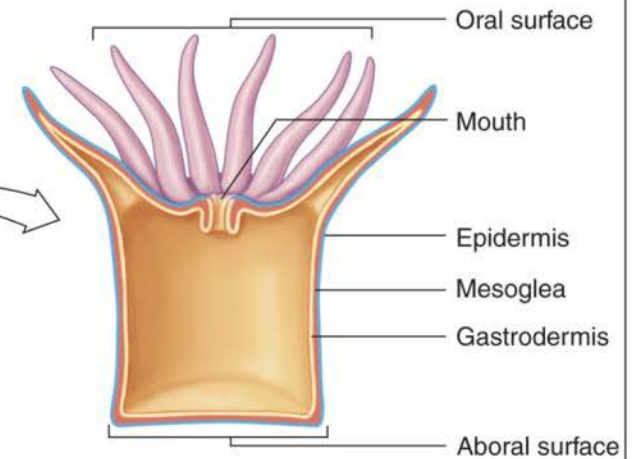
POLYP



Oral view



Lateral view



Sectional view



# Invertebrates

- **Cnidarians: Stinging animals**
- **Characteristics of Phylum:**
  - Cnidocytes (stinging cells) with nematocyst capsules located on tentacles. These are used for protection and for feeding
  - Digestive system is incomplete (sac-like with mouth only)
  - Nerve net throughout body coordinates movements
  - Some jellyfish also have sensory cells and contractile cells





# Invertebrates

- Reproduction in Cnidarians:
- **Sexual-**
  - Medusa is normally the sexual stage with epidermal gonads – eggs and sperm released from medusa
  - Fertilized egg results in zygote
  - Zygotes develops into a swimming larva called a planula
  - Planula “settles” on bottom to form colony
  - Eventually, new medusa are formed by this mature colony
- **Asexual-**
  - Polyps normally reproduce by budding

# Invertebrates

- **Classification of Cnidarians**

1. **Class Scyphozoa** - True Jellyfish

- Free swimming large medusa forms with polyp only in reproductive life
- All marine
- They move by rhythmic contractions, but cannot fight against prevailing water currents
- Many with powerful stings



Figure 7.10

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# Invertebrates

- Classification of Cnidarians
- 2. **Class Anthozoa** – Corals, Anemones, Sea Fans/Whips, Sea Pansy
  - Colonial polyps that normally lack a medusa stage
  - Corals secrete calcium carbonate "shells"
  - Most coral species possess symbiotic algae within body tissues called zooxanthellae
  - All marine



Figure 7.11

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# Invertebrates

- **Classification of Cnidarians**

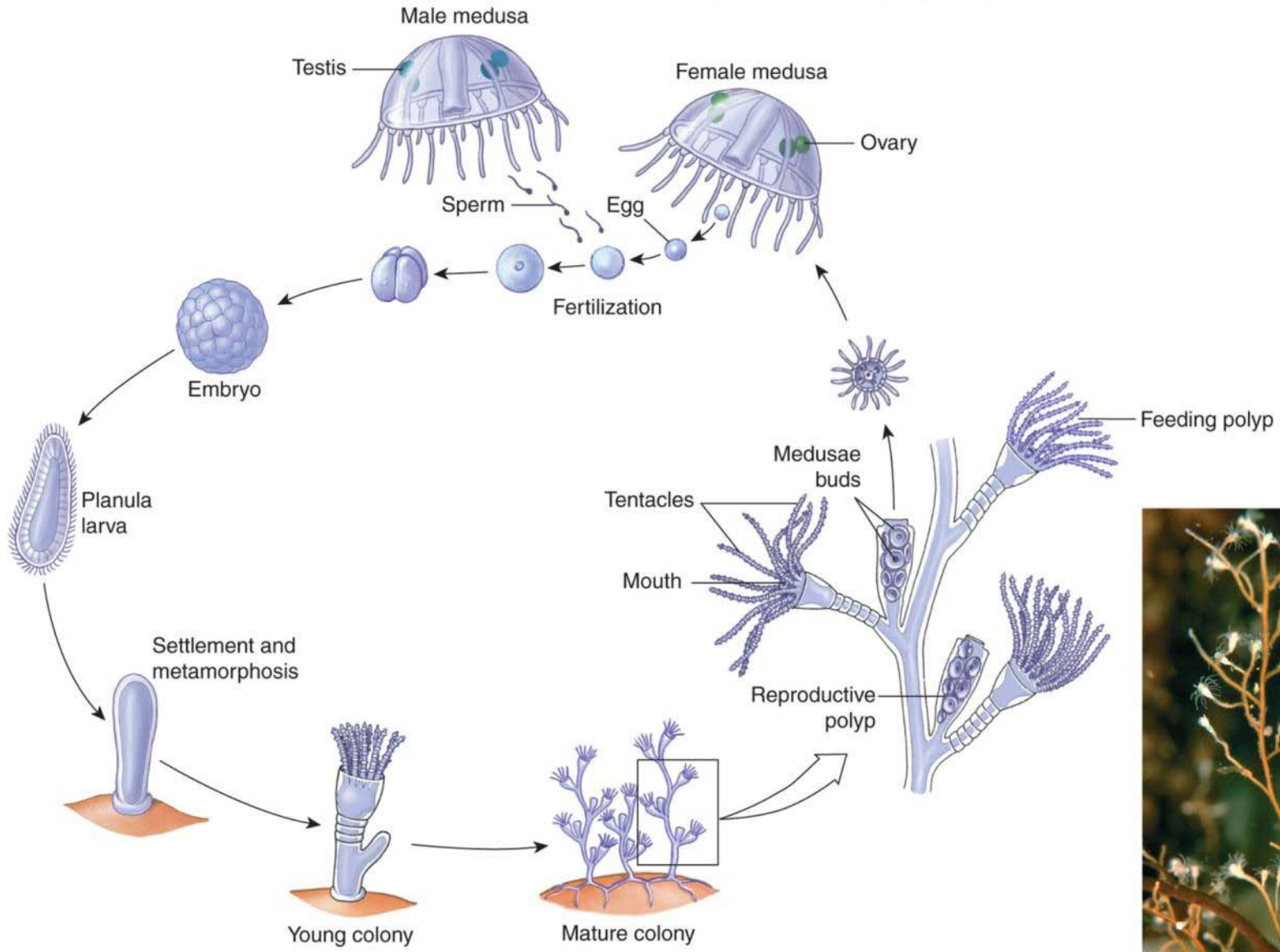
## 3. Class Hydrozoa

- Mostly polyp forms with reproductive medusa
- *Physalia* is unusual species with a colony of polyps carried by a gas-filled float
- Freshwater and marine species



Figure 7.8

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*Eudendrium*, worldwide

**Life Cycle of a Hydrozoan**

© Bill Ober

Figure 7.7

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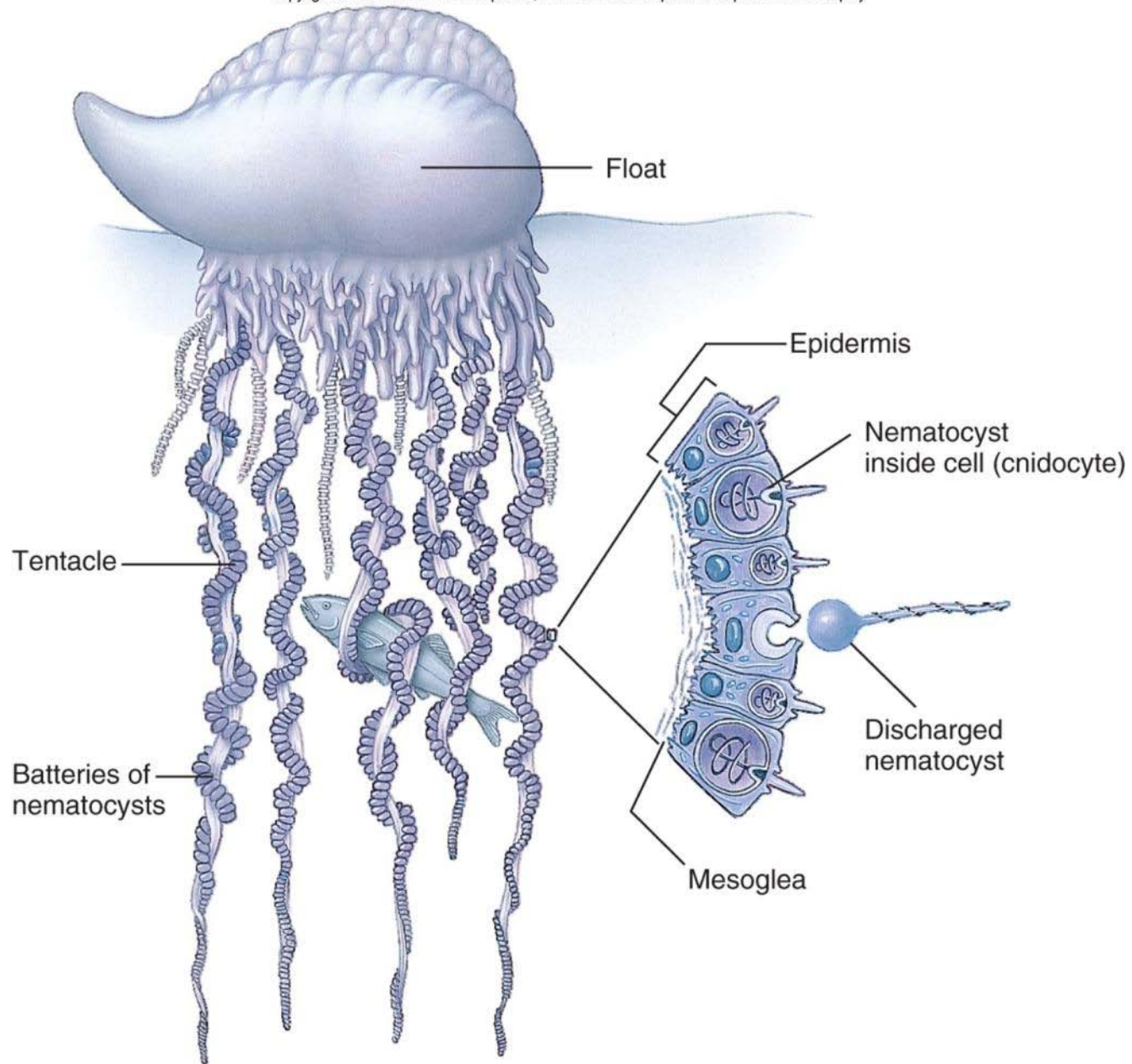


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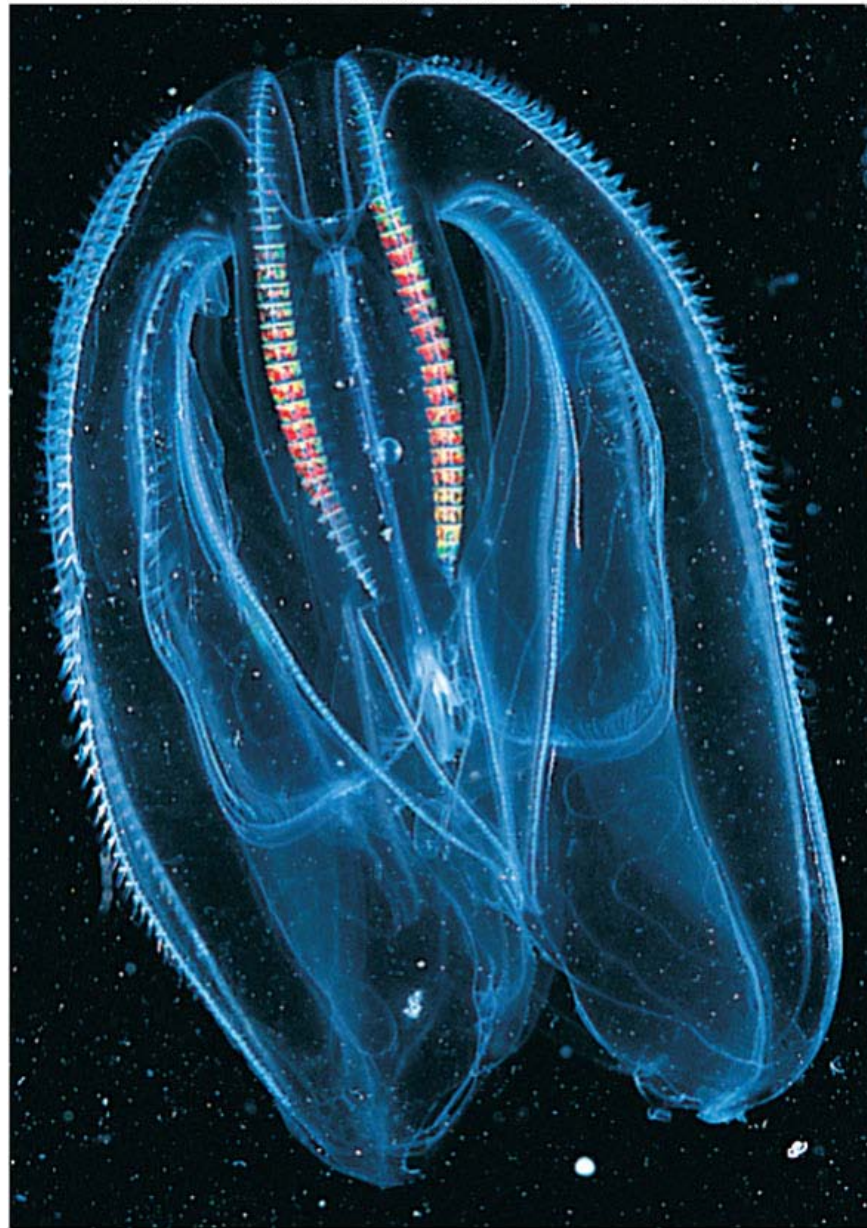
# Invertebrates

- Ctenophores – also known as comb jellies
- Characteristics of Phylum:
  - About 100 species, all marine
  - 8 rows of thick cilia that beat continuously
  - No nematocysts unless they harbor some from eating cnidarians
  - Long sticky tentacles used to capture prey
  - Most species are planktonic
  - Can be found in warm and cold waters
  - Fig. 7.12, pg. 122 displays a comb jelly



Figure 7.12

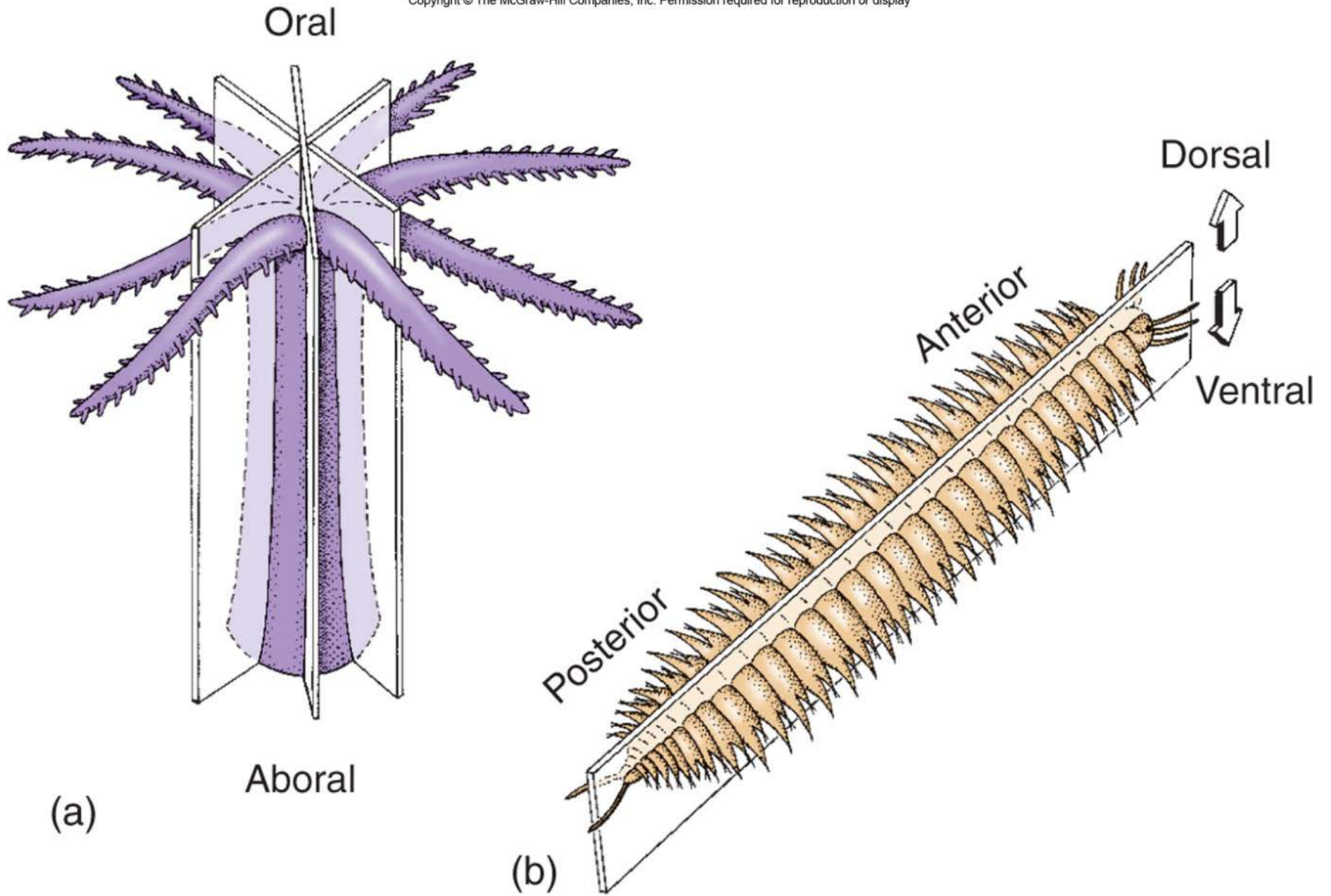
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# Invertebrates

- Flatworms
- Characteristics of Phylum:
  - Consist of flukes, tapeworms and turbellarians
  - About 20,000 species exist
  - Some parasitic, others free-living
  - Well developed reproductive system in most
  - First brain- clusters of nervous tissue in head
  - Three distinct tissue layers
  - Bilateral symmetry

Figure 7.14a

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# Invertebrates

- Types of Marine Flatworms
  - Turbellarians
    - Mainly free-living carnivores
    - Eye-spots present to determine light/dark patterns
    - Most small
    - Some with striking coloration patterns

Figure 7.14b

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Courtesy of Dr. Nico K. Michiels, Institute of Evolution and Ecology, University Tuebingen, Germany



# Invertebrates

- Types of Marine Flatworms
  - Flukes
    - All parasitic
    - Amazing reproductive abilities
    - Have suckers to attach to inside of blood vessels near intestines of host or other tissues
    - Vertebrates are the host of the adult fluke
    - Larval stages may be harbored in shellfish or fish

# Invertebrates

- Types of Marine Flatworms

- Tapeworms

- Parasitic
    - Scolex with suckers and hooks for attachment in host's intestines
    - Body is made of repeated segments
    - Specialized cuticle surrounds body - allows absorption of nutrients
    - No digestive system of their own – they get all their nutrients from their host
    - Adult tapeworms live in vertebrates, larvae are found in invertebrate and vertebrate species



# Invertebrates

- Ribbon Worms
- Characteristics of Phylum:
  - About 900 species, mostly marine
  - Prefer shallow, coastal waters
  - Complete digestive system with mouth and anus
  - Ciliated epidermis.
  - Circulatory system
  - Proboscis, a long fleshy tube, is used to entangle prey
  - These marine predators eat other invertebrates such as worms and crustaceans
  - One species reaches a length of 100 ft making it the longest invertebrate known

Figure 7.15

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# Invertebrates

- Nematodes, or Round Worms
- Characteristics of Phylum:
  - Bilateral symmetry
  - Complete digestive system
  - Cuticle present to guard against drying
  - Some species are important decomposers on the sea floor
  - Some species are parasitic
  - Estimates on the actual number of species range from 10,000 to 25,000 - real numbers probably higher
  - Larval stages often seen in fish – these larval stages can be passed to humans if raw (or undercooked) fish is consumed

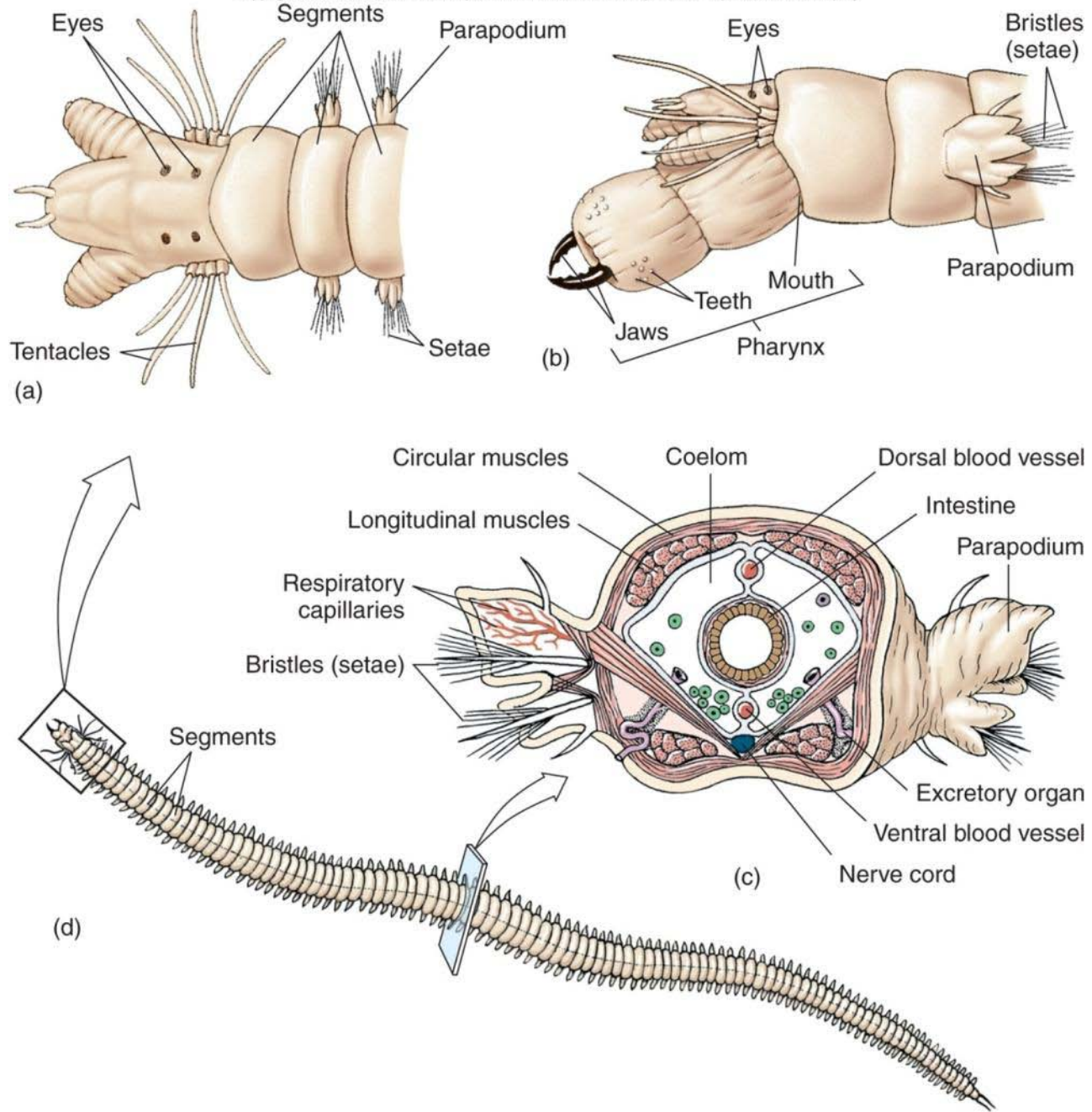
# Invertebrates

- Annelids, Segmented Worms
- Characteristics of Phylum:
  - About 20,000 species
  - Live in salt water, freshwater or moist terrestrial
  - Well developed nervous system (with brain)
  - Segmented internally and externally
  - Closed circulatory system
  - Bilateral symmetry
  - Setae in most (except leeches) – these are bristle-like structures that extend from the sides of each segment which help the annelid stay in place



Figure 7.16

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# Invertebrates

- Types of Annelids:
- Polychaetes:
  - Largest group of annelids, also most diverse
  - About 10,000 species
  - Nearly exclusively marine, some in freshwater and brackish water
  - Distinct head
  - Some build calcareous tubes or tubes of sticky proteins
  - Some are carnivorous, others are deposit feeders
  - Many polychaetes have a planktonic larval stage called a trochophore; this type of larvae is also seen in other invertebrate groups



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Figure 7.17b

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# Invertebrates

- Types of Annelids:
- Leeches
  - Most found in freshwater, some tropical species in moist terrestrial environment, few marine
  - Marine species are parasitic and may prey on other invertebrates or fish
  - Anterior and posterior suckers to hold prey
  - Dorsoventrally flattened
  - Segmentation not as distinct as in other annelids
  - No setae like in other annelids

# Invertebrates

- Types of Annelids:
- Oligochaetes:
  - Terrestrial earthworms are also in this group
  - The marine species are like terrestrial earthworms in that they burrow in soft sediments where they are deposit feeders
  - Mainly found in shallow coastal waters
  - Have fewer setae than seen in polychaetes

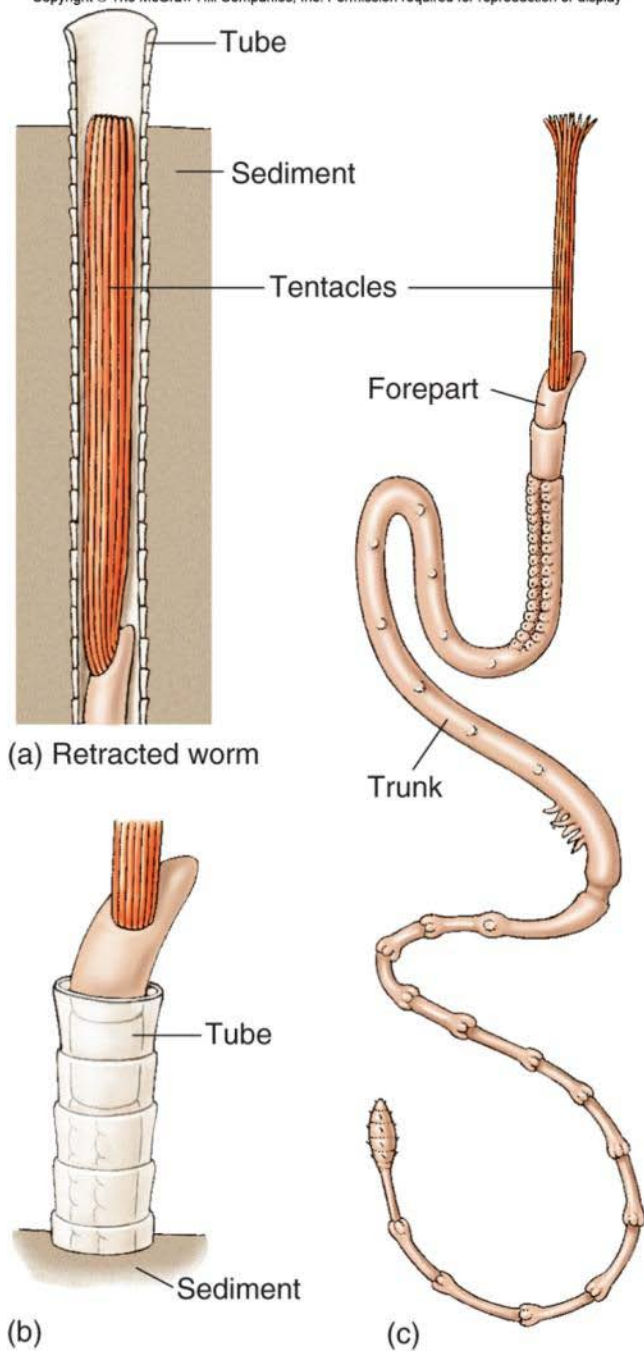


# Invertebrates

- Types of Annelids:
- Pogonophorans or beard worms
  - Highly specialized group of about 135 species
  - Lack a digestive system, which is highly uncommon in the animal world
  - They appear to use tentacles located at the interior end to absorb nutrients directly from the seawater
  - As a group, they are largely restricted to the deep sea
  - Range in size from 4 inches to 7 feet or longer

Figure 7.18

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(a) Retracted worm

(b)

(c)



# Invertebrates

- Sipunculans or Peanut Worms
- Characteristics of Phylum:
  - About 320 species
  - All marine, found mainly in shallow coastal waters
  - Deposit feeders
  - Their soft unsegmented bodies possess a retraxtable multi-lobed or tentacled anterior used for feeding
  - They normally burrow into soft sediments
  - Sometimes found in corals or in empty shells of other animals

Figure 7.19

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# Invertebrates

- Echiurans
- Characteristics of Phylum:
  - 135 species
  - Non-retractable spoon-shaped or forked proboscis (feeding structure)
  - Some taxonomists classify them with annelids
  - Deposit feeder
  - Some burrow in soft bottoms
  - Others live in coral

# Invertebrates

- Molluscs
- Characteristics of Phylum:
  - More than 200,000 species
  - Name means "soft body"
  - Basic body plan – head, muscular foot and visceral mass in most species
  - Mantle- secretes shell, waste disposal, sensory reception, respiration
  - Many have a shell of calcium carbonate
  - Radula for grazing is unique to this group
  - Some are deposit feeders, others carnivores, some use radula for scraping algae, encrusting animals, etc. off substrates
  - Well developed nervous system
  - Open circulatory system & complete digestive system
  - Trochophore larvae develops into a planktonic veliger larvae complete with shell (miniature version of adult)



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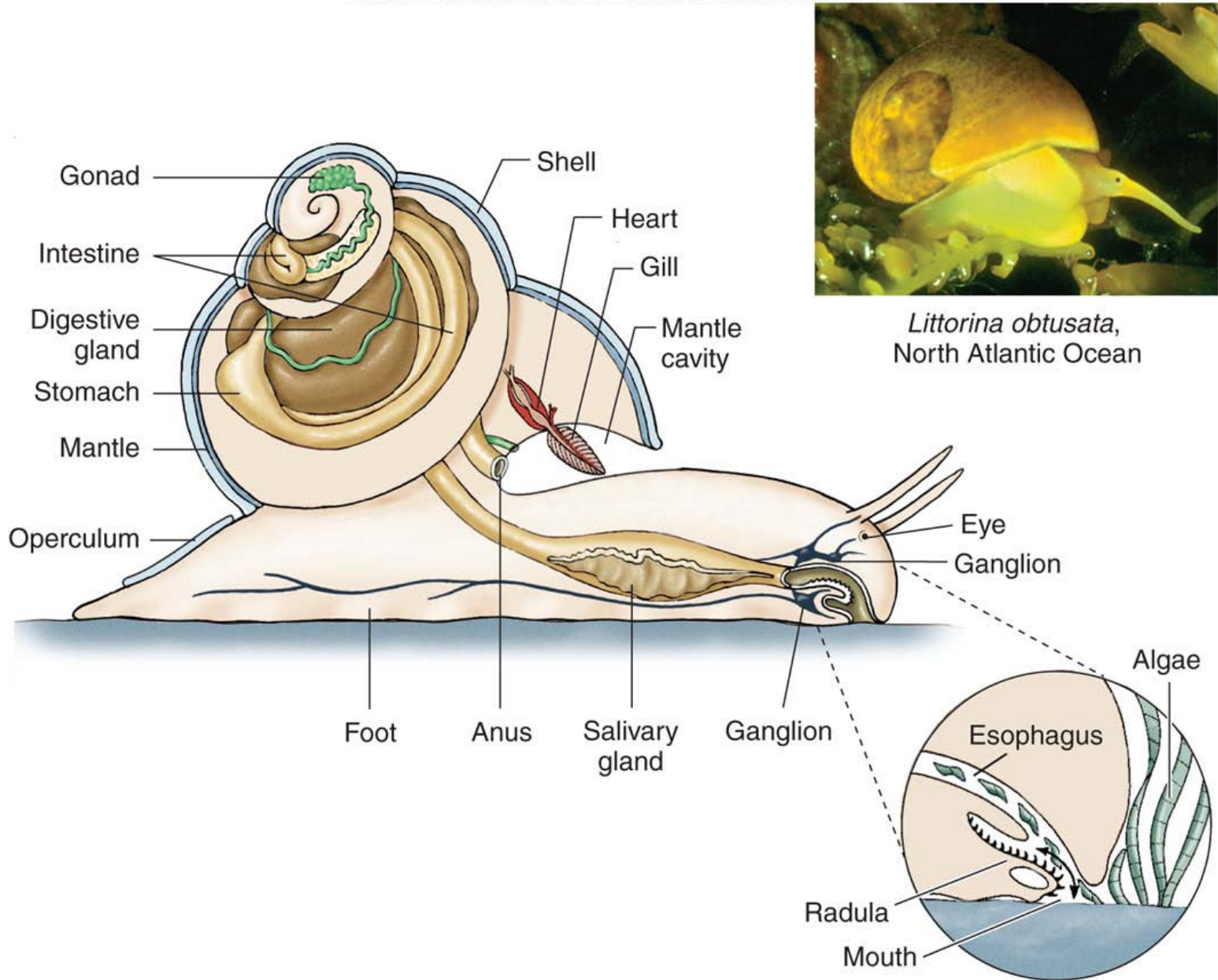


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Courtesy of John O'Sullivan



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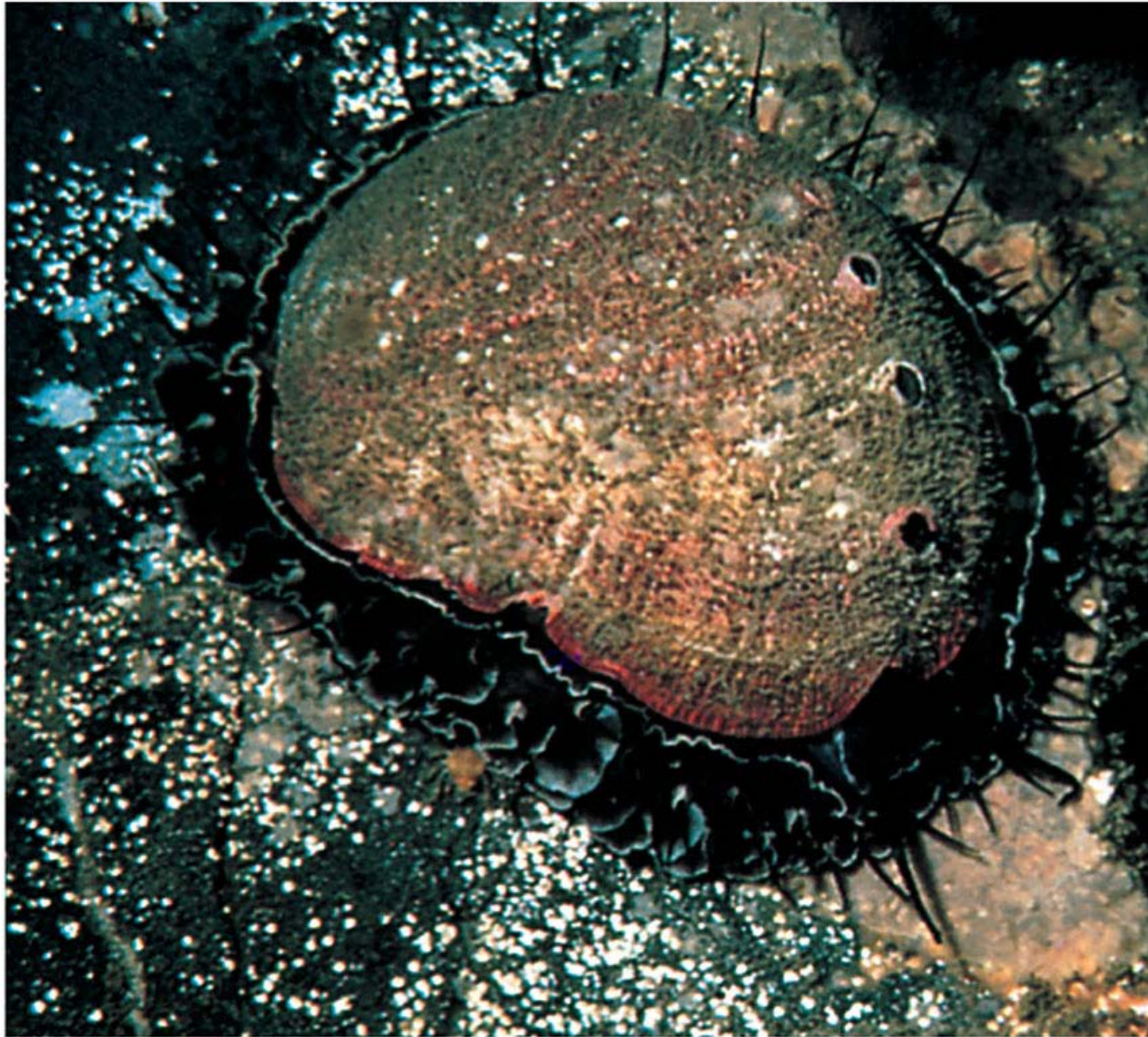




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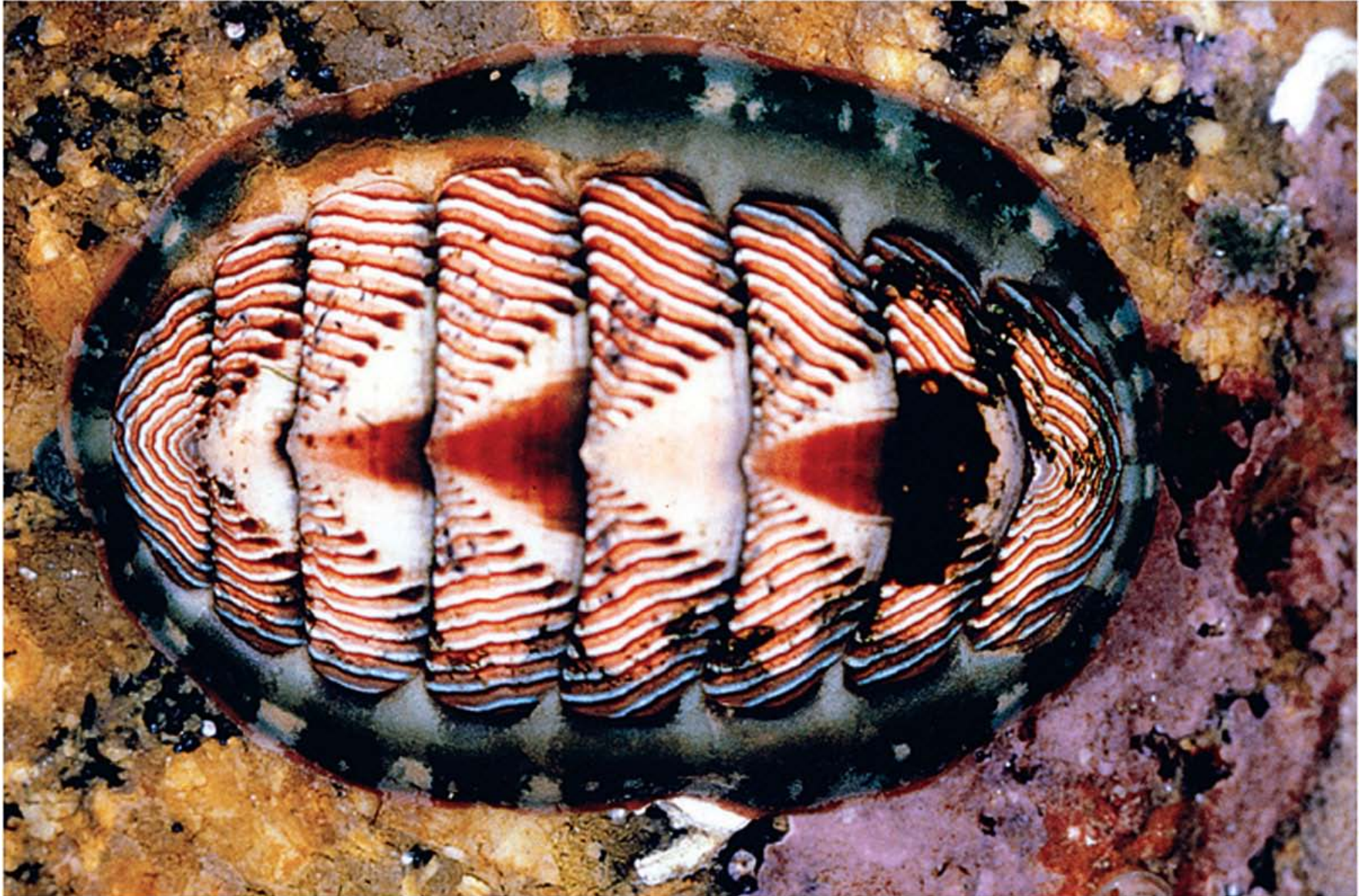
# Invertebrates

- Types of Molluscs:
  - Chitons
    - 800 species
    - All marine
    - Dorsal shell of 8 plates.
    - Ventral muscular foot.
    - Ventral mouth with radula
    - Mostly found in shallow water, coastal environments of hard substrate
    - Many graze on algae & small animals in marine intertidal zone (area between high and low tides)



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# Invertebrates

- Types of Molluscs:
- Bivalves
  - Clams, Oysters, Scallops, Mussels, etc.
  - Two shells or “valves”
  - Oldest part of the shell is called the umbo
  - Shell grows out from the umbo in concentric rings
  - No head present
  - No radula present
  - Adductor muscles secure valves together
  - Muscular foot used for burrowing in bottom and other locomotion
  - Water circulated with siphons
  - Gills for respiration & food gathering (filter feeding)
  - Some species burrow, others attach to hard substrates via byssal threads, or grow attached to each other



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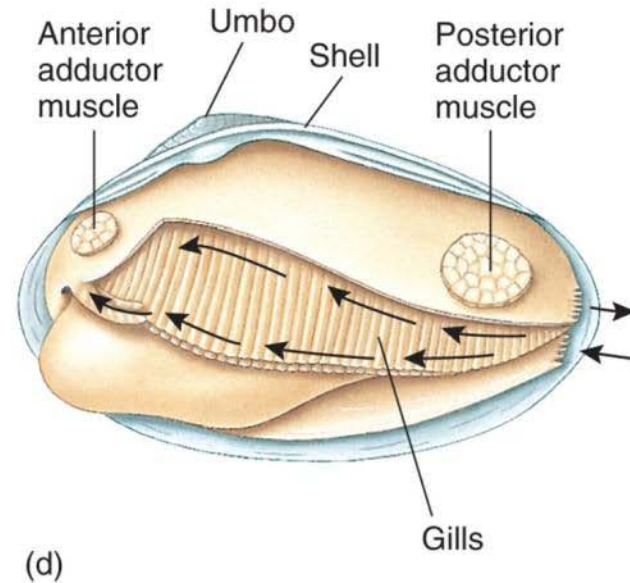
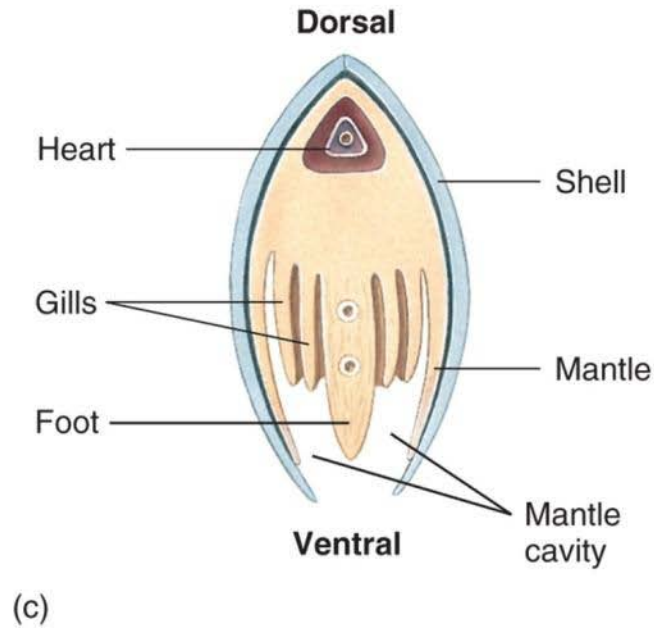
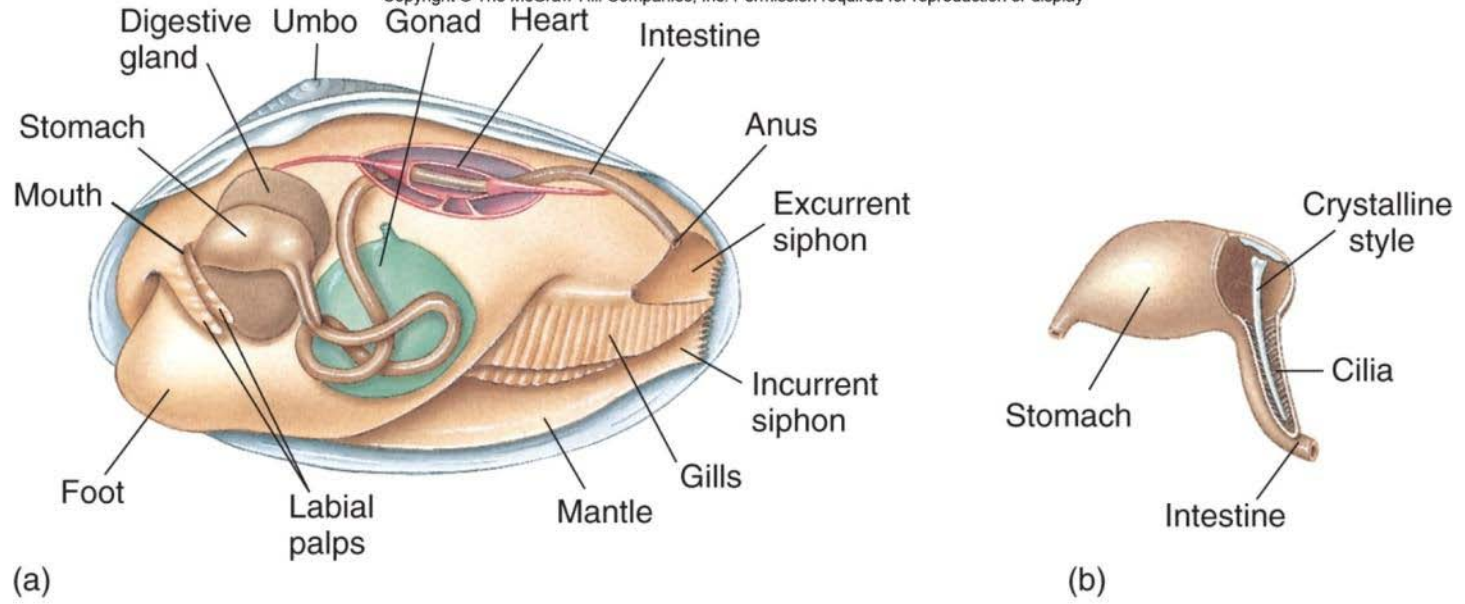


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# Invertebrates

- Types of Molluscs:
- Gastropods
  - Largest class of molluscs, about 75,000 species
  - Name means "belly-footed"
  - Coiled shell on most species
  - No shell on sea slugs (nudibranchs)
  - Radula for grazing on plants in most, some are deposit feeders
  - Some species are carnivorous and use radula for prey capture



# Invertebrates

- Types of Molluscs:
- Cephalopods
  - Squid, Octopus, Nautilus, & Cuttlefish
  - All 650 species marine
  - Fast swimming predators due to water jet propulsion
  - Well developed eyes
  - Thick mantle covers the body
  - Use beak-like jaws and radula to crush or rip prey
  - Adapted tentacles

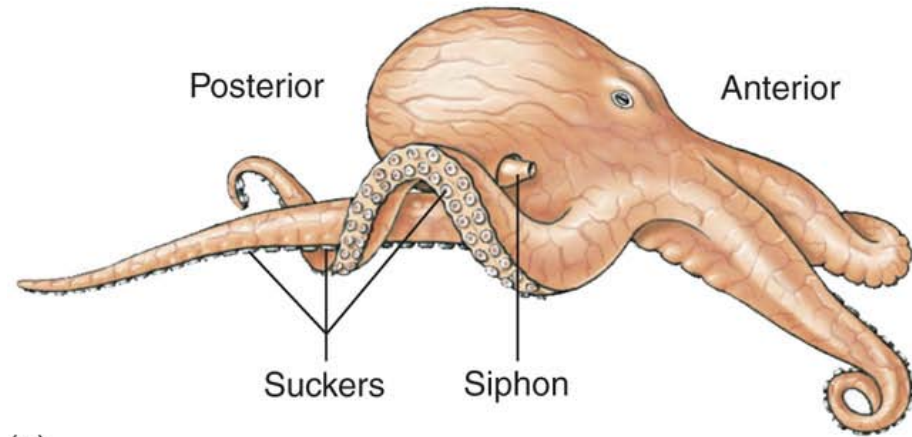
# Invertebrates

- Types of Molluscs:
- Cephalopods
  - Shell internal or absent in most
  - Most advanced invertebrates
  - In octopus, the shell has been replaced by a beak-like jaw which can deliver a powerful bite
  - Some octopus have toxic bites
  - Ink sac is also seen in octopus to allow escape from predators
  - A stiff internal "pen" is seen in squid is a modified shell

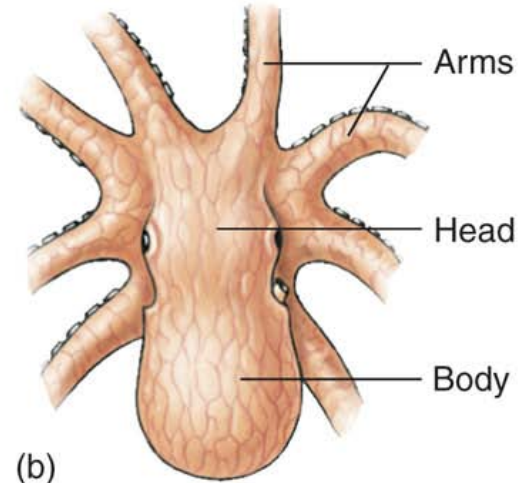


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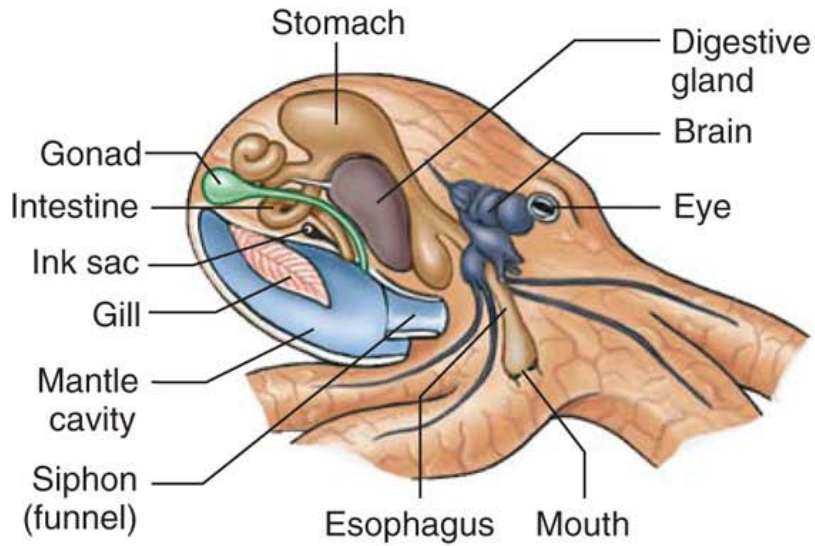
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(a)



(b)



(c)



Blue-ringed octopus (*Hepalochlaena*), tropical Indian and Pacific oceans

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Courtesy of Cindy Clark, Scripps Institution of Oceanography

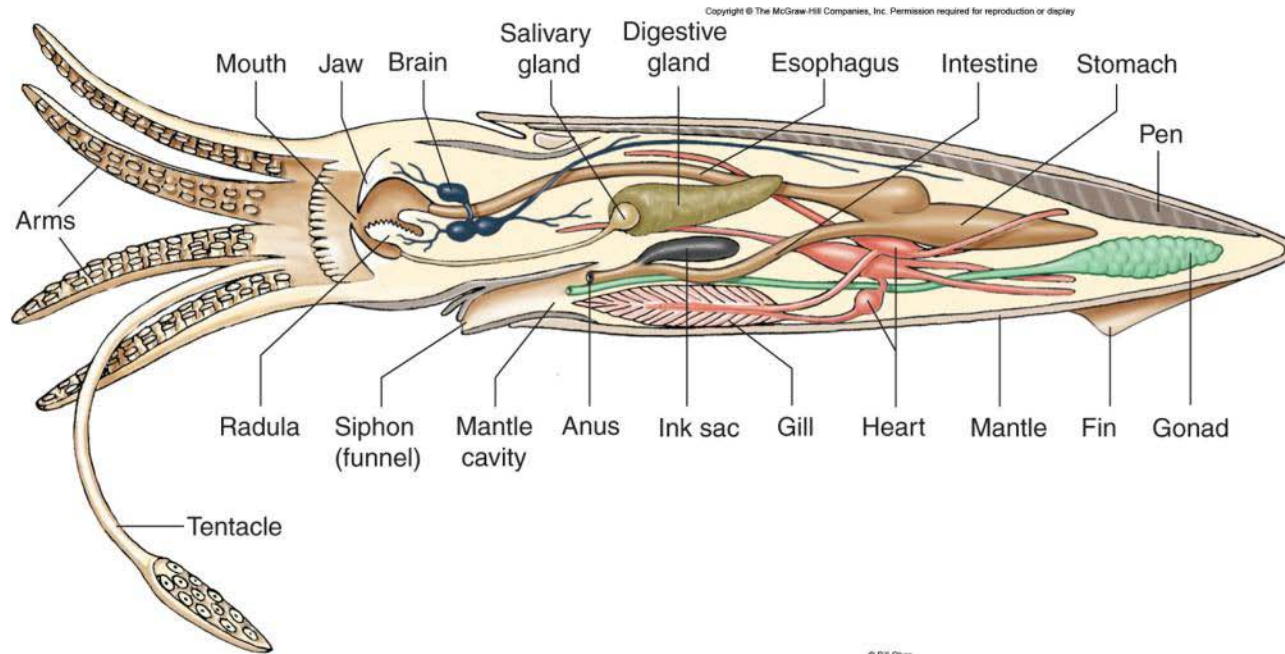


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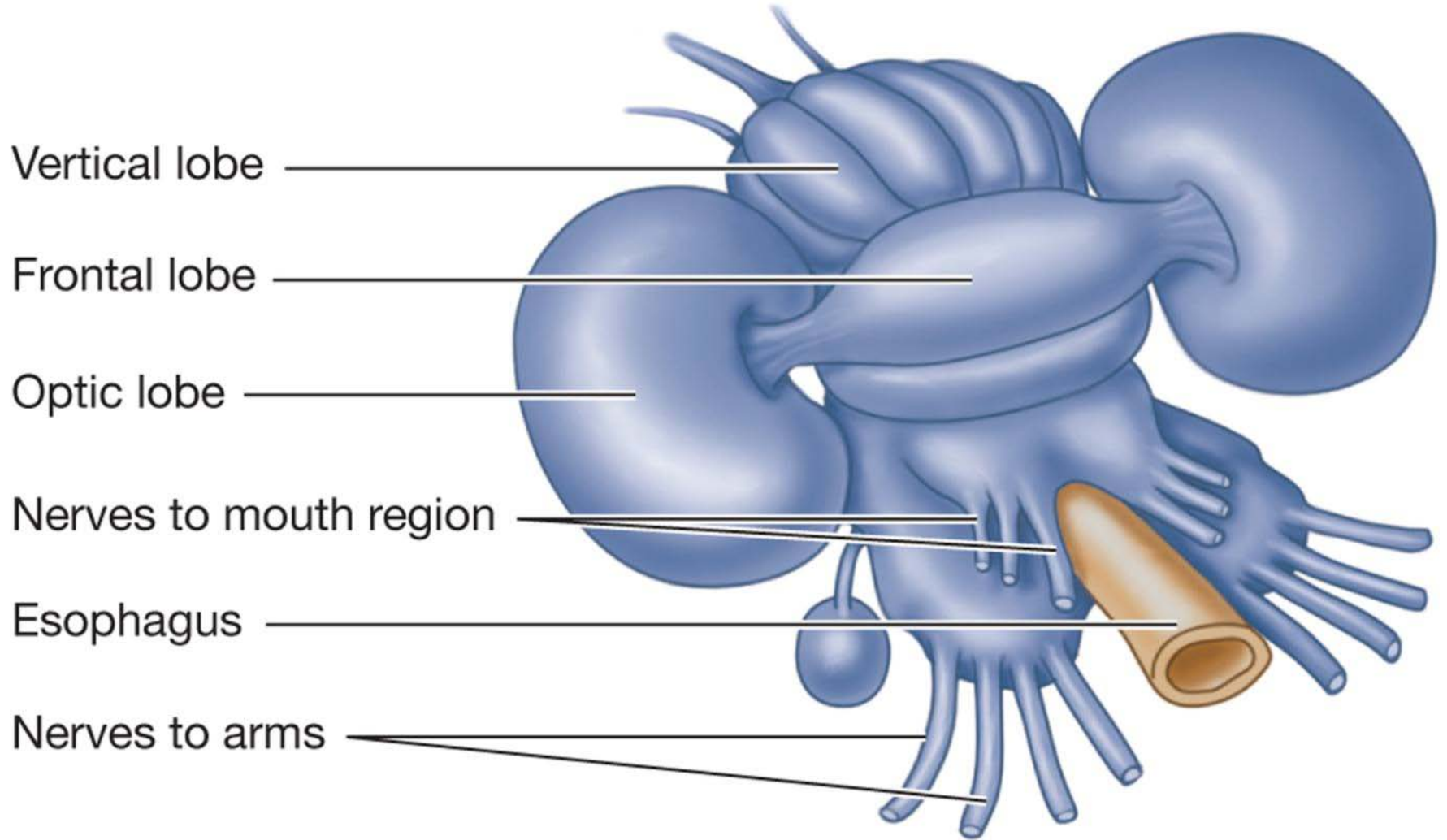
Figure 7.27



Juvenile *Illex illecebrosus*, Atlantic coast of North America



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# Invertebrates

- **Arthropods**
- **Characteristics of Phylum:**
  - About 1 million species known, mostly marine
  - Most marine species are in a group of arthropods called crustaceans
  - About 75% of all animals on earth are arthropods
  - Chitin exoskeleton - hard, but light and moderately flexible
  - Since the skeleton is external, an arthropod must shed the shell to be able to grow – this process is called molting. There is a soft new shell underneath.
  - Jointed appendages
  - Many divided into sections called head, thorax and abdomen
  - Specialized segmentation - segments combined for specific functions
  - Specialized eye & sensory organs - wide angle of vision



# Invertebrates

- Arthropods
- Characteristics of phylum:
  - Specialized respiratory structures, gills, used for gas exchange
  - Some are filter feeders, some scavengers, others carnivores
  - Male transfers sperm directly to female to ensure reproductive success
  - In some species, female will house eggs for a time until they are further developed
  - Females can store sperm for fertilization at a later time
  - Many arthropods have complex behaviors including mating rituals

# Invertebrates

- Types of Marine Arthropods:
- Crustaceans
  - 68,000 species
  - 2 pairs antennae
  - Gills for respiration
  - Head and thorax fused into a single unit called a cephalothorax; entire external body is called the carapace
  - Large array of appendages specialized for different functions; ex: pinchers on crabs, swimmerettes on the underside of shrimp hold developing eggs, etc.
  - Types of crustaceans – copepods, barnacles, amphipods, isopods, crabs, shrimp, lobsters, etc.



# Invertebrates

- Types of Marine Arthropods:
- Horseshoe crabs-
  - 5 pairs of legs, first pair modified in males for reproduction
  - Females larger than males
  - Mating pairs come onto beaches each spring to breed and lay their eggs in wet sand
  - Among the oldest creatures on earth – they have remained virtually unchanged for millions of years
  - They live and borrow in soft sediments, normally near shore where they feed on other invertebrates and scavenge.

# Invertebrates

- Types of Marine Arthropods
- Sea Spiders:
  - Four or more pairs of jointed legs
  - Not insects or true spiders
  - Possess a mouth and proboscis for feeding
  - Mainly feed on sea anemones and hydrozoans (they are voracious predators!)
  - More common in cold waters, but can be found worldwide



# Invertebrates

- Types of Marine Arthropods
- Insects:
  - Very few marine insects exist
  - Many insects feed in the intertidal zone at low tide, but these are just temporary visitors

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Figure 7.30

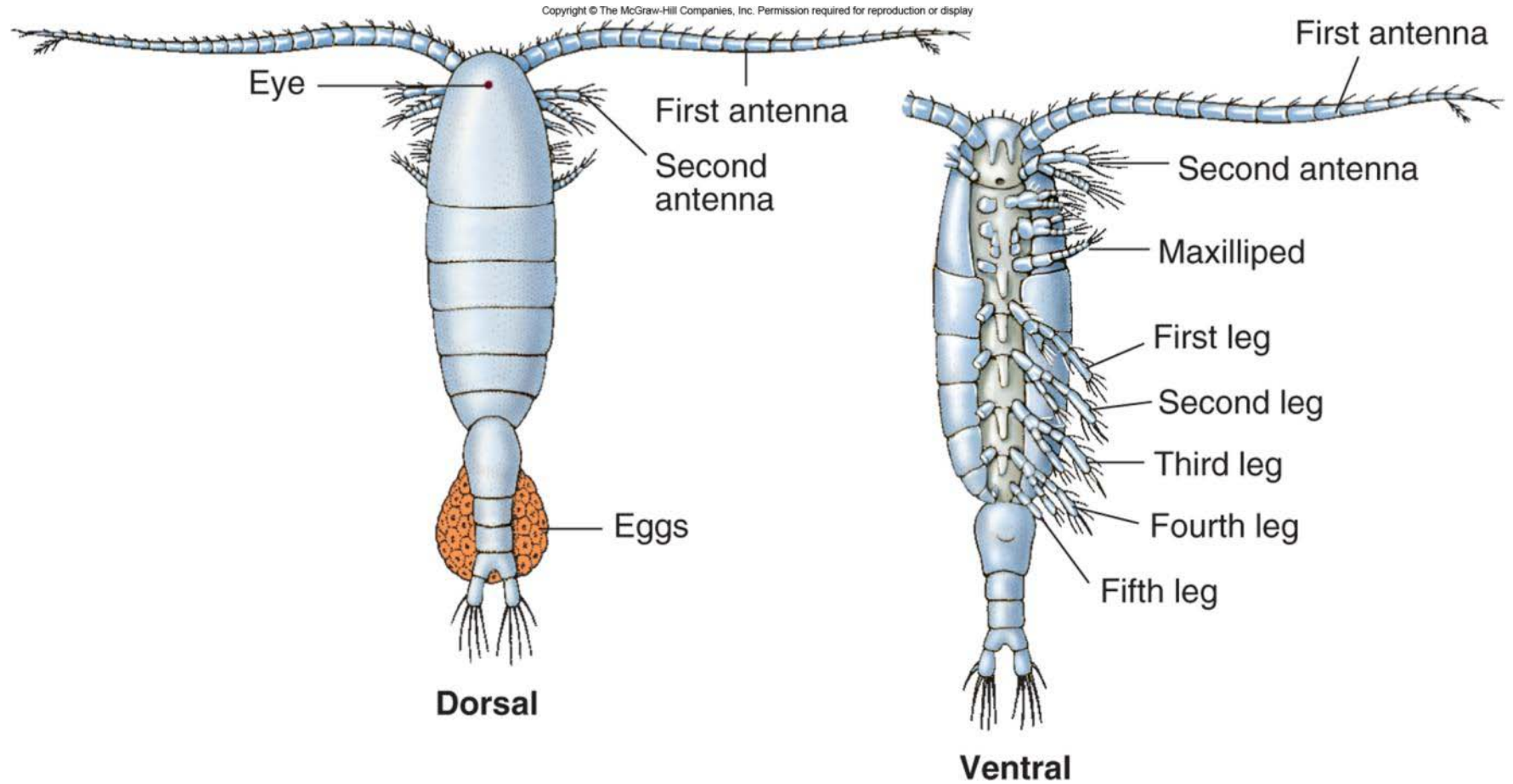


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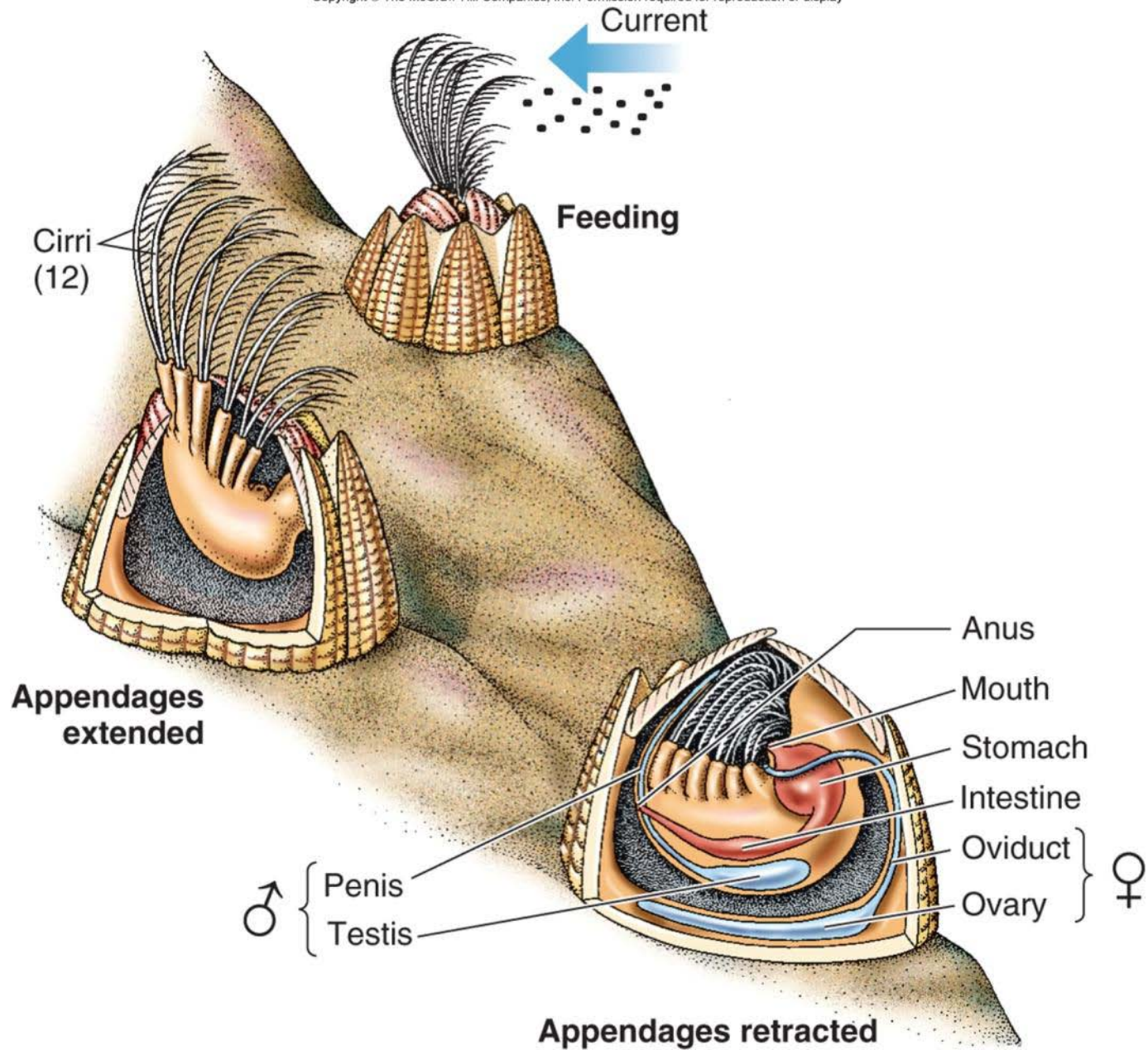




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First antenna

Second antenna

Maxilliped

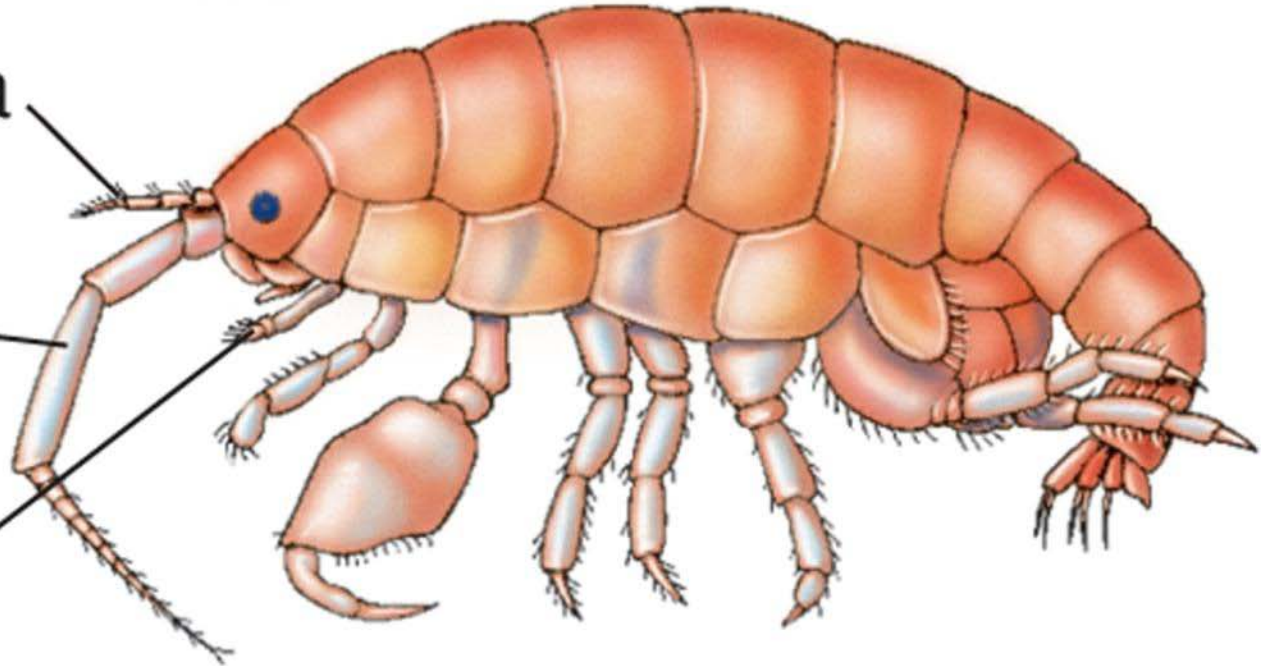




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Second antenna

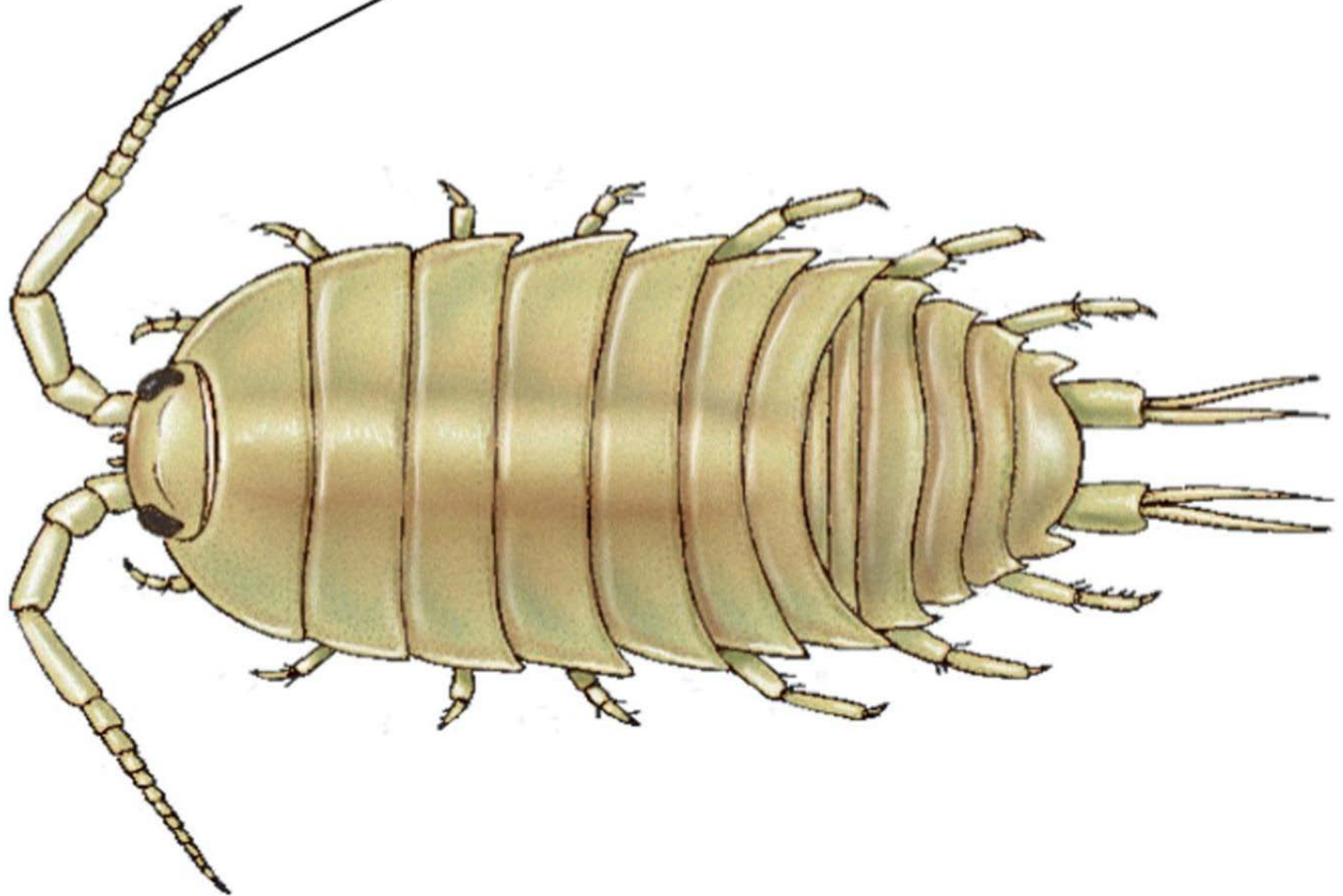


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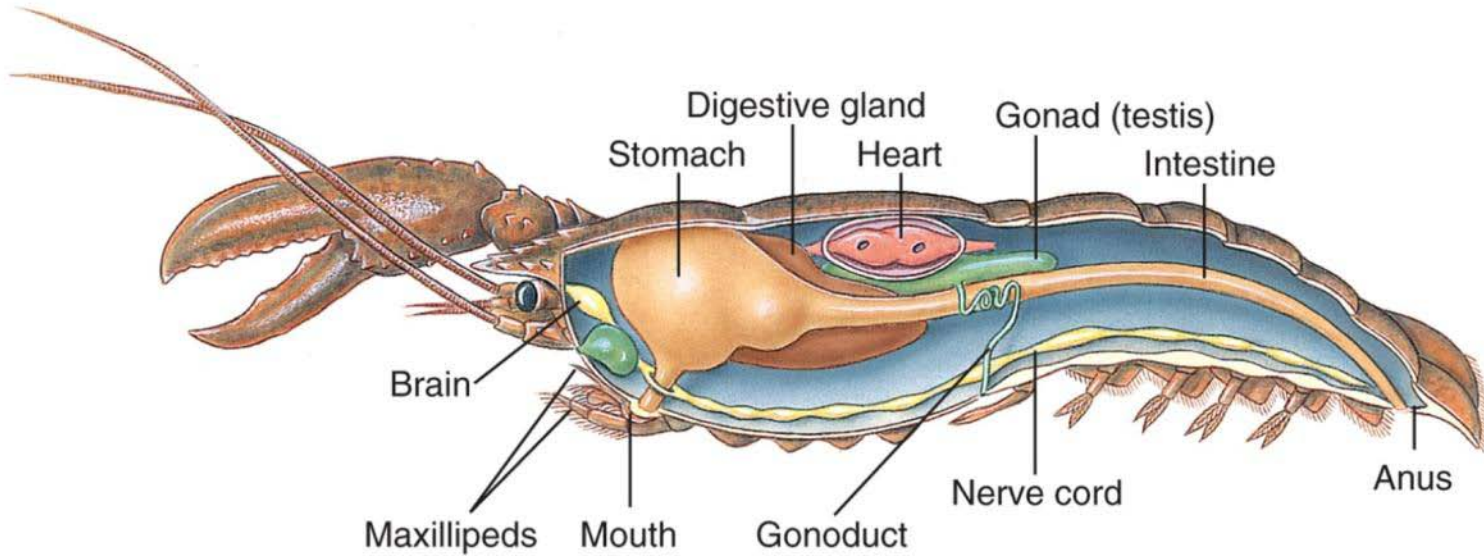
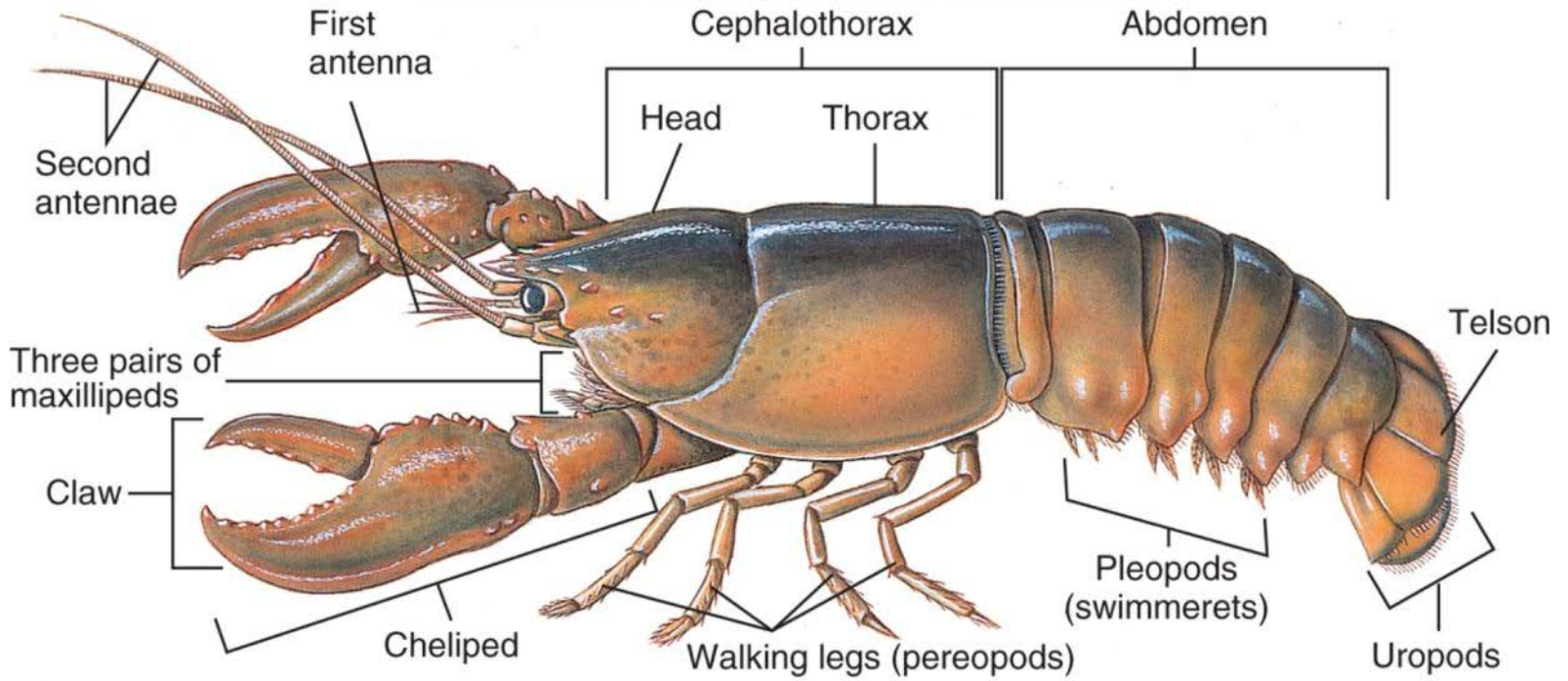




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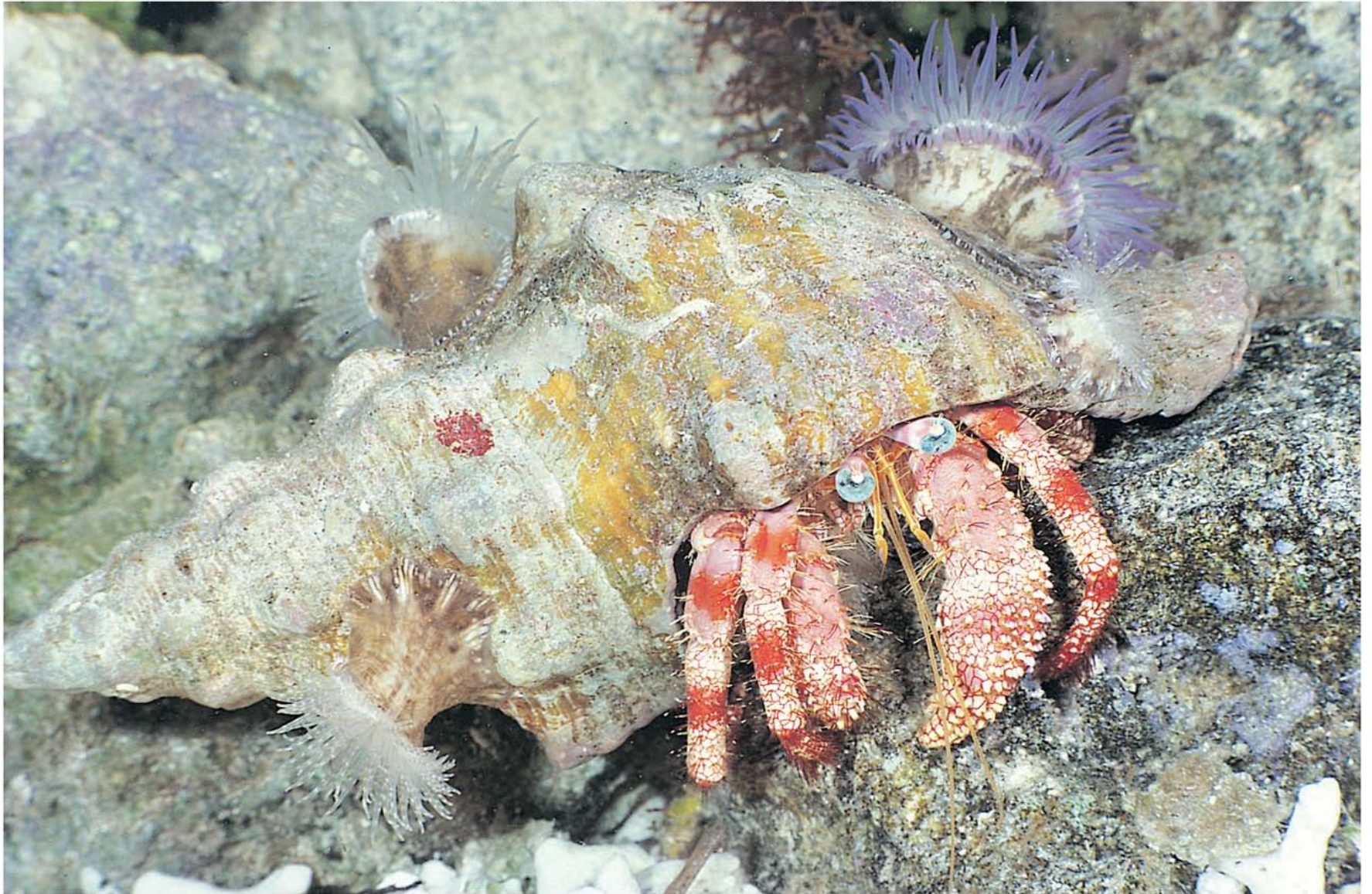


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Courtesy of Dr. Ernst S. Reese, University of Hawaii



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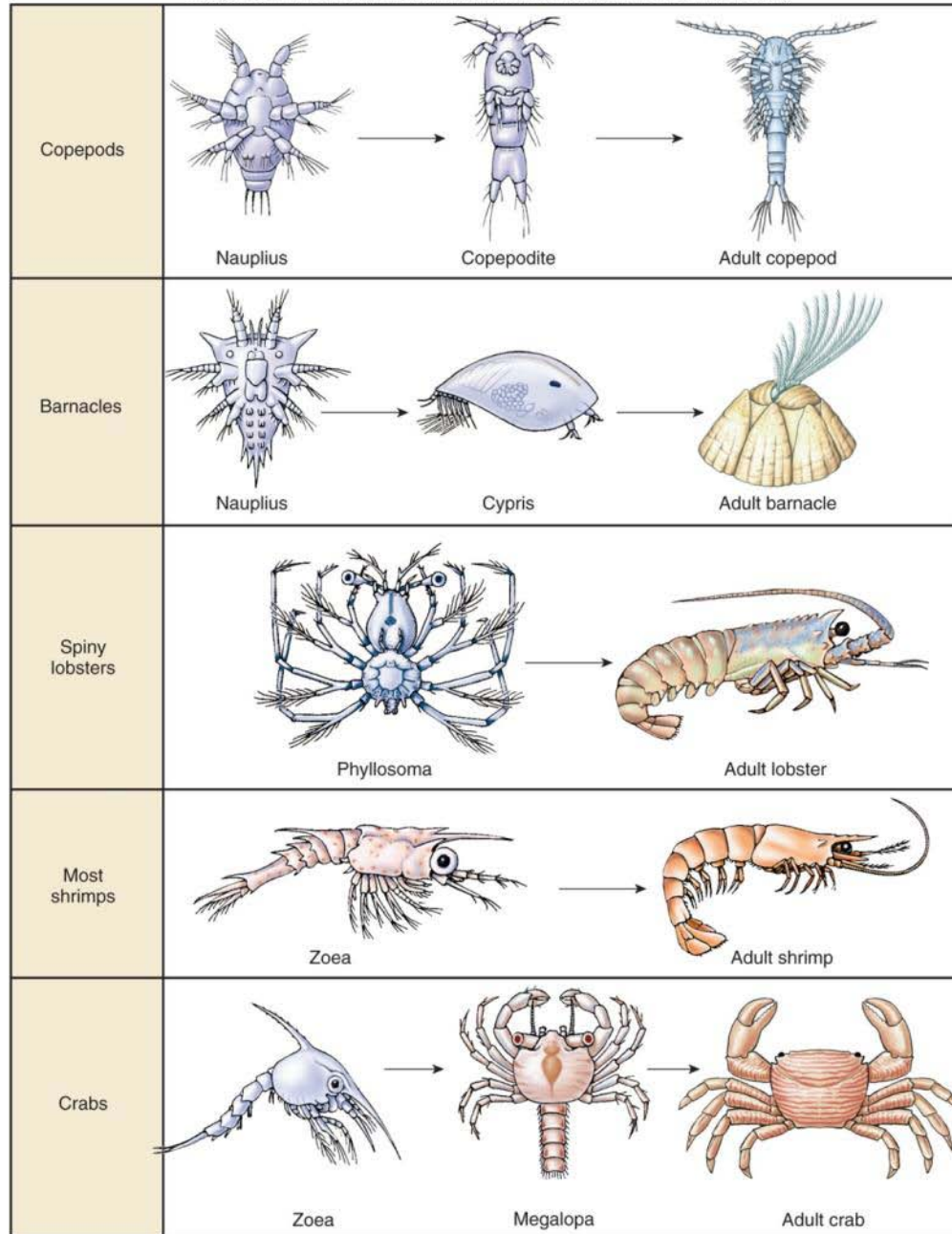




Figure 7.40

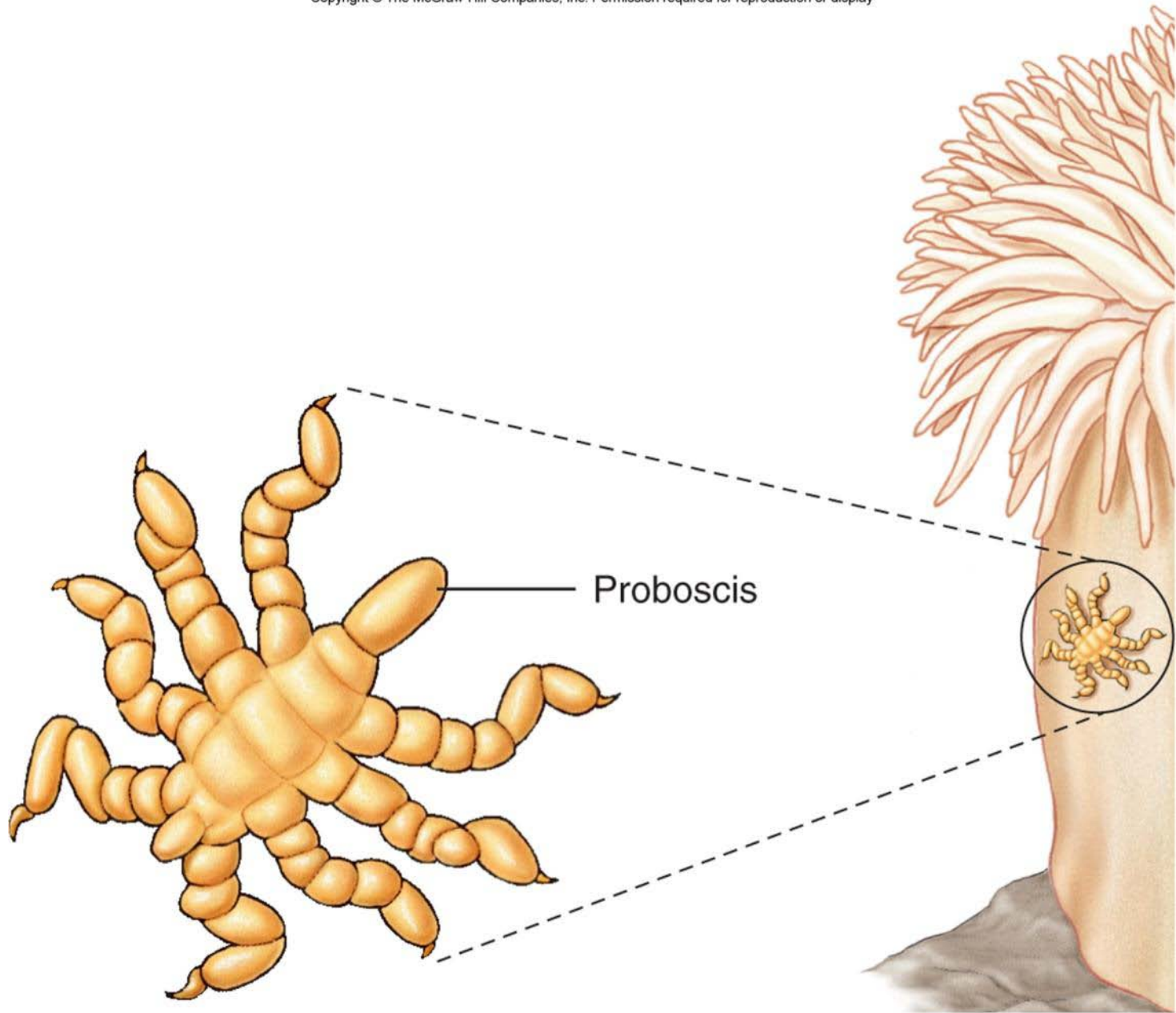
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Courtesy USFWS

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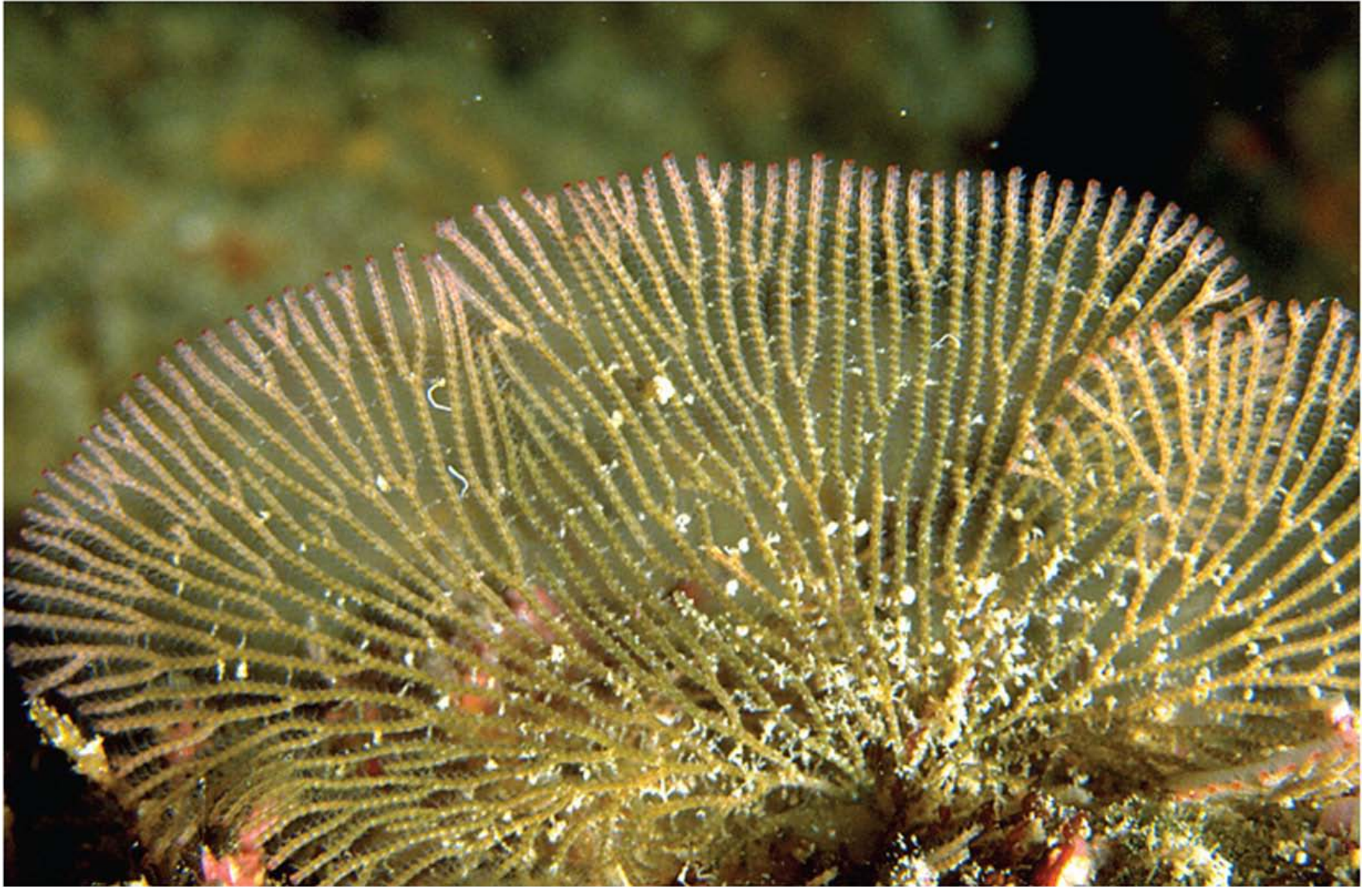
# Invertebrates

- Bryozoans
- Characteristics of Phylum:
  - 4500 species, all marine
  - Sometimes called moss animals
  - Small, colonial animals
  - Some are encrusting forms, others form a branching network that looks like a small tree
  - Suspension feeders
  - Bryozoans (plus phoronids and brachiopods) possess a unique feeding structure called a lophophore. The lophophore is an extension of the body wall that ends in a tentacled structure that surrounds the mouth



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# Invertebrates

- Phoronids
- Characteristics of Phylum:
  - 20 species
  - Found in shallow, coastal waters
  - Phoronids make tubes where they live
  - Somewhat resemble polychaete worms externally
  - Lochophore present

# Invertebrates

- Brachiopods
- Characteristics of Phylum:
  - 300 species, exclusively marine
  - Many live in deep sea or at polar regions
  - Two shells or “valves” enclose the body
  - Possess lophophore
  - Well known from fossil record
  - Fossil record indicates there were many more species in geologic past



# Invertebrates

- Arrow Worms
- Characteristics of Phylum:
  - 100 species, all marine
  - These organisms are planktonic, but slightly larger than most plankton
  - They are voracious predators that are widely distributed in the marine community
  - They will swim in rapid, darting movements to capture prey

Figure 7.43 Right

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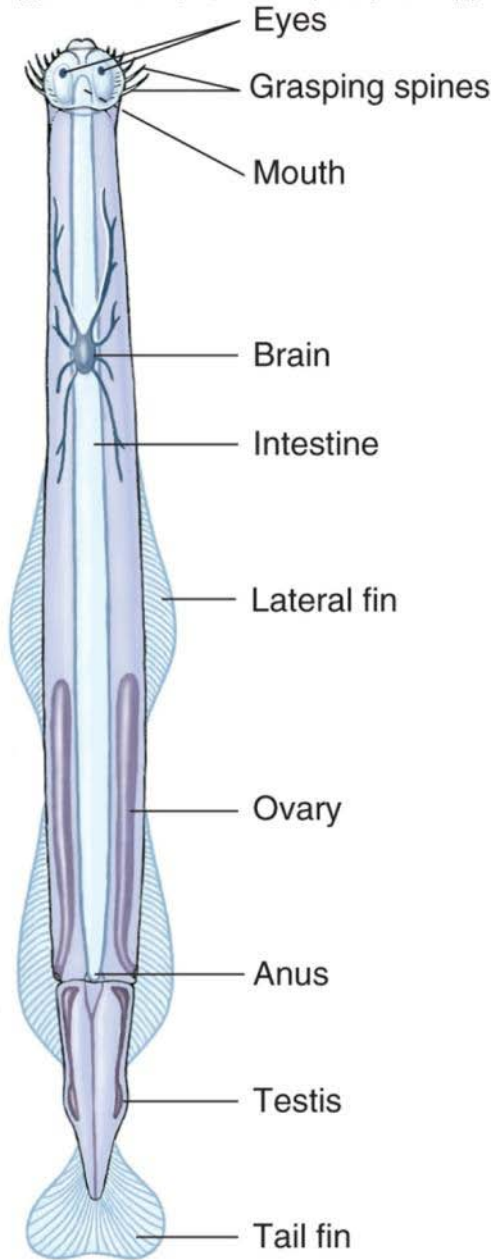




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Clarke/UAF/CMarZ

© Cheryl Hopcroft, Institute of Marine Science, Fairbanks, AK

# Invertebrates

- Echinoderms
- Characteristics of Phylum:
  - Name means "Spiny Skin"
  - Endoskeleton
  - Water vascular system with tube feet important in feeding and locomotion
  - Skin gills for respiration.
  - Radial symmetry in adults- larvae are bilaterally symmetrical
  - Nervous system is decentralized- no brain- this allows any portion of the body to lead
  - Can regenerate lost body parts
  - All 7000 species exclusively marine



# Invertebrates

- Types of Echinoderms:
- Sea stars-
  - Move with tube feet
  - Have a central disc in center of body surrounded by five arms (or multiples of 5 arms – some species have 50 arms)
  - Internal organs extend through the entire body, including the arms
  - Calcium carbonate plates are loosely embedded in spiny skin making them slightly flexible
  - Carnivores that normally consume shellfish and coral



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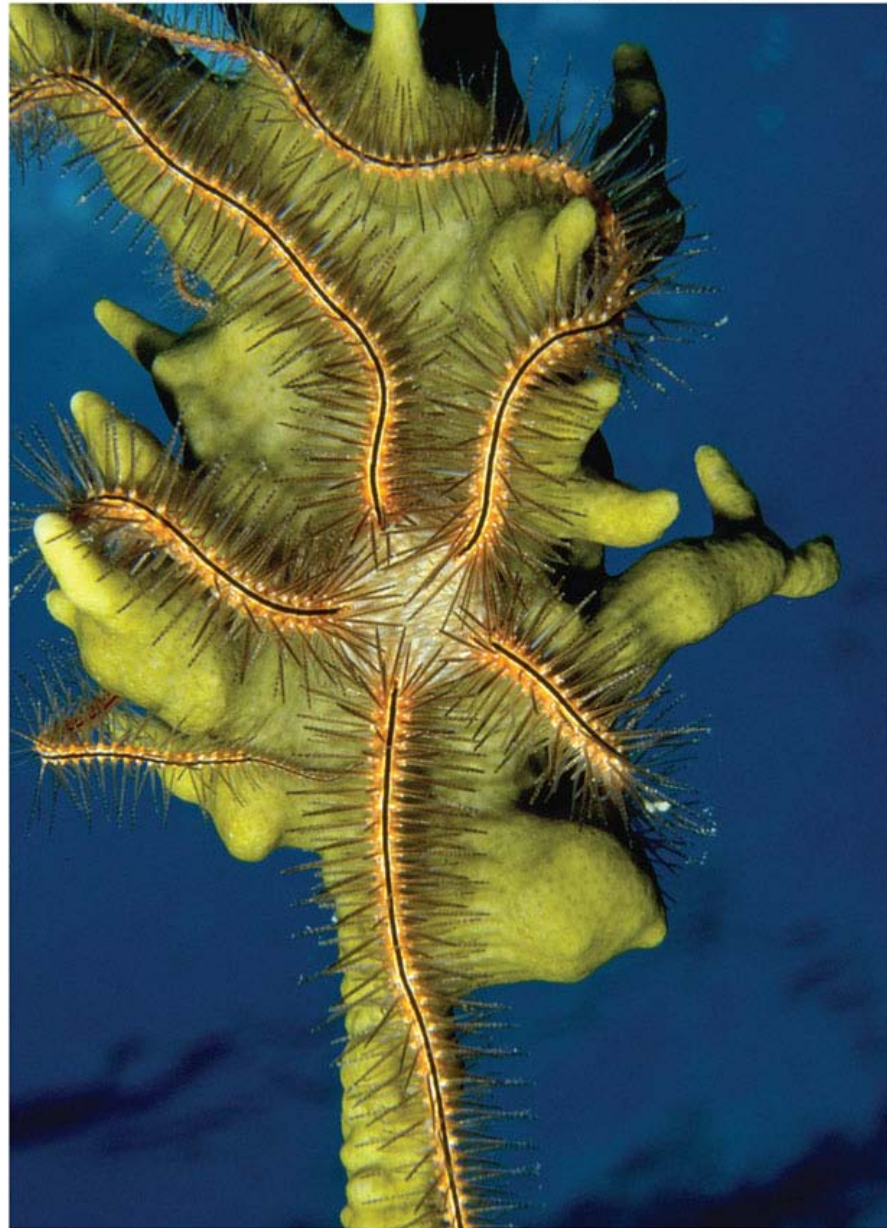
# Invertebrates

- Types of Echinoderms
- Brittle stars
  - Like sea stars, they have a central disc surrounded by arms
  - Five arms seen in brittle stars are thin and covered in numerous spines
  - Internal organs are restricted to the central disc
  - The tube feet present in brittle stars are without suckers and used for feeding on detritus and small animals



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# Invertebrates

- Types of Echinoderms
- Sea Urchins, Sea Biscuits, Sand Dollars
  - Elongated, movable spines much longer than those sea in other groups
  - Rigid plates are fused into a solid structure called a "test"
  - Move with tube feet
  - Mouth on the bottom, anus on top of body
  - Biting mouth for grazing – aristotles lantern is the feeding structure of muscles and mouthpieces
  - Feed on detritus, encrusting organisms, algae or anything else they can scrape off surfaces



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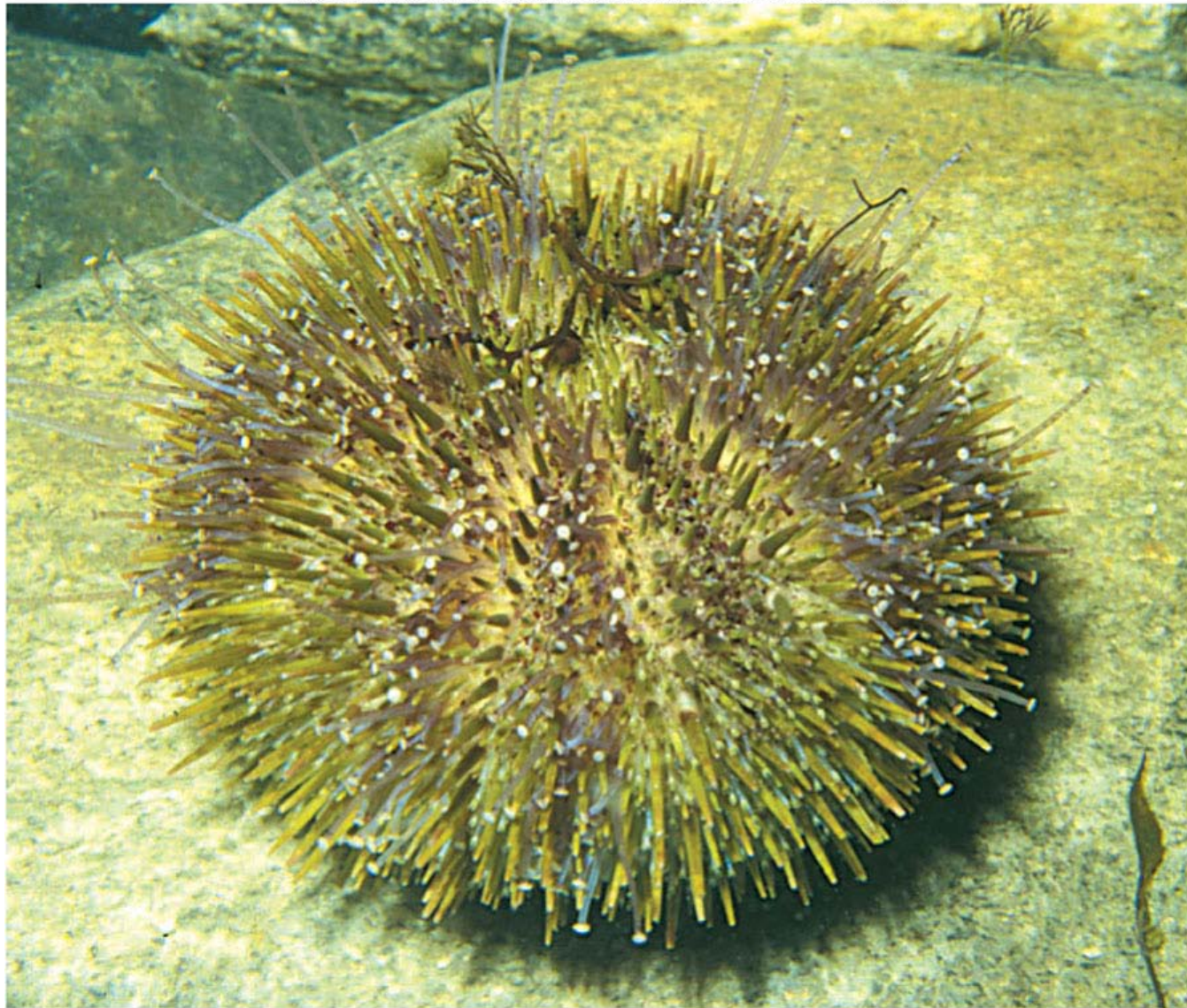




Figure 7.47b

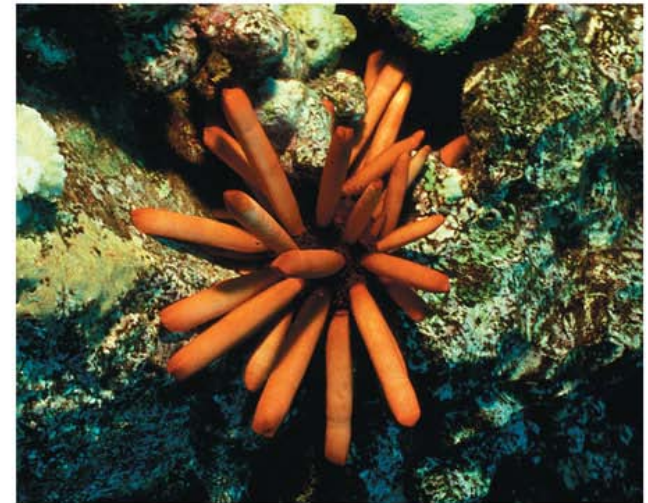
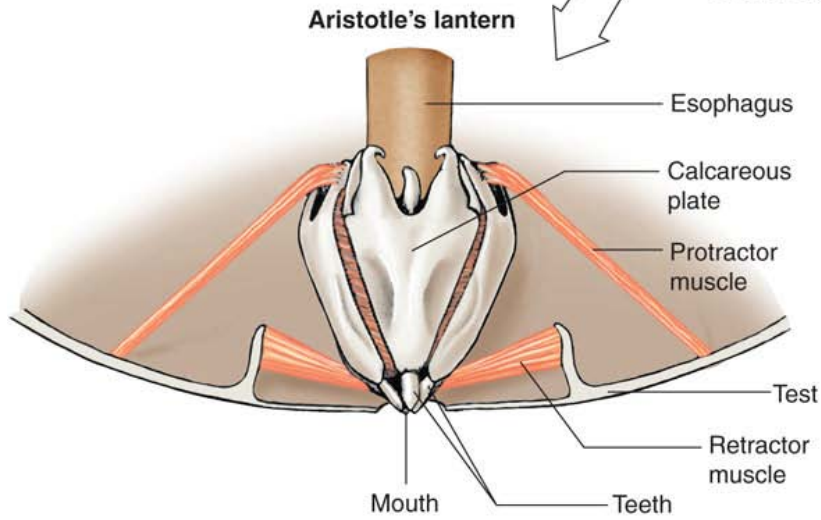
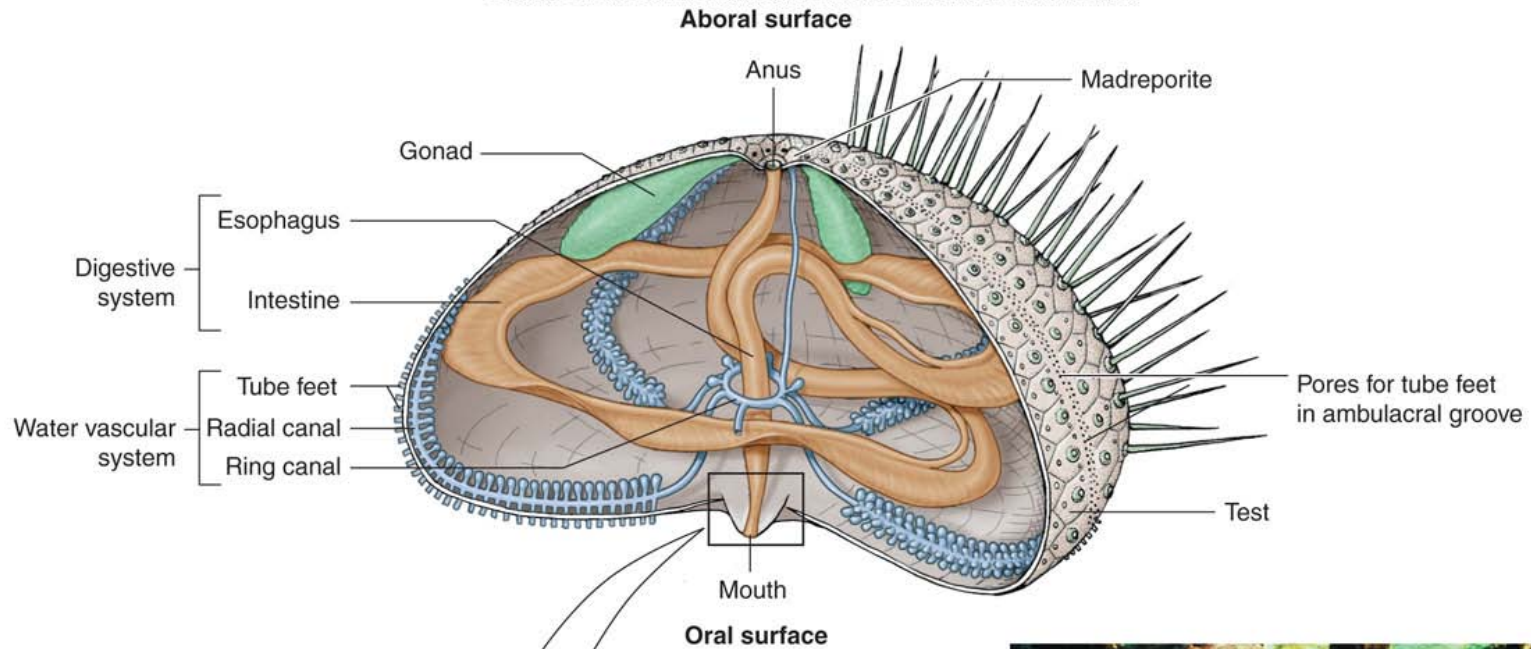
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*Heterocentrotus mammilatus*, tropical Indian and Pacific oceans.

# Invertebrates

- Types of Echinoderms
- Crinoids
  - Represented by feather stars and sea lilies
  - 600 species are typically found in deep water
  - Sea lilies live attached while feather stars are mobile
  - These organisms have 5 or more arms that branch out for suspension feeding
  - Some use a mucous net to aid in food capture



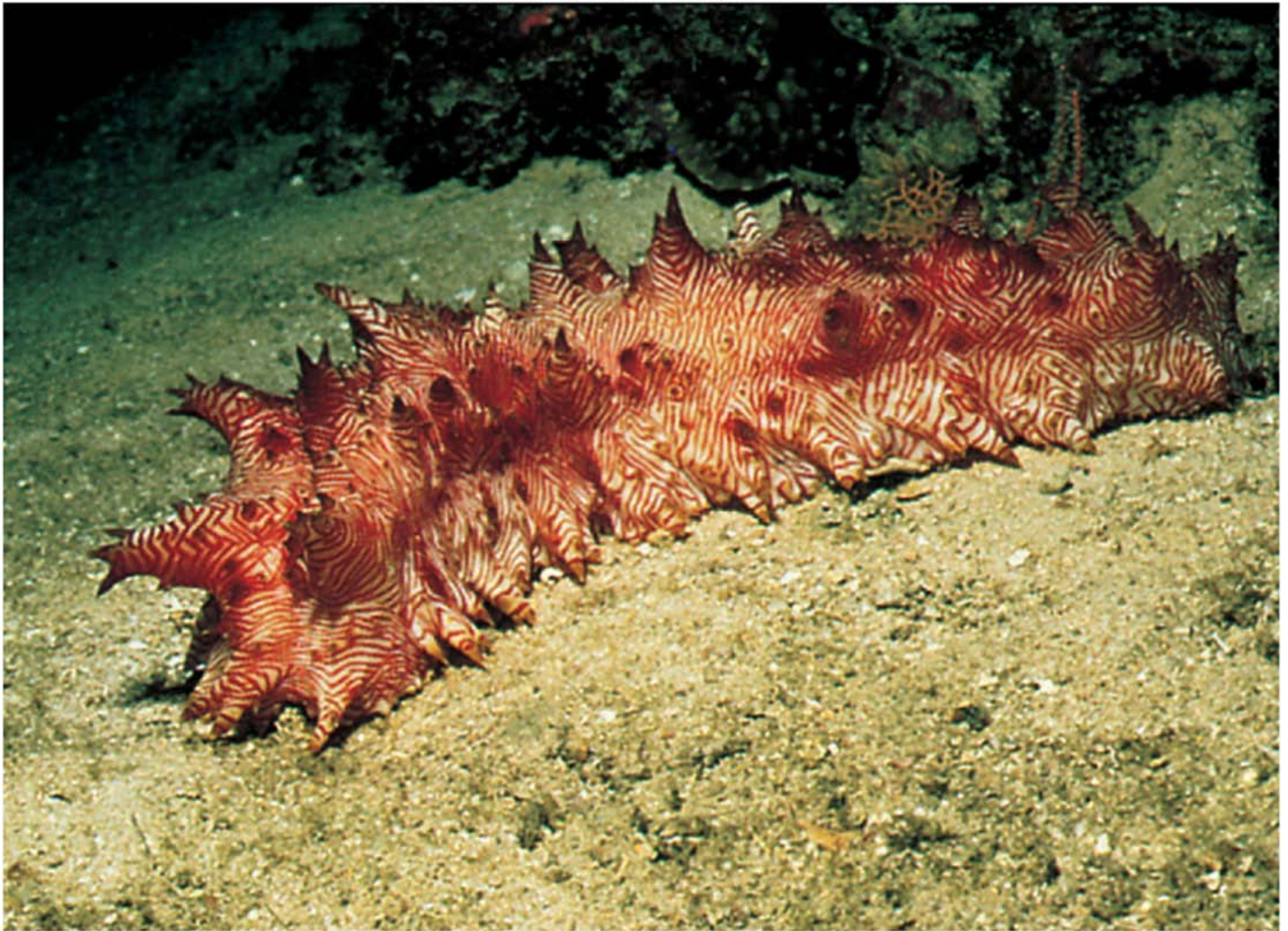
# Invertebrates

- Types of Echinoderms
- Sea cucumbers
  - Five rows of two feet are restricted to one side, where the animal lies
  - The plates found in the sea cucumbers are loosely embedded in the thick skin
  - They are deposit feeders
  - Sea cucumbers have a interesting predator escape plan called evisceration, where they expel the internal organs; it is assumed this allows escape for the sea cucumber.
  - Since all echinoderms have regenerative capabilities, these internal organs will grow back.



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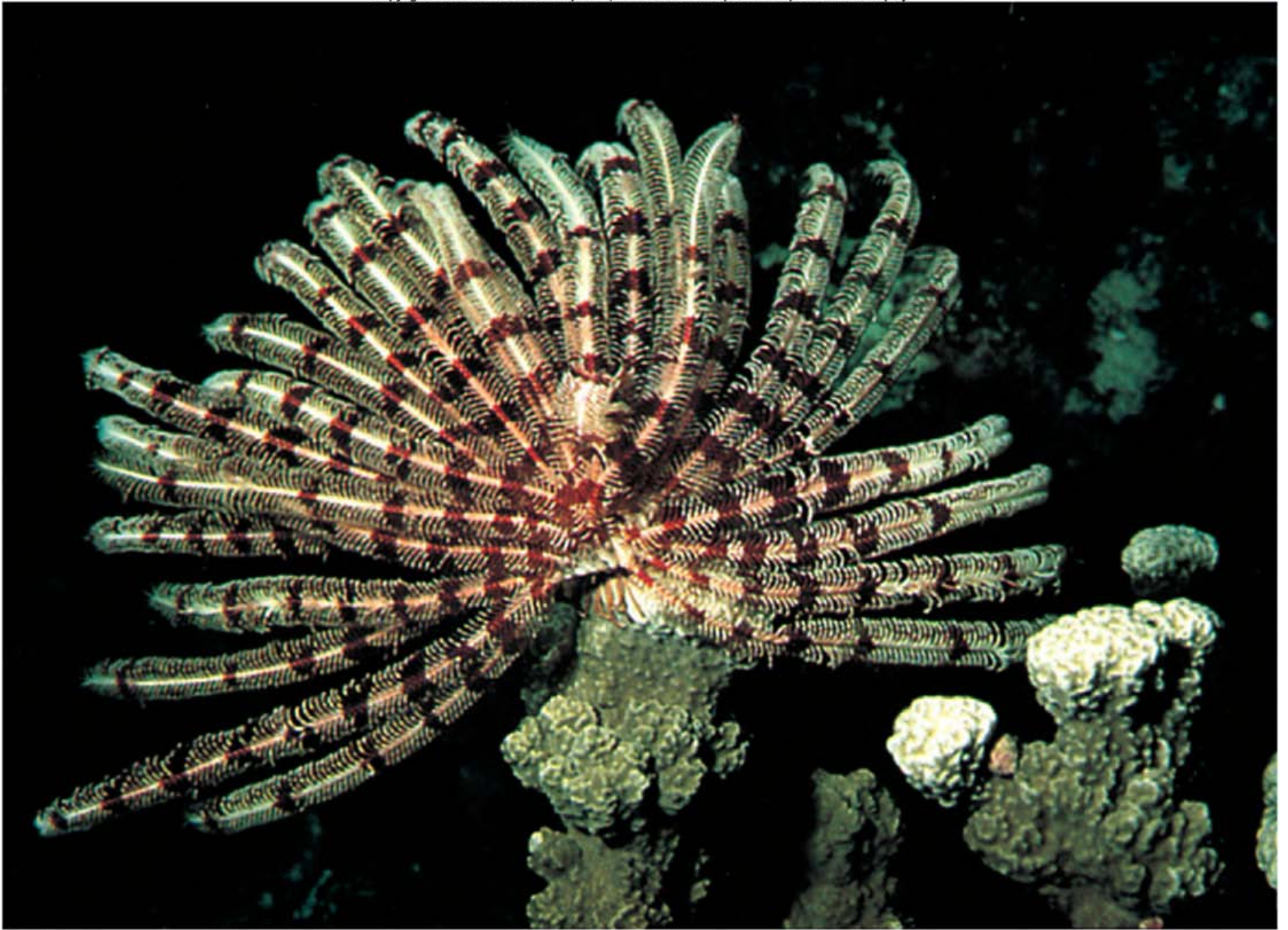


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Figure 7.50

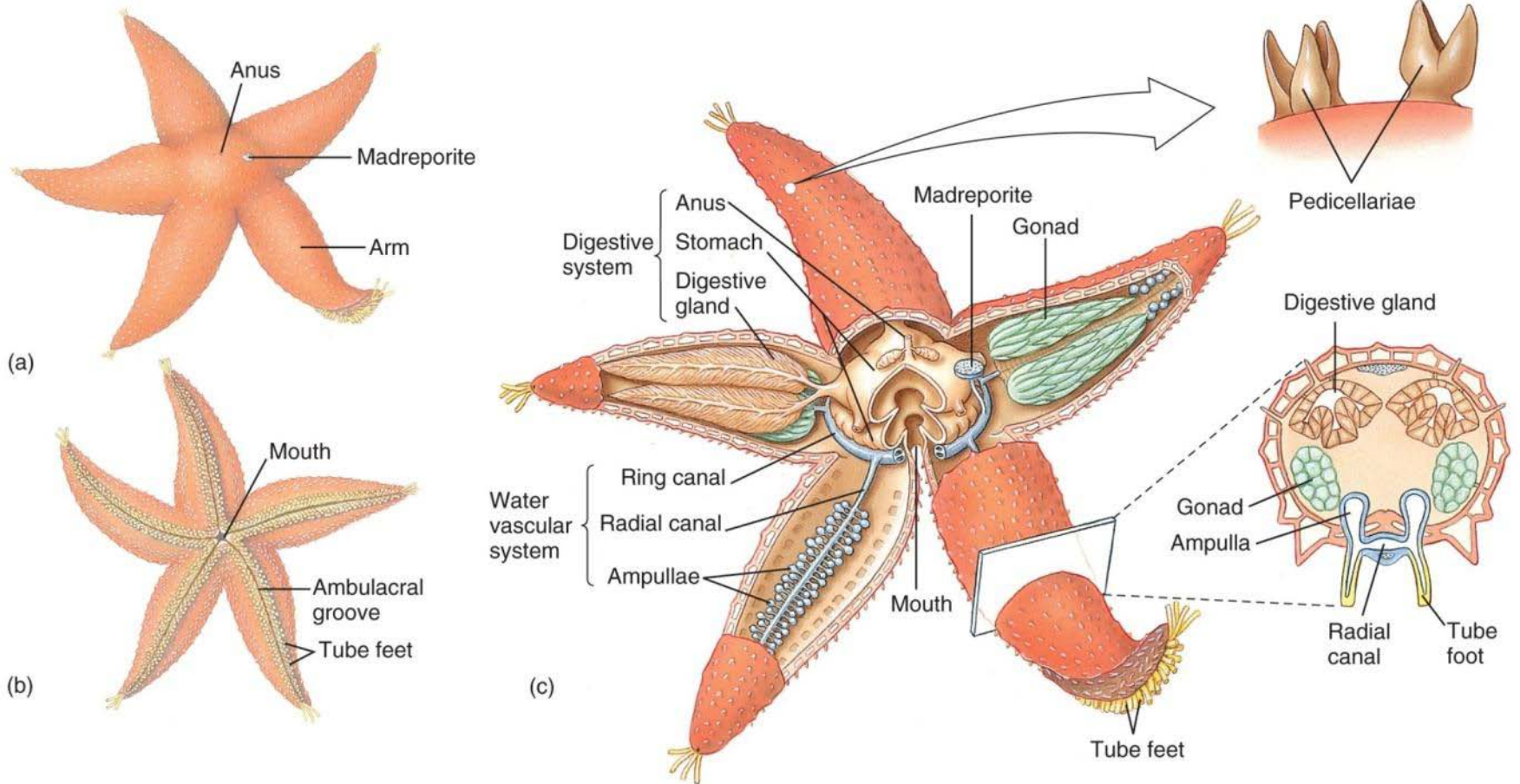
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# Invertebrates

- Hemichordates
- Characteristics of Phylum:
  - Although a rare group, these worms seem to span a gap between invertebrates and more advanced chordate animals
  - Acorn worms share some features with chordates including pharyngeal gill slits, nerve cord and a stomocord that is similar to the chordate notochord
  - Acorn worms are deposit or suspension feeders and use proboscis for feeding
  - Acorn worms have larvae that resemble those seen in echinoderms
  - 85 known species

# Invertebrate Chordates

- The Phylum Chordata is a phylum that contains two invertebrate groups, tunicates and lancelets, as well as many other, more familiar animals such as fish, amphibians, reptiles, birds and mammals.
- Chordates have several features that are seen at least during some portion of the life.
- Lancelets are the only chordates that possess all the features as adults.



# Invertebrate Chordates

- Characteristics of Chordates:
  - Notochord - nerve cord support
  - Tubular nerve cord
  - Muscular pharynx
  - Gill slits
  - Post-Anal Tail
  - Ventral heart

# Invertebrate Chordates

- Tunicates
- Characteristics of Phylum:
  - Commonly called "sea squirts" because they filter feed via an incurrent siphon and "squirt" water out a siphon after the water has been filtered
  - Larvae has chordate characteristics that are not seen in adults- only pharynx remains
  - Called tunicates because of thick outer covering called a tunic
  - Larvae are free swimming after fertilization occurs in open water- mass reproduction
  - Adults normally live attached to boats, docks, reefs, or other hard substrate
  - All 3000 known species are marine



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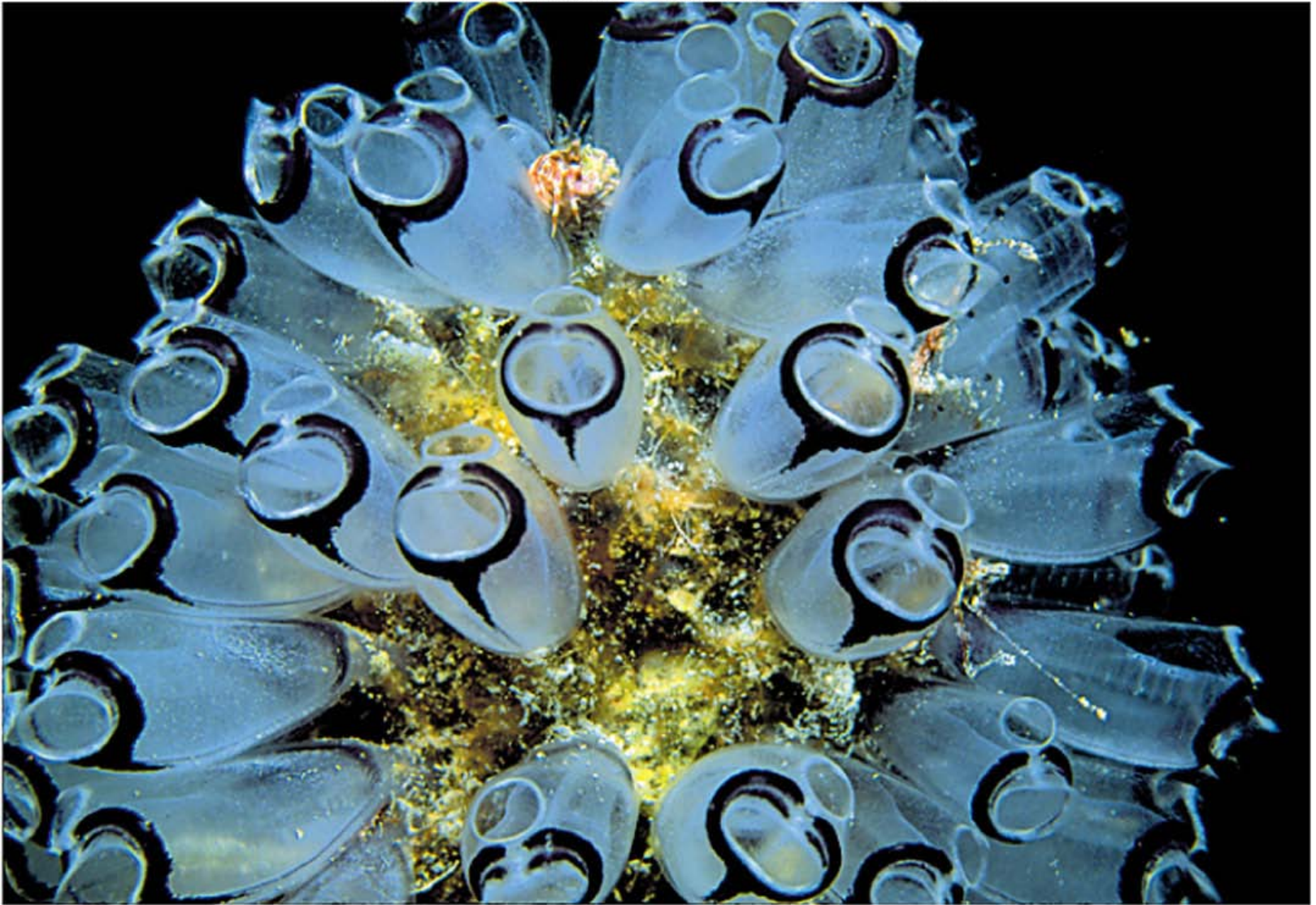


Figure 7.51b

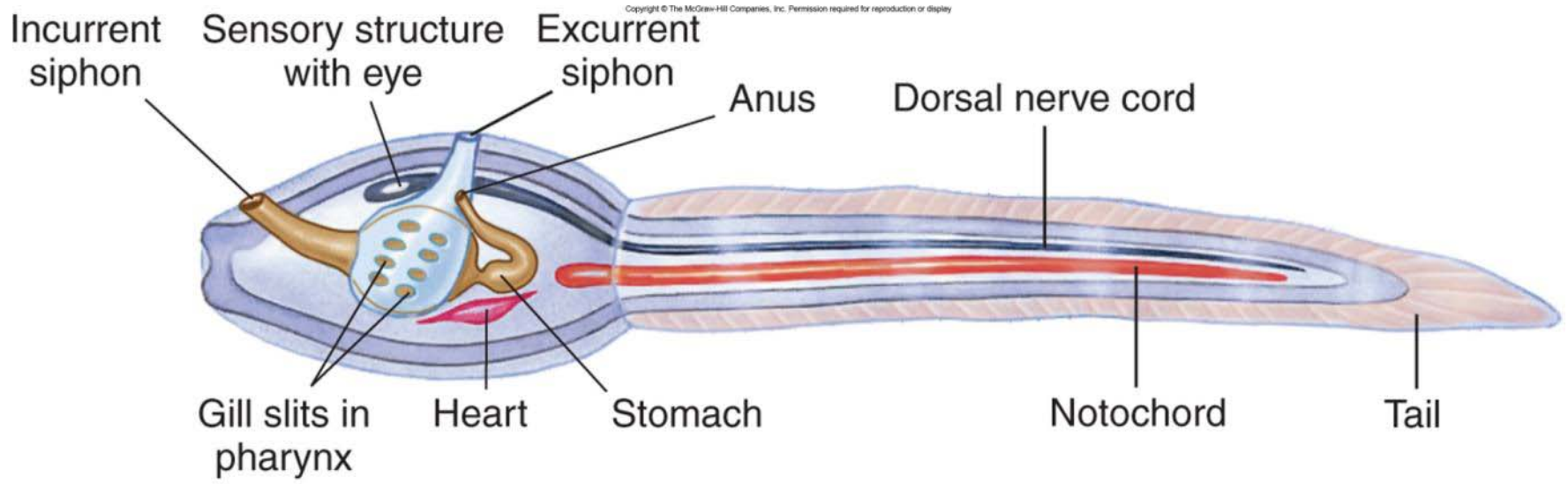
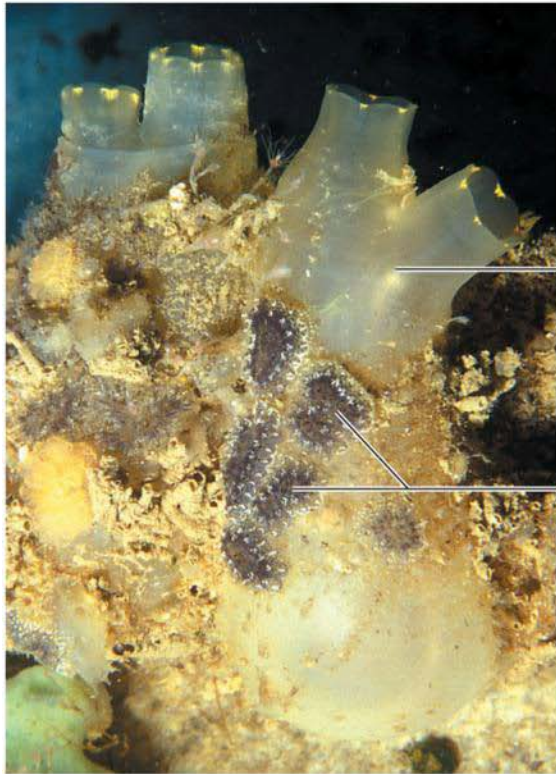




Figure 7.52L

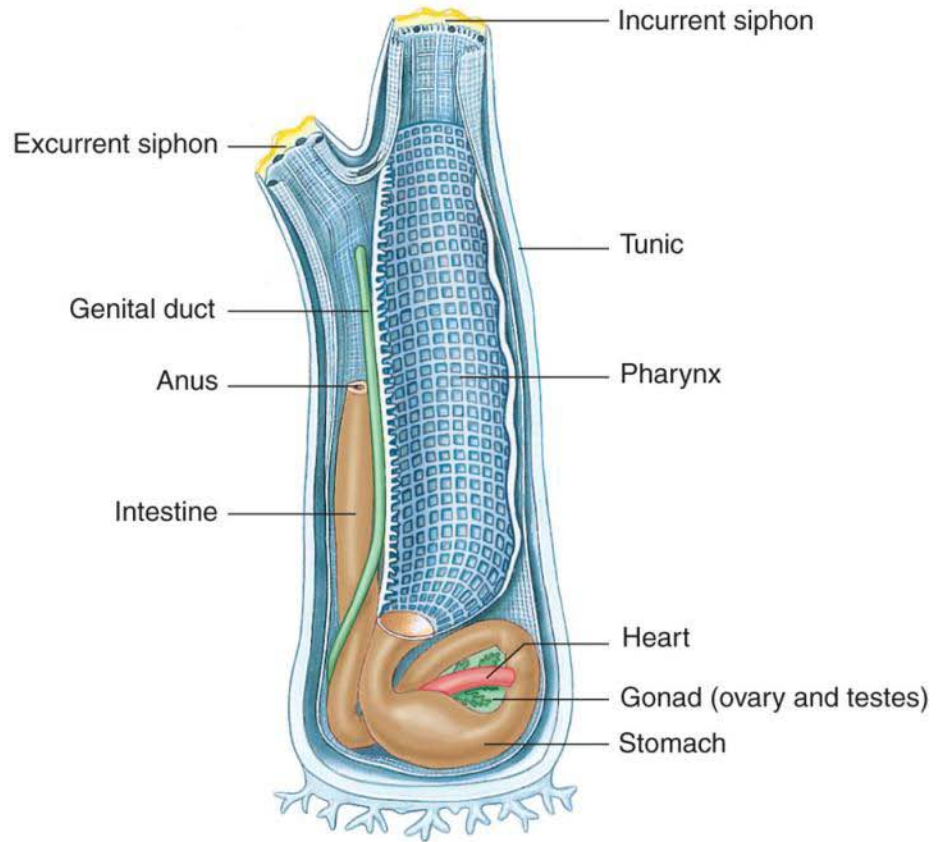
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*Cliona intestinalis*

*Botryllus schlosseri*

*Cliona intestinalis*, fouling species worldwide, and *Botryllus schlosseri*



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# Invertebrate Chordates

- Lancelets
- Characteristics of Phylum:
  - 23 species
  - Very small, only up to 3 inches long
  - Live in shallow marine waters as filter feeders
  - Body shows segmented muscle tissue
  - Notochord attached to the muscles
  - Gills are used to filter food, not in respiration
  - Possess all chordate features as an adult



Figure 7.53

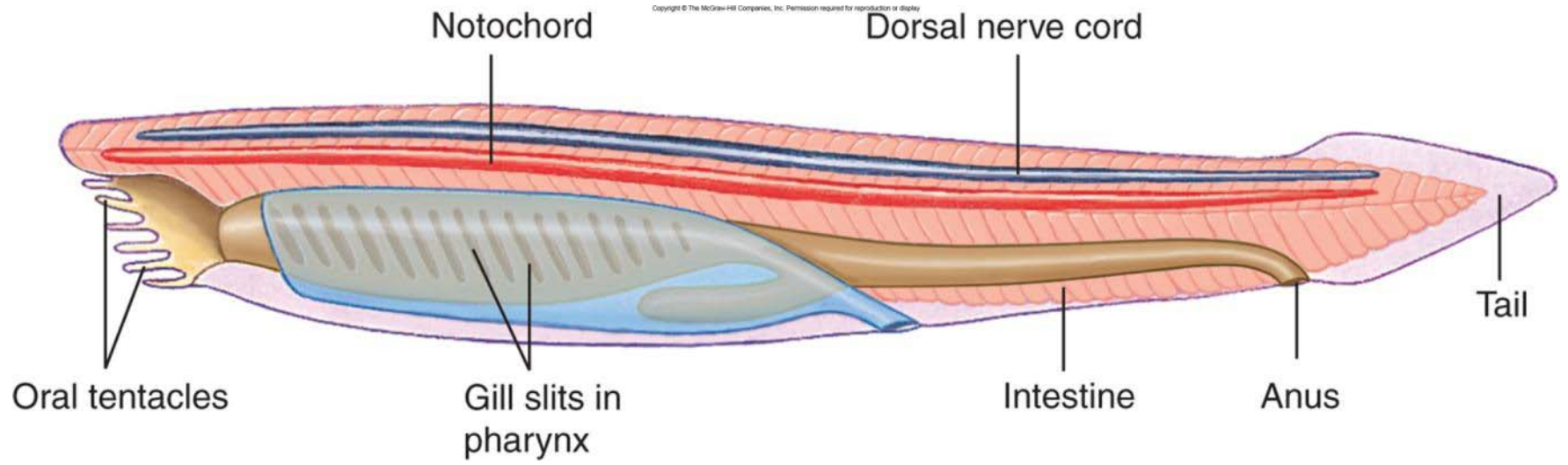


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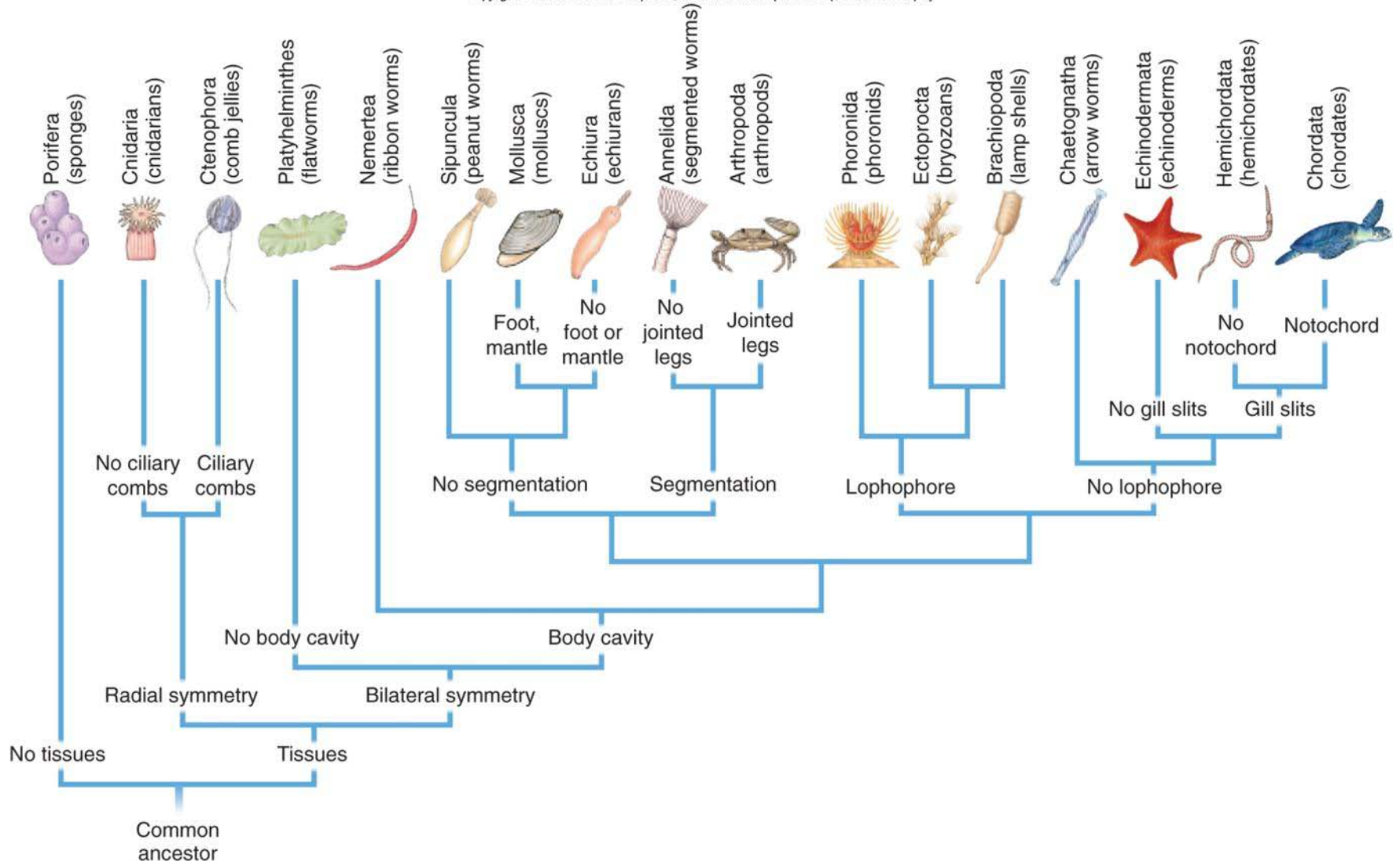




Table 7.1

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Table 7.1 Some of the Most Important Characteristics of the Major Animal Phyla					
Phylum	Representative Groups	Distinguishing Features	General Habitat	Significance in the Marine Environment	
Porifera (sponges)	Sponges 	Collar cells (choanocytes)	Benthic	Filter feeders	
Cnidaria (cnidarians)	Jellyfishes (sea jellies), sea anemones, corals 	Nematocysts	Benthic, pelagic	Predators, passive suspension feeders; corals are important reef builders	
Ctenophora (comb jellies)	Comb jellies 	Ciliary combs, colloblasts	Mostly pelagic	Predators	
Platyhelminthes (flatworms)	Turbellarians, flukes, tapeworms 	Flattened body	Mostly benthic, many parasitic	Predators, many parasitic	
Nemertea (ribbon worms)	Ribbon worms 	Long proboscis	Mostly benthic	Predators	
Nematoda (nematodes)	Nematodes, roundworms 	Body round in cross section	Mostly benthic, many parasitic	Many parasitic, deposit feeders	
Annelida (segmented worms)	Polychaetes, oligochaetes, leeches 	Segmentation	Mostly benthic	Predators, deposit feeders, passive suspension feeders	
Sipuncula (peanut worms)	Peanut worms 	Long, retractable anterior end	Benthic	Predators	
Echiura (echiurans)	Echiurans 	Non-retractable proboscis	Benthic	Predators	
Mollusca (molluscs)	Snails, clams, oysters, octopuses, chitons 	Foot, mantle, radula (absent in some groups)	Benthic, pelagic	Predators, grazers, filter feeders, some parasitic	
Arthropoda (arthropods)	Crustaceans (crabs, shrimps), insects 	Exoskeleton, jointed legs	Benthic, pelagic, some parasitic	Predators, grazers, filter feeders, some parasitic	
Ectoprocta (bryozoans)	Bryozoans 	Lophophore, colonial	Benthic	Filter feeders	
Phoronida (phoronids)	Phoronids 	Lophophore, worm-like body	Benthic	Filter feeders	
Brachiopoda (lamp shells)	Lamp shells 	Lophophore, clam-like shells	Benthic	Filter feeders	
Chaetognatha (arrow worms)	Arrow worms 	Transparent body with fins	Mostly pelagic	Mostly pelagic	
Echinodermata (echinoderms)	Sea stars, brittle stars, sea urchins, sea cucumbers 	Tube feet, five-way radial symmetry, water vascular system	Mostly benthic	Predators, deposit feeders, passive suspension feeders	
Hemichordata (hemichordates)	Acorn worms 	Dorsal, hollow nerve cord, gill slits	Mostly benthic	Deposit feeders	
Chordata (chordates)	Tunicates, vertebrates (fishes, reptiles, birds, mammals) 	Dorsal, hollow nerve cord, gill slits, notochord	Benthic, pelagic	Predators, grazers, filter feeders	

Table 7.1cont

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	Level of Organization	Symmetry	Segmentation	Body Cavity	Digestive Tract	Respiratory Exchange	Circulatory System	
	Cellular	Asymmetrical	No	None	None	Body surface	None	
	Tissue	Radial	No	None	Incomplete	Body surface	None	
	Tissue	Radial	No	None	Incomplete	Body surface	None	
	↑ Organ system ↓	Bilateral	No	None	Incomplete or absent	Body surface	None	
		Bilateral	No	Reduced (proboscis cavity)	Complete	Body surface	Closed	
		Bilateral	No	Pseudocoelom	Complete	Body surface	None	
		Bilateral	Yes	↑ Coelom ↓	↑ Complete ↓	Complete or absent	Gills or body surface	Closed
		Bilateral	No			Body surface	None	
		Bilateral	No			Body surface	Closed	
		Bilateral	No			Gills	Open or closed	
		Bilateral	Yes			Gills (in many crustaceans)	Open	
		Bilateral	No			Body surface	None	
		Bilateral	No			Body surface	Closed	
		Bilateral	No			Body surface	Open	
		Bilateral	No			Body surface	None	
		Radial (adults) Bilateral (larvae)	No			Body surface	None	
		Bilateral	Reduced			Body surface	Part closed, part open	
		Bilateral	Reduced			Gills, lungs	Closed	