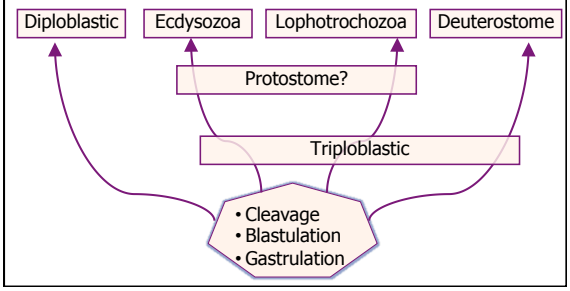
Major patterns of **baupläne**



Phylum Mollusca "soft body"

- Bauplan / development:
  - Triploblastic
  - Bilateral symmetry w/ cephalization
    - Bivalves lack cephalization
    - Gastropods have **torsion**
  - Protostome
  - Lophotrochozoa
  - Eucoelomate - reduced
  - Hemocoel / Open circulatory system [except cephalopods]
- Special features:
  - Muscular foot, visceral mass, and mantle, usually w/ shell
  - Mantle cavity w/ gills
  - Radula

Molluscan body plan

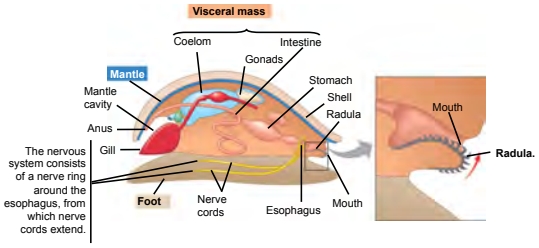
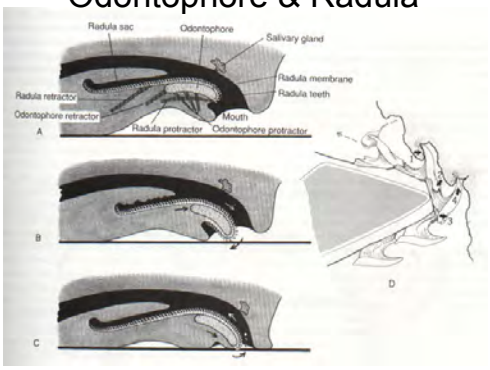


Figure 33.16

Odontophore & Radula



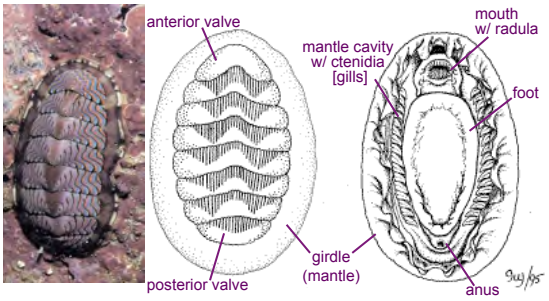
Phylum Mollusca

2nd most diverse phylum: >100,000 spp.

- Class Polyplacophora: chitons
- Class Gastropoda: snails & slugs
- Class Cephalopoda: octopus & squid
- Class Bivalvia: clams & mussels

Polyplacophora

"bearing many [8] plates" — **chitons**



Gastropod molluscs

- The most distinctive characteristic of this class is a developmental process known as torsion, which causes the animal's anus and mantle to end up above its head

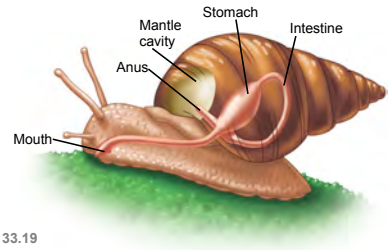
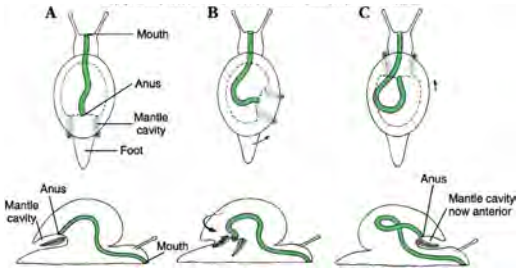


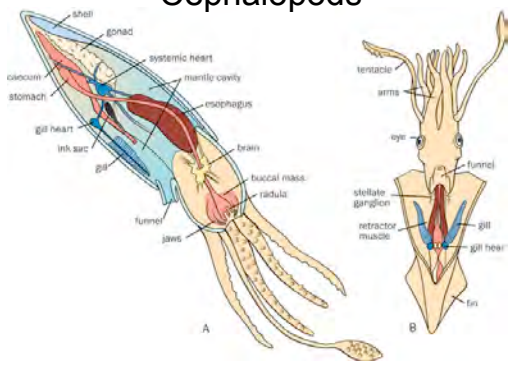
Figure 33.19

Torsion in Gastropods

- In early development, left side of body grows faster than right side.
- Results in 180° twist of visceral mass relative to head-foot axis.
- Relocates anus & mantle cavity behind head:
  - ↑ventilation of gills & elimination of feces
  - ↑ retraction of head into shell aperture



Cephalopods



Bivalve molluscs

- The mantle cavity of a bivalve contains gills that are used for feeding as well as gas exchange

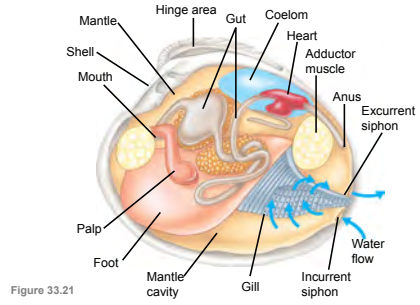
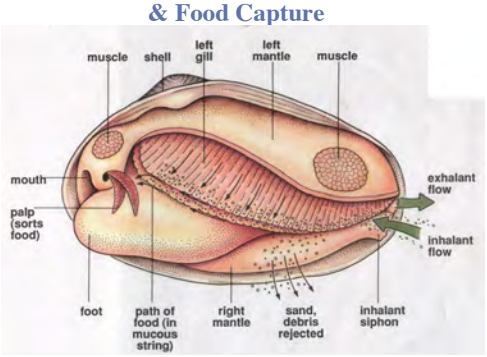


Figure 33.21

Movement of the Ventilating Currents & Food Capture



Phylum Arthropoda: bugs

Arthropod Domination!

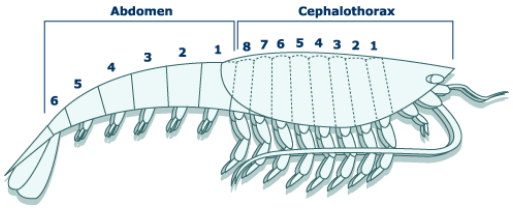
- **The most diverse and widely distributed taxon on Earth!**
- **>1,000,000 known species**
- **Found in every habitat — usually as the dominant life form.**

Phylum Arthropoda: bugs

- Bauplan / development:
  - Triploblastic
  - Bilateral symmetry w/ cephalization
  - Protostome
  - Ecdysozoa
  - Eucoelomate
  - Hemocoel / Open circulatory system
- Special features:
  - Segmentation → tagmata
    - usually: head / thorax / abdomen
  - Chitinous exoskeleton / ecdysis
  - Paired jointed appendages — usually one pair per segment

Arthropods

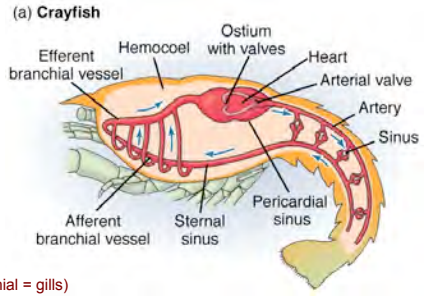
- Segmented body covered by an exoskelton
- Numerous specialized jointed appendages
  - Usually one pair per segment



C.f., Figure 33.29

Open circulation in aquatic arthropods (crustacea)

- heart ➔ hemocoel ➔ gills ➔ heart

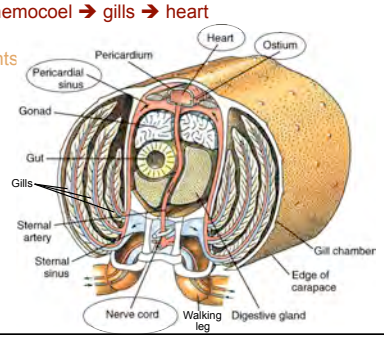


(branchial = gills)

Open circulation in aquatic arthropods (crustacea)

- heart ➔ hemocoel ➔ gills ➔ heart

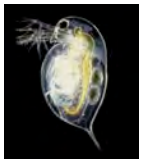
Thorax segments



Arthropoda, Class [Subphylum]: Crustacea

~30,000 spp.

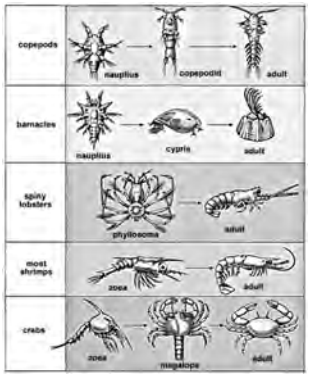
- **Major Sub-Classes & Orders:**
- Sub-Cl.: Branchiopoda
  - Or.: Cladocera — water fleas
- Sub-Cl.: Maxillopoda
  - Or.: Copepoda — copepods
  - Or.: Cirripedia — barnacles
- Sub-Cl.: Malacostraca
  - Or.: Amphipoda — side-swimmers, beach hoppers
  - Or.: Isopoda — pill bugs, sea lice
  - Or.: Euphausiacea — krill
  - Or.: Decapoda — shrimp, crabs, lobsters



Cladocera — water flea
Daphnia pulex

Arthropoda, Class [Subphylum]: Crustacea

Growth and development in steps (n-stars) & stages defined by molts



Planktonic crustaceans

- Esp. copepods & euphausids (krill)
- The most abundant animals on earth

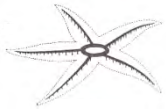
Most copepods are only 1–2 mm in length. But the total biomass of all the oceans' copepods exceed by far the total mass of all the oceans' whales!

Fig. 33.38b

Planktonic crustaceans known as krill are consumed in vast quantities by whales.

Phylum Echinodermata

- Bauplan / development:
  - Triploblastic
  - Pentamerous radial symmetry
  - Eucoelomate
  - Deuterostome
  - 3 circulatory systems — reduced open hemal system around gut
    - ciliated eucoelom – gas exchange via dermal gills
    - ciliated hydrocoel – gas exchange via tube feet

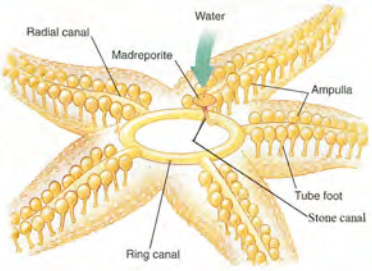


- Special features:
  - Water vascular system
  - Tube feet & pedicellaria
  - Calcareous endoskeleton (mesodermal ossicles with mutable [lockable] collagenous ligaments)

Water Vascular System

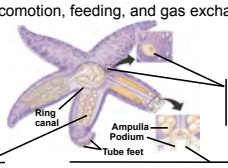
- network of hydraulic canals — unique to echinoderms
  - ciliated hydrocoel
  - branch into tube feet
  - function in locomotion, feeding, and gas exchange

The starfish's water vascular system provides the water pressure that operates the animal's tube feet. From the madreporite, water moves into the ring canal, then into the rays through radial canals, and finally to the tube feet. The canals are like a network of water pipes attached to the tube feet. Water also exits the body through the madreporite.



Water Vascular System

- network of hydraulic canals — unique to echinoderms
  - ciliated hydrocoel
  - branch into tube feet
  - function in locomotion, feeding, and gas exchange



Madreporite. Water can flow in or out of the water vascular system into the surrounding water through the madreporite.

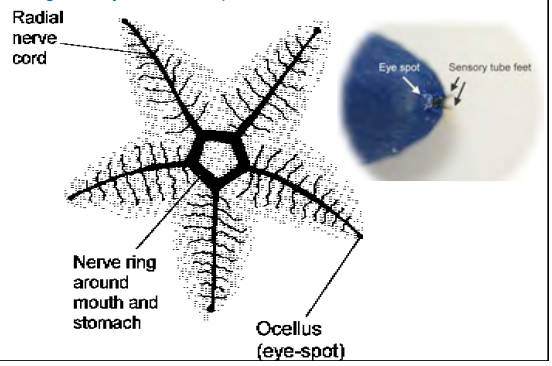
Radial canal. The water vascular system consists of a ring canal in the central disk and five radial canals, each running in a groove down the entire length of an arm.

Branching from each **radial canal** are hundreds of hollow, muscular **tube feet** filled with fluid. Each tube foot consists of a bulb-like **ampulla** and suckered **podium** (foot portion). When the ampulla squeezes, it forces water into the podium and makes it expand. The podium then contacts the substrate. When the muscles in the wall of the podium contract, they force water back into the ampulla, making the podium shorten and bend.

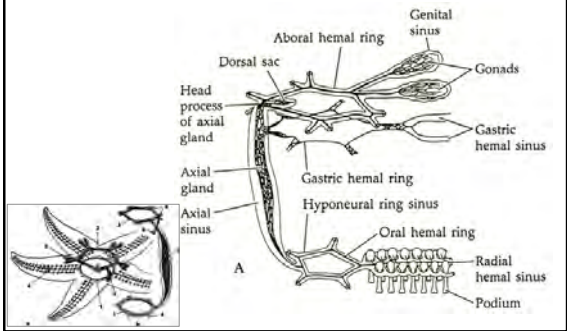
Figure 33.39

Ring / Radial Nervous System

generally runs under/parallel to water vascular canals



Hemal System
open vascular circulation



Phylum Echinodermata

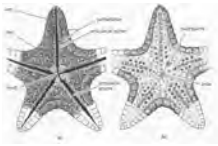
~7,000 spp. — all marine

- Class **Asteroidea**: sea stars
- Class **Ophiuroidea**: brittle stars; serpent stars; basket stars
- Class **Echinoidea**: sea urchins; sea biscuits; sand dollars
- Class **Holothuroidea**: sea cucumbers




Phylum Echinodermata

- Class **Asteroidea**: sea stars
  - Coelom & viscera extend into hollow arms
  - Eversible cardiac (oral) stomach — external digestion

Phylum Echinodermata

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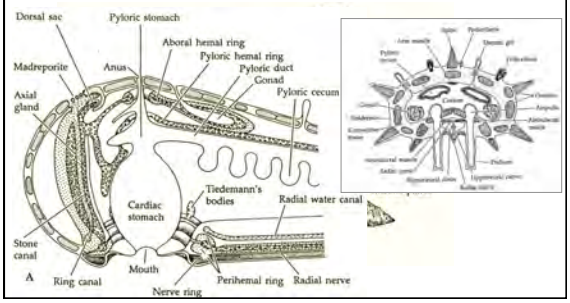
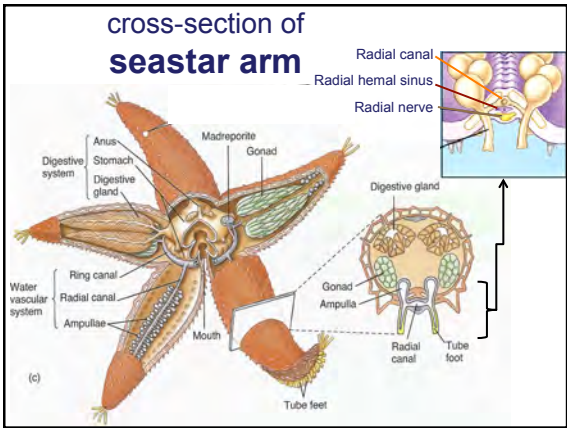


cross-section of seastar arm

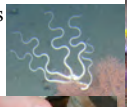
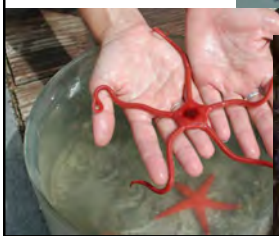
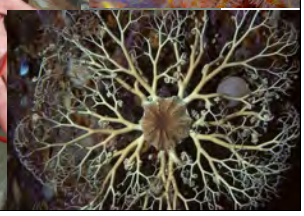


Phylum Echinodermata

- Class **Asteroidea**: sea stars
  - Coelom & viscera extend into hollow arms
  - Eversible cardiac (oral) stomach — external digestion

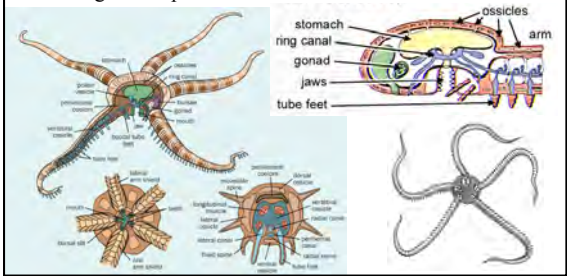
Phylum Echinodermata

- Class **Ophiuroidea**: brittle stars
  - Viscera confined to central disk
  - Slender, flexible arms
  - Blind gut
  - Suspension feeders

Phylum Echinodermata

- Class **Ophiuroidea**: brittle stars
  - Viscera confined to central disk
  - Slender, flexible arms
  - Blind gut / Suspension feeders

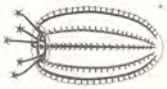


Seastar / Urchin / Sea cucumber

Water vascular,
Hemal, &
Nervous systems

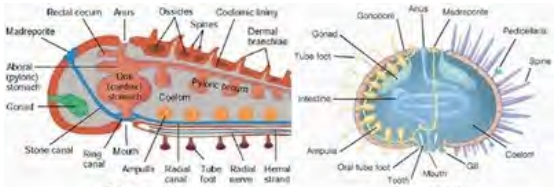
Asteroidea

Echinoidea



Holothuroidea

Seastar / Urchin

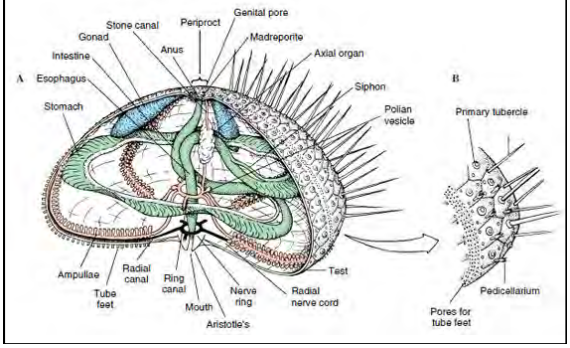


Phylum Echinodermata

- Class **Echinoidea**: sea urchins; sea biscuits; sand dollars

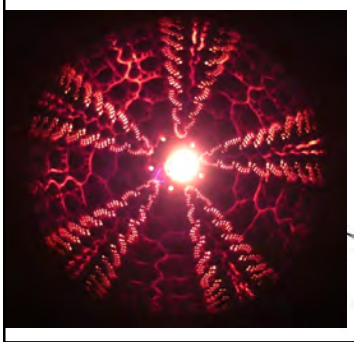
Phylum Echinodermata

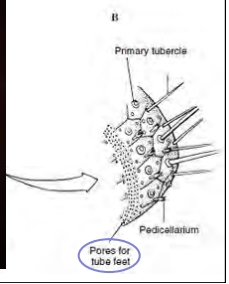
- Class **Echinoidea**: sea urchins; sea biscuits; sand dollars



Phylum Echinodermata

- Class **Echinoidea**: sea urchins; sea biscuits; sand dollars





Phylum Echinodermata

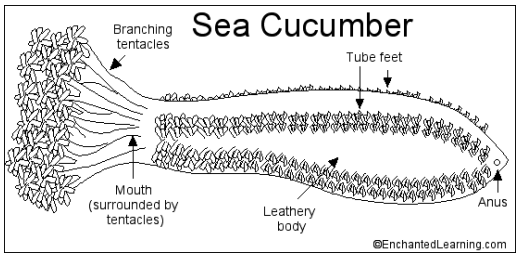
- Class **Holothuroidea**: sea cucumbers
  - elongated body
  - oral tube feet modified into feeding tentacles

deposit feeder

suspension feeder

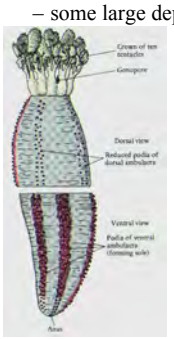
Phylum Echinodermata

- Class **Holothuroidea**: sea cucumbers
  - elongated body
  - oral tube feet modified into feeding tentacles

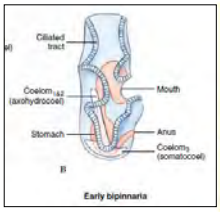


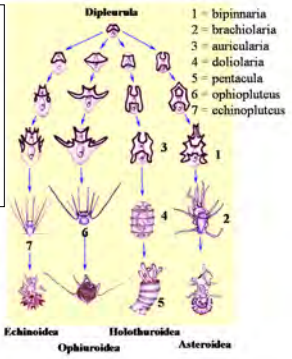
Phylum Echinodermata

- Class **Holothuroidea**: sea cucumbers
  - some large deposit feeders lose dorsal bands
  - → bilateral symmetry

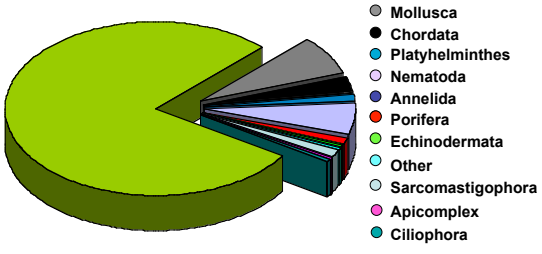


Echinoderm Development





Numbers of species



Kingdom Animalia

~30 phyla / disputed clades*

* Probably not true monophyletic clades

Diploblastic	Triploblastic Acoelomate	Triploblastic Pseudocoelomate	Triploblastic Eucoelomate
Porifera **Cnidaria**	**Platyhelminthes**	**Nematoda**	**Annelida** **Mollusca** **Arthropoda** **Echinodermata** **Chordata**

Mesozoa	Radiata	Lophotrochozoa	Ecdysozoa	Deuterostomia
Porifera	**Cnidaria**	**Platyhelminthes** **Annelida** **Mollusca**	**Nematoda** **Arthropoda**	**Echinodermata** **Chordata**

"For nearly every facet of early metazoan [animal] history there is an array of hypotheses that cannot be definitively falsified by the available data."

James W. Valentine, *On the Origin of Phyla*, University of Chicago Press, 2004.