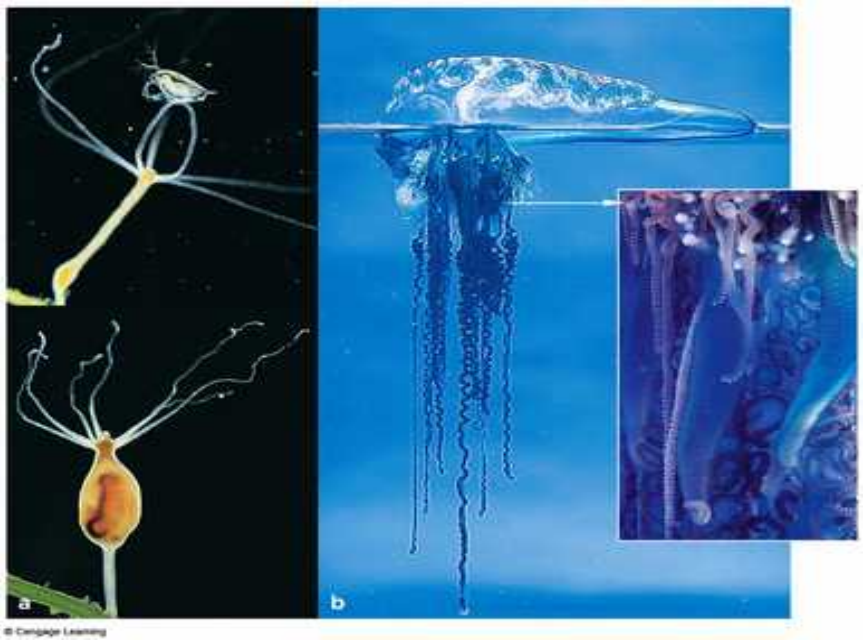
Fig. 33-UN6

Key Concept	Phylum		Description
Concept 33.1 Sponges are basal animals that lack true tissues	Calcarea, Silicea (sponges)		Lack true tissues; have choanocytes (collar cells—flagellated cells that ingest bacteria and tiny food particles)
Concept 33.2 Cnidarians are an ancient phylum of eumetazoans	Cnidaria (hydras, jellies, sea anemones, corals)		Unique stinging structures (cnidae), each housed in a specialized cell (cnidocyte); diploblastic; radially symmetrical; gastrovascular cavity (digestive compartment with a single opening)
Concept 33.3 Lophotrochozoans, a clade identified by molecular data, have the widest range of animal body forms	Platyhelminthes (flatworms)		Dorsoventrally flattened, unsegmented acoelomates; gastrovascular cavity or no digestive tract
	Rotifera (rotifers)		Pseudocoelomates with alimentary canal (digestive tube with mouth and anus); jaws (trophi) in pharynx; head with ciliated crown
	Lophophorates: Ectoprocta, Brachiopoda		Coelomates with lophophores (feeding structures bearing ciliated tentacles)
	Mollusca (clams, snails, squids)		Coelomates with three main body parts (muscular foot, visceral mass, mantle); coelom reduced; most have hard shell made of calcium carbonate
	Annelida (segmented worms)		Coelomates with segmented body wall and internal organs (except digestive tract, which is unsegmented)
Concept 33.4 Ecdysozoans are the most species-rich animal group	Nematoda (roundworms)		Cylindrical, unsegmented pseudocoelomates with tapered ends; no circulatory system; undergoes ecdysis
	Arthropoda (crustaceans, insects, spiders)		Coelomates with segmented body, jointed appendages, and exoskeleton made of protein and chitin
Concept 33.5 Echinoderms and chordates are deuterostomes	Echinodermata (sea stars, sea urchins)		Coelomates with bilaterally symmetrical larvae and five-part body organization as adults; unique water vascular system; endoskeleton
	Chordata (lancelets, tunicates, vertebrates)		Coelomates with notochord; dorsal, hollow nerve cord; pharyngeal slits; post-anal tail (see Chapter 34)

Metazoa
Eumetazoa
Bilateria
Lophotrochozoa
Ecdysozoa
Deuterostomia

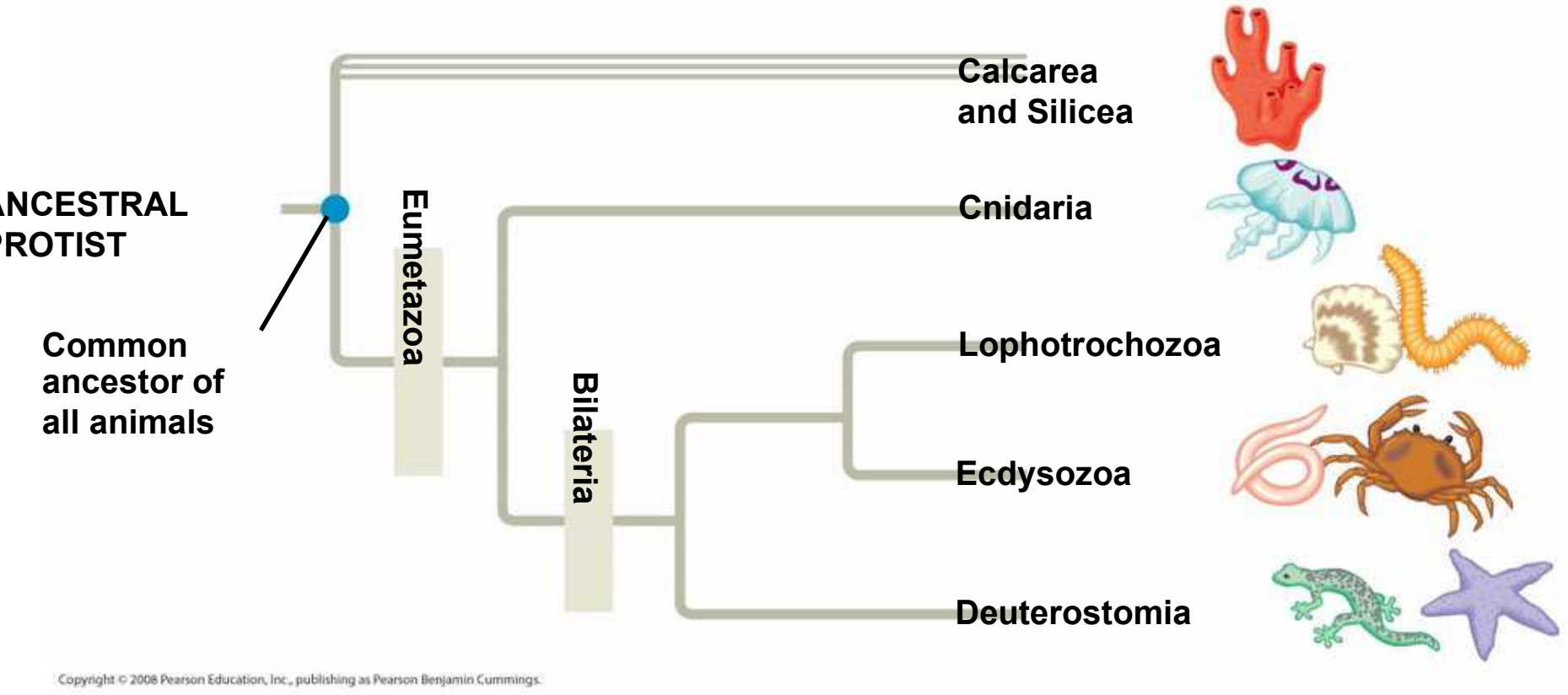
Overview: Life Without a Backbone

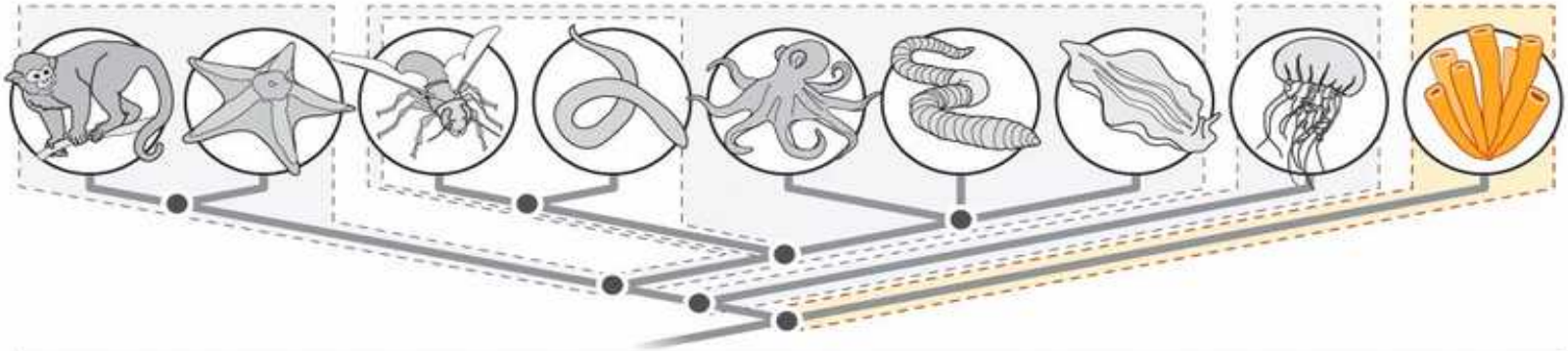
- **Invertebrates** are animals that lack a backbone
- They account for 95% of known animal species



Acoelomates and pseudocoelomates are always protostomes

Coelomates are either protostomes or deuterostomes





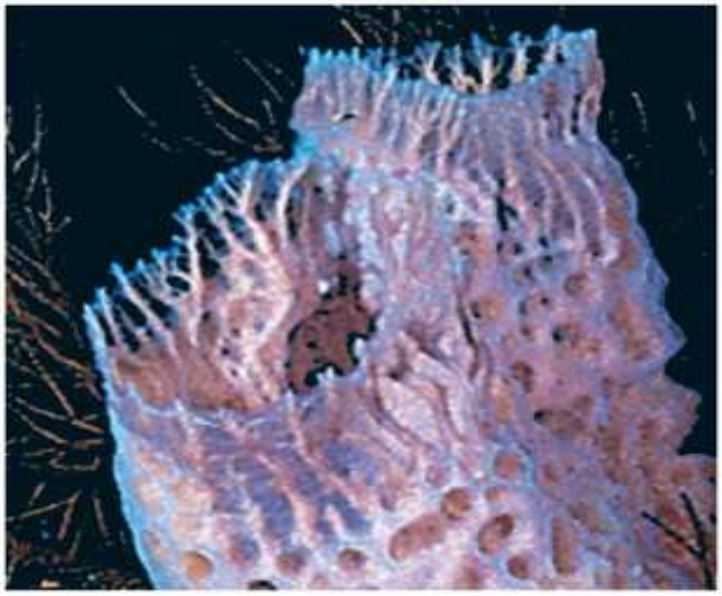
THE SPONGES

Concept 33.1: Sponges are basal animals that lack true tissues

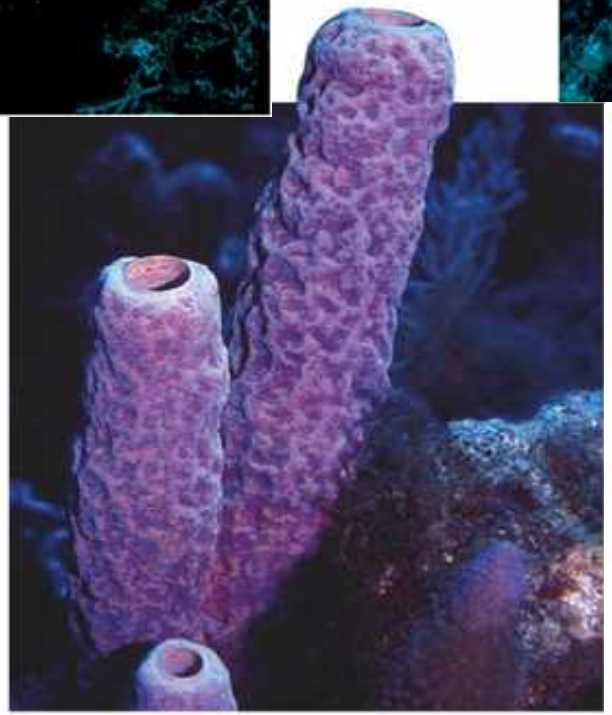
- Sponges are sedentary animals from the **Subkingdom Parazoa**, **Phylum Porifera**, **Class Calcarea-calcium carbonate sponges and siliceous sponges, Class Hexactnellida (silica and chitin) and Demospongiae (composed of silica and/or spongin with chitin)**

- They live in both fresh and marine waters

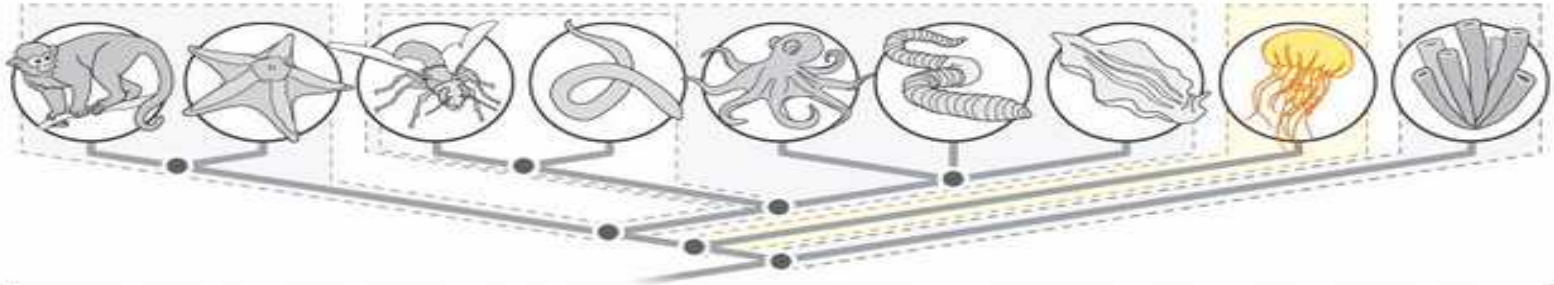
- Sponges lack true tissues and organs



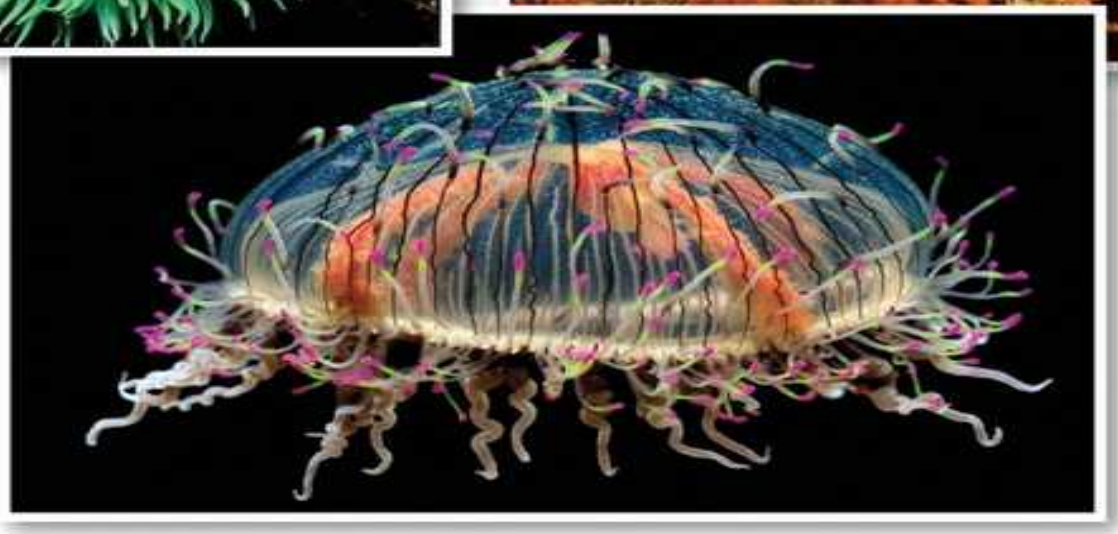
(a) *Euplectella aspergillum*



(b) *Aplysina lacunosa*



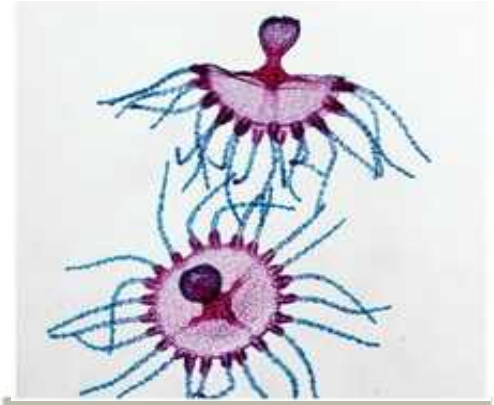
THE CNIDARIANS

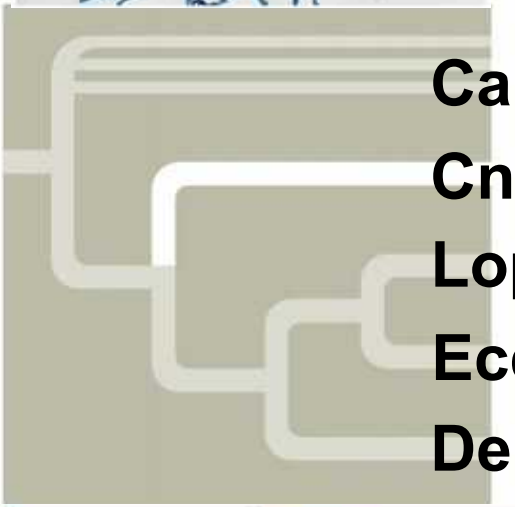


Concept 33.2: Cnidarians are an ancient phylum of eumetazoans

- All animals except sponges and a few other groups belong to the clade Eumetazoa, animals with true tissues
- Cnidarians have diversified into a wide range of both sessile and motile forms including jellies, corals, and hydras
- They exhibit a relatively simple **diploblastic** (two embryonic tissues), and a **radially symmetrical** body plan

Fig. 33-UN2





Calcarea and Silicea

Cnidaria

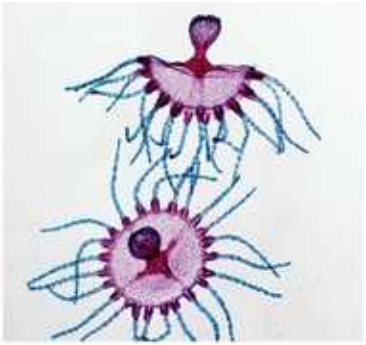
Lophotrochozoa

Ecdysozoa

Deuterostomia

Four Classes of Cnidarians

Hydrozoa (hydroids)



Scyphozoa (jellyfish)

Cubozoa (box jellyfish)

Anthozoa (corals and sea anemones)

- The basic body plan of a cnidarian is a sac with a central digestive compartment, the **gastrovascular cavity**
- A single opening functions as mouth and anus
- There are two variations on the body plan: the sessile **polyp** and motile **medusa**

Fig. 33-5

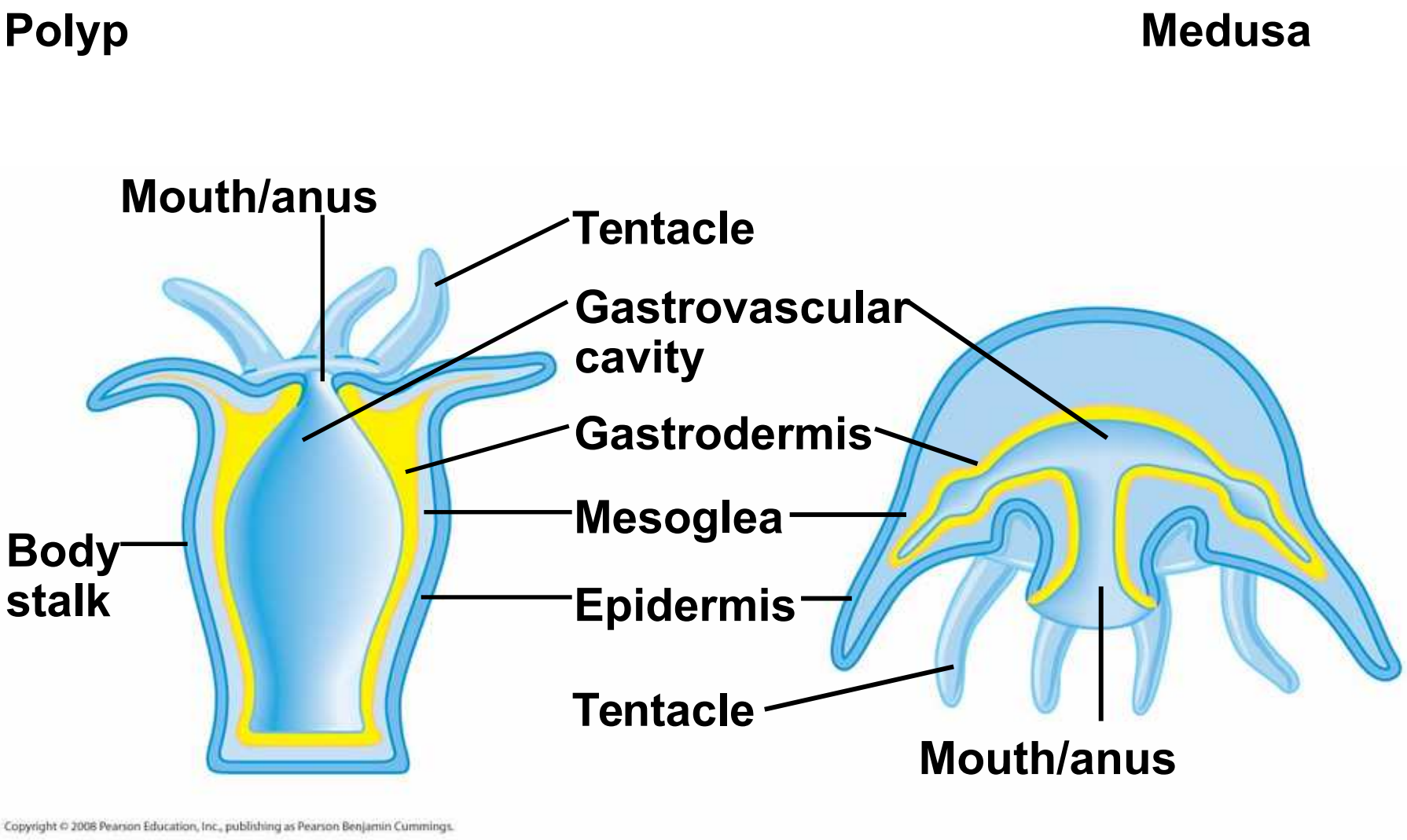


Fig. 33-6

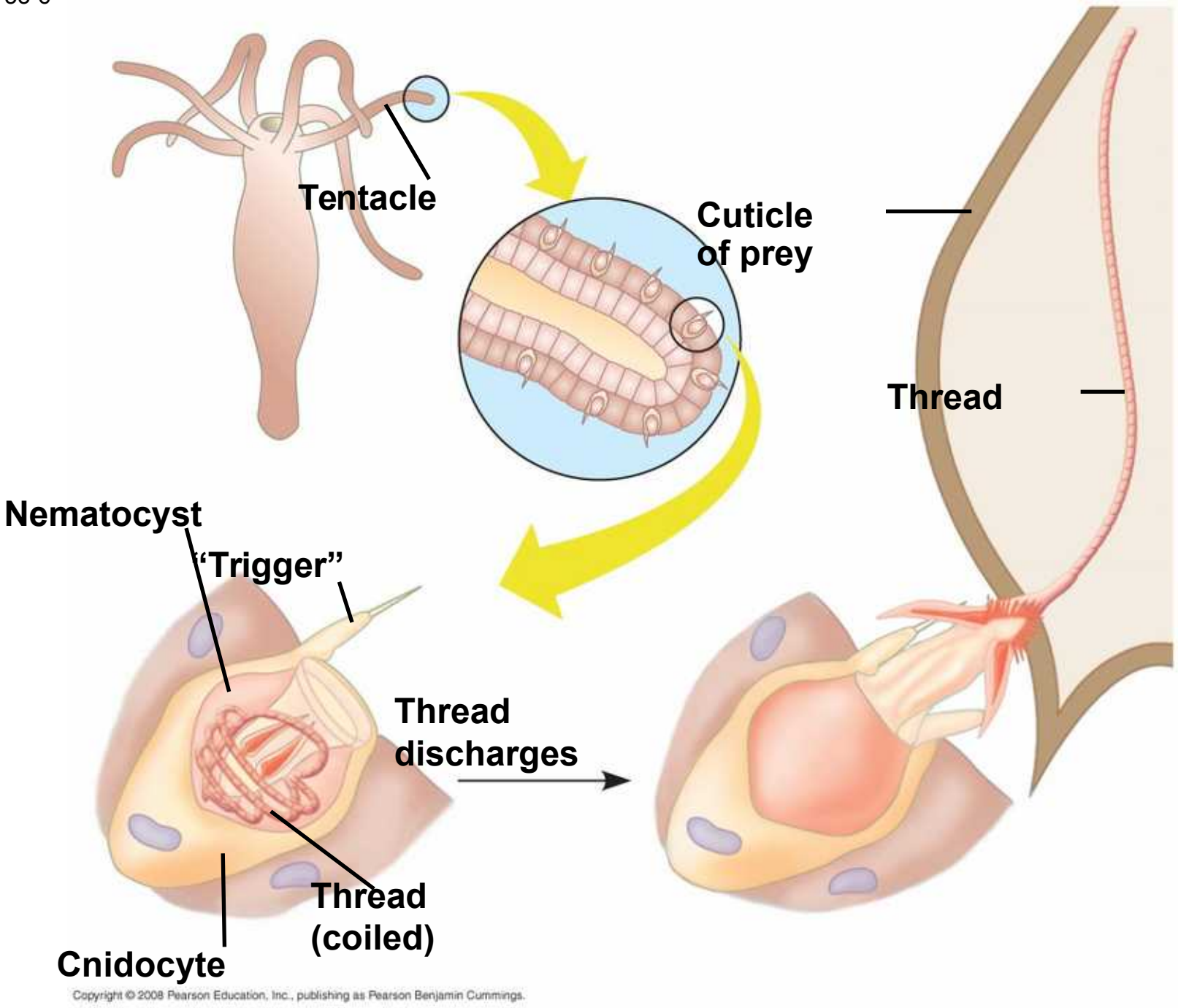


Fig. 33-7

(a) Colonial polyps (class Hydrozoa)

(b) Jellies (class Scyphozoa)

(c) Sea wasp (class Cubozoa)

(d) Sea anemone (class Anthozoa)

Hydrozoans

- Most hydrozoans (Gr. Water animal) alternate between polyp and medusa forms

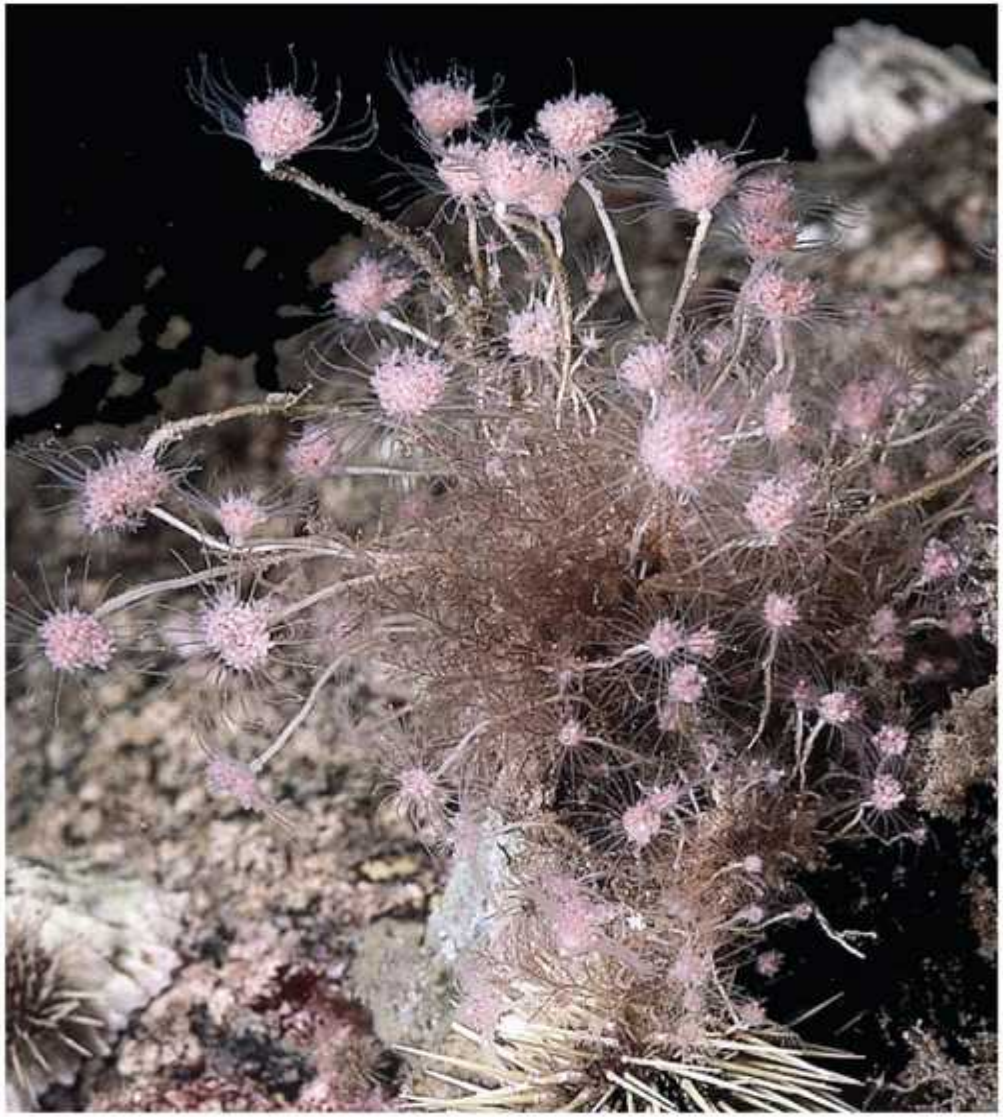
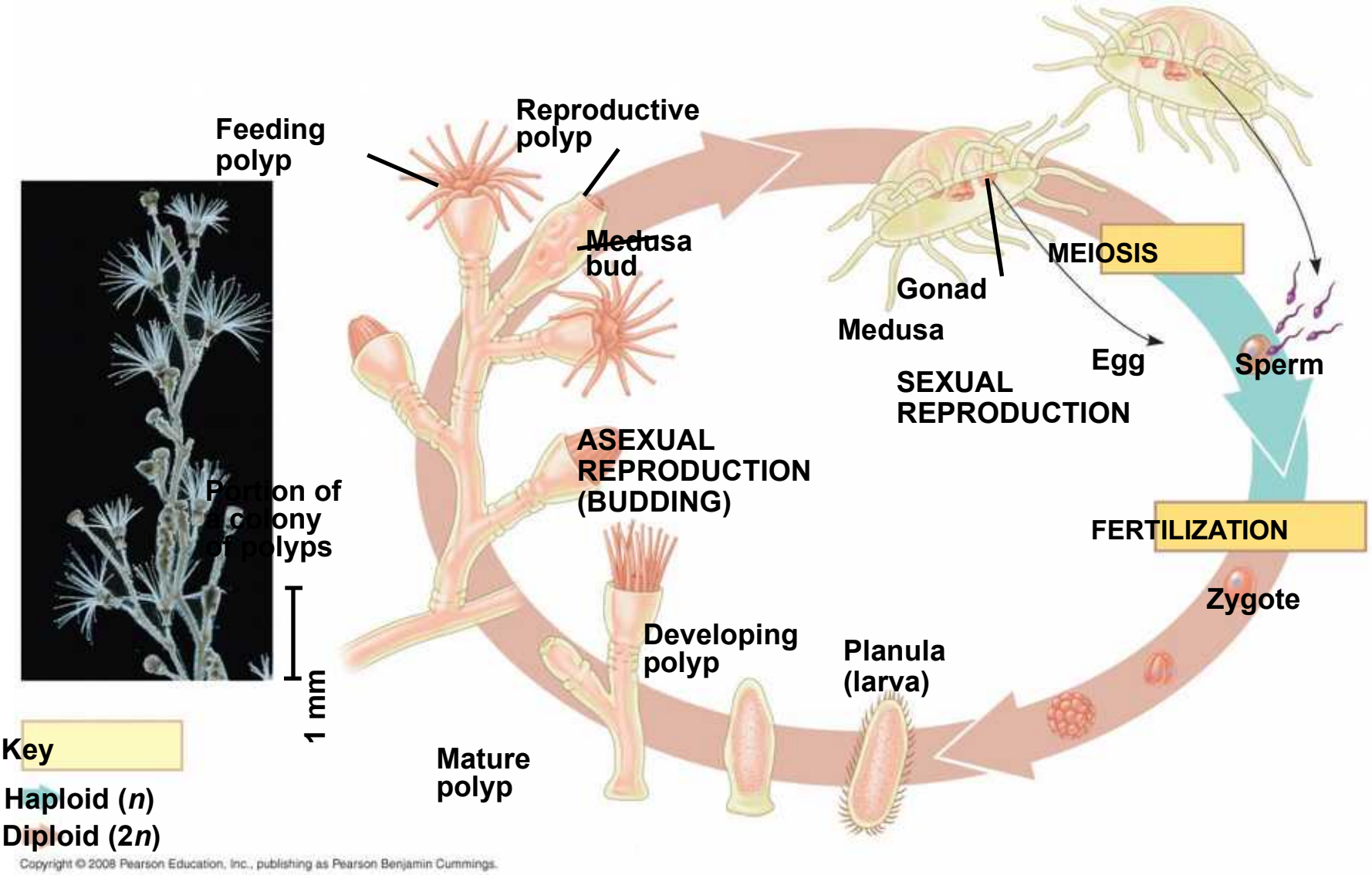


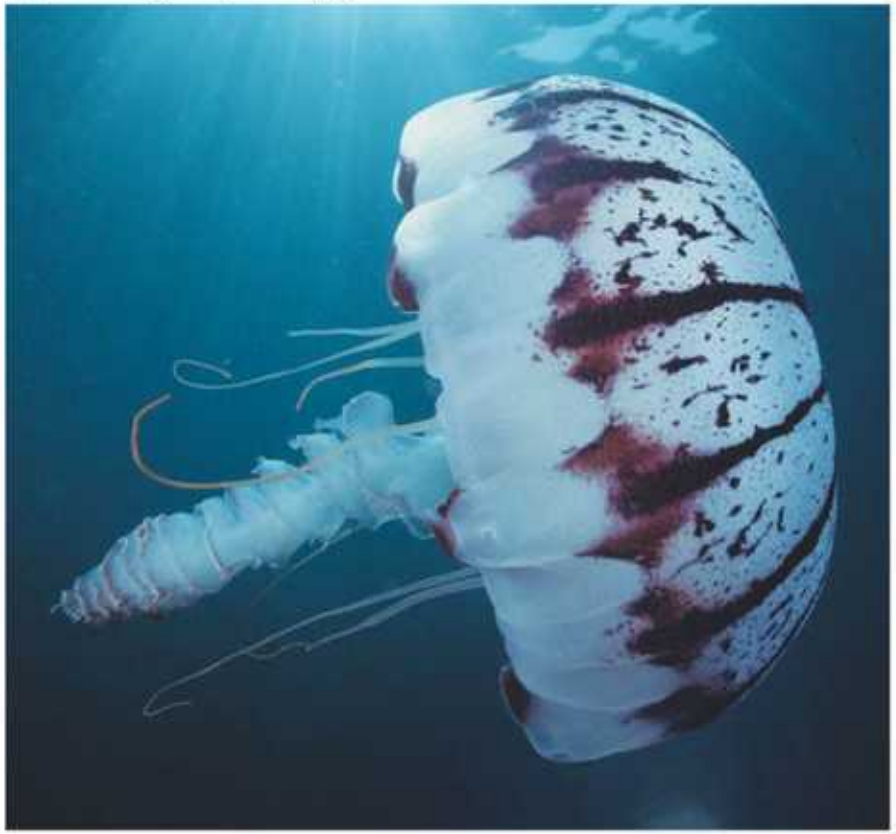
Fig. 33-8-3



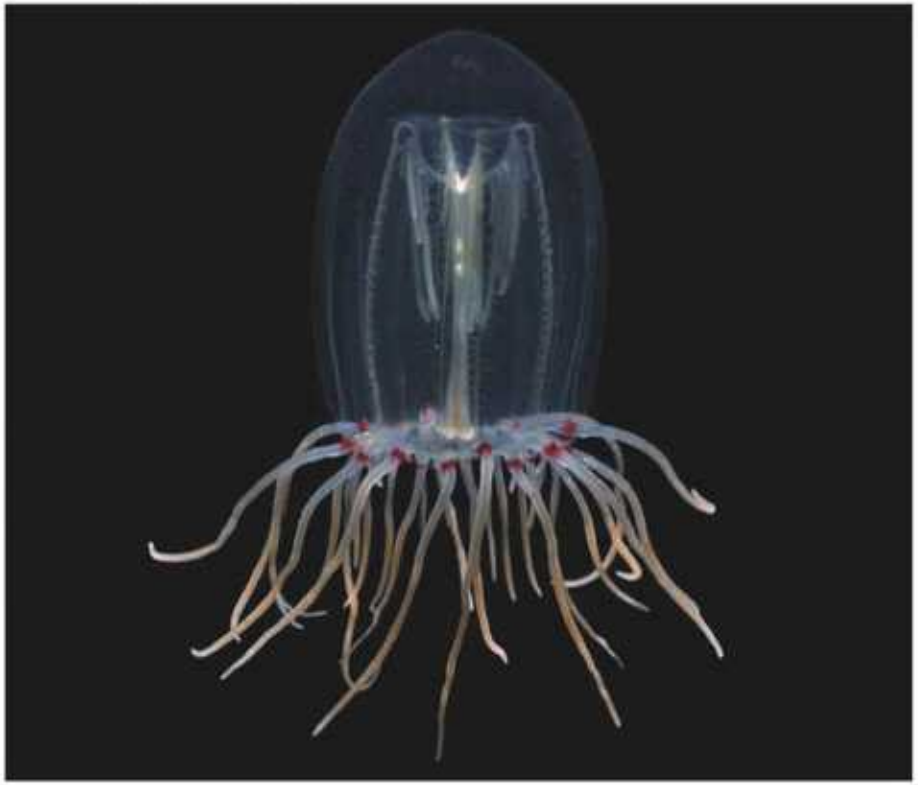
Scyphozoans

- In the class Scyphozoa (Gr. Cup animal), jellies (**rounded medusae**) are the prevalent form of the life cycle

(c) *Pelagia panopyra*



(d) *Polyorchis penicillatus*

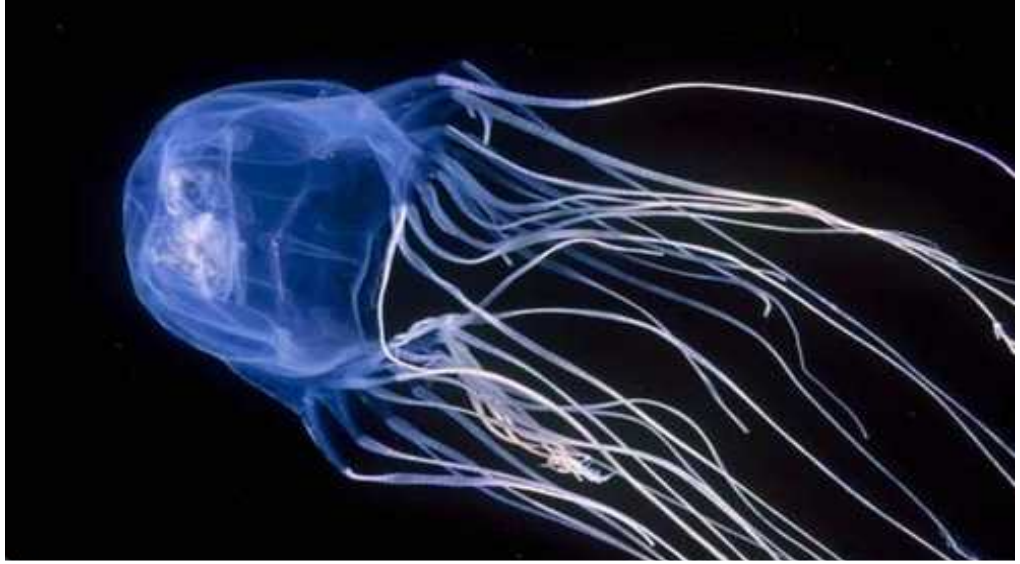


Cubozoans

- In the class Cubozoa (Gr. Cube animal), which includes box jellies and sea wasps, the medusa is box-shaped and has complex eyes

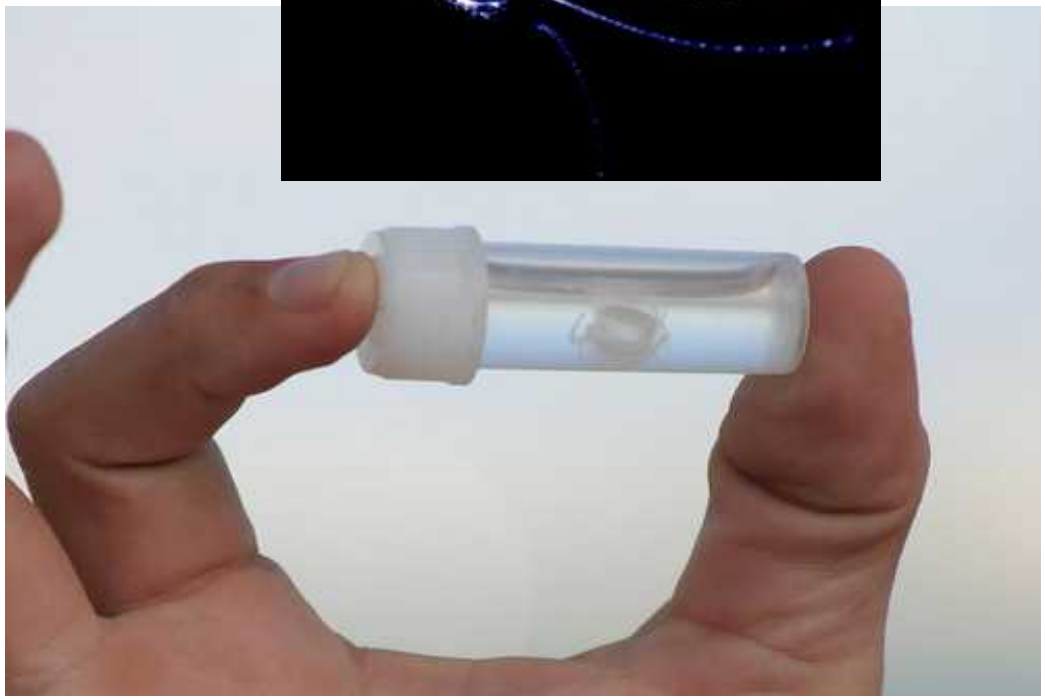
- Cubozoans often have highly toxic cnidocytes

Sea wasp



Chironex fleckeri (Sea Wasp)

Irukandji jellyfish inhabit marine waters of Australia Its size is roughly no larger than a cubic centimetre (1 cm^3). There are two known species of Irukandji: *Carukia barnesi* and the recently discovered *Malo kingi*



Anthozoans

- Class Anthozoa (Gr. Flower animal) includes the corals and sea anemones, which occur only as polyps

(*b*)

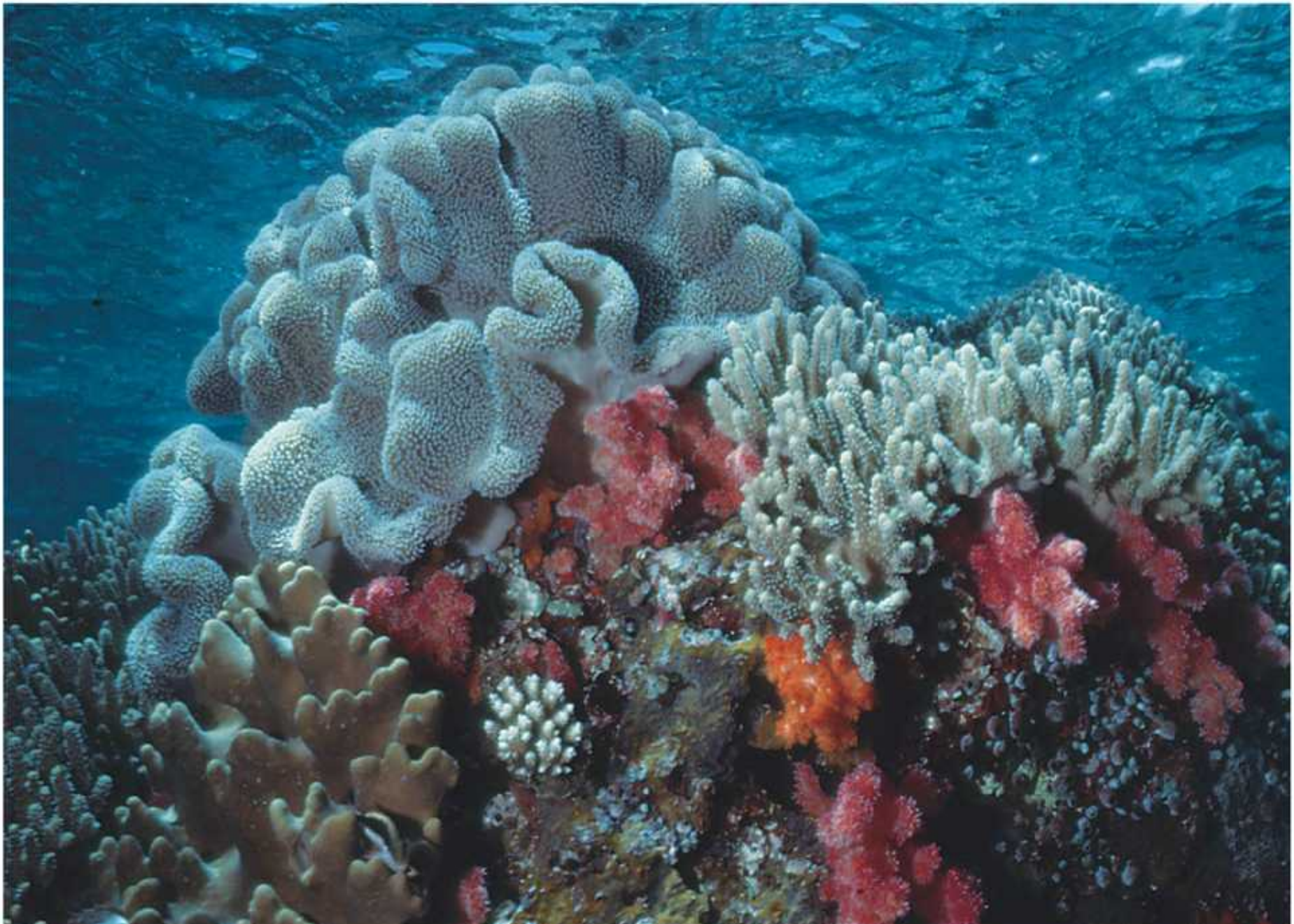


Fig. 33-UN6

Key Concept	Phylum		Description
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Concept 33.3 Lophotrochozoans, a clade identified by molecular data, have the widest range of animal body forms	Platyhelminthes (flatworms)		Dorsoventrally flattened, unsegmented acoelomates; gastrovascular cavity or no digestive tract
	Rotifera (rotifers)		Pseudocoelomates with alimentary canal (digestive tube with mouth and anus); jaws (trophi) in pharynx; head with ciliated crown
	Lophophorates: Ectoprocta, Brachiopoda		Coelomates with lophophores (feeding structures bearing ciliated tentacles)
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	Annelida (segmented worms)		Coelomates with segmented body wall and internal organs (except digestive tract, which is unsegmented)
Concept 33.4 Ecdysozoans are the most species-rich animal group	Nematoda (roundworms)		Cylindrical, unsegmented pseudocoelomates with tapered ends; no circulatory system; undergoes ecdysis
	Arthropoda (crustaceans, insects, spiders)		Coelomates with segmented body, jointed appendages, and exoskeleton made of protein and chitin
Concept 33.5 Echinoderms and chordates are deuterostomes	Echinodermata (sea stars, sea urchins)		Coelomates with bilaterally symmetrical larvae and five-part body organization as adults; unique water vascular system; endoskeleton
	Chordata (lancelets, tunicates, vertebrates)		Coelomates with notochord; dorsal, hollow nerve cord; pharyngeal slits; post-anal tail (see Chapter 34)

Metazoa
Eumetazoa
Bilateria
Lophotrochozoa
Ecdysozoa
Deuterostomia

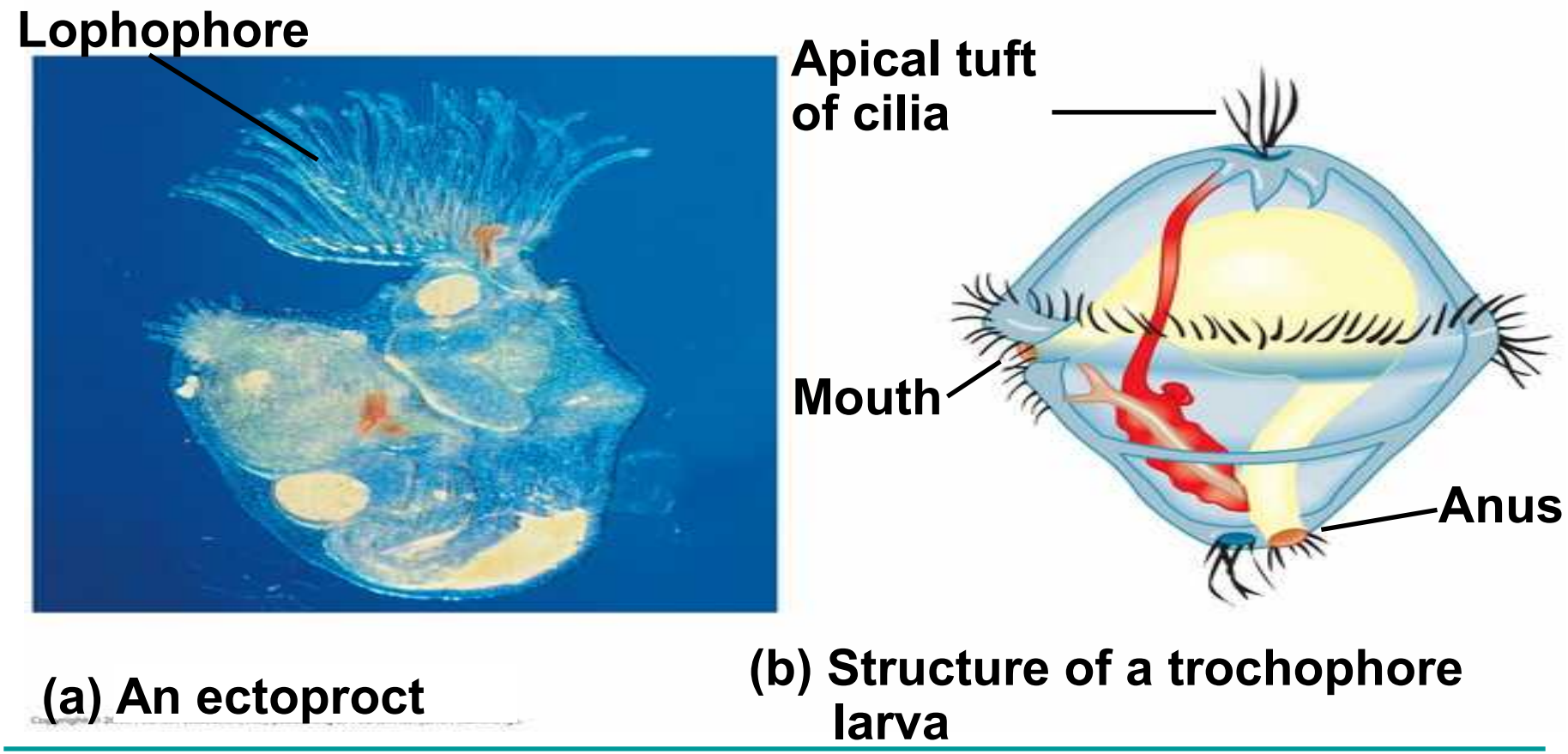
Concept 33.3: Lophotrochozoans, a clade identified by molecular data, have the widest range of animal body forms

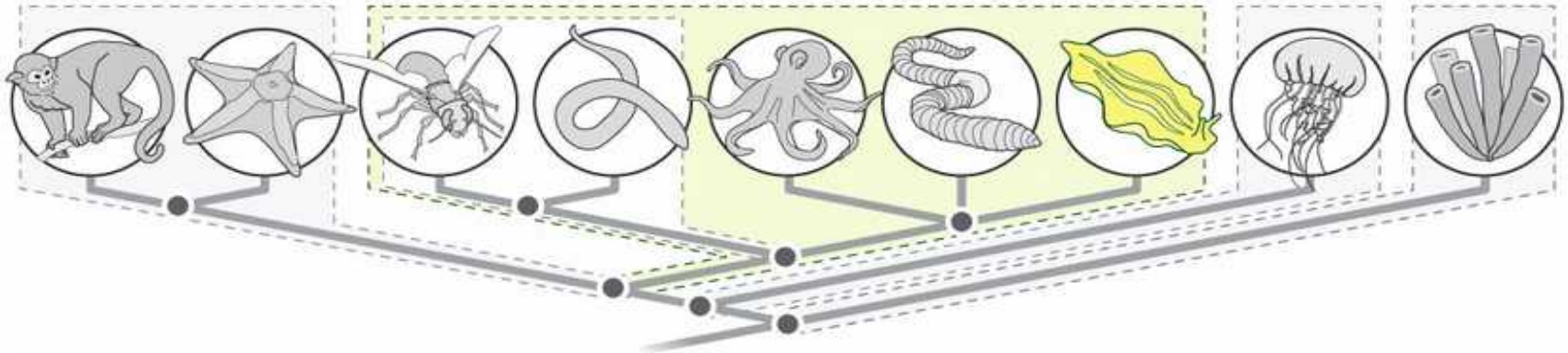
- Bilaterian animals have bilateral symmetry and triploblastic development
- The clade Bilateria contains Lophotrochozoa, Ecdysozoa, and Deuterostomia

Fig. 33-UN3

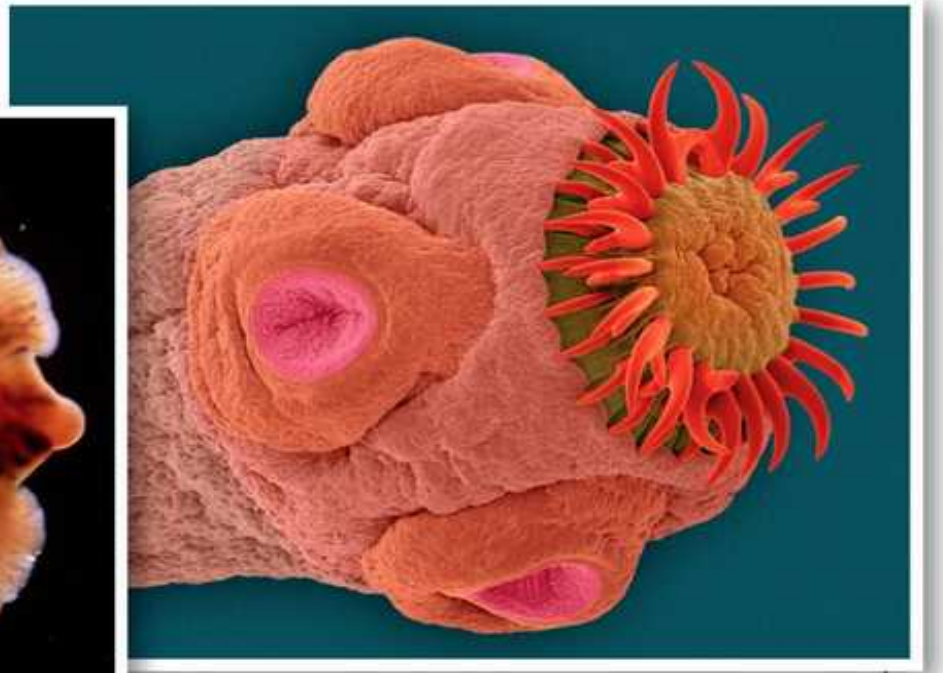
- The clade Lophotrochozoa was identified by molecular data
- Lophotrochozoa includes the flatworms, rotifers, ectoprocts, brachiopods, molluscs, and annelids

- Some **lophotrochozoans** have a feeding structure called a **lophophore**
- Other phyla go through a distinct developmental stage called the **trochophore**





THE FLATWORMS



Flatworms

- Members of phylum Platyhelminthes (Gr. Flatworm) live in marine, freshwater, and damp terrestrial habitats
- Although flatworms undergo triploblastic development, they are acoelomates
- They are flattened dorsoventrally and have a gastrovascular cavity

Fig. 33-9

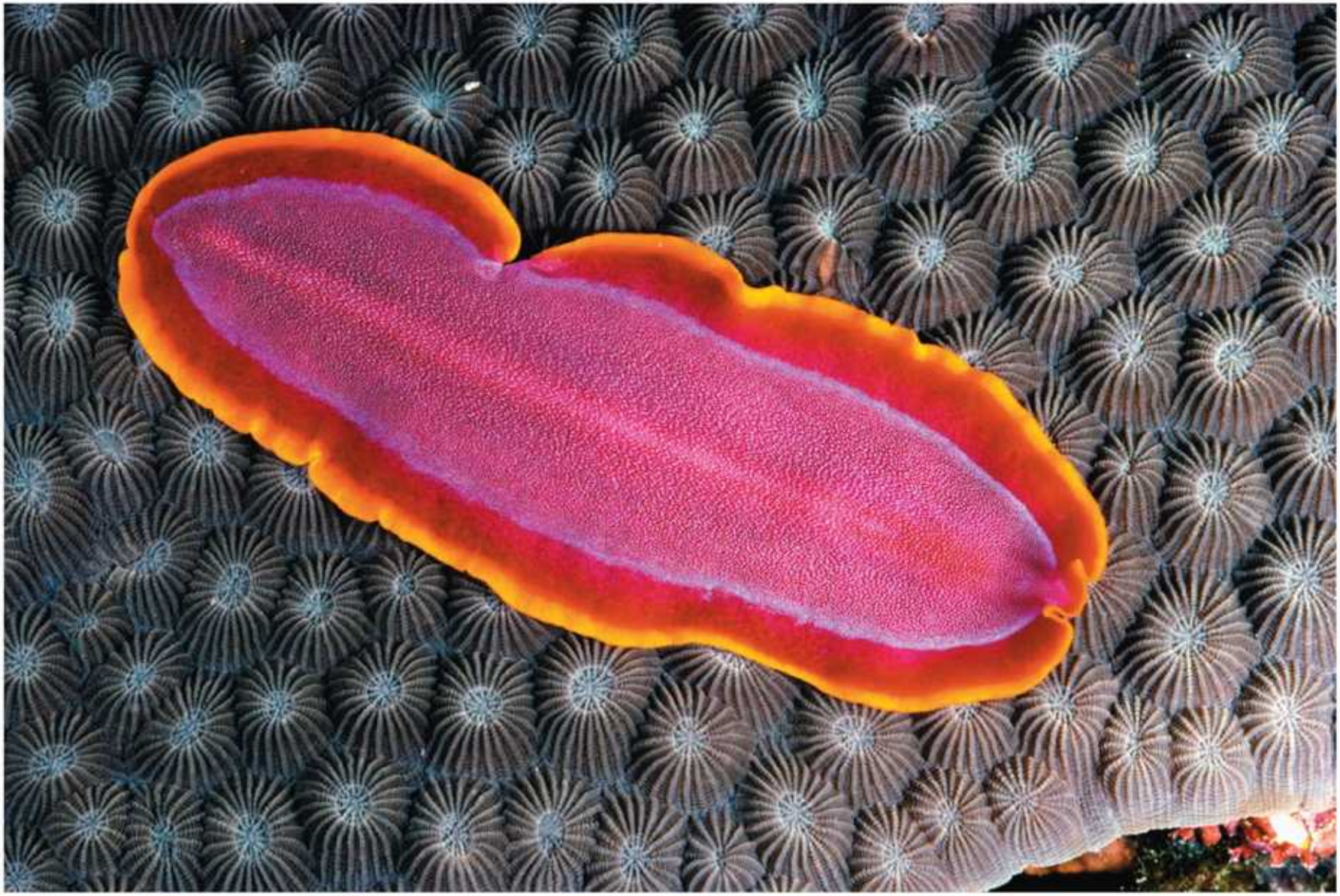
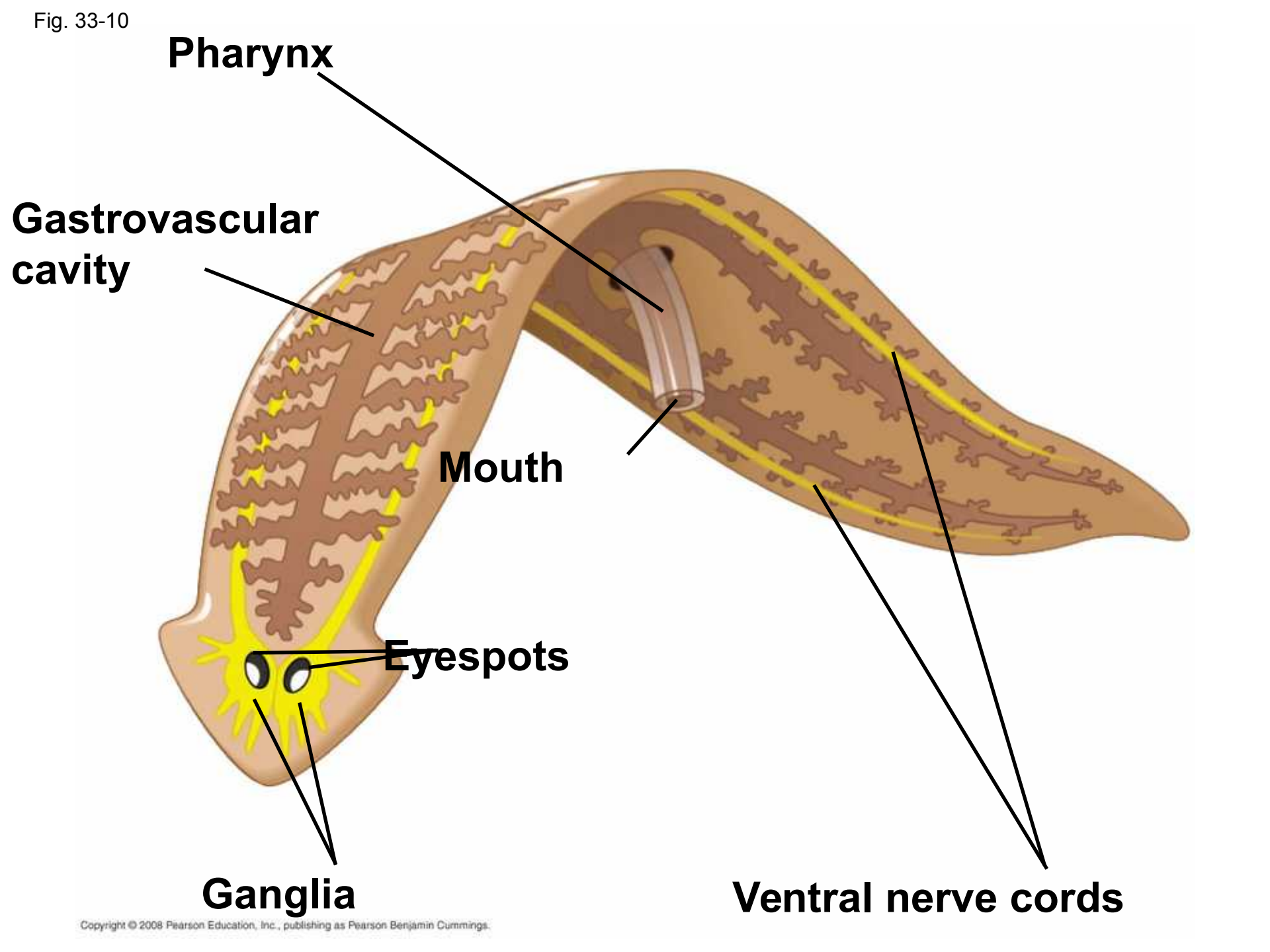
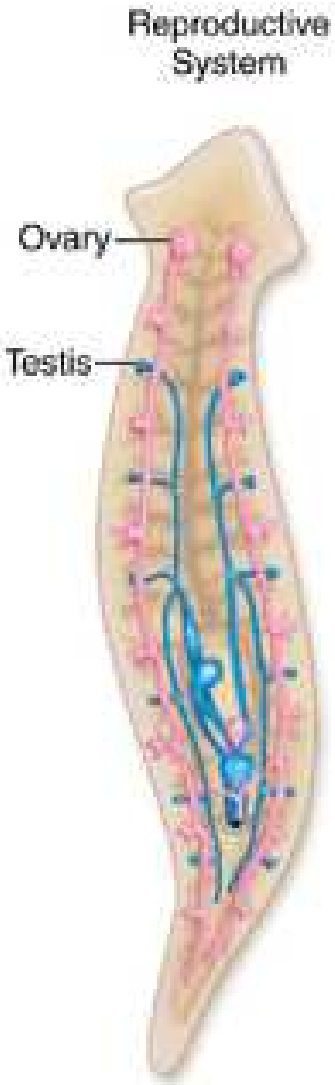
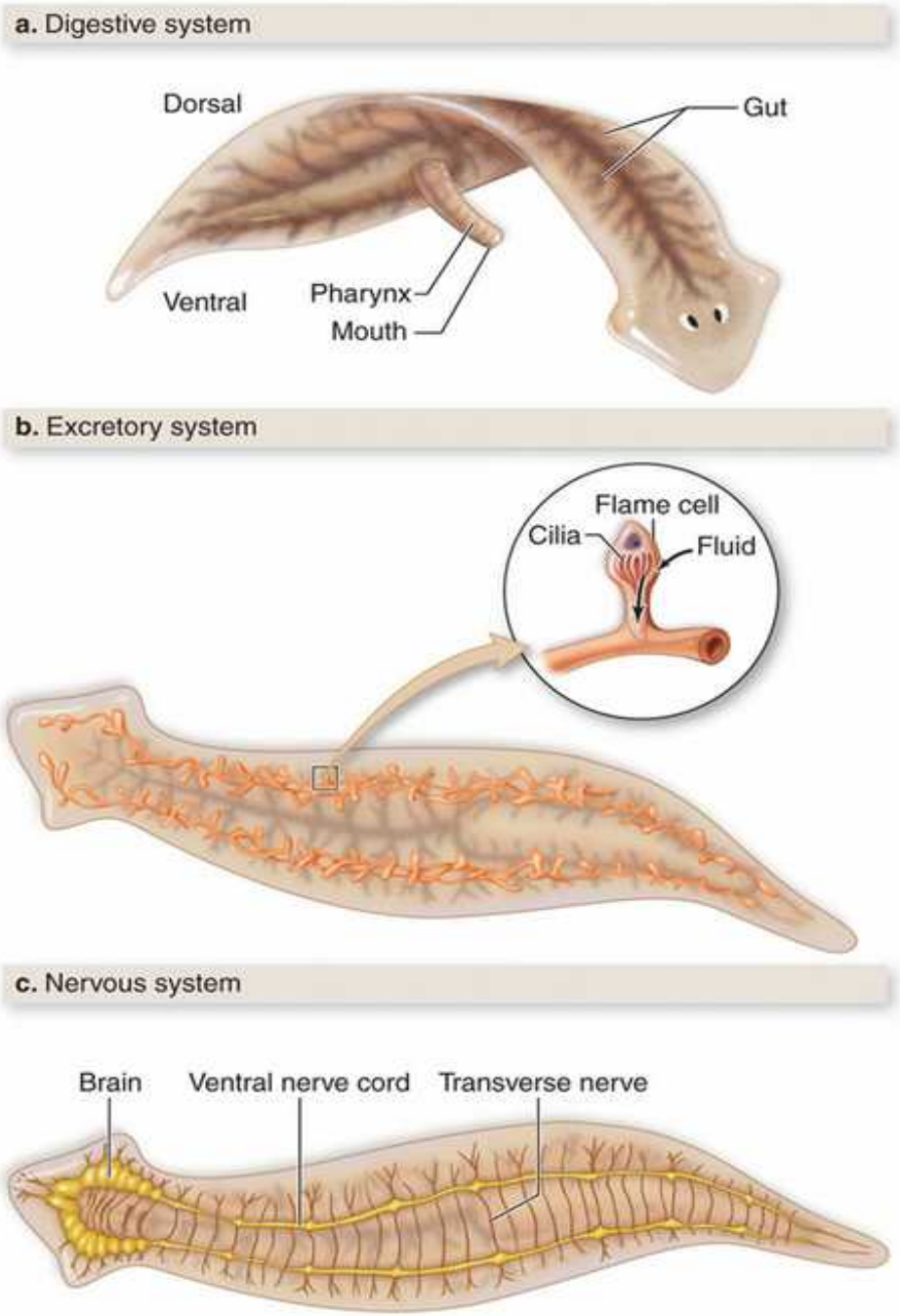


Fig. 33-10




Reproductive System
Ovary
Testis


a. Digestive system
Dorsal
Gut
Ventral
Pharynx
Mouth
b. Excretory system
Flame cell
Cilia
Fluid
c. Nervous system
Brain
Ventral nerve cord
Transverse nerve


10,000 µm

Fig. 33-12

Fig. 33-UN6

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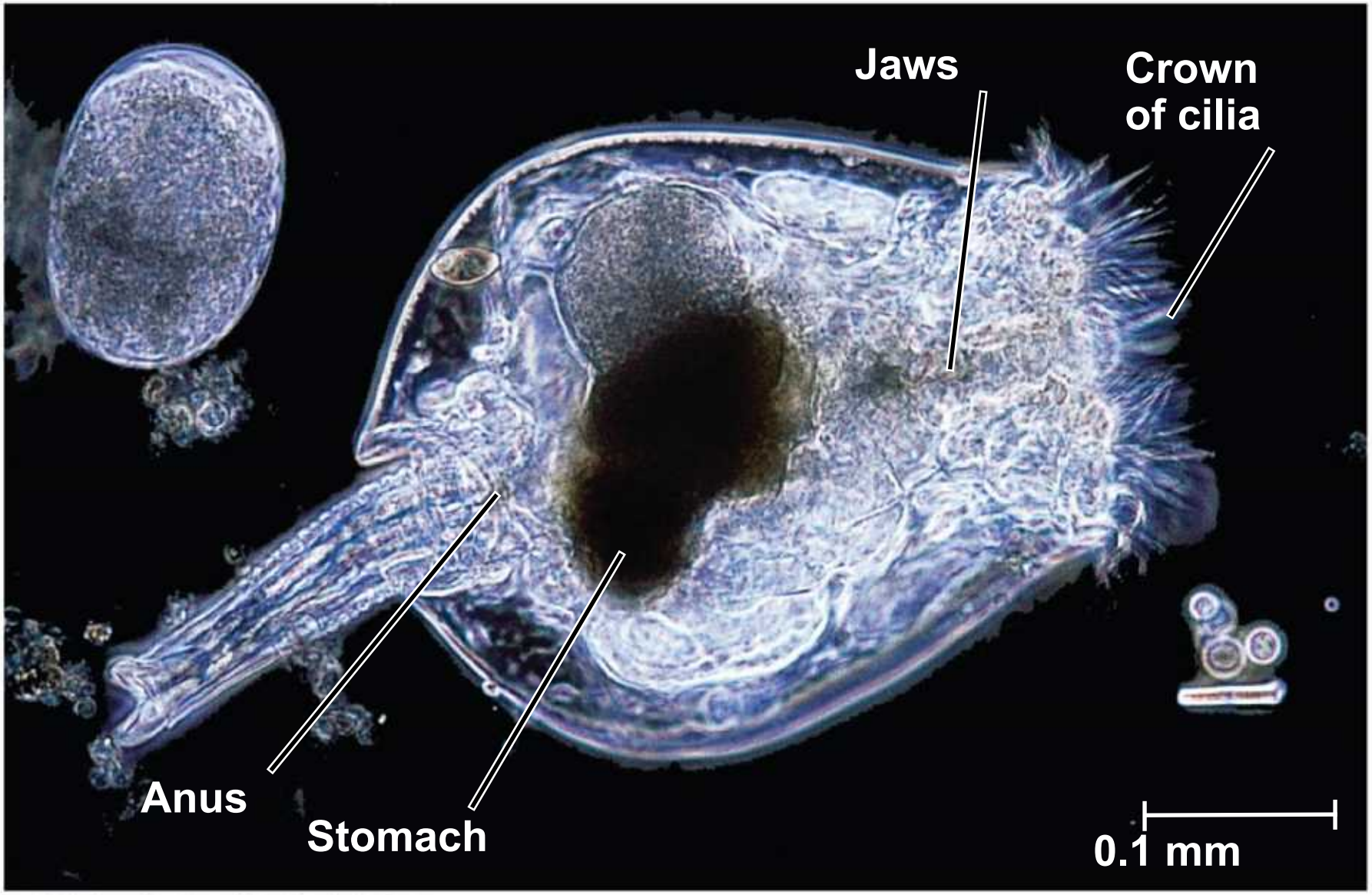
Metazoa
Eumetazoa
Bilateria
Lophotrochozoa
Ecdysozoa
Deuterostomia

Rotifers

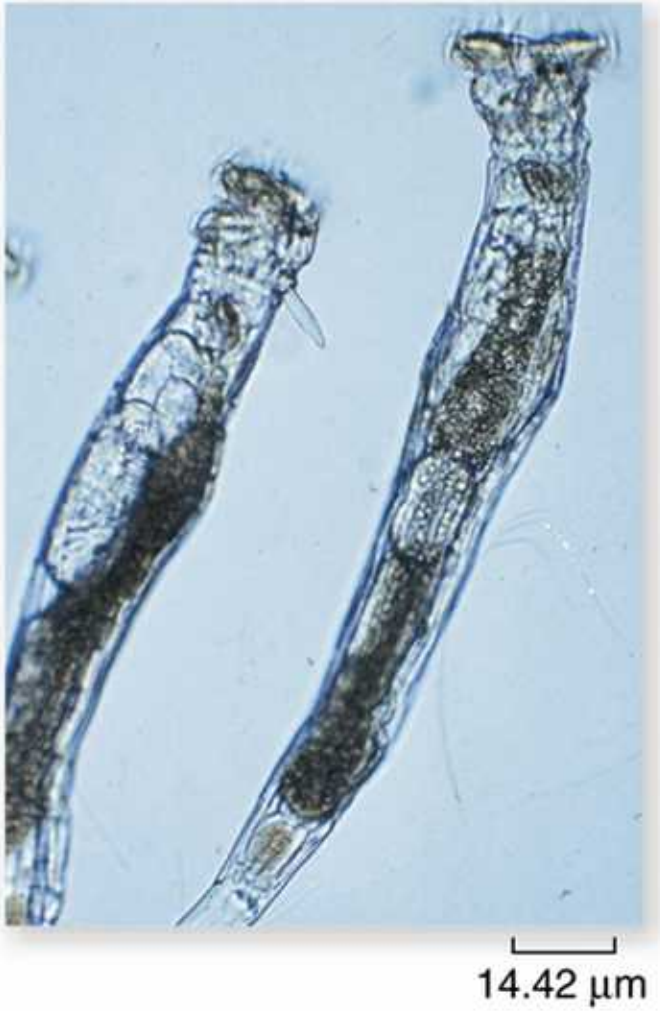
- Rotifers, phylum Rotifera (Syndermata), are tiny animals that inhabit fresh water, the ocean, and damp soil
- Rotifers are smaller than many protists but are truly multicellular and have specialized organ systems
- They posses a mouth with tiny cillia

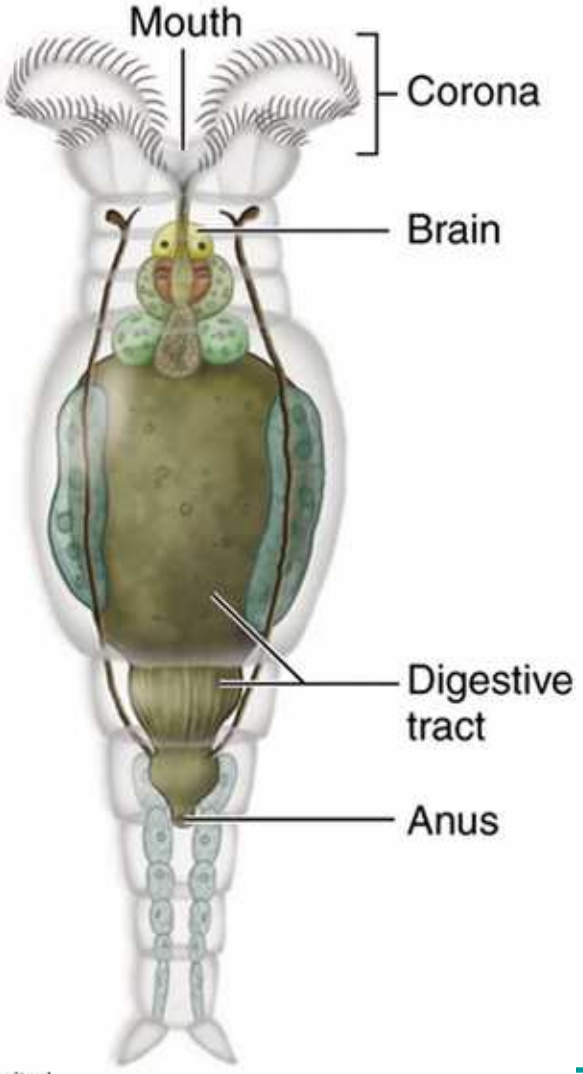
Fig. 33-13

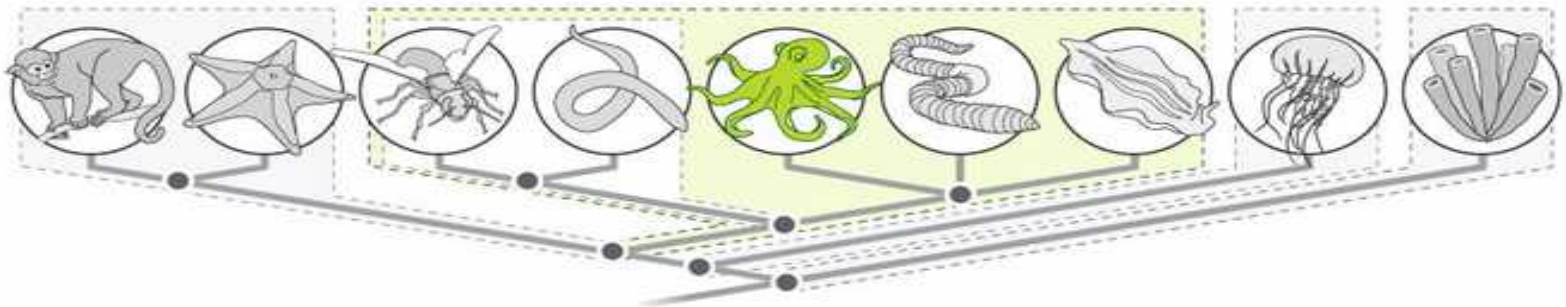


- Rotifers have an **alimentary canal**, a digestive tube with a separate mouth and anus that lies within a fluid-filled pseudocoelom
- Rotifers reproduce by **parthenogenesis**, in which females produce offspring from unfertilized eggs
- Some species are unusual in that they lack males entirely

Phylum Rotifera (New name: Syndermata)







THE MOLLUSCS

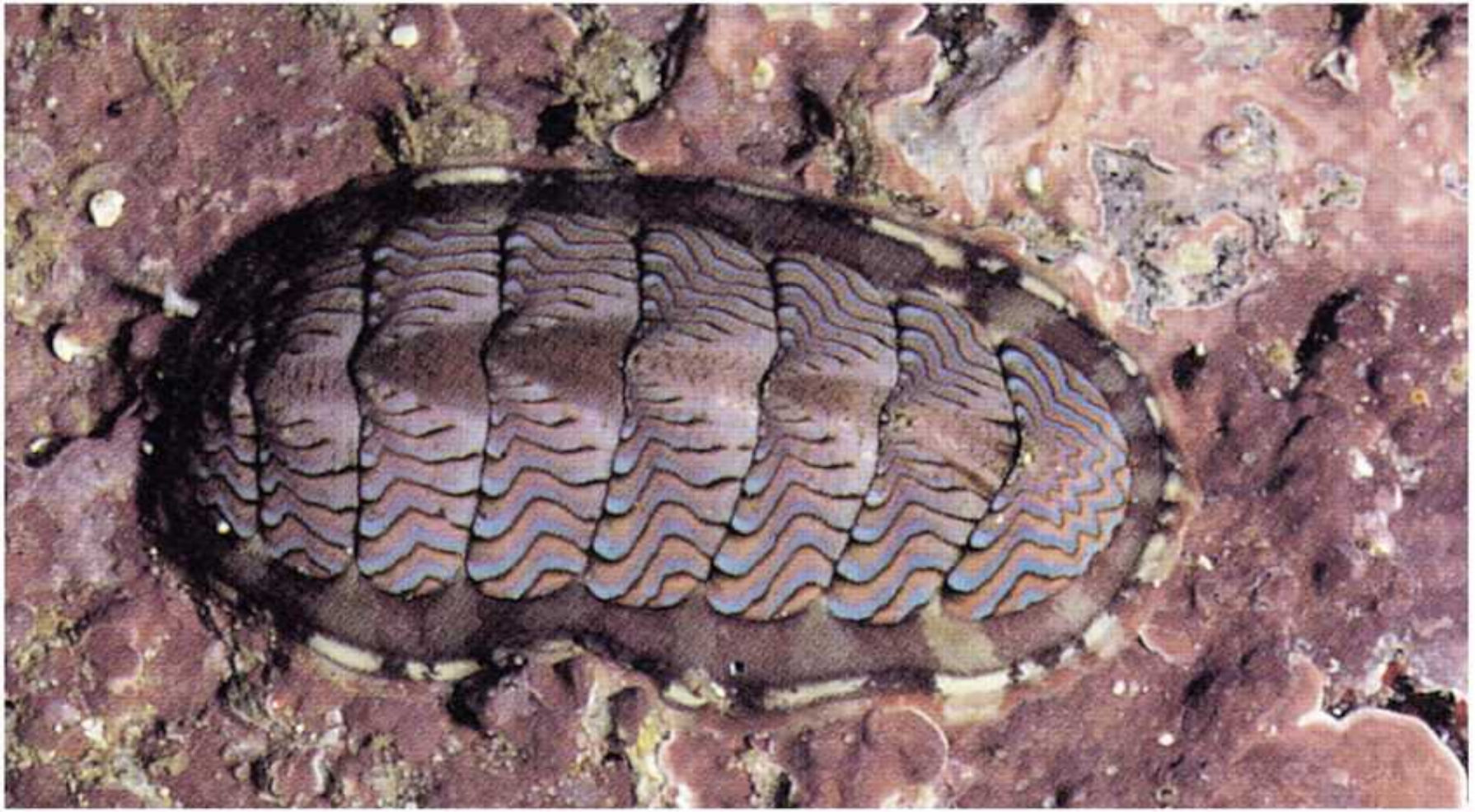
Table 33-3

Table 33.3 Major Classes of Phylum Mollusca

Class and Examples	Main Characteristics
Polyplacophora (chitons)	Marine; shell with eight plates; foot used for locomotion; radula; no head
Gastropoda (snails, slugs)	Marine, freshwater, or terrestrial; head present; a symmetrical body, usually with a coiled shell; shell reduced or absent; foot for locomotion; radula
Bivalvia (clams, mussels, scallops, oysters)	Marine and freshwater; flattened shell with two valves; head reduced; paired gills; no radula
Cephalopoda (squids, octopuses, cuttlefishes, chambered nautiluses)	Marine; head surrounded by grasping tentacles, usually with suckers; shell external, internal, or absent; mouth with or without radula; locomotion by jet propulsion

Chitons

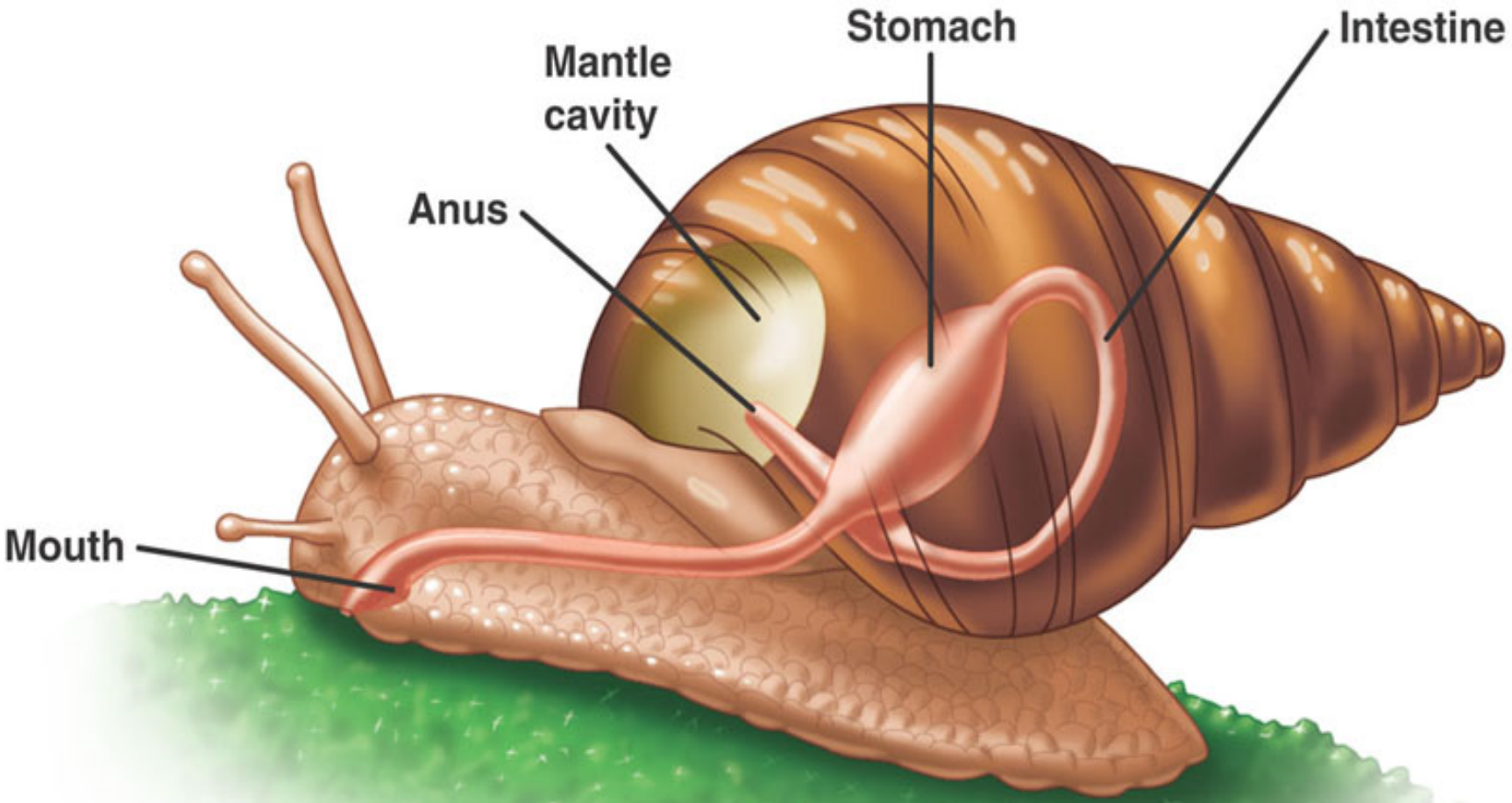
- **Class Polyplacophora, Gr: many, plate, bear or carry,** consists of the chitons, oval-shaped marine animals encased in an armor of eight

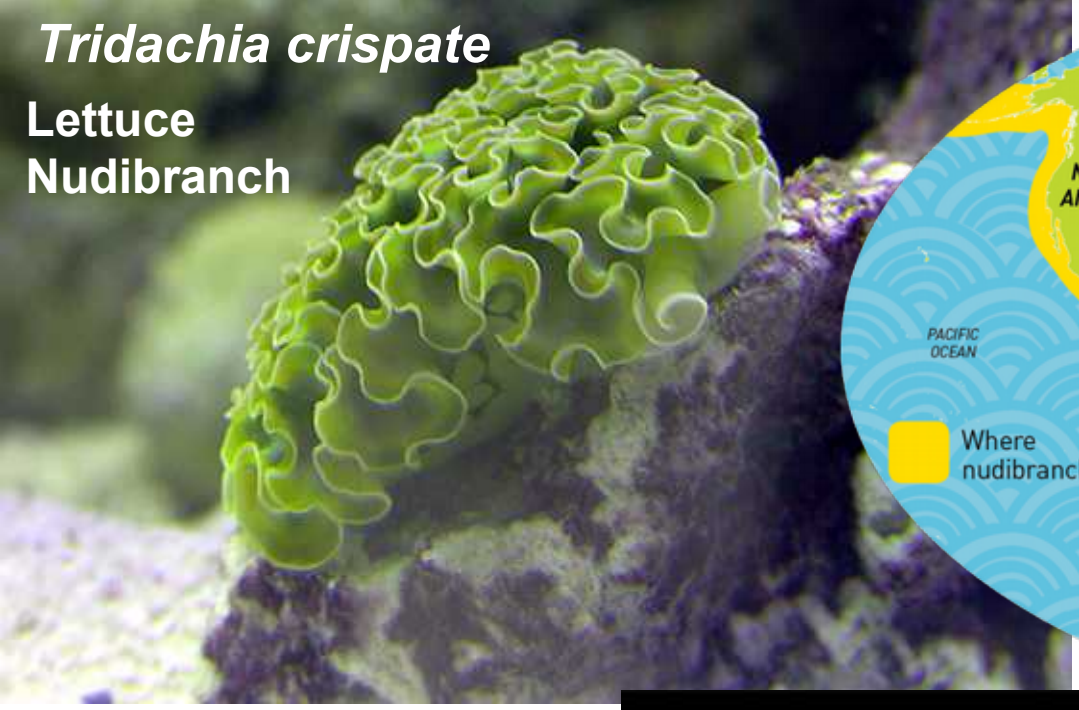


Gastropods, Class Gastropoda

- About three-quarters of all living species of molluscs are gastropods

- Most gastropods are marine, but many are freshwater and terrestrial species
- Most have a single, spiraled shell
- Slugs lack a shell or have a reduced shell
- The most distinctive characteristic of gastropods is **torsion**, which causes the animal's anus and mantle to end up above its head


Stomach
Intestine
Mantle cavity
Anus
Mouth



Tridachia crispate

Lettuce Nudibranch

Costasiella kuroshimae. **The algae-eating ocean-dweller is found near Japan, Indonesia and the Philippines. What is really amazing about this little animal is that it is one of very few able to perform photosynthesis. When it eats algae, it sucks out the chloroplasts, incorporating them into their own bodies.**

Elysia chlorotica **is a "solar-powered" marine sea slug that sequesters and retains photosynthetically active chloroplasts from the algae it eats and, remarkably, has incorporated algal genes into its own genetic code. It is emerald green in color often with small red or white markings, has a slender shape typical of members of its genus, and parapodia (lateral "wings") that fold over its body in life. This sea slug is unique among animals to possess photosynthesis-specific genes and is an extraordinary example of symbiosis between an alga and mollusc as well as a genetic chimera of these two organisms.**

Notodoris minor

Ardeadoris egretta

Chromodoris annae

Chromodoris coi

Chromodoris strigata

Hypselodoris purpureomaculosa

Nembrotha crista

Nembrotha kubaryana

Chromodoris annae

Cone Snails have a extremely potent toxin (called Conotoxin) (Neurotoxic Peptides)

marbled cone snail

Conus marmoreus

Conus textile

Cone snails have the world's fasting mutating genes. The genes which encode the snail's venom mutate at a rate that is 5 times faster than the highest mutation rate known in mammals. It is hypothesized that this rapid mutation rate allowed for the development of diverse venomous compounds which target several specific ion channels and receptors.

Bivalves

- Molluscs of **class Bivalvia** include many species of clams, oysters, mussels, and scallops
- They have a shell divided into two halves
- They are primarily suspension feeders

Cephalopods

- **Class Cephalopoda** includes squids, cuttlefish, and octopuses, carnivores with beak-like jaws (radula also in some species) surrounded by tentacles of their modified foot

GROUPS OF CEPHALOPODS

SQUIDS

- 8 short tentacles and 2 long sucker-bearing tentacles
- Free-swimming
- Contains about 300 species

OCTOPUSES

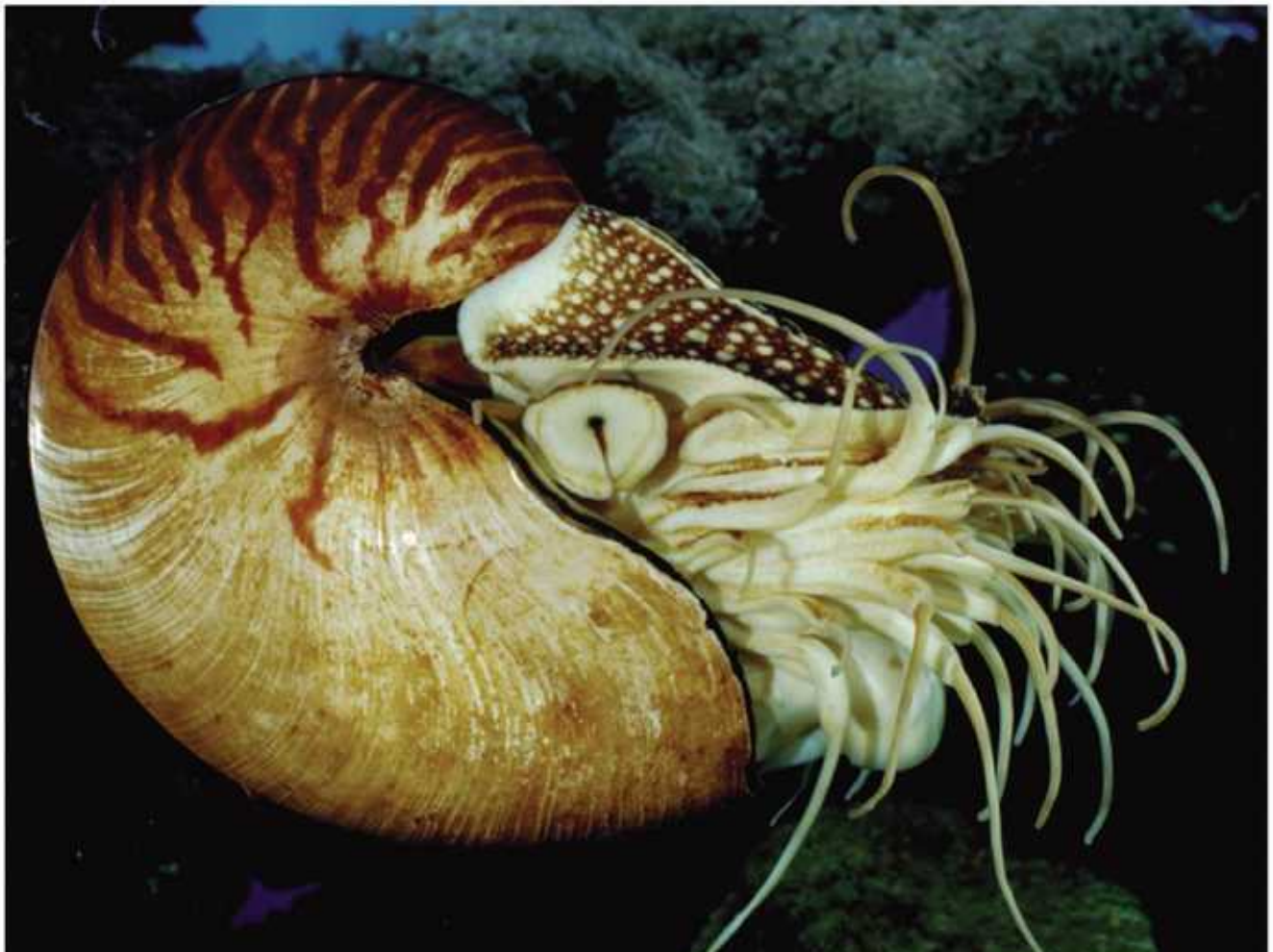
- 8 short tentacles called arms
- Bottom dwellers, living in coral reefs and rocky coasts
- Contains about 300 species

NAUTILUSES

- Chambered shell used for protection
- Free-swimming
- Contains 6 species

Subclass Nautiloidea

- One small group of shelled cephalopods, the nautiluses, survives today



Class Cephalopoda, Subclass Coleoidea, Order Octopoda

- Cephalopods have a closed circulatory system, well-developed sense organs, and a complex brain
- Shelled cephalopods called **ammonites, belemnites and nautiloids** were common but went mostly extinct at the end of the Cretaceous, except for a few remnant species in small populations

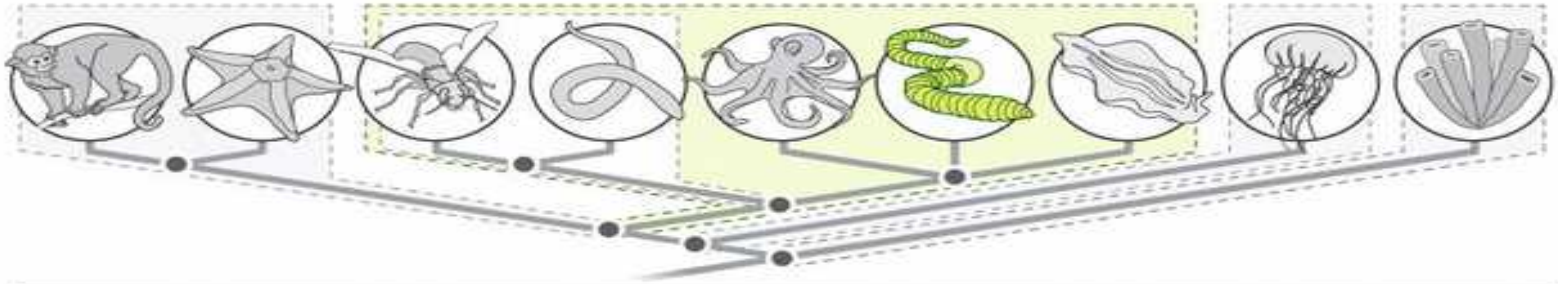
Ammonite from the Upper Jurassic period called Hegevisphinctus

Ammonite and human for size

Fig. 33-UN6

Key Concept	Phylum		Description
Concept 33.1 Sponges are basal animals that lack true tissues	Calcarea, Silicea (sponges)		Lack true tissues; have choanocytes (collar cells—flagellated cells that ingest bacteria and tiny food particles)
Concept 33.2 Cnidarians are an ancient phylum of eumetazoans	Cnidaria (hydras, jellies, sea anemones, corals)		Unique stinging structures (cnidae), each housed in a specialized cell (cnidocyte); diploblastic; radially symmetrical; gastrovascular cavity (digestive compartment with a single opening)
Concept 33.3 Lophotrochozoans, a clade identified by molecular data, have the widest range of animal body forms	Platyhelminthes (flatworms)		Dorsoventrally flattened, unsegmented acoelomates; gastrovascular cavity or no digestive tract
	Rotifera (rotifers)		Pseudocoelomates with alimentary canal (digestive tube with mouth and anus); jaws (trophi) in pharynx; head with ciliated crown
	Lophophorates: Ectoprocta, Brachiopoda		Coelomates with lophophores (feeding structures bearing ciliated tentacles)
	Mollusca (clams, snails, squids)		Coelomates with three main body parts (muscular foot, visceral mass, mantle); coelom reduced; most have hard shell made of calcium carbonate
	Annelida (segmented worms)		Coelomates with segmented body wall and internal organs (except digestive tract, which is unsegmented)
Concept 33.4 Ecdysozoans are the most species-rich animal group	Nematoda (roundworms)		Cylindrical, unsegmented pseudocoelomates with tapered ends; no circulatory system; undergoes ecdysis
	Arthropoda (crustaceans, insects, spiders)		Coelomates with segmented body, jointed appendages, and exoskeleton made of protein and chitin
Concept 33.5 Echinoderms and chordates are deuterostomes	Echinodermata (sea stars, sea urchins)		Coelomates with bilaterally symmetrical larvae and five-part body organization as adults; unique water vascular system; endoskeleton
	Chordata (lancelets, tunicates, vertebrates)		Coelomates with notochord; dorsal, hollow nerve cord; pharyngeal slits; post-anal tail (see Chapter 34)

Metazoa
Eumetazoa
Bilateria
Lophotrochozoa
Ecdysozoa
Deuterostomia



THE ANNELIDS

Annelids, Phylum Annelida-L.-annulus:ring

- Annelids have bodies composed of a series of fused rings
- The phylum Annelida is divided into three groups:
  - **Subclass Oligochaeta (earthworms and their relatives)**
  - **Class Polychaeta (polychaetes)**
  - **Subclass Hirudinea (leeches)**

Table 33-4

Table 33.4 Classes of Phylum Annelida

Class and Examples	Main Characteristics
Oligochaeta (freshwater, marine, and terrestrial segmented worms)	Reduced head; no parapodia, but chaetae present
Polychaeta (mostly marine segmented worms)	Many have a well-developed head; each segment usually has parapodia with many chaetae; free-living
Hirudinea (leeches)	Body usually flattened, with reduced coelom and segmentation; chaetae usually absent; suckers at anterior and posterior ends; parasites, predators, and scavengers

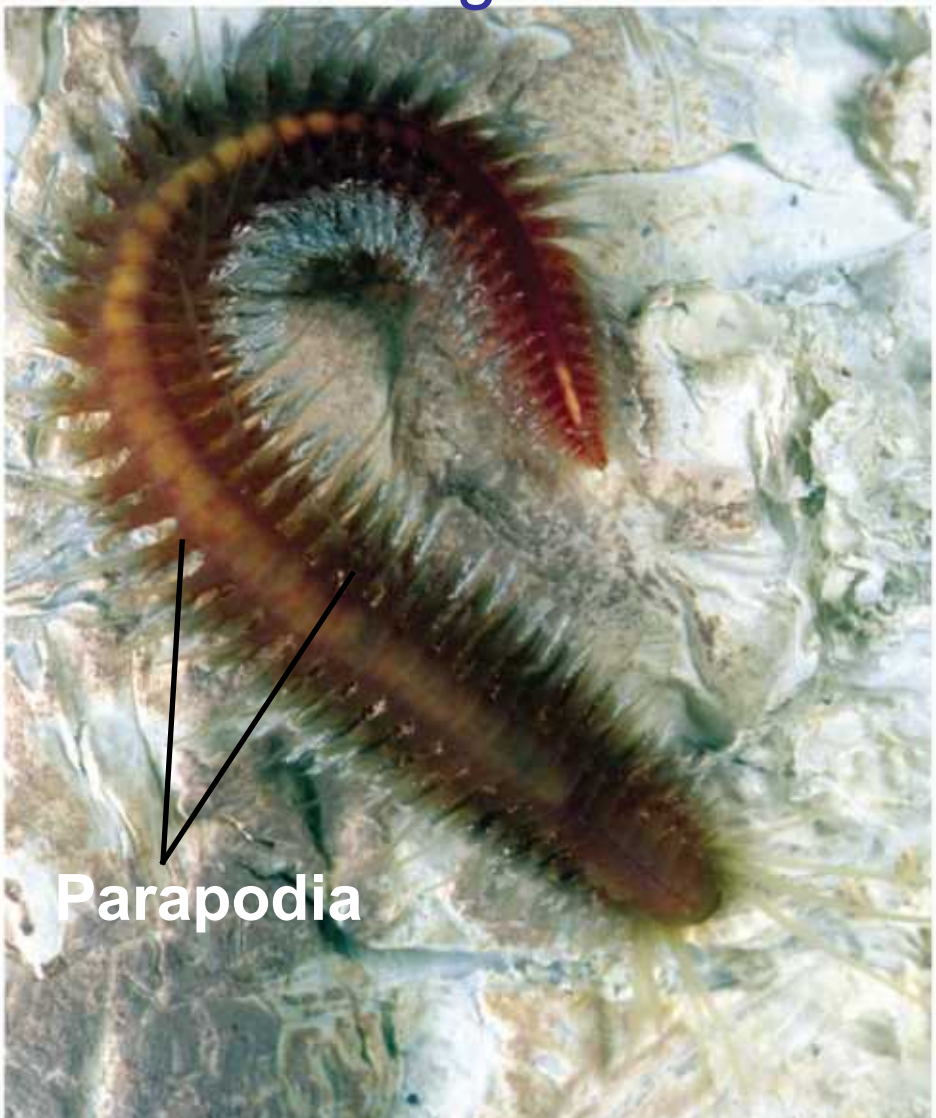
Oligochaetes

- Oligochaetes (Subclass Oligochaeta) are named for relatively sparse chaetae, bristles made of chitin
- They include the earthworms and a variety of aquatic species
- Earthworms eat through soil, extracting nutrients as the soil moves through the alimentary canal
- Earthworms are hermaphrodites but cross-fertilize

Fig. 33-23

Polychaetes

Members of class Polychaetes have paddle-like parapodia that work as gills and aid in locomotion



Leeches

- Members of Subclass Hirudinea are blood-sucking parasites, such as leeches
- Leeches secrete a chemical called hirudin to prevent blood from coagulating

Have no chaetae (except for one species)

Medicinal leech, *Hirudo medicinalis*
-Secretes anticoagulant

Fig. 33-UN6

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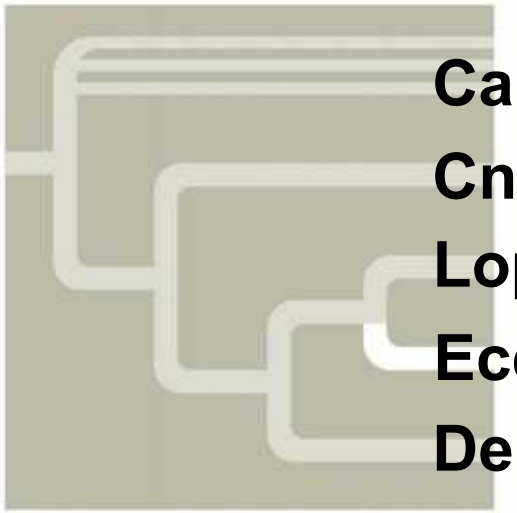
	Chordata (lancelets, tunicates, vertebrates)		Coelomates with notochord; dorsal, hollow nerve cord; pharyngeal slits; post-anal tail (see Chapter 34)

Metazoa
Eumetazoa
Bilateria
Lophotrochozoa
Ecdysozoa
Deuterostomia

Concept 33.4: Ecdysozoans are the most species-rich animal group – Nematodes and Arthropods

- Ecdysozoans (Gr. Slipping out, an escape, animal) are covered by a tough coat called a **cuticle**
- The cuticle is shed or **molted** through a process called ecdysis
- The two largest phyla are nematodes and arthropods

Fig. 33-UN4



Calcarea and Silicea

Cnidaria

Lophotrochozoa

Ecdysozoa

Deuterostomia

Phylum Nematoda

Many nematodes are active hunters, preying on protists and other small animals and many are parasites on animals (Pinworms, hookworms)

Others are parasites of plants

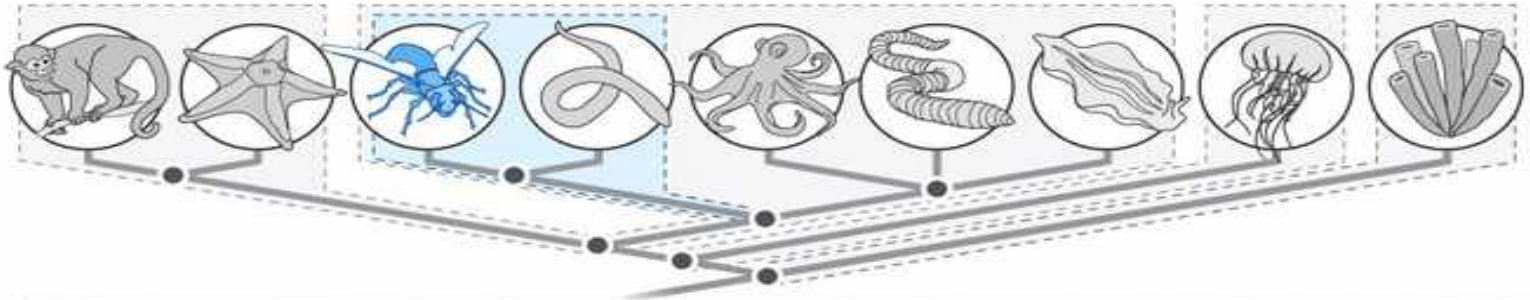
Still others live within the bodies of larger animals

Examples-*Enterobius vermicularis* (pinworms)

Ascaris lumbricoides (intestinal roundworm)

Mosquitoes transmit *Wuchereria bancrofti* (Elephantiasis)

left: © Sinclair Stammers/Photo Researchers, Inc.; right: © R. Umesh Chandran, TDR, WHO/Photo Researchers, Inc.

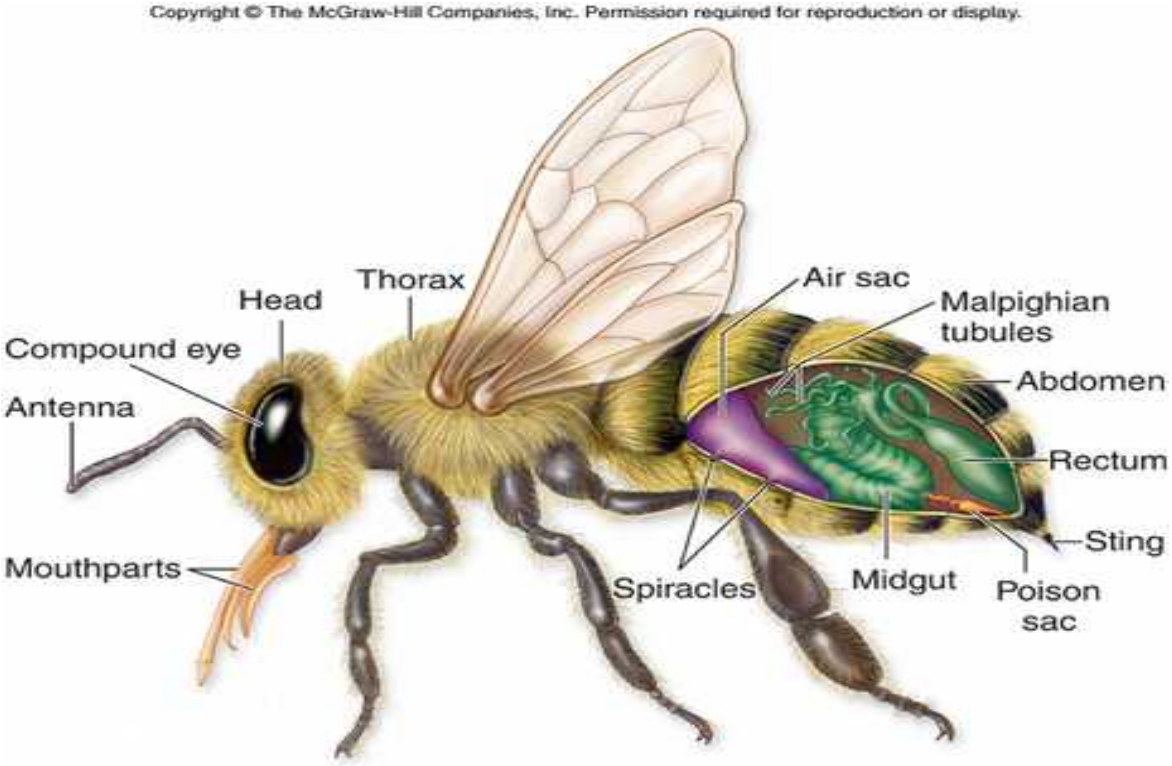


THE ARTHROPODS

Arthropods

- Two out of every three known species of animals are arthropods

- Members of the phylum Arthropoda are found in nearly all habitats of the biosphere



Arthropod Origins

- The **arthropod** body plan consists of a segmented body, hard exoskeleton, and jointed appendages, and dates to the Cambrian explosion (530–510 million years ago)
- Early arthropods show little variation from segment to segment

- Molecular evidence suggests that living arthropods consist of four major lineages that diverged early in the phylum's evolution:

Table 33.5 Subphyla of Phylum Arthropoda

Subphylum and Examples	Main Characteristics
Cheliceriformes (horseshoe crabs, spiders, scorpions, ticks, mites)	Body having one or two main parts; six pairs of appendages mostly terrestrial or marine
Myriapoda (millipedes and centipedes)	Distinct head bearing antennae and chewing mouthparts; terrestrial
Hexapoda (insects, springtails)	Body divided into head, thorax, and abdomen; antennae present; three pairs of legs and usually two pairs of wings; mostly terrestrial
Crustacea (crabs, lobsters, crayfishes, shrimps)	Body of two or three parts; antennae present; chewing mouthparts; three or more pairs of legs; mostly marine and freshwater

- Arthropod evolution is characterized by a decrease in the number of segments and an increase in appendage specialization
- These changes may have been caused by changes in *Hox* gene sequence or regulation

General Characteristics of Arthropods

- The appendages of some living arthropods are modified for many different functions

All arthropods have jointed appendages Which is the most characteristic evolutionary innovation of the most successful group of animals on earth

Fig. 33-30

Class Merostomata, *Limulus polyphemus*

Class Arachnida

Black Widow

a.

© National Geographic/Getty Images

Brown Recluse

b.

© S. Camazine/K. Visscher/Photo Researchers Inc

Arizona bark scorpion, *Centruroides exilicauda*

Type: Opportunistic Burrower
Origin: North America
Size: 3.14 -2.75 inches).

Centruroides exilicauda (formerly C. sculpturatus)

Extreme reaction to the venom is indicated by numbness, frothing at the mouth, paralysis, and a neuromotor syndrome that may be confused with a seizure and that may make breathing difficult, particularly for small children. Two recorded fatalities have occurred in the state of Arizona since 1968; the number of victims stung each year in Arizona is estimated to be in the thousands.

The bark scorpion is the most venomous scorpion in North America, and its venom can cause severe pain (coupled with numbness, tingling, and vomiting) in adult humans, typically lasting between 24 and 72 hours.

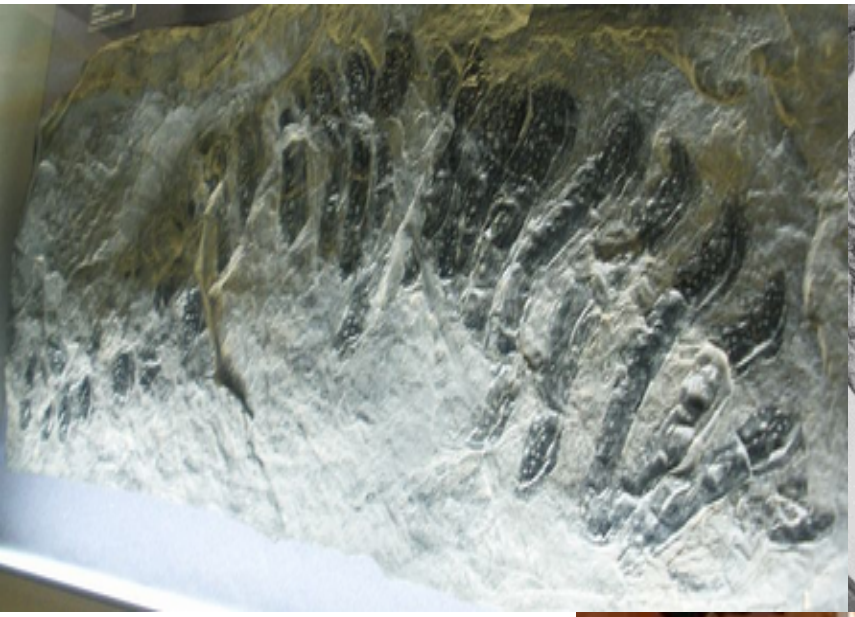
- Class Myriapoda (Gr. Many feet) (subphylum Mandibulata) includes millipedes and centipedes

  – Myriapods are terrestrial, and have jaw-like **mandibles**

- Millipedes “one thousand feet”, Order Diplopoda(Gr. double), have many legs, each trunk segment has two pairs of legs

- Centipedes “one hundred feet”, Order Chilopoda, are carnivores. They have one pair of legs per trunk segment

Centipedes are all carnivores (eat insects)
Millipedes are largely herbivores



Arthropleura (Gr. for Jointed Ribs) is a genus of extinct, 0.3–2.3 metre (1–7.5 feet) long millipede arthropods, native to the upper Carboniferous (323 to 299 million years ago) of what is now northeastern North America and Scotland.

Superclass Hexapoda, Class Insecta

Order: Lepidoptera

a.

Order: Homoptera

b.

Order: Coleoptera

c.

Order: Diptera

d.

Order: Orthoptera

e.

Order: Isoptera

f.

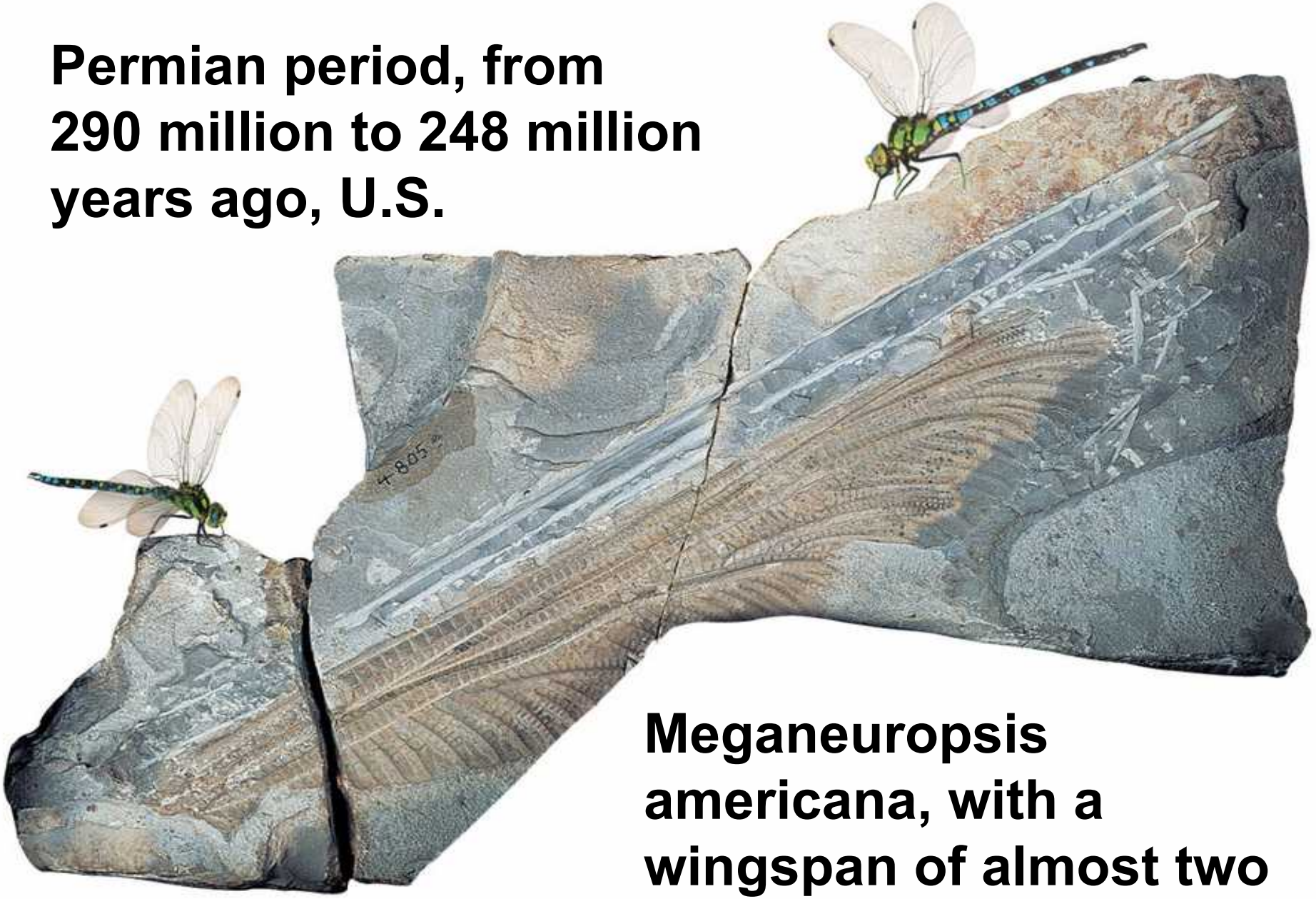
Insects

- **Superclass Hexapoda, Class Insecta** insects and relatives, has more species than all other animal groups combined
- They live in almost every terrestrial habitat and in fresh water
- The internal anatomy of an insect includes several complex organ systems

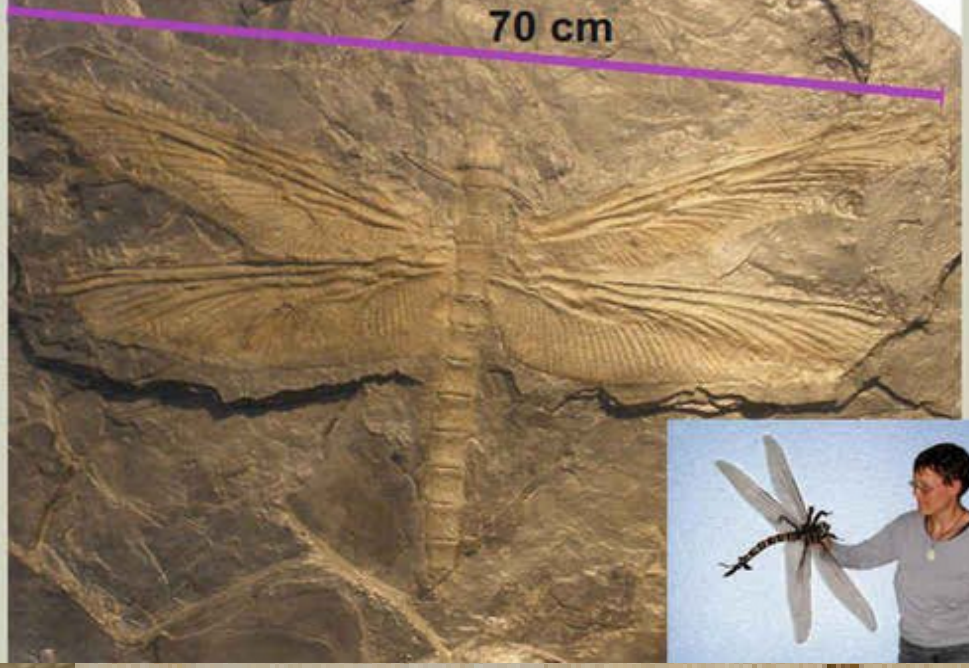
Meganeuropsis permiana

Werner Kraus reconstructed this model in life-size (72 cm wingspan) for the University Museum of Clausthal-Zellerfeld. He worked in cooperation with Prof. Carsten Brauckmann.

Permian period, from 290 million to 248 million years ago, U.S.



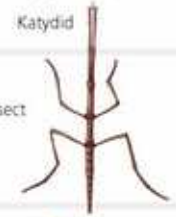
Meganeuropsis americana, with a wingspan of almost two and a half feet.


70 cm

- Flight is one key to the great success of insects
- An animal that can fly can escape predators, find food, and disperse to new habitats much faster than organisms that can only crawl

Fig. 33-37

Order	Approximate Number of Species	Examples
Blattodea	4,000	German cockroach 
Coleoptera	350,000	Japanese beetle 
Dermaptera	1,200	 Earwig
Diptera	151,000	Horsefly 
Hemiptera	85,000	Leaf-footed bug 
Hymenoptera	125,000	 Cicada-killer wasp
Isoptera	2,000	 Termite

Order	Approximate Number of Species	Examples
Lepidoptera	120,000	Swallowtail butterfly 
Odonata	5,000	 Dragonfly
Orthoptera	13,000	 Katydid 
Phasmatodea	2,600	Stick insect
Phthiraptera	2,400	Human body louse 
Siphonaptera	2,400	 Flea
Thysanura	450	 Silverfish
Trichoptera	7,100	 Caddisfly

Crustaceans

- While arachnids and insects thrive on land, crustaceans, for the most part, have remained in marine and freshwater environments
- Crustaceans, **Class Crustacea**, typically have branched appendages that are extensively specialized for feeding and locomotion and posses two pairs of antennae
- Most crustaceans have separate males and females

- **Isopods, Subclass Malacostraca** include terrestrial, freshwater, and marine species
  - Pill bugs are a well known group of terrestrial isopods

- **Decapods, Subclass Malacostraca** are all relatively large crustaceans and include lobsters, crabs, shrimp

Ghost crab

- Planktonic crustaceans include many species of **copepods (Subclass Copepoda)**, which are among the most numerous of all animals

Fig. 33-UN6

Key Concept	Phylum		Description
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Concept 33.5 Echinoderms and chordates are deuterostomes	Echinodermata (sea stars, sea urchins)		Coelomates with bilaterally symmetrical larvae and five-part body organization as adults; unique water vascular system; endoskeleton
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Metazoa
Eumetazoa
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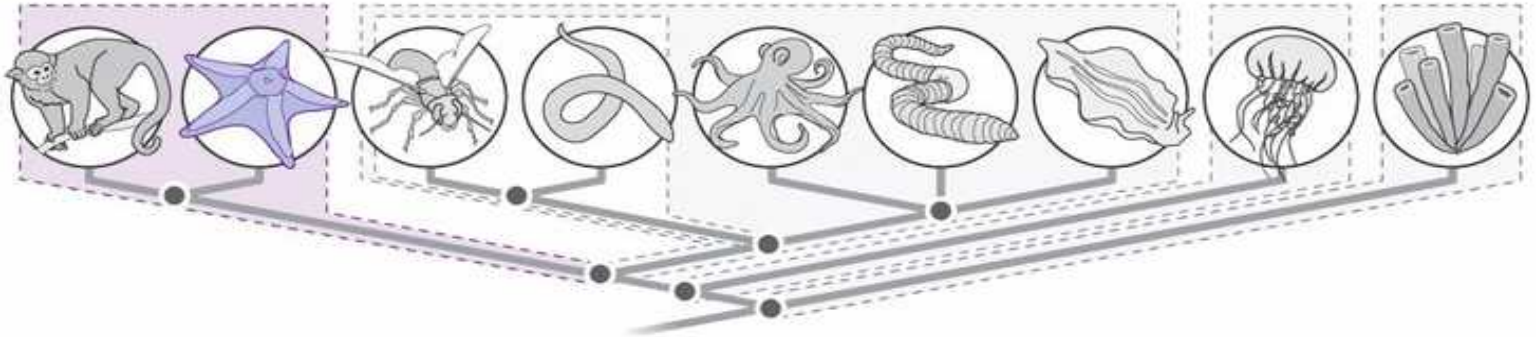
Ecdysozoa
Deuterostomia



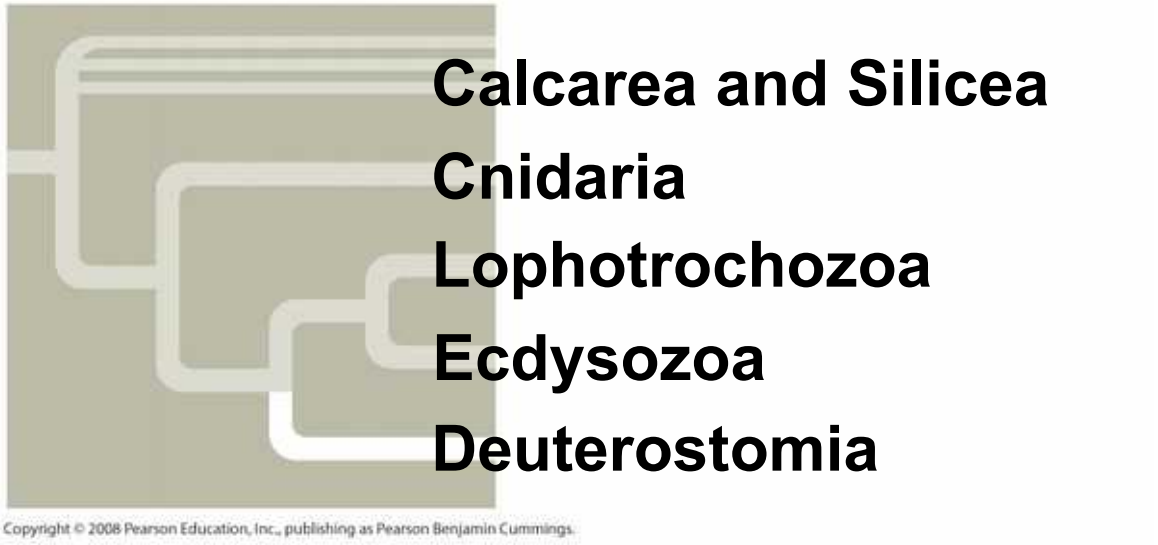
THE ECHINODERMS

Concept 33.5: Echinoderms and chordates are deuterostomes

- Sea stars and other echinoderms, phylum Echinodermata, may seem to have little in common with phylum Chordata, which includes the vertebrates
- Shared characteristics define deuterostomes (Chordates and Echinoderms), such as:
  - Formation of the mouth at the end of the embryo opposite the blastopore (deuterostome)

Unique to echinoderms is Pentaradial symmetry

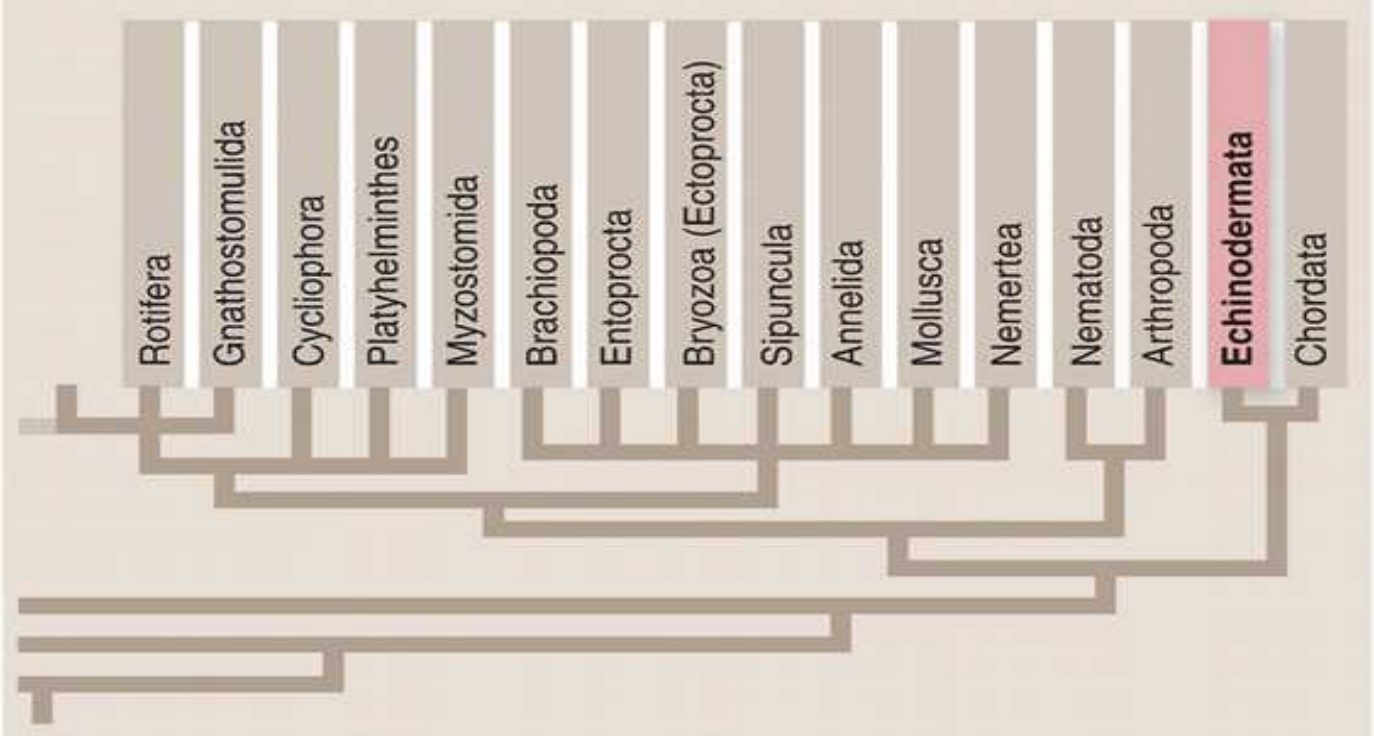
•Phylum Echinodermata (Gr. Sea urchin skin = spiny skin)



Phylum Echinodermata

Echinoderms are an ancient group of marine animals, with about 6000 living species

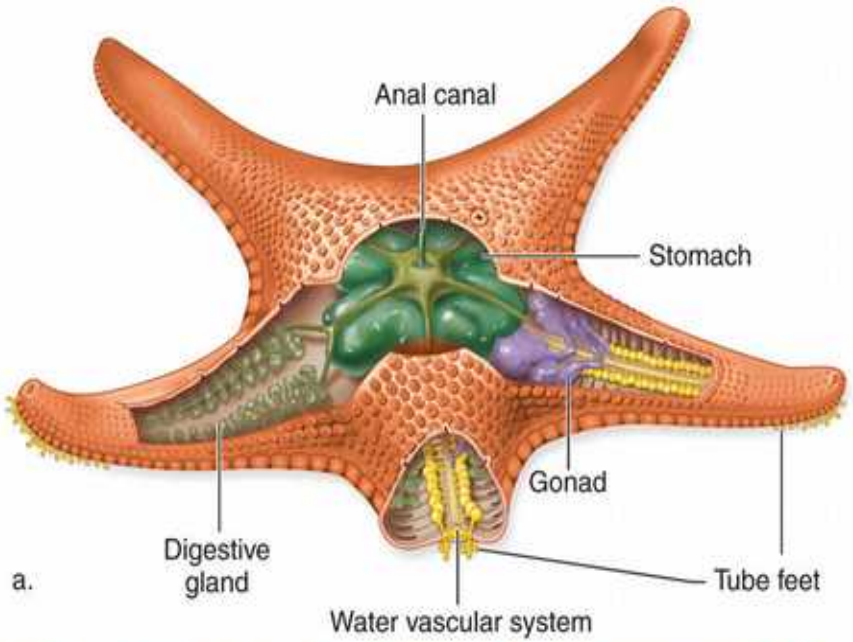
-Characterized by deuterostome development and an **endoskeleton** of dermal plates (ossicles) beneath the skin



Echinoderms

- Sea stars and most other **echinoderms** are slow-moving or sessile (Class Crinoidea) marine animals
- A thin epidermis covers an endoskeleton of hard calcareous (mostly calcium carbonate) plates
- Echinoderms have a unique **water vascular system**, a network of hydraulic canals branching into **tube feet** that function in locomotion, feeding, and gas exchange. No true circulatory system,
- Males and females are usually separate, and sexual reproduction is external

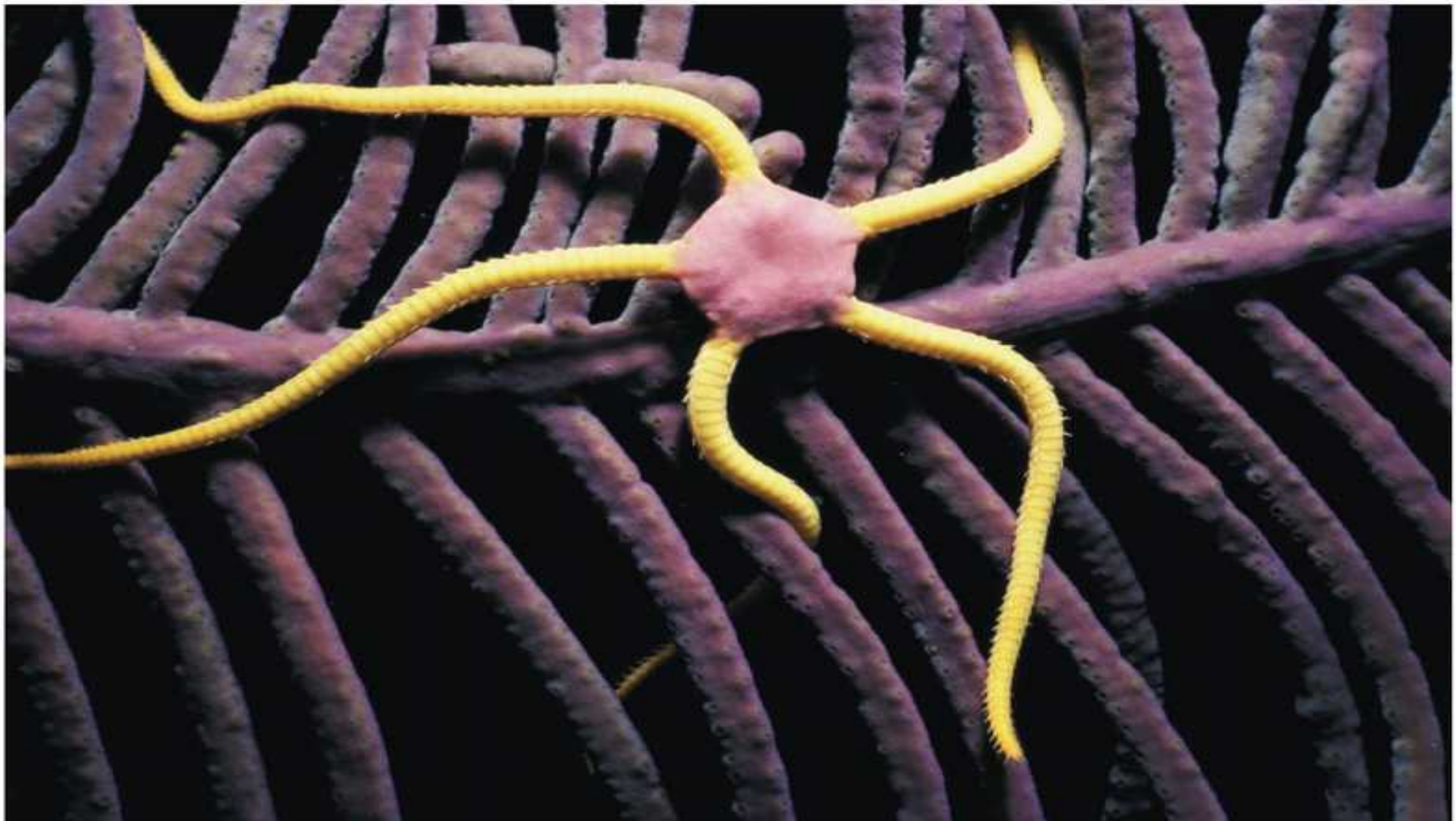
- Lack heads and brains but still have a nervous system.
- Some echinoderms eat dead organic matter or are herbivores, some are predators
- Central nerve ring
- Express bilateral symmetry as larvae but then exhibit radial (pentaradial) symmetry as adults



b: © David Fleetham/Visuals Unlimited

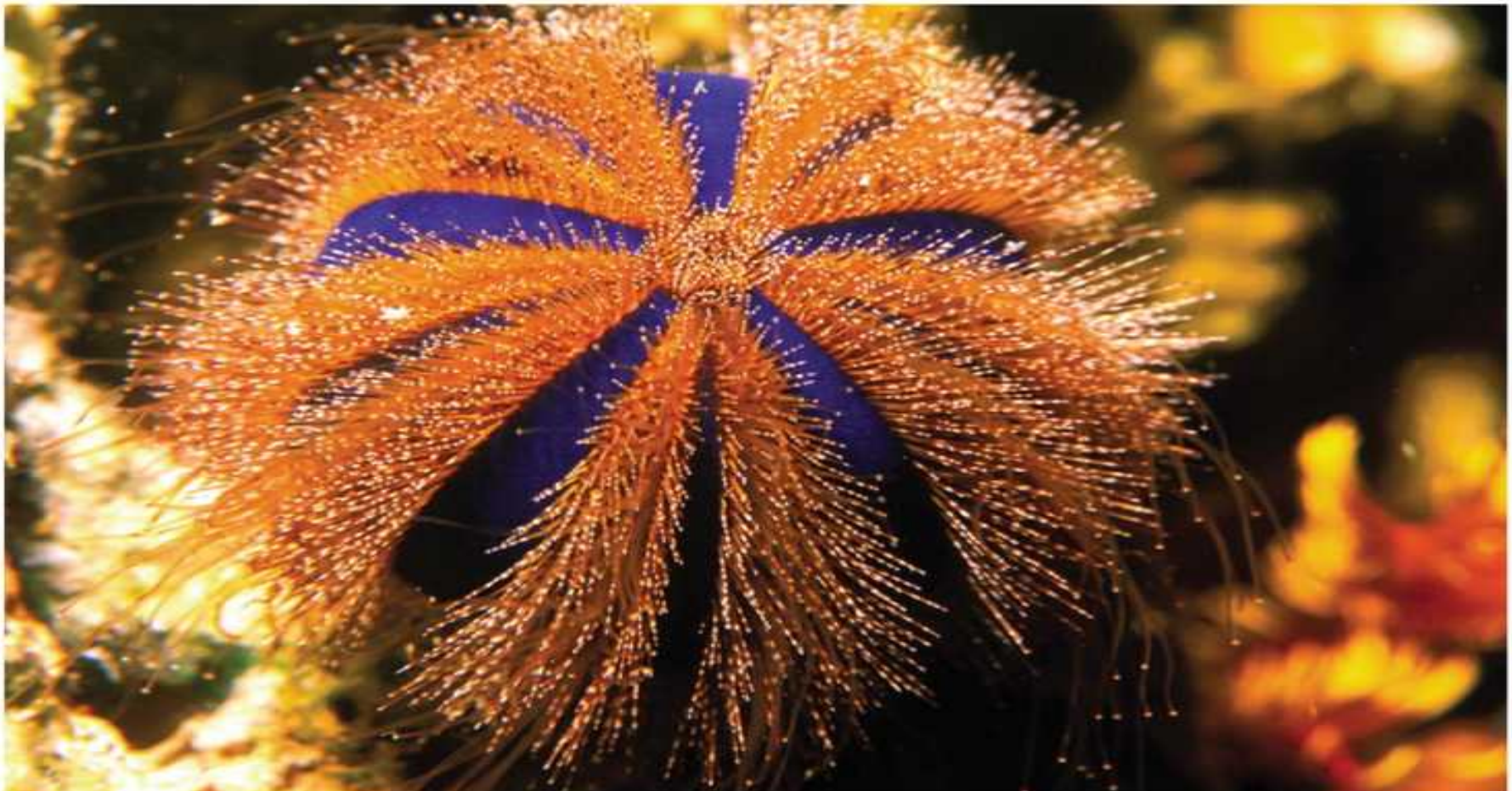
Brittle Stars-Subclass Ophiurodea (Gr. Serpent-tailed)

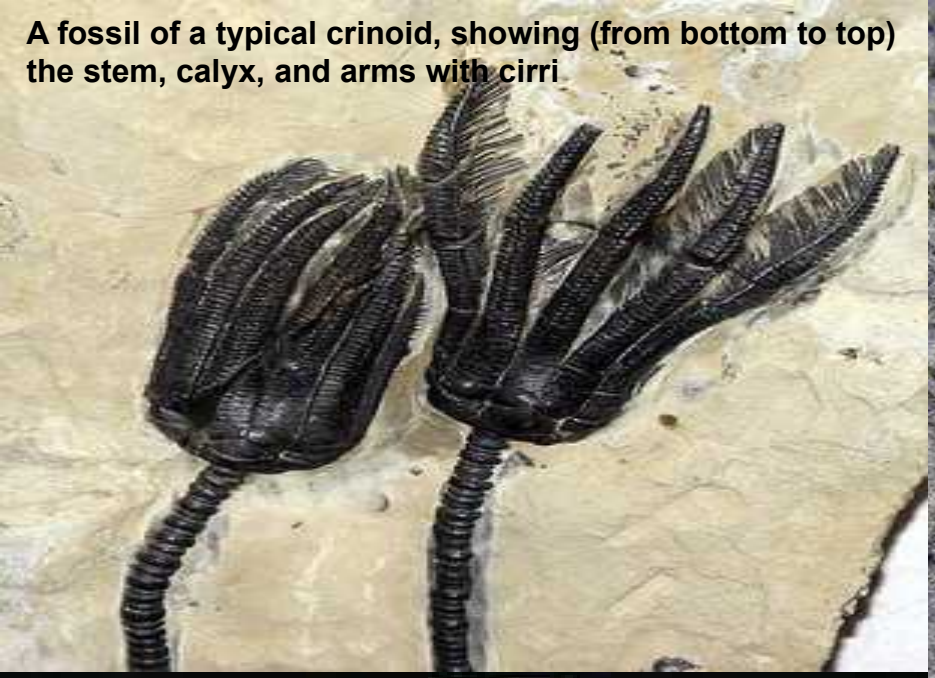
- Brittle stars have a distinct central disk and long, flexible arms, which they use for movement



Sea Urchins and Sand Dollars-Class Echinoidea (Gr. Sea urchin)

- Sea urchins and sand dollars have no arms but have five rows of tube feet, feed mostly on algae, but also have different modes of feeding





A fossil of a typical crinoid, showing (from bottom to top) the stem, calyx, and arms with cirri

420 million year old Crinoid from Morocco.

Agaricocrinus americanus, a fossil crinoid from the Carboniferous of Indiana

Fossil Crinoids

Most modern crinoids, i.e., the feather stars, are free-swimming and lack a stem as adults. Examples of fossil crinoids that have been interpreted as free-swimming include Marsupitsa, Saccocoma and Uintacrinus. In 2005, a stalked crinoid was recorded pulling itself along the sea floor off the Grand Bahama Island. Crinoids are the only group of echinoderms that have sessile members.

Sea Cucumbers-Class Holothuroidea, (Gr. A kind of a zoophyte-(plant animal))

- Sea cucumbers lack spines, have a very reduced endoskeleton, and do not look much like other echinoderms

- Sea cucumbers have five rows of tube feet; some of these are developed as feeding tentacles

Chordates

- Phylum Chordata consists of two subphyla of invertebrates as well as hagfishes and vertebrates
- Chordates share many features of embryonic development with echinoderms, but have evolved separately for at least 500 million years

Fig. 33-UN6

Key Concept	Phylum		Description
Concept 33.1 Sponges are basal animals that lack true tissues	Calcarea, Silicea (sponges)		Lack true tissues; have choanocytes (collar cells—flagellated cells that ingest bacteria and tiny food particles)
Concept 33.2 Cnidarians are an ancient phylum of eumetazoans	Cnidaria (hydras, jellies, sea anemones, corals)		Unique stinging structures (cnidae), each housed in a specialized cell (cnidocyte); diploblastic; radially symmetrical; gastrovascular cavity (digestive compartment with a single opening)
Concept 33.3 Lophotrochozoans, a clade identified by molecular data, have the widest range of animal body forms	Platyhelminthes (flatworms)		Dorsoventrally flattened, unsegmented acoelomates; gastrovascular cavity or no digestive tract
	Rotifera (rotifers)		Pseudocoelomates with alimentary canal (digestive tube with mouth and anus); jaws (trophi) in pharynx; head with ciliated crown
	Lophophorates: Ectoprocta, Brachiopoda		Coelomates with lophophores (feeding structures bearing ciliated tentacles)
	Mollusca (clams, snails, squids)		Coelomates with three main body parts (muscular foot, visceral mass, mantle); coelom reduced; most have hard shell made of calcium carbonate
	Annelida (segmented worms)		Coelomates with segmented body wall and internal organs (except digestive tract, which is unsegmented)
Concept 33.4 Ecdysozoans are the most species-rich animal group	Nematoda (roundworms)		Cylindrical, unsegmented pseudocoelomates with tapered ends; no circulatory system; undergoes ecdysis
	Arthropoda (crustaceans, insects, spiders)		Coelomates with segmented body, jointed appendages, and exoskeleton made of protein and chitin
Concept 33.5 Echinoderms and chordates are deuterostomes	Echinodermata (sea stars, sea urchins)		Coelomates with bilaterally symmetrical larvae and five-part body organization as adults; unique water vascular system; endoskeleton
	Chordata (lancelets, tunicates, vertebrates)		Coelomates with notochord; dorsal, hollow nerve cord; pharyngeal slits; post-anal tail (see Chapter 34)

Metazoa
Eumetazoa
Bilateria
Lophotrochozoa
Ecdysozoa
Deuterostomia