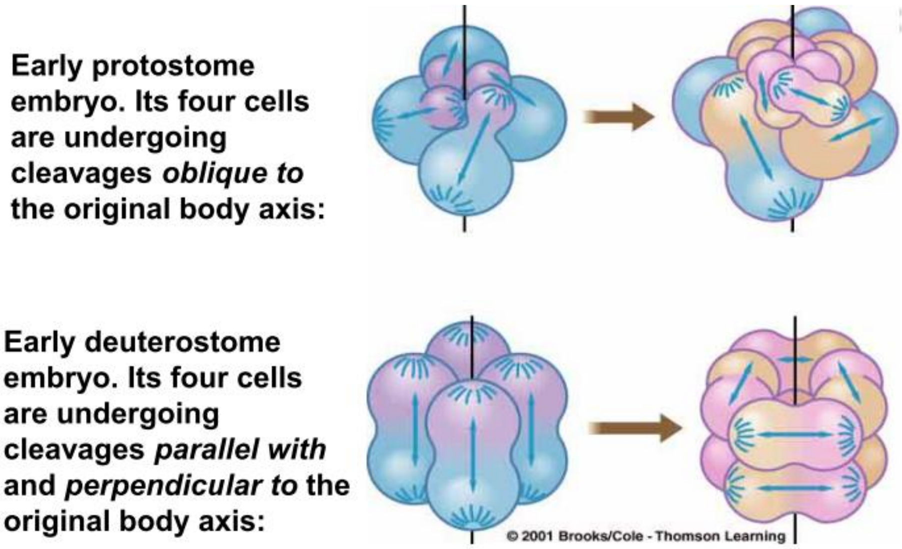
Animal Diversity Notes

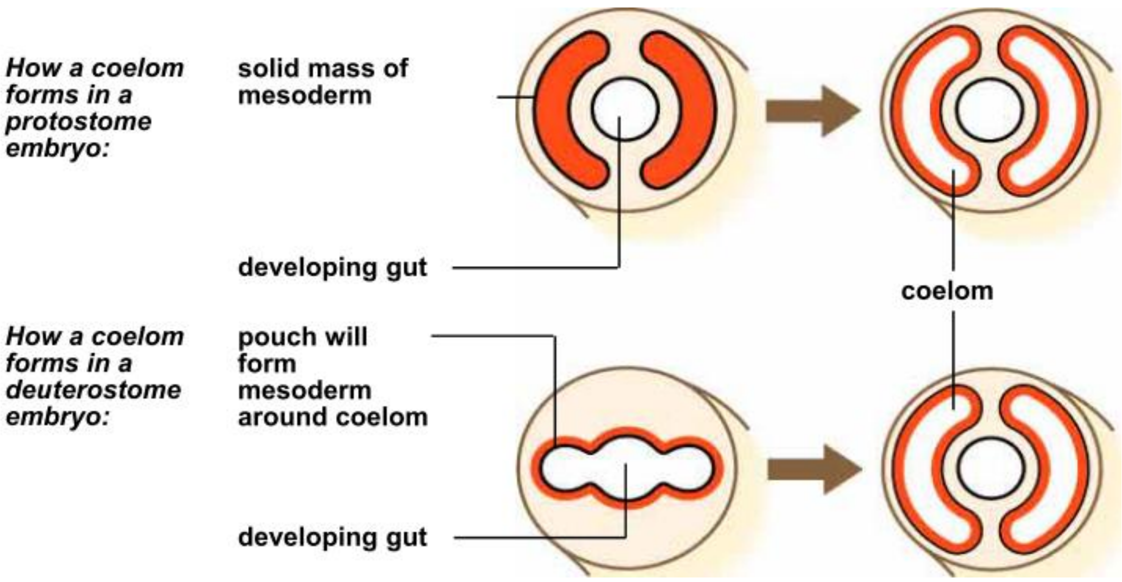
Key Biology Concepts

Protostomes/Deuterostomes

Difference based on:

- type of embryo cleavage
- fate of blastopore
- ontogeny of coelom (schizocely vs enterocely)





Tradeoffs of Ectothermy

- Disadvantages:
  - Activity limited by external temperature
  - Requires behavioural adaptations for finding thermal microenvironments (basking in sun or finding cool refuge)
  - Become inactive for part of the year
  - Limitations on latitudinal range (not as far north or south as endotherms)

- Advantages:
    - High efficiency of converting ingested food to biomass
    - Can thrive in ecosystems of low productivity (deserts, hot and dry)
    - Can survive with low metabolic rate

Purposes of Migration

- broadens the resource base, tracks available food
- high latitudes have longer days in summer, allowing extended foraging
- maintains relatively constant temperature by going tropics as winter sets in
- prevents permanent predation pressure in one location

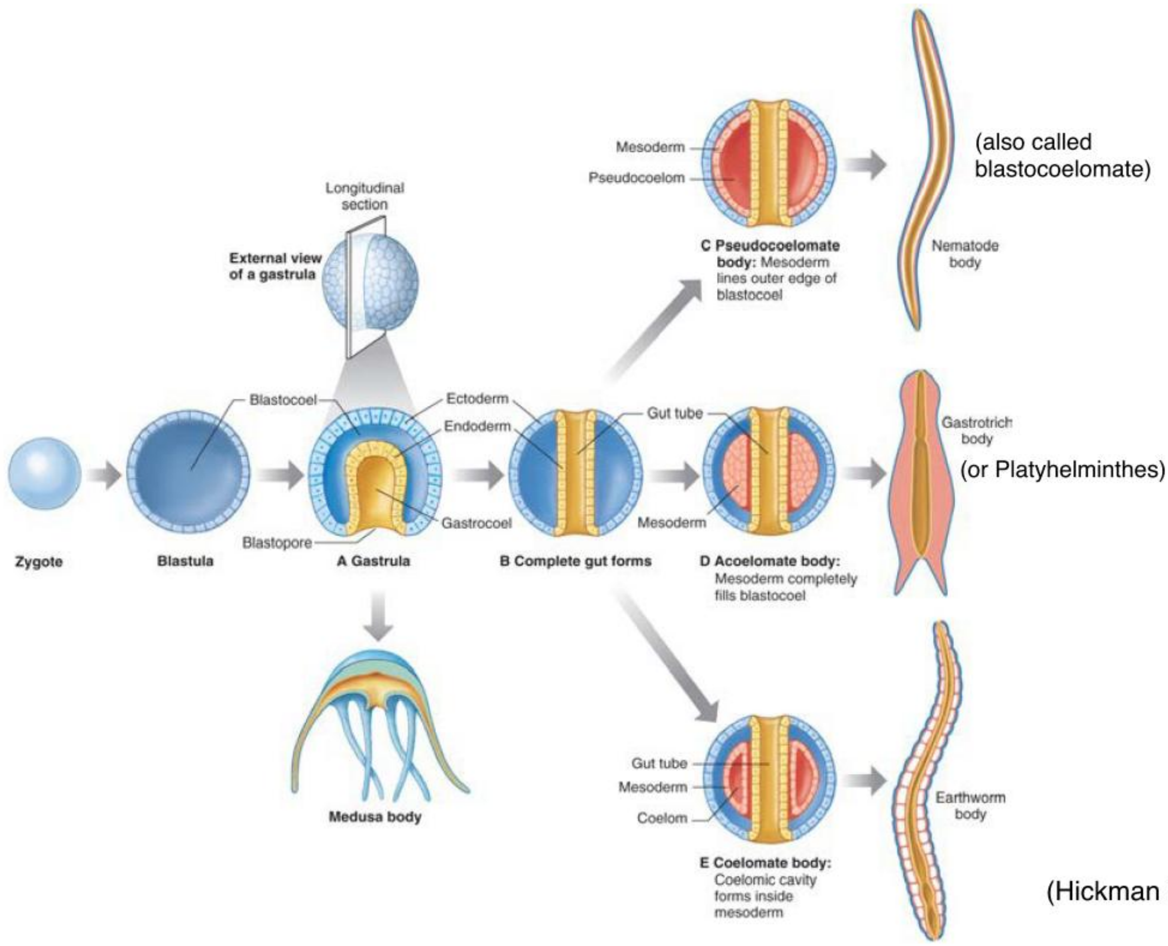
Advantages of the Coelomate Body Plan

- Cavity can function for circulation, waste disposal, and gamete storage and release
- Enables the development of a hydrostatic skeleton
- Provides cushioning for the digestive tract
- Muscular movements of the digestive tract isolated from the outer body wall and skeletal muscular movements

Advantages of Metamerism

- Improved efficiency of motion using hydrostatic skeleton
- Independent nervous control and movement of segments
- Architectural redundancy allows specialisation of segments as well as survival/regeneration when segments are lost

Modes of Development



(Hickman Fig.

Summary of Development

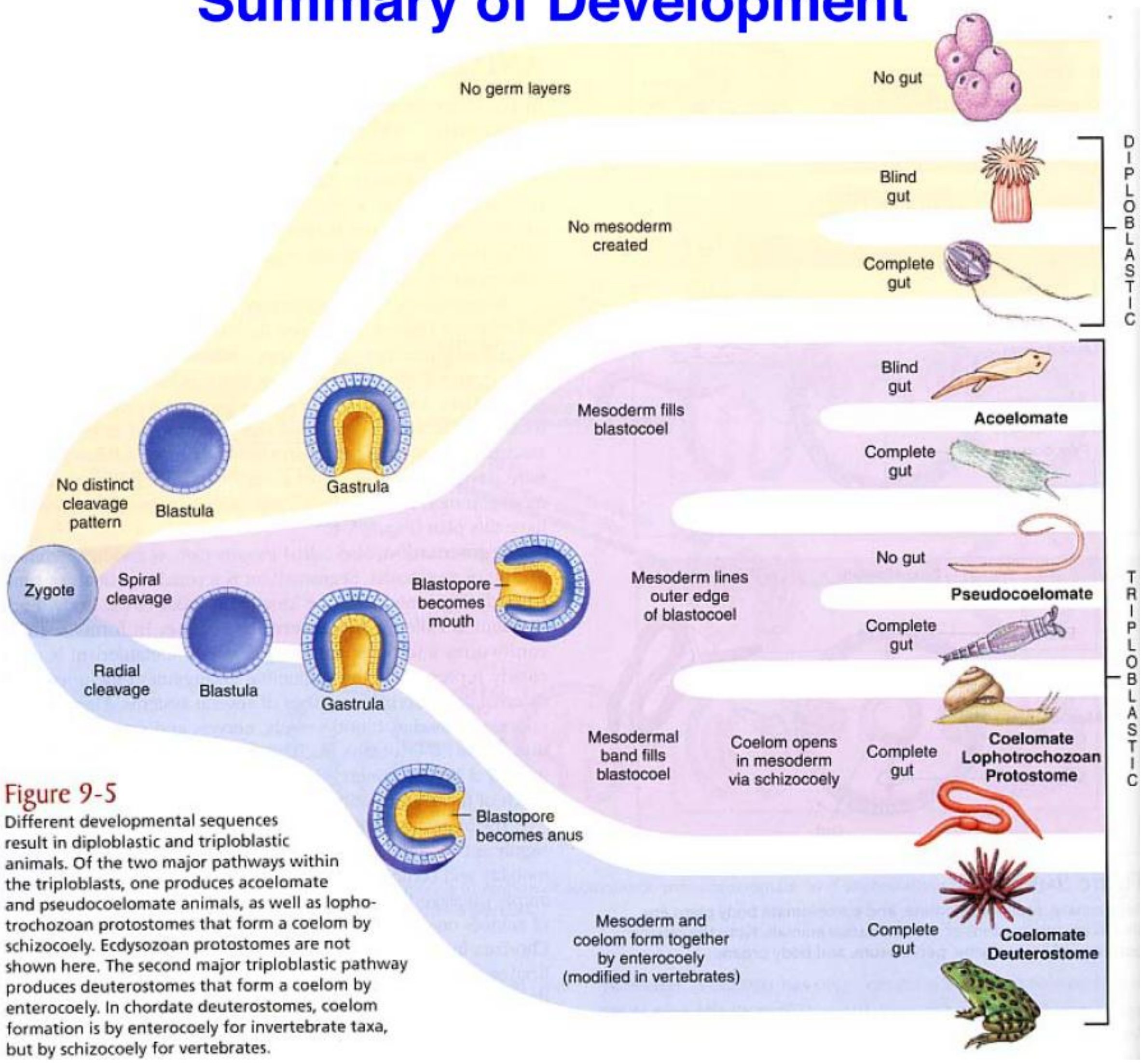
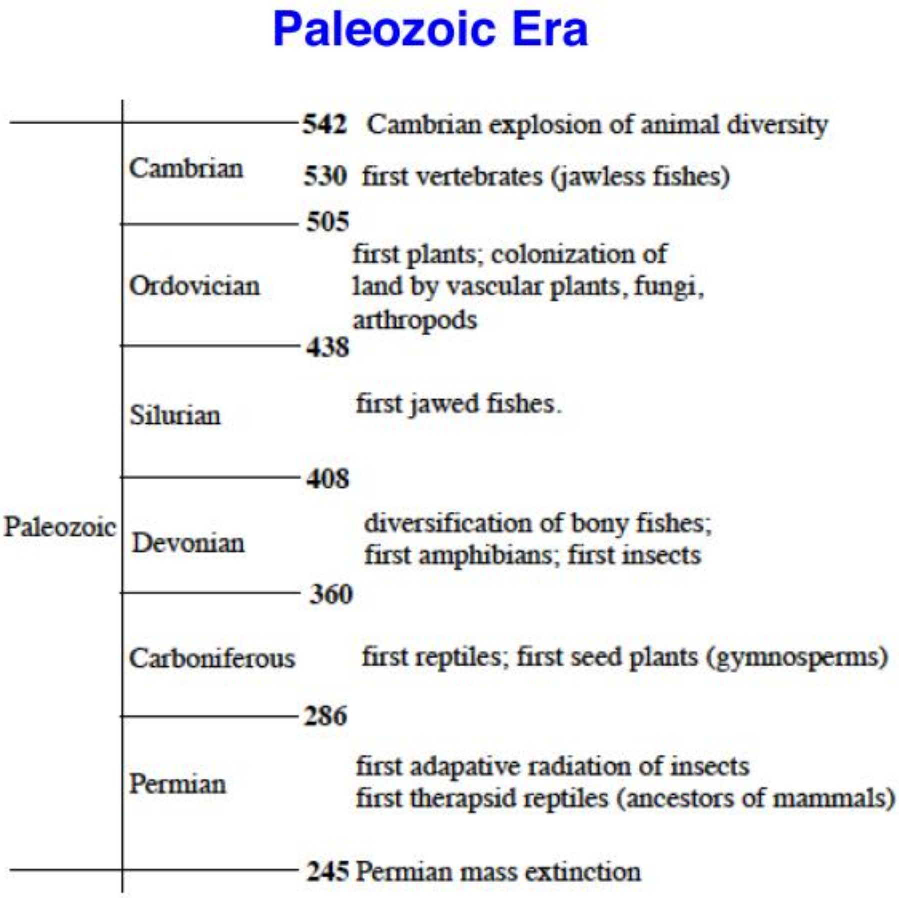
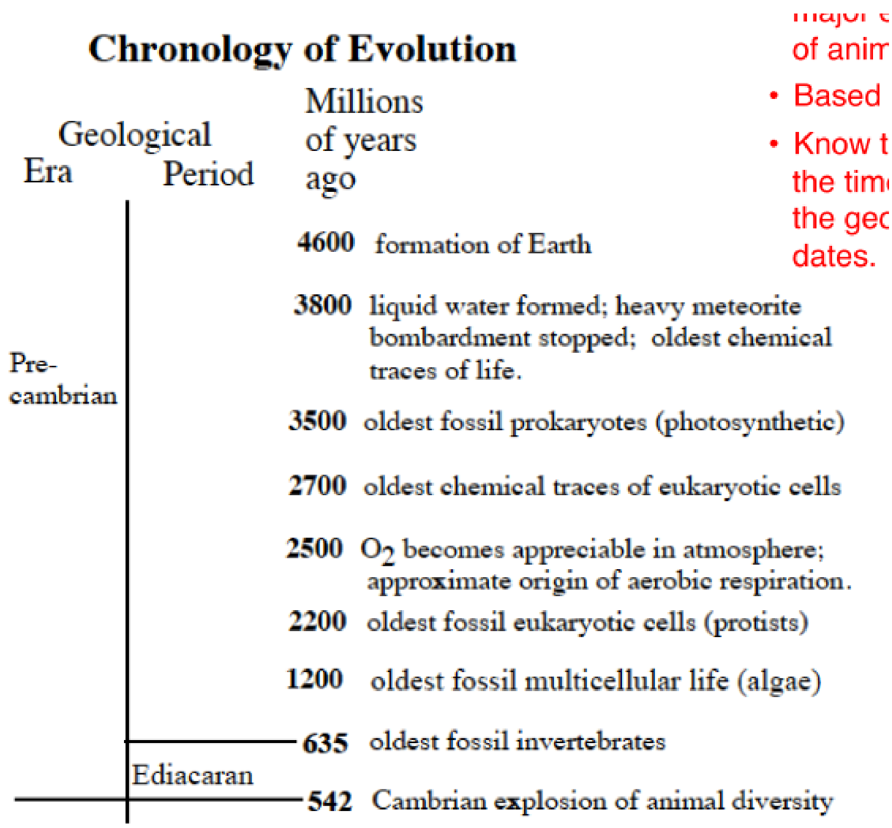


Figure 9-5

Different developmental sequences result in diploblastic and triploblastic animals. Of the two major pathways within the triploblasts, one produces acoelomate and pseudocoelomate animals, as well as lophotrochozoan protostomes that form a coelom by schizocoely. Ecdysozoan protostomes are not shown here. The second major triploblastic pathway produces deuterostomes that form a coelom by enterocoely. In chordate deuterostomes, coelom formation is by enterocoely for invertebrate taxa, but by schizocoely for vertebrates.

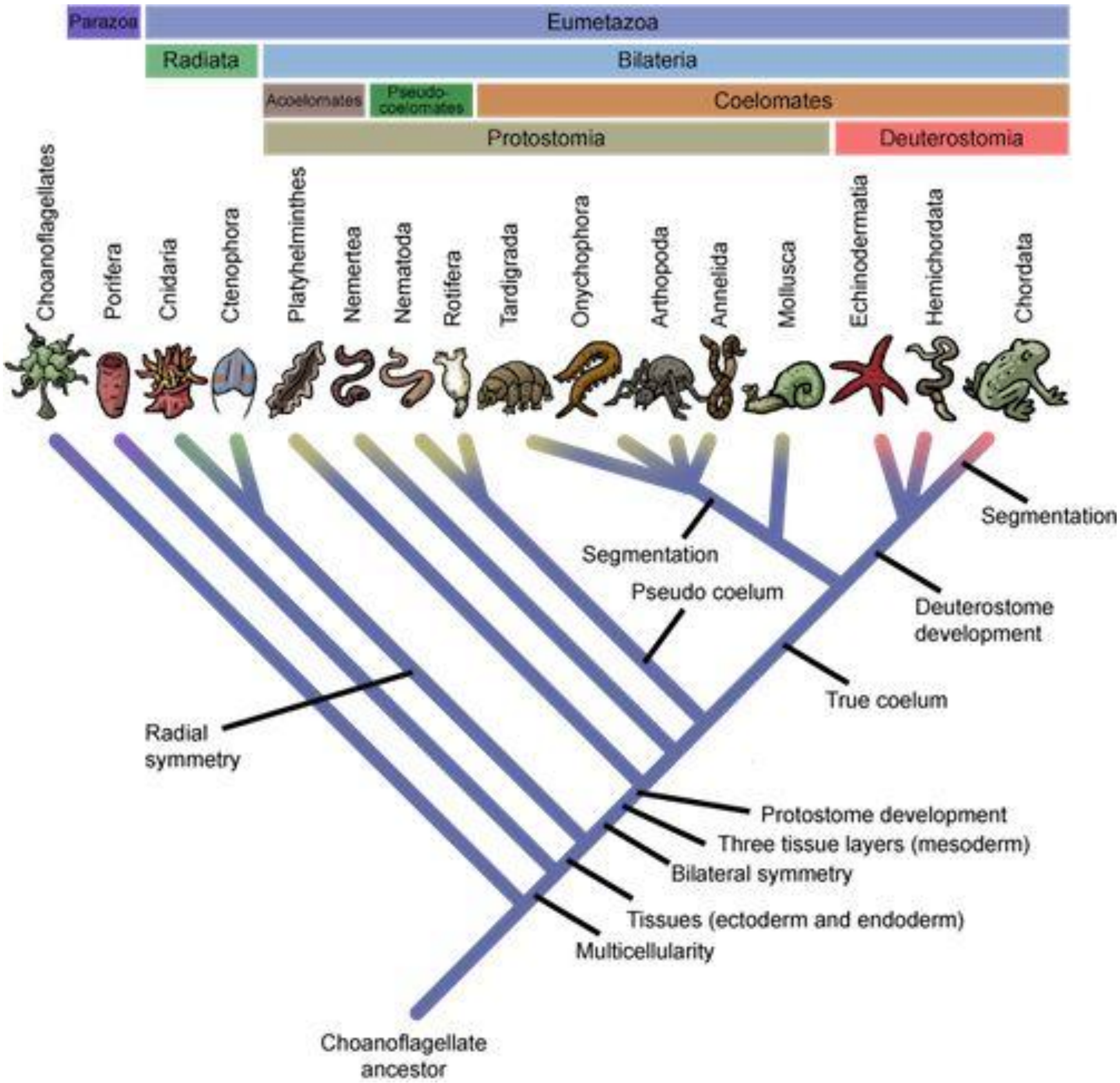
Timeline of Evolution

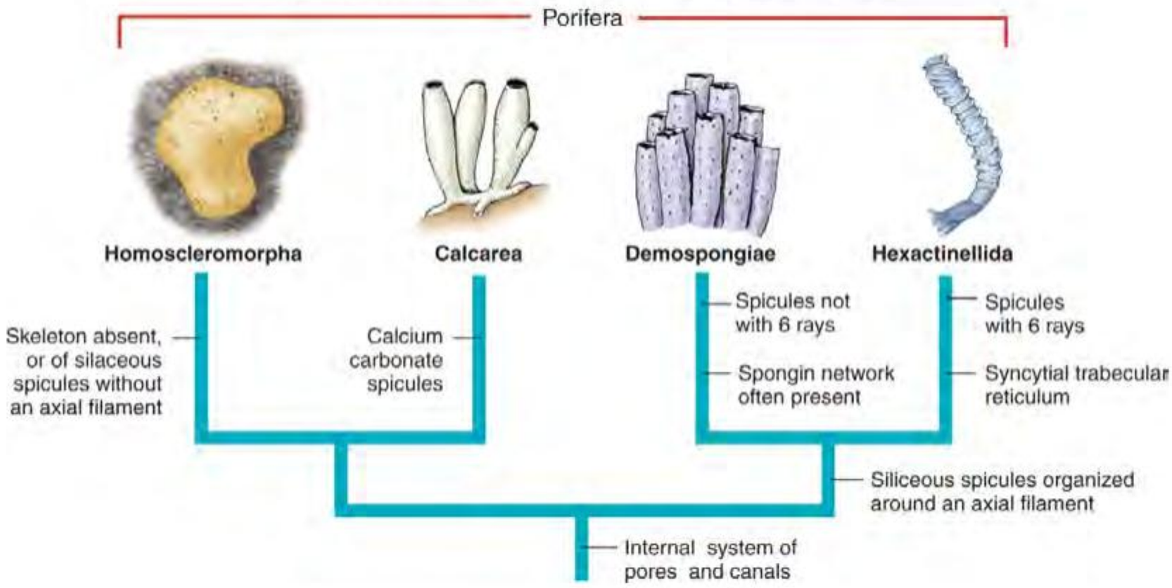




Essential Diagrams

Cladograms





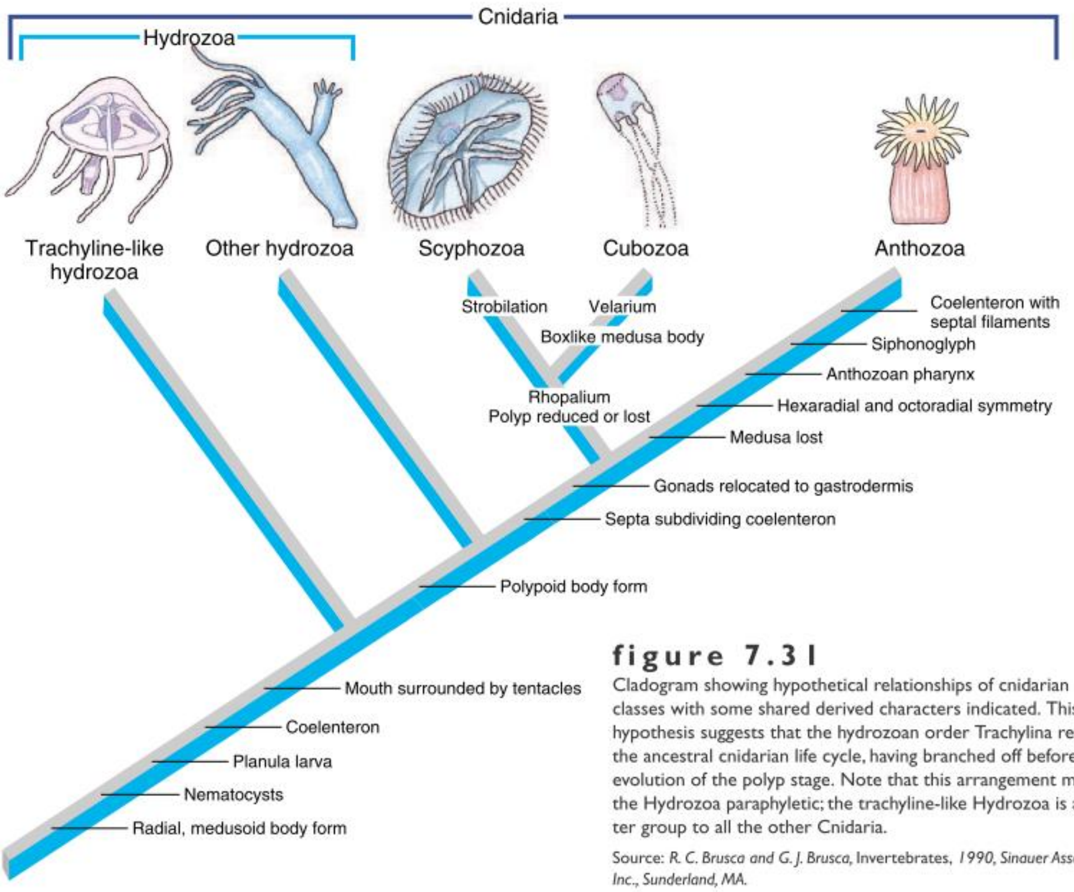
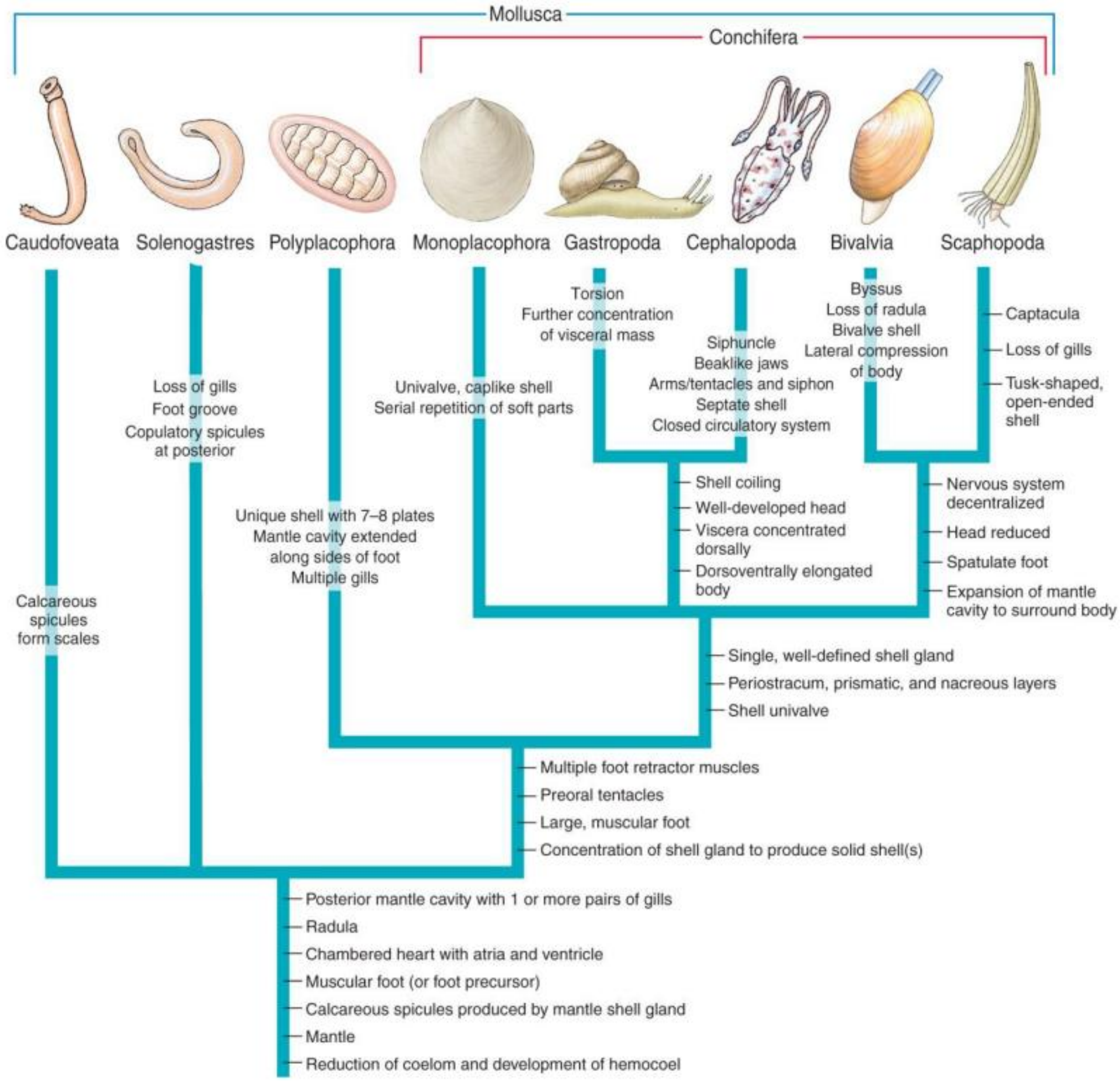
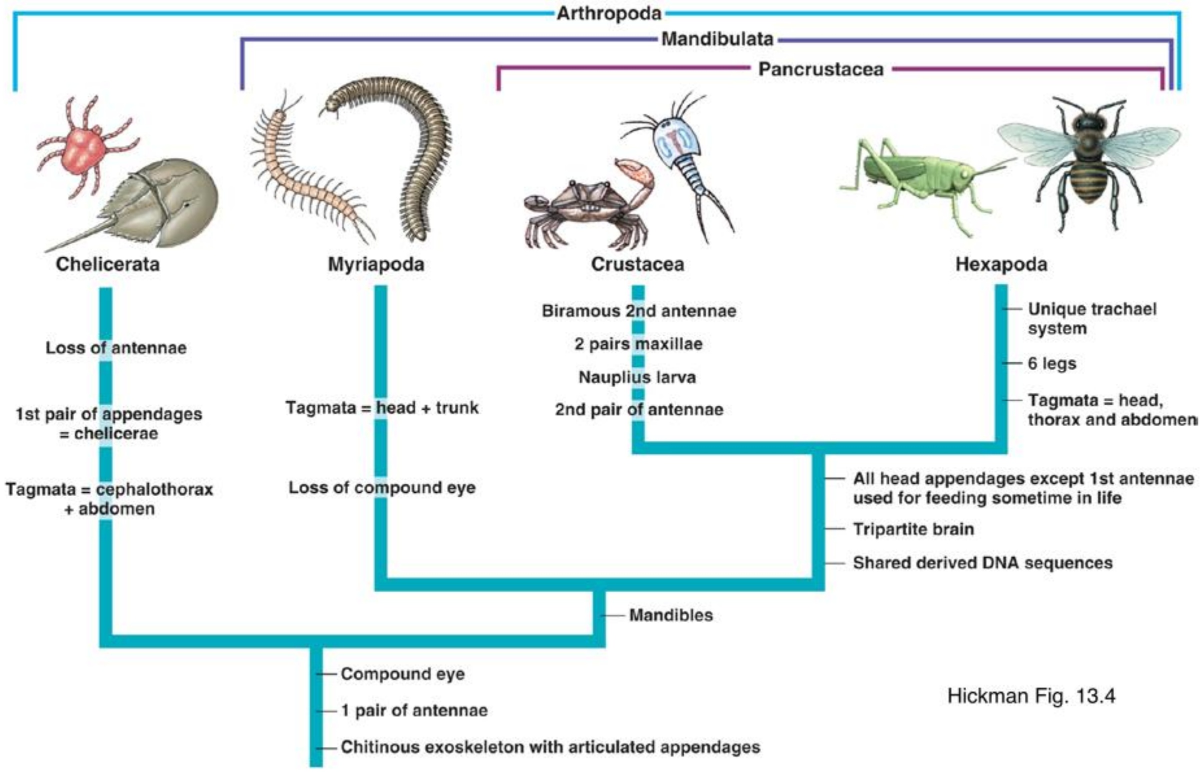


figure 7.31

Cladogram showing hypothetical relationships of cnidarian classes with some shared derived characters indicated. This hypothesis suggests that the hydrozoan order Trachylina retains the ancestral cnidarian life cycle, having branched off before the evolution of the polyp stage. Note that this arrangement makes the Hydrozoa paraphyletic; the trachyline-like Hydrozoa is a sister group to all the other Cnidaria.

Source: *R. C. Brusca and G. J. Brusca*, Invertebrates, *1990, Sinauer Associates, Inc., Sunderland, MA.*


Mollusca
Conchifera
Caudofoveata
Solenogastres
Polyplacophora
Monoplacophora
Gastropoda
Cephalopoda
Bivalvia
Scaphopoda
Torsion
Further concentration of visceral mass
Siphuncle
Beaklike jaws
Arms/tentacles and siphon
Septate shell
Closed circulatory system
Byssus
Loss of radula
Bivalve shell
Lateral compression of body
Captacula
Loss of gills
Tusk-shaped, open-ended shell
Loss of gills
Foot groove
Copulatory spicules at posterior
Univalve, caplike shell
Serial repetition of soft parts
Shell coiling
Well-developed head
Viscera concentrated dorsally
Dorsoventrally elongated body
Nervous system decentralized
Head reduced
Spatulate foot
Expansion of mantle cavity to surround body
Unique shell with 7–8 plates
Mantle cavity extended along sides of foot
Multiple gills
Calcareous spicules form scales
Single, well-defined shell gland
Periostracum, prismatic, and nacreous layers
Shell univalve
Multiple foot retractor muscles
Preoral tentacles
Large, muscular foot
Concentration of shell gland to produce solid shell(s)
Posterior mantle cavity with 1 or more pairs of gills
Radula
Chambered heart with atria and ventricle
Muscular foot (or foot precursor)
Calcareous spicules produced by mantle shell gland
Mantle
Reduction of coelom and development of hemocoel



Hickman Fig. 13.4

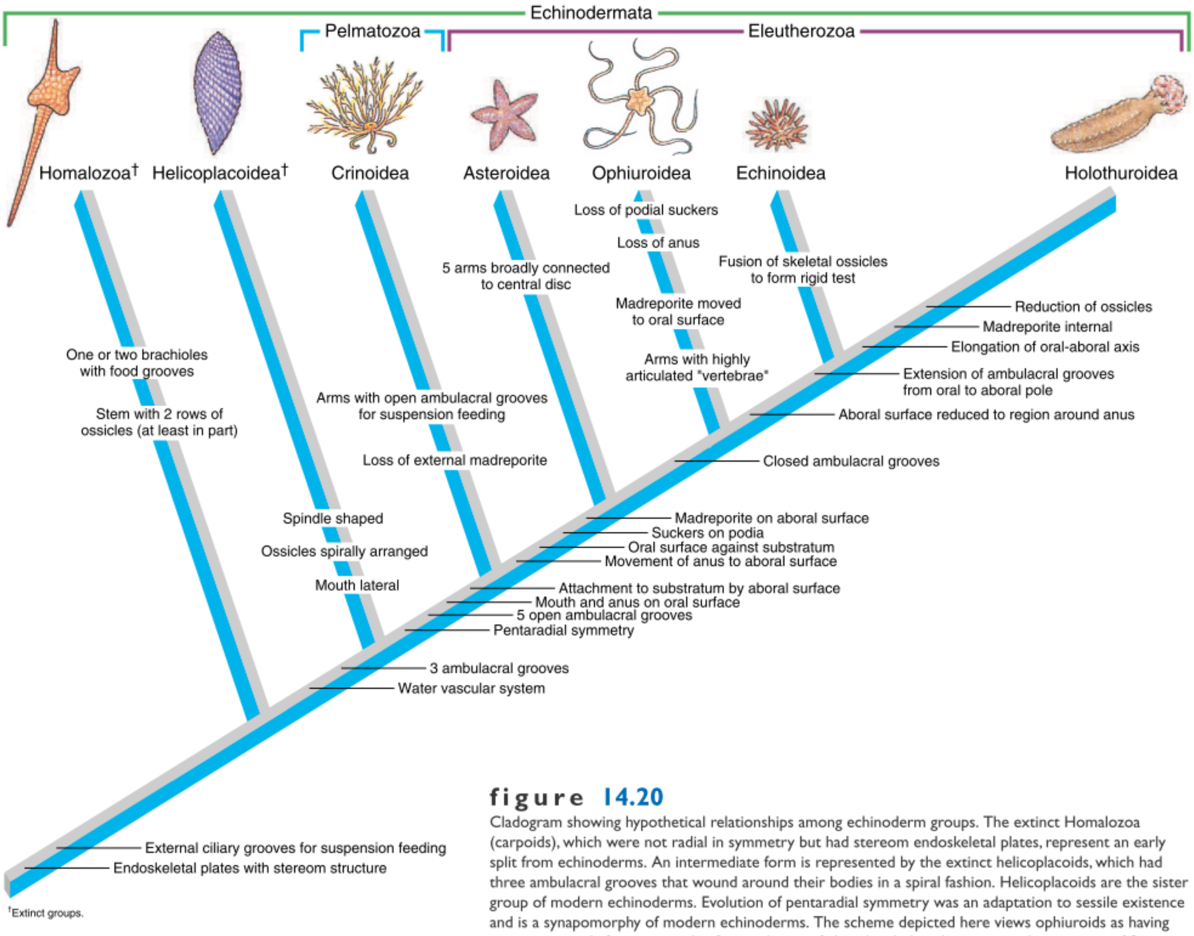
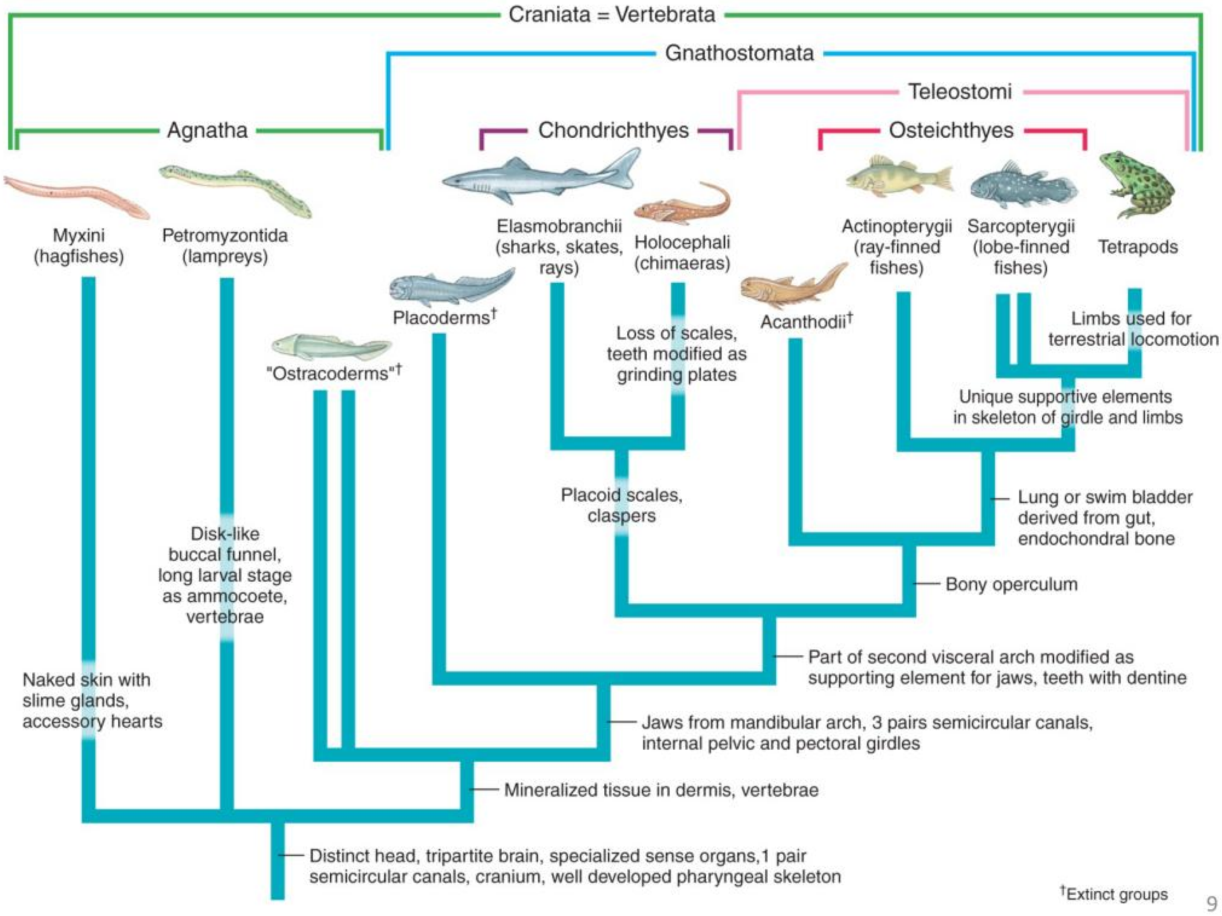
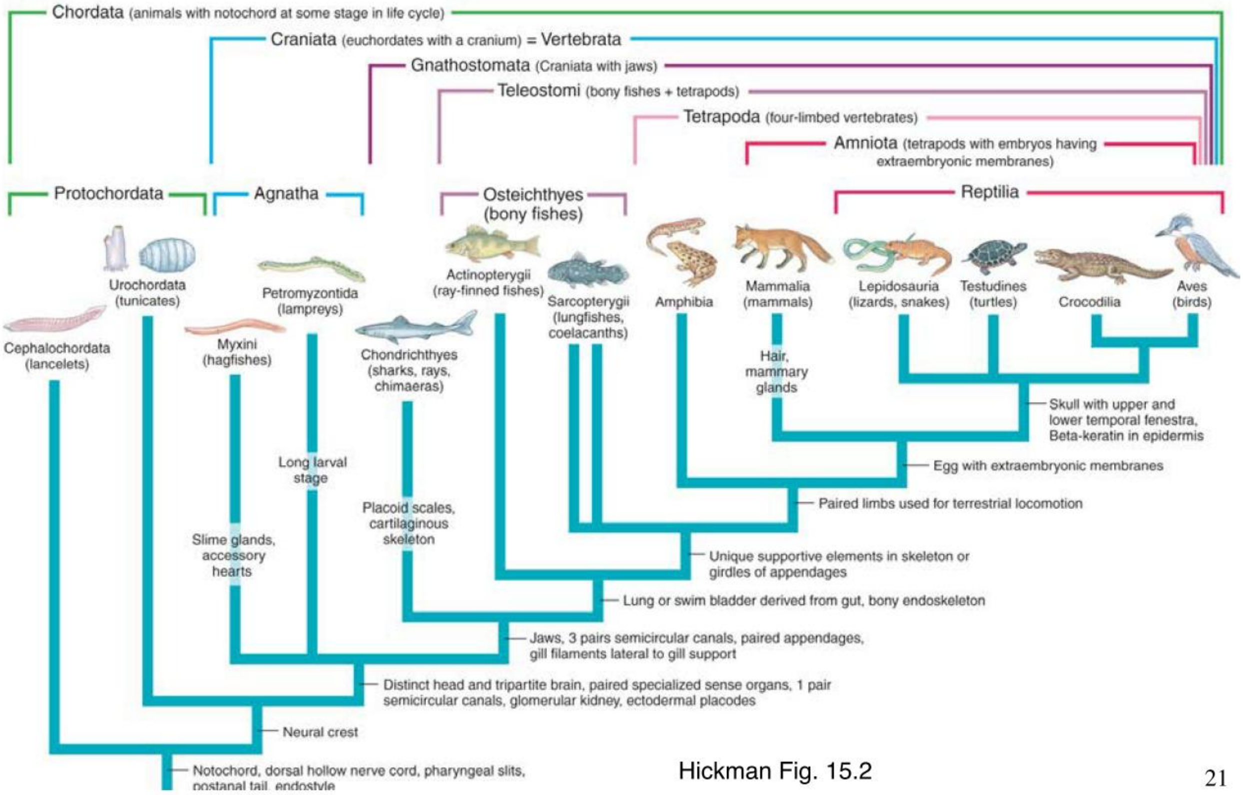


figure 14.20
Cladogram showing hypothetical relationships among echinoderm groups. The extinct Homalozoa (carpoids), which were not radial in symmetry but had stereom endoskeletal plates, represent an early split from echinoderms. An intermediate form is represented by the extinct helicoplacoids, which had three ambulacral grooves that wound around their bodies in a spiral fashion. Helicoplacoids are the sister group of modern echinoderms. Evolution of pentaradial symmetry was an adaptation to sessile existence and is a synapomorphy of modern echinoderms. The scheme depicted here views ophiuroids as having arisen separately from asteroids, after evolution of closed ambulacral grooves, and possession of five arms would thus have been of separate origin. Alternatively, if Asteroidea and Ophiuroidea form a clade, with

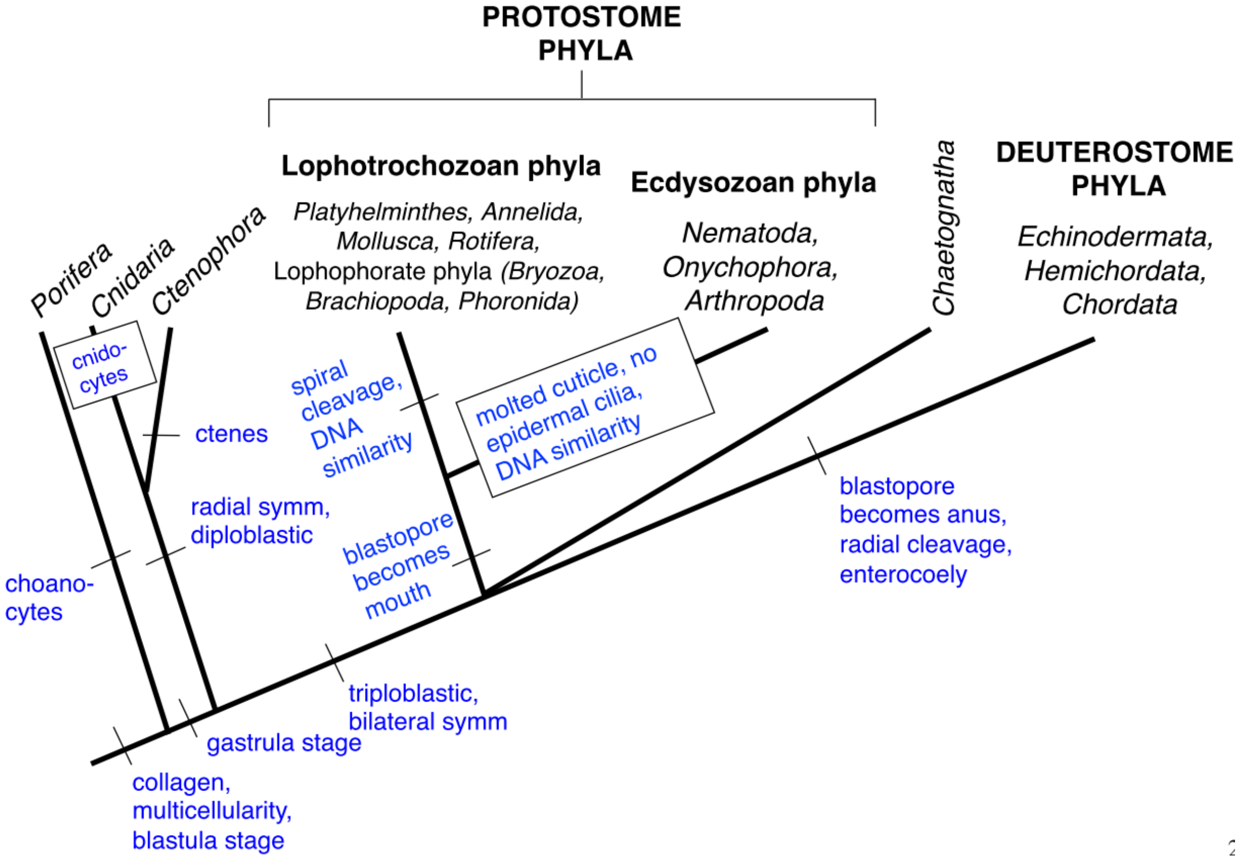


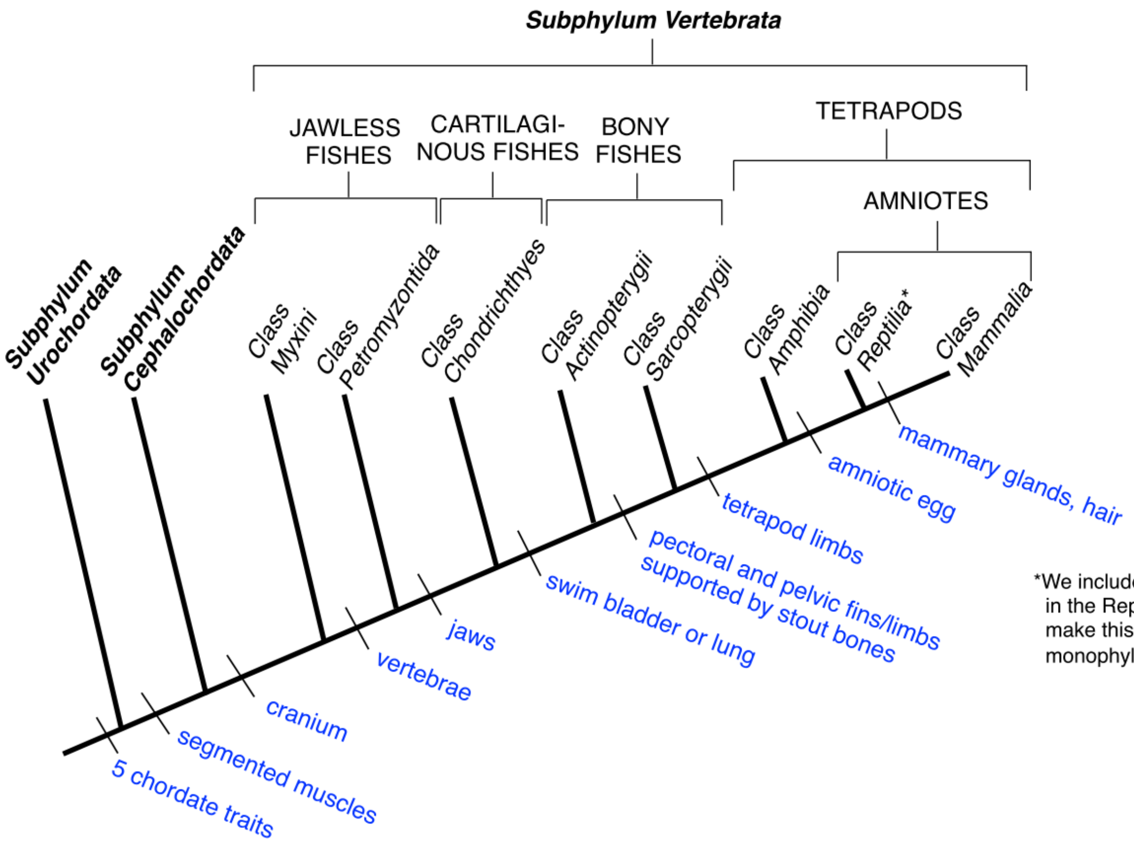
9



Hickman Fig. 15.2

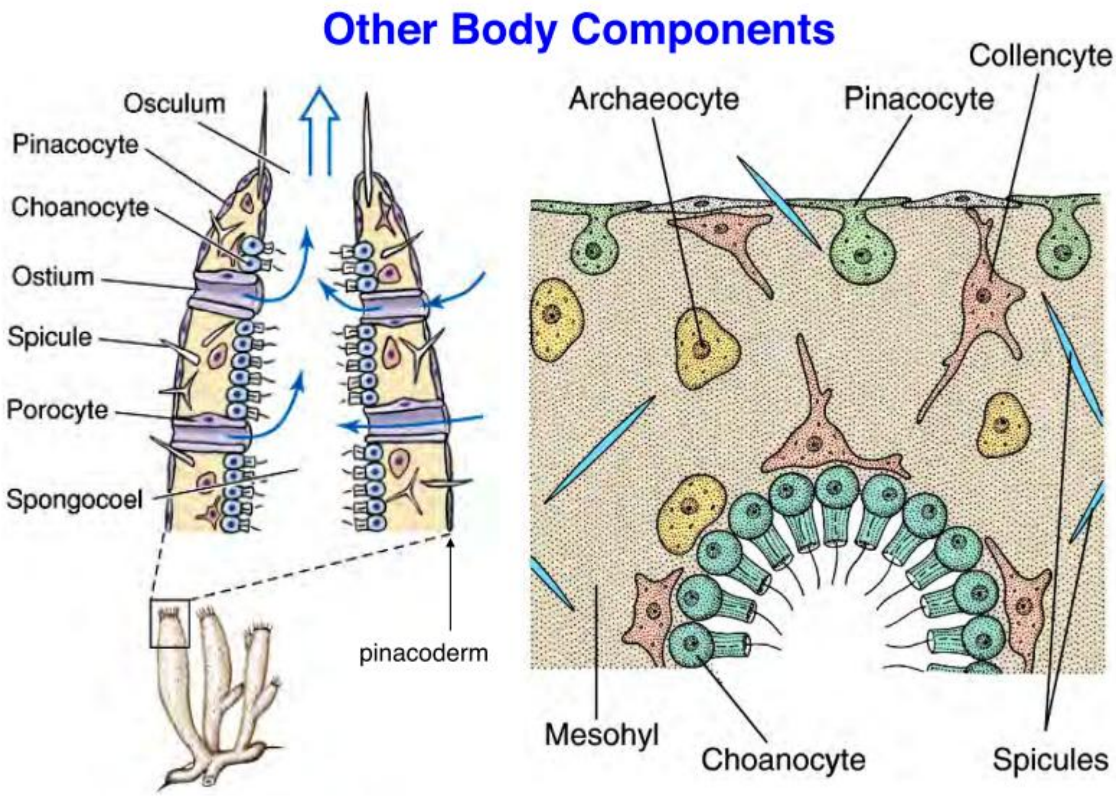
21





*We include birds in the Reptilia to make this Class monophyletic.

Key Animal Diagrams



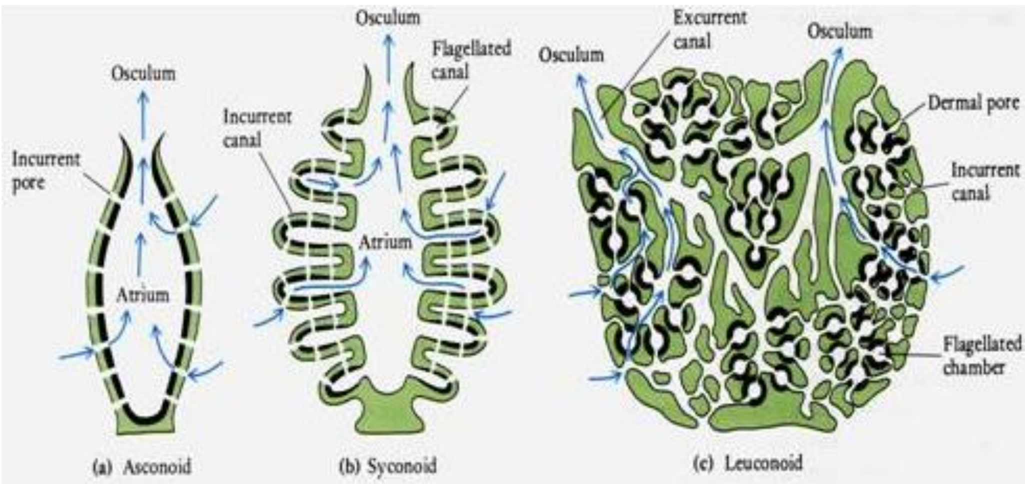
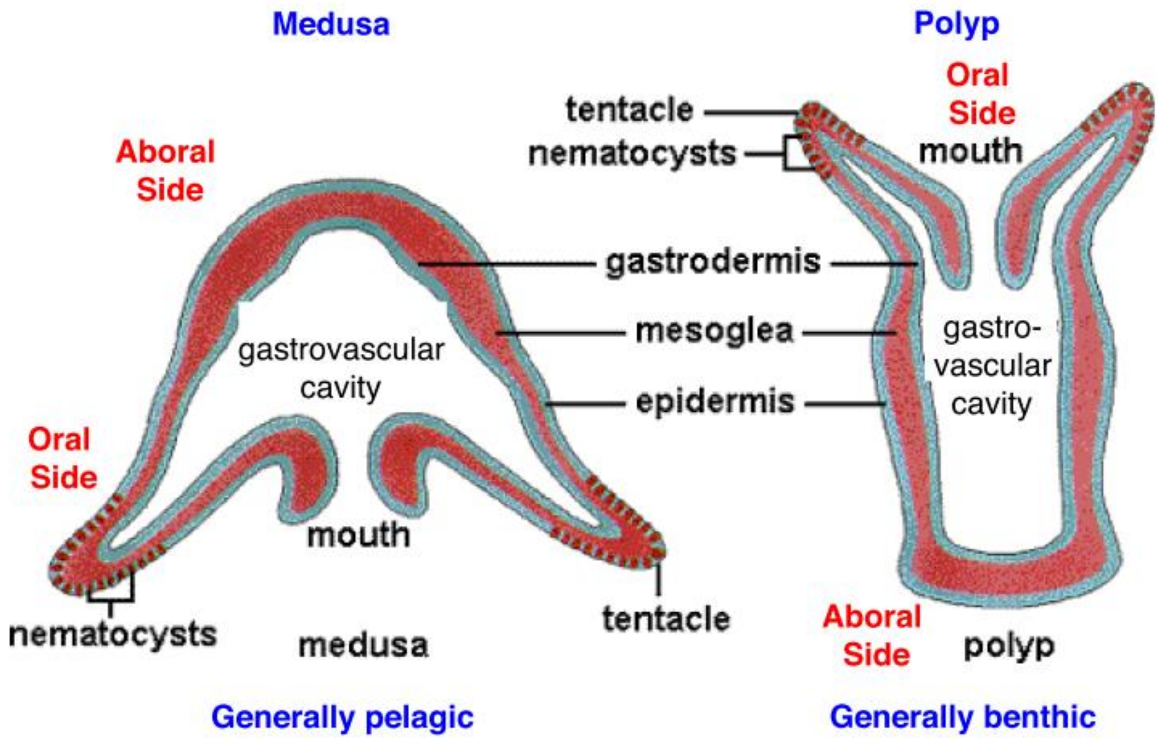
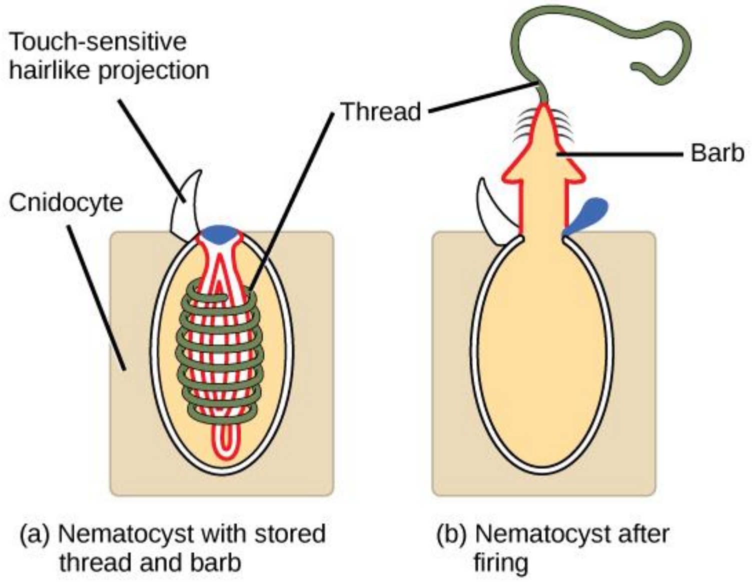
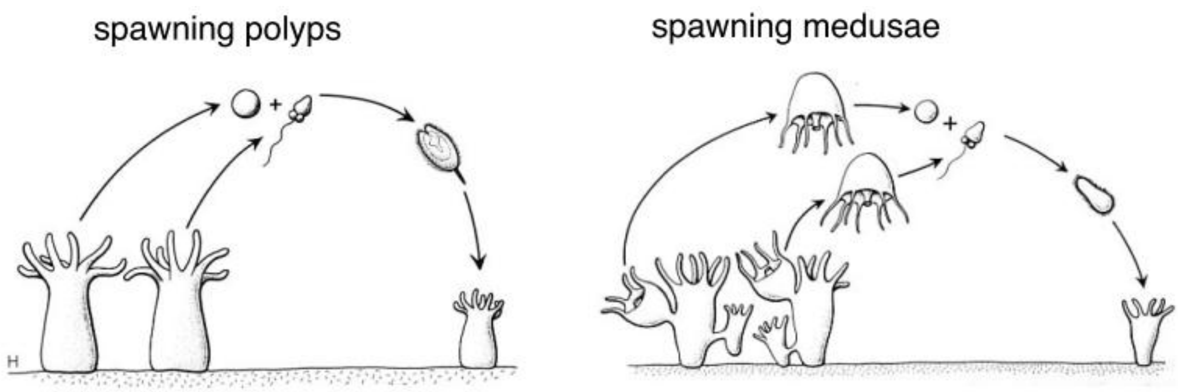
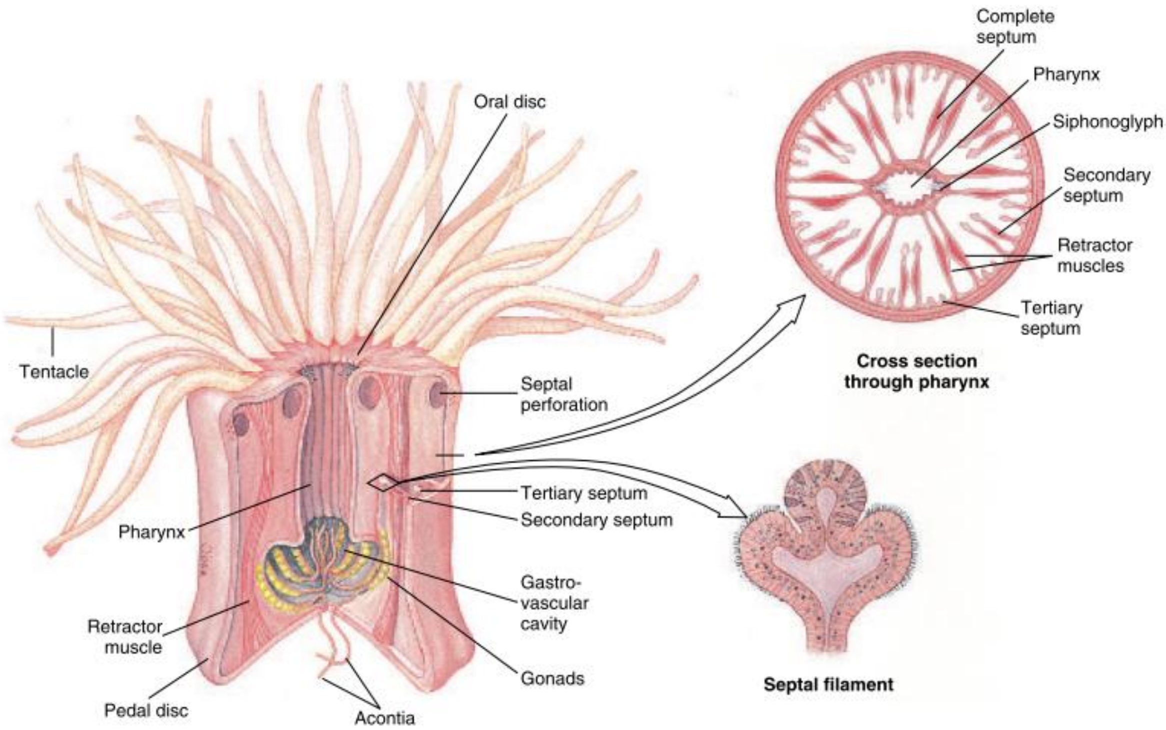


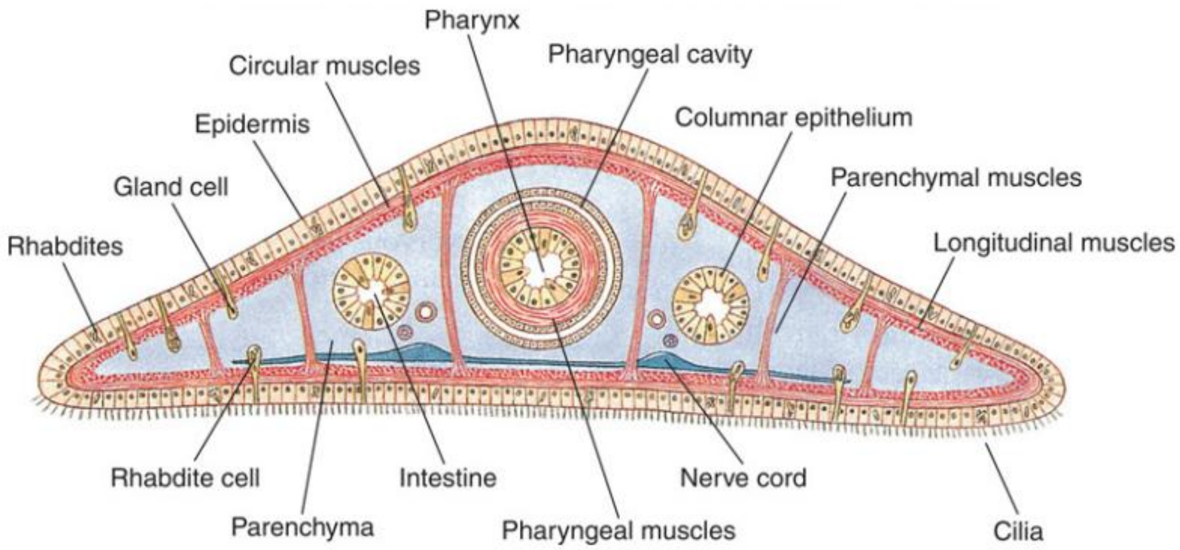
Figure 25.5
Types of sponge structure. (a–c) The three structural types of sponges. In each, the choanocytes are shown in black. Light arrows indicate the direction of water flow; heavy arrows indicate the exhalant flow from the osculum.

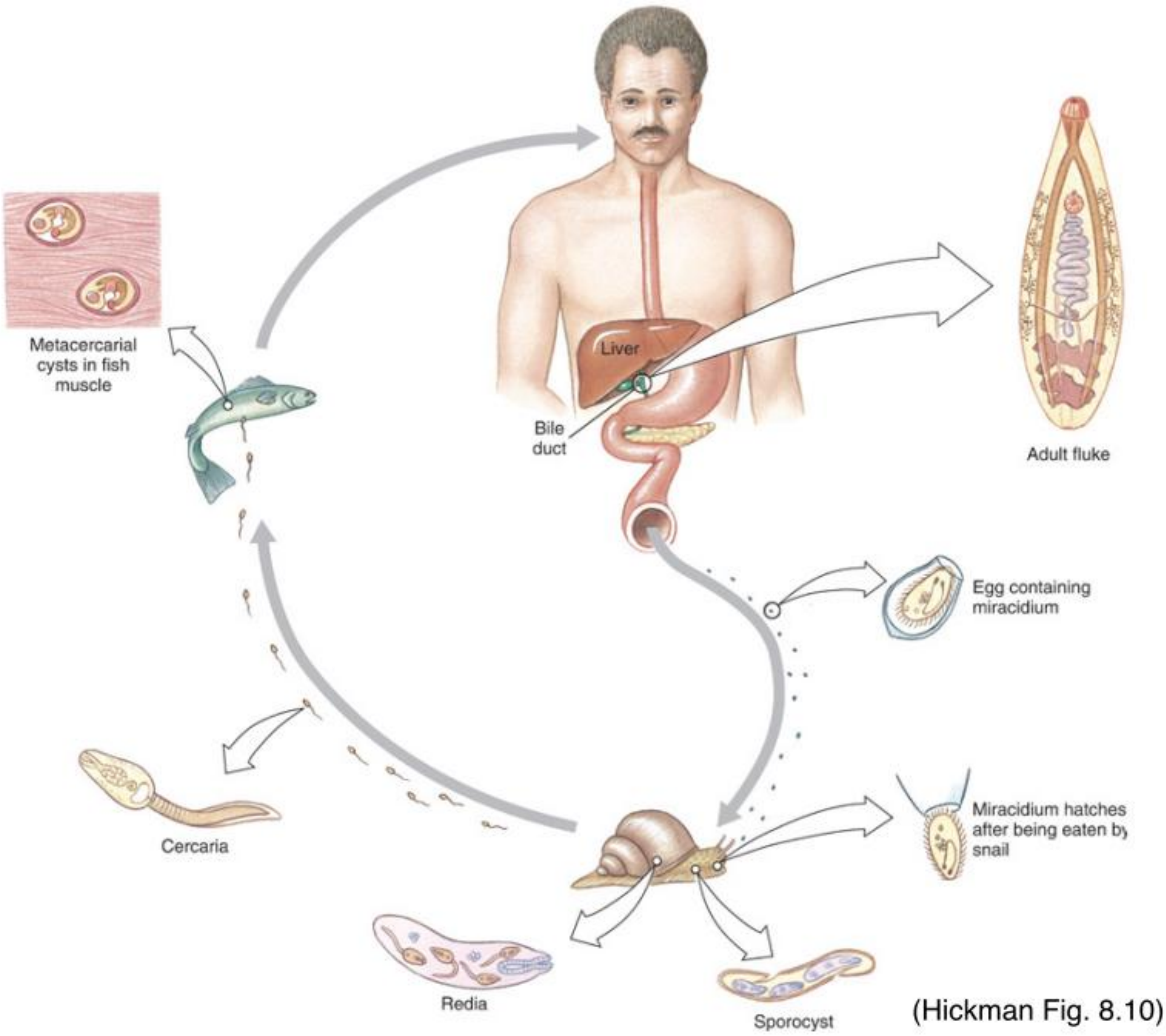

Medusa
Polyp
Aboral
Side
Oral
Side
tentacle
nematocysts
mouth
gastrodermis
mesoglea
epidermis
gastrovascular
cavity
gastro-
vascular
cavity
Oral
Side
mouth
nematocysts
medusa
tentacle
Aboral
Side
polyp
Generally pelagic
Generally benthic


Touch-sensitive
hairlike projection
Thread
Barb
Cnidocyte
(a) Nematocyst with stored
thread and barb
(b) Nematocyst after
firing

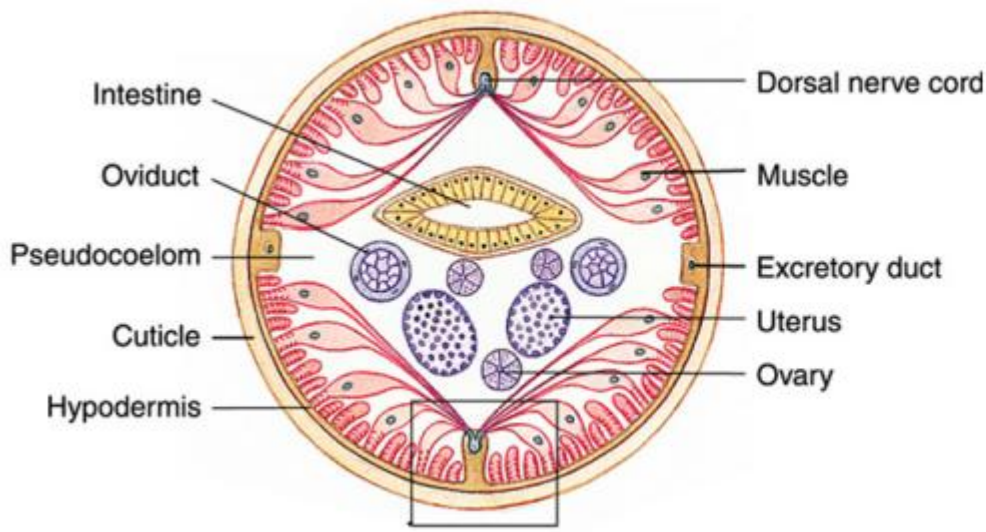

spawning polyps
spawning medusae

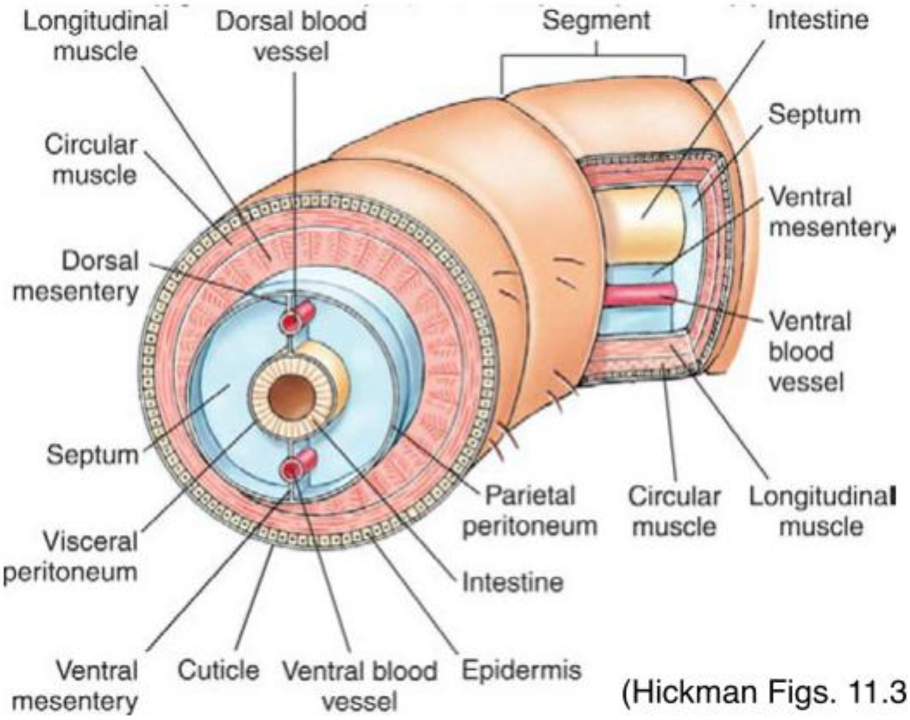

Oral disc
Tentacle
Septal perforation
Tertiary septum
Secondary septum
Pharynx
Gastro-vascular cavity
Retractor muscle
Gonads
Pedal disc
Acontia
Complete septum
Pharynx
Siphonoglyph
Secondary septum
Retractor muscles
Tertiary septum
Cross section through pharynx
Septal filament


Pharynx
Circular muscles
Pharyngeal cavity
Epidermis
Columnar epithelium
Gland cell
Parenchymal muscles
Rhabdites
Longitudinal muscles
Rhabdite cell
Intestine
Nerve cord
Parenchyma
Pharyngeal muscles
Cilia

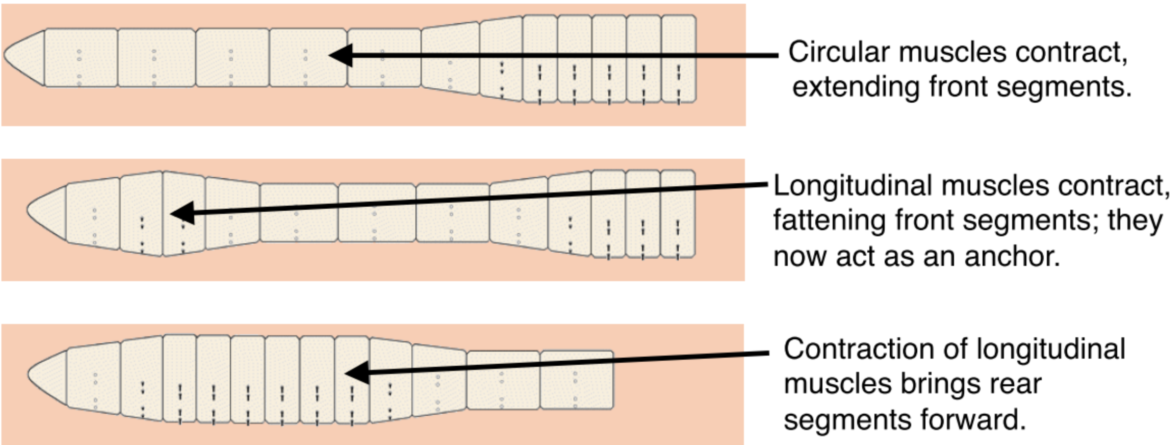


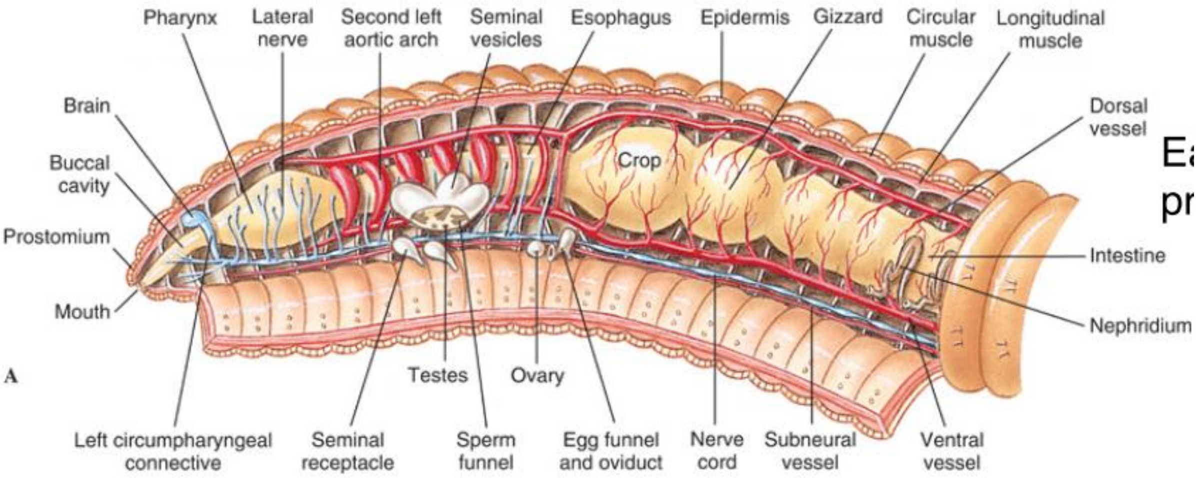
(Hickman Fig. 8.10)

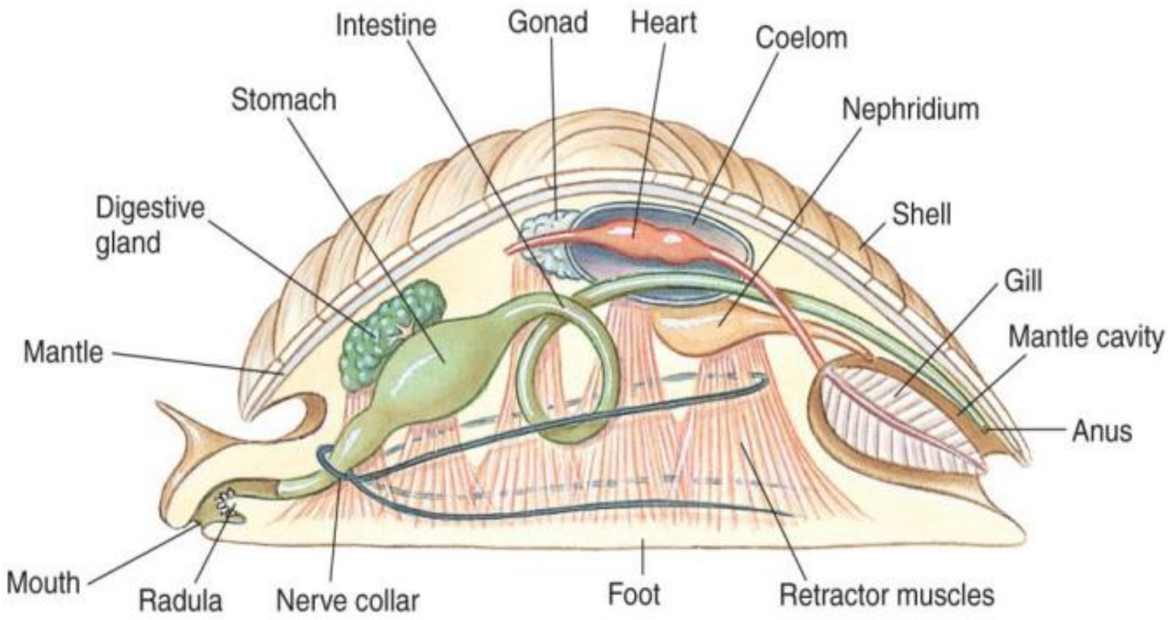


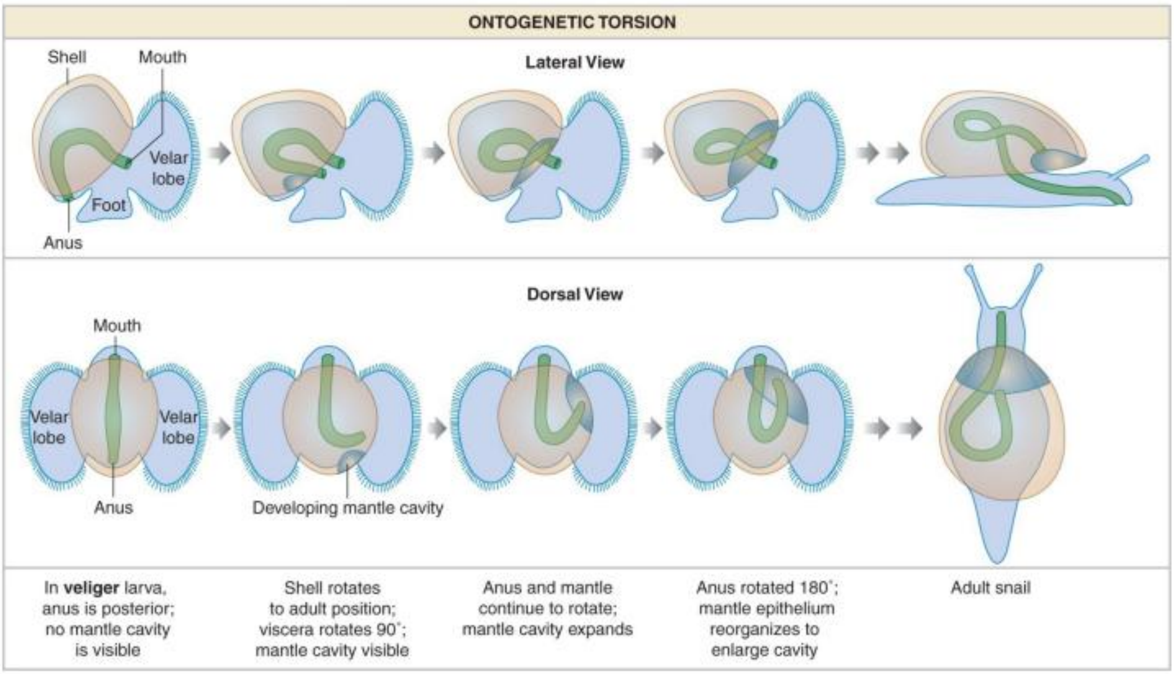


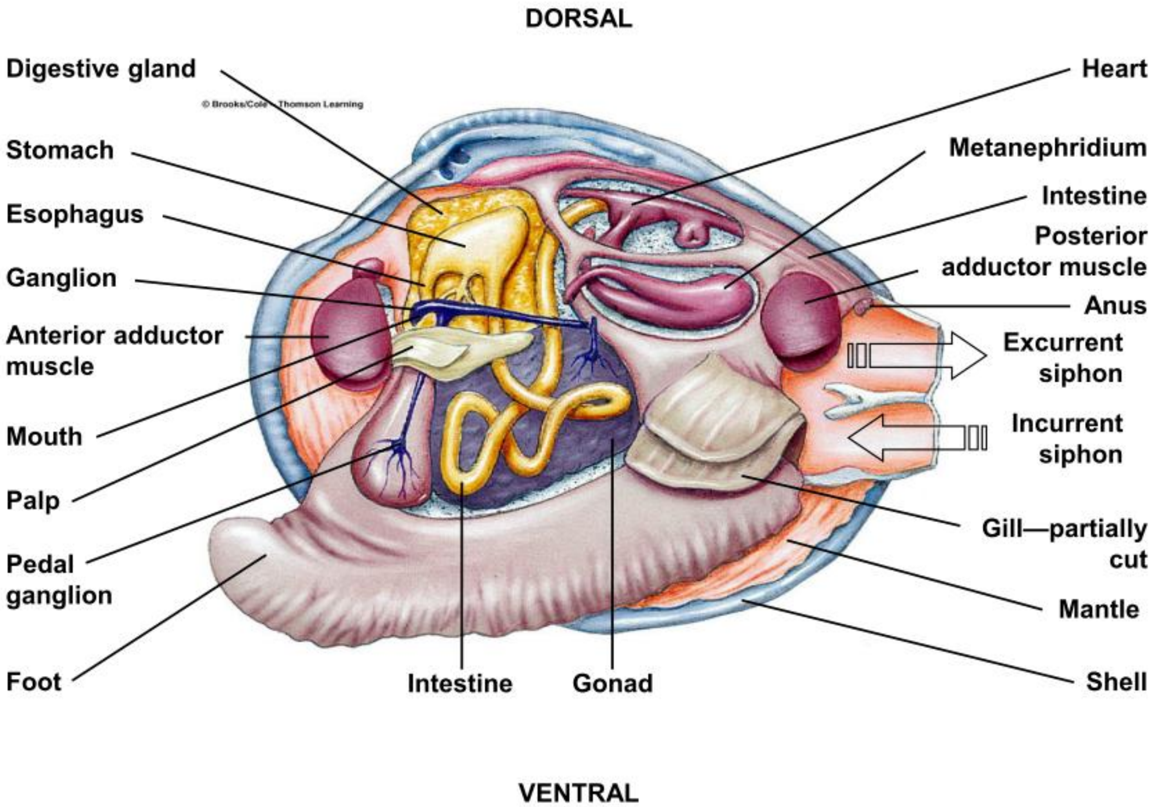
(Hickman Figs. 11.3

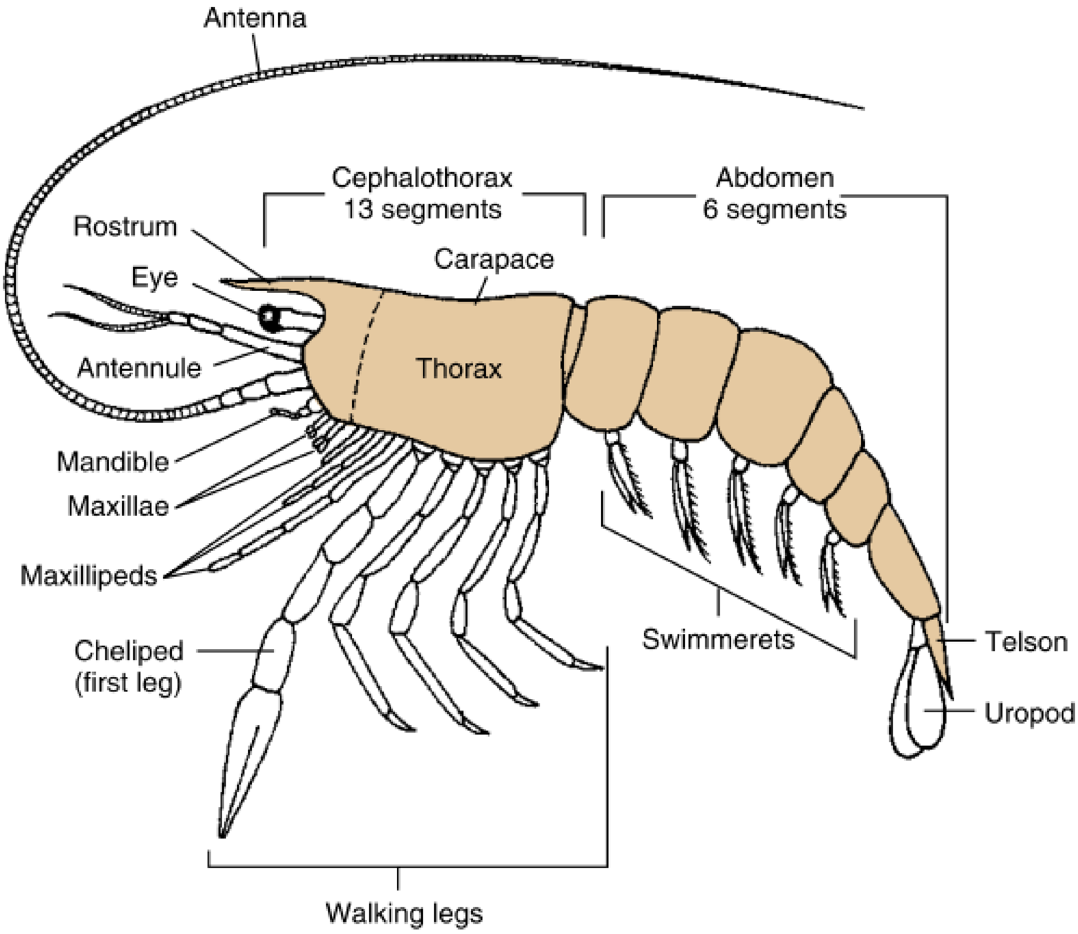


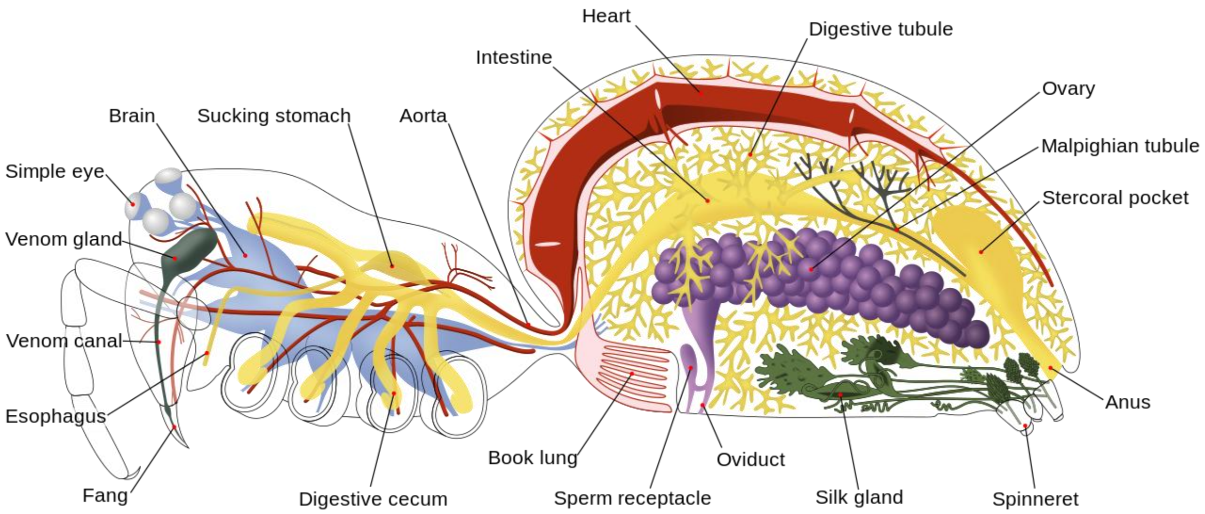


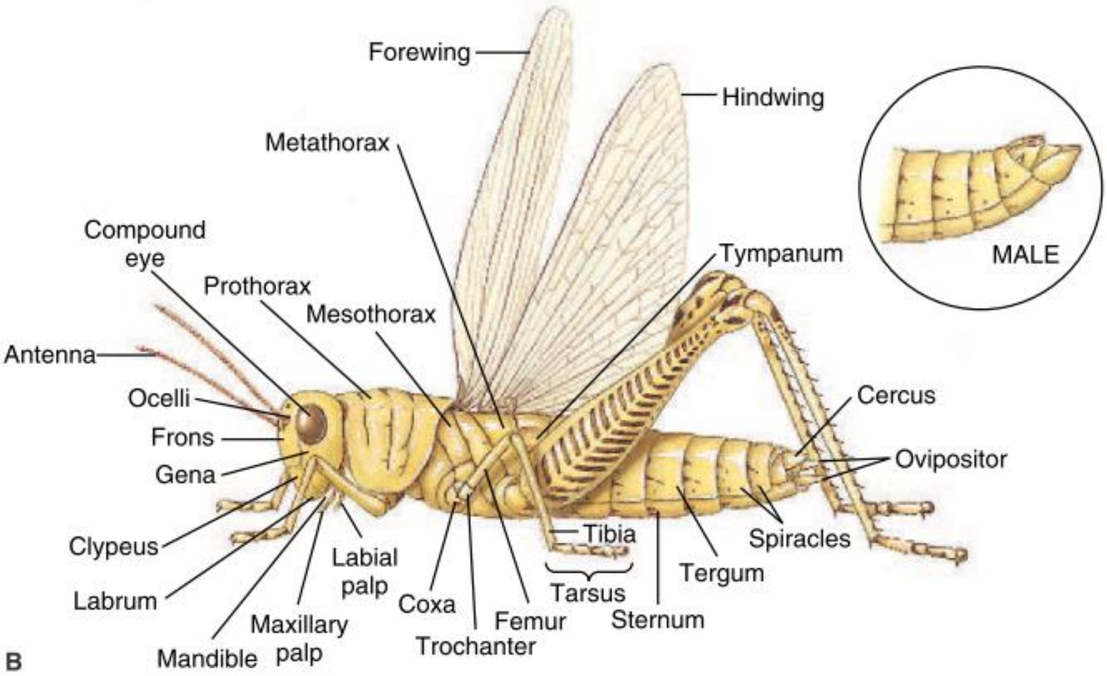

Intestine
Gonad
Heart
Coelom
Stomach
Nephridium
Digestive gland
Shell
Gill
Mantle cavity
Mantle
Anus
Mouth
Radula
Nerve collar
Foot
Retractor muscles


ONTOGENETIC TORSION
Lateral View
Shell
Mouth
Velar lobe
Foot
Anus
Dorsal View
Mouth
Velar lobe
Velar lobe
Anus
Developing mantle cavity
In veliger larva, anus is posterior; no mantle cavity is visible
Shell rotates to adult position; viscera rotates 90˚; mantle cavity visible
Anus and mantle continue to rotate; mantle cavity expands
Anus rotated 180˚; mantle epithelium reorganizes to enlarge cavity
Adult snail


DORSAL
Digestive gland
© Brooks/Cole Thomson Learning
Stomach
Esophagus
Ganglion
Anterior adductor muscle
Mouth
Palp
Pedal ganglion
Foot
Intestine
Gonad
Heart
Metanephridium
Intestine
Posterior adductor muscle
Anus
Excurrent siphon
Incurrent siphon
Gill—partially cut
Mantle
Shell
VENTRAL


Antenna
Cephalothorax
13 segments
Abdomen
6 segments
Rostrum
Eye
Carapace
Thorax
Antennule
Mandible
Maxillae
Maxillipeds
Cheliped
(first leg)
Swimmerets
Telson
Uropod
Walking legs


Heart
Digestive tubule
Intestine
Ovary
Brain
Sucking stomach
Aorta
Malpighian tubule
Simple eye
Stercoral pocket
Venom gland
Venom canal
Esophagus
Anus
Book lung
Oviduct
Fang
Digestive cecum
Sperm receptacle
Silk gland
Spinneret


Forewing
Hindwing
Metathorax
MALE
Compound eye
Tympanum
Prothorax
Mesothorax
Antenna
Ocelli
Cercus
Frons
Ovipositor
Gena
Tibia
Spiracles
Clypeus
Labial palp
Tergum
Tarsus
Labrum
Coxa
Femur
Sternum
Maxillary palp
Trochanter
B
Mandible

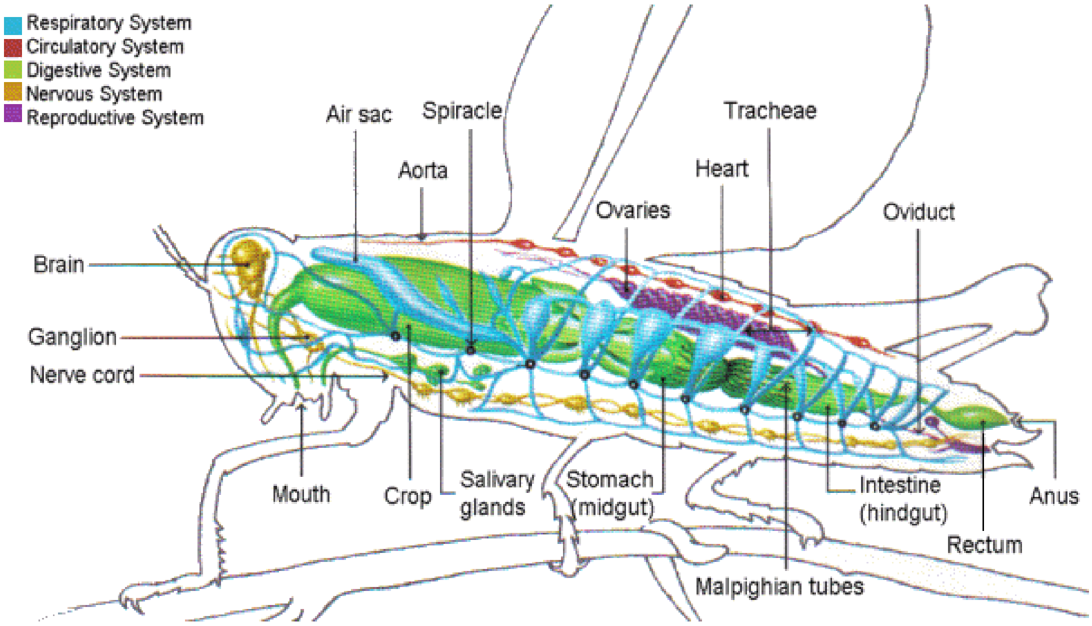
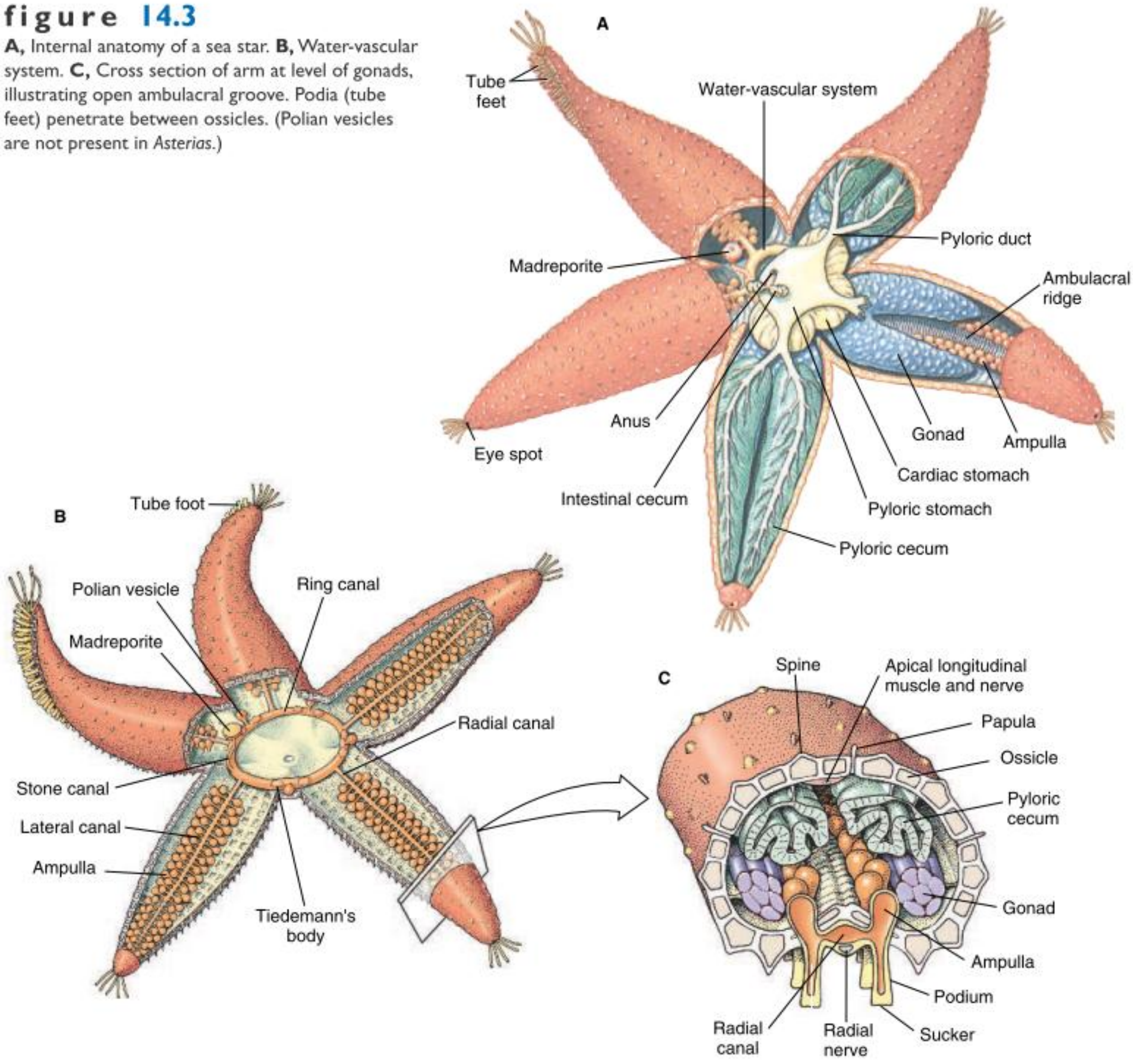
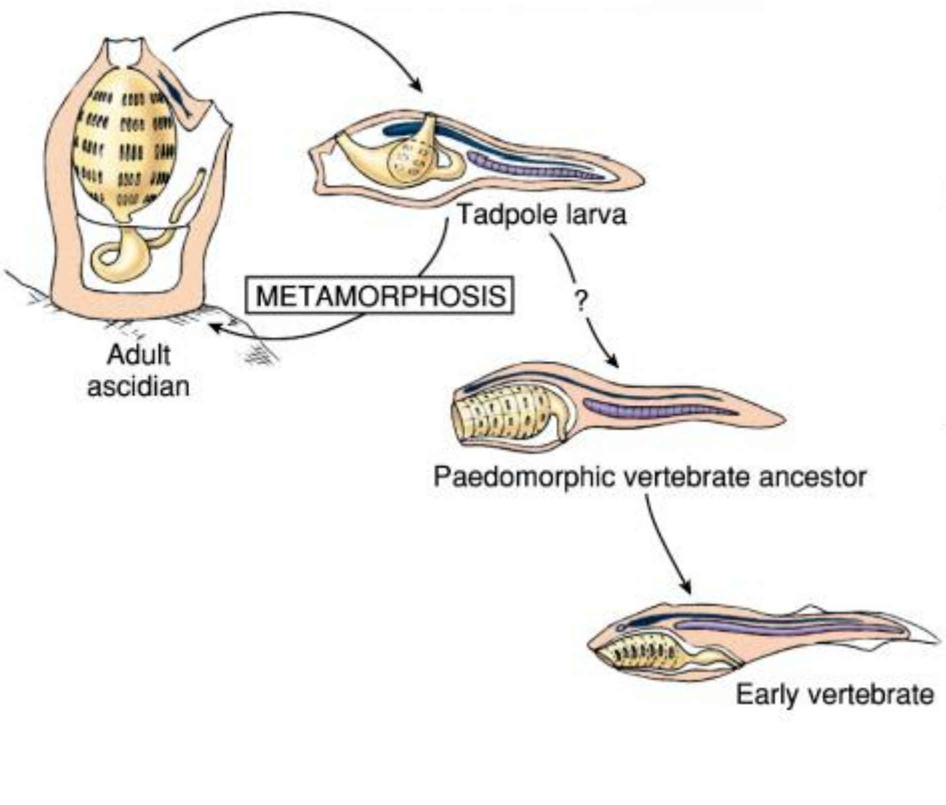
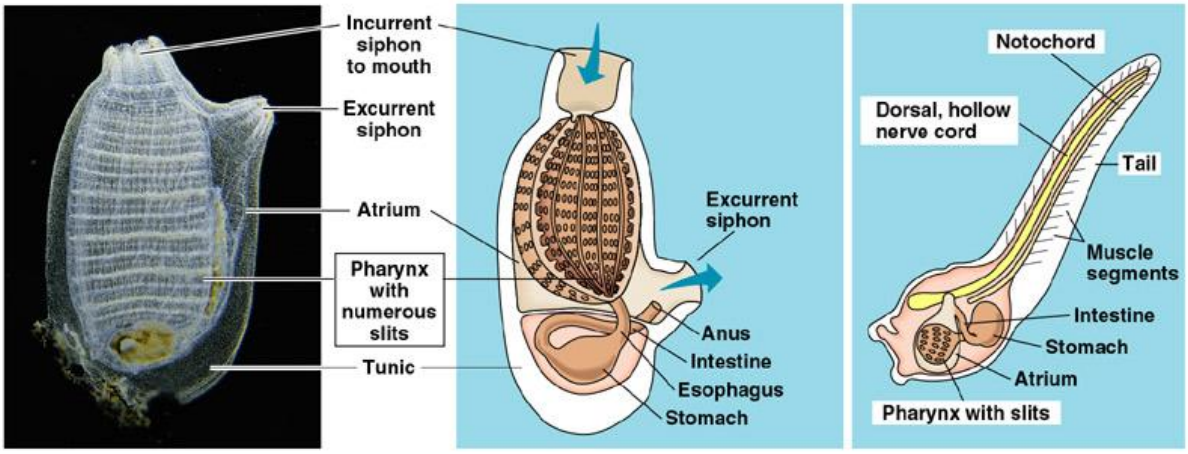

Respiratory System
Circulatory System
Digestive System
Nervous System
Reproductive System
Air sac
Spiracle
Tracheae
Aorta
Heart
Ovaries
Oviduct
Brain
Ganglion
Nerve cord
Mouth
Crop
Salivary glands
Stomach (midgut)
Intestine (hindgut)
Anus
Rectum
Malpighian tubes

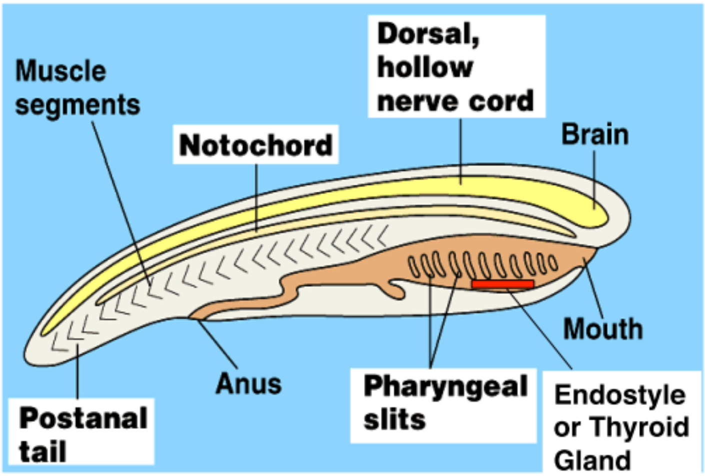
figure 14.3

A, Internal anatomy of a sea star. **B,** Water-vascular system. **C,** Cross section of arm at level of gonads, illustrating open ambulacral groove. Podia (tube feet) penetrate between ossicles. (Polian vesicles are not present in *Asterias*.)

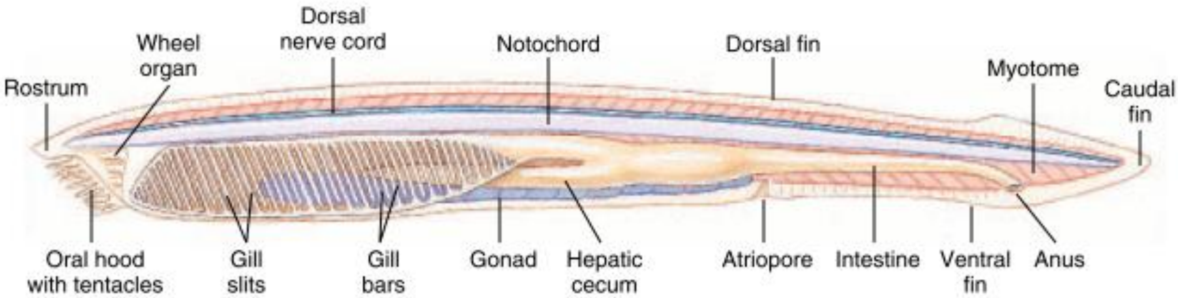


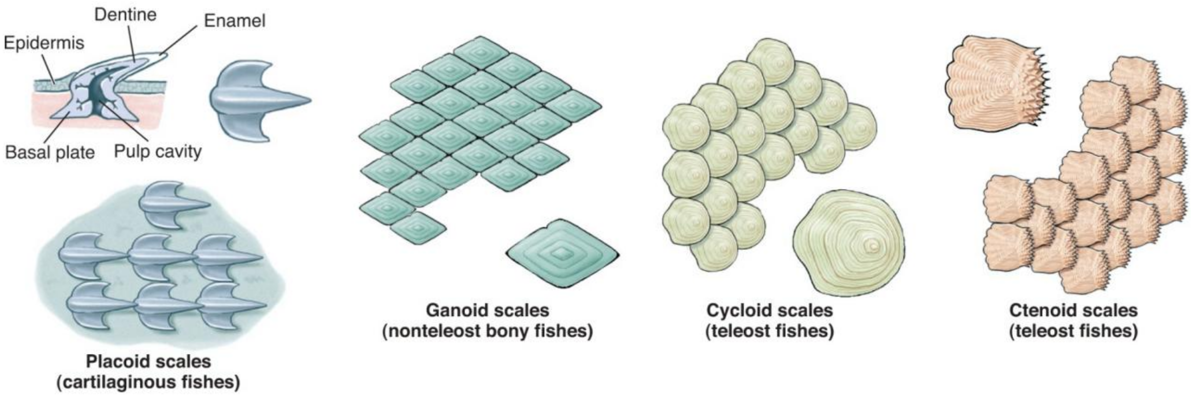


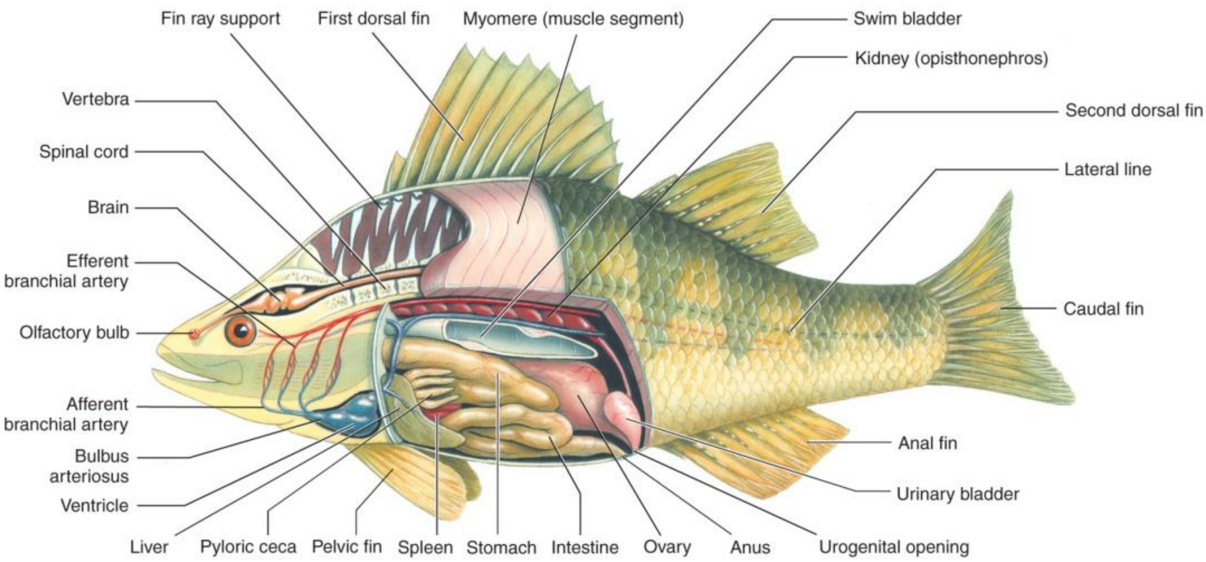


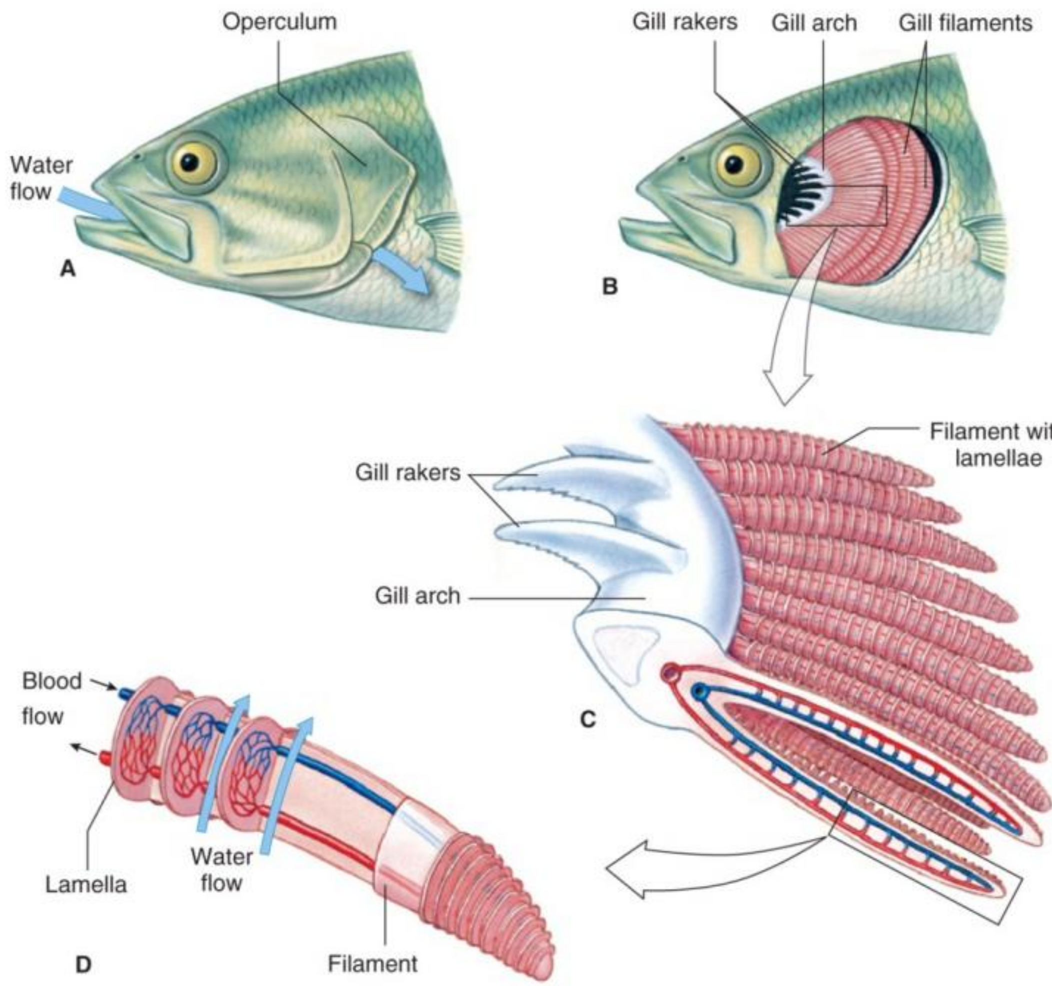


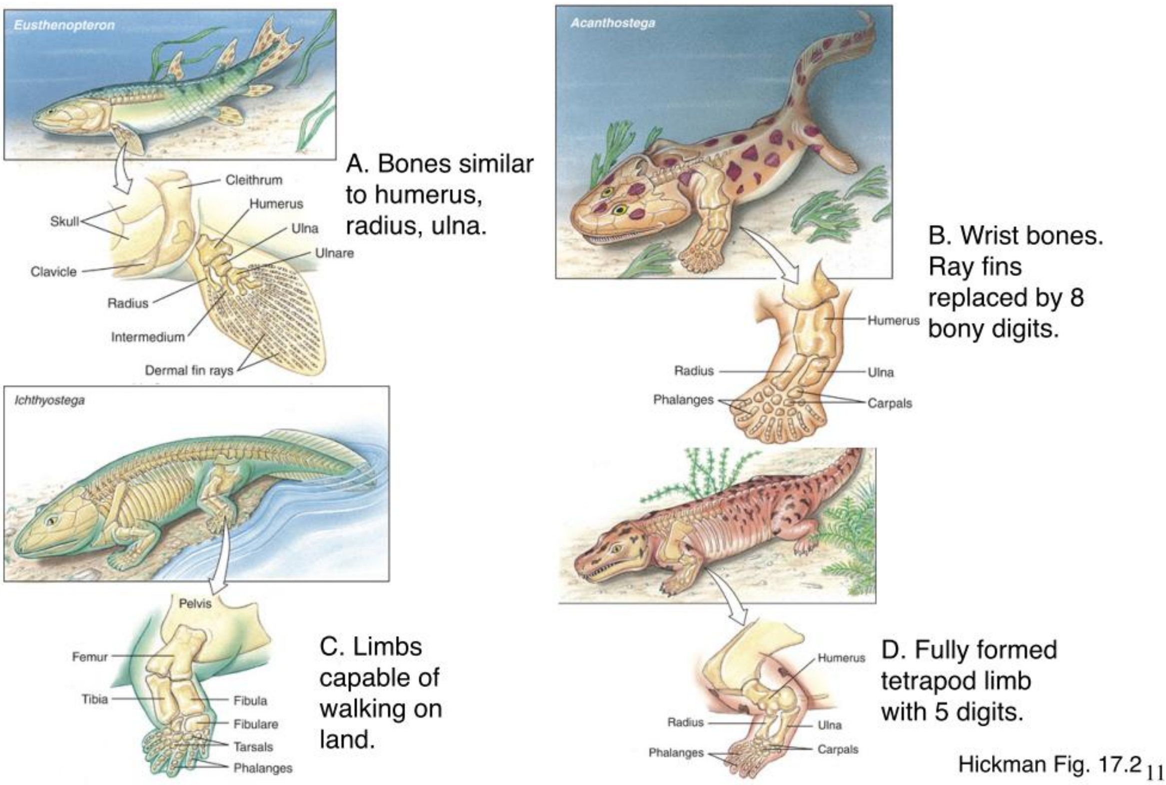
Five defining chordate traits (some may be lost during development)






Fin ray support
First dorsal fin
Myomere (muscle segment)
Swim bladder
Kidney (opisthonephros)
Second dorsal fin
Lateral line
Caudal fin
Vertebra
Spinal cord
Brain
Efferent branchial artery
Olfactory bulb
Afferent branchial artery
Bulbus arteriosus
Ventricle
Liver
Pyloric ceca
Pelvic fin
Spleen
Stomach
Intestine
Ovary
Anus
Urogenital opening
Urinary bladder
Anal fin

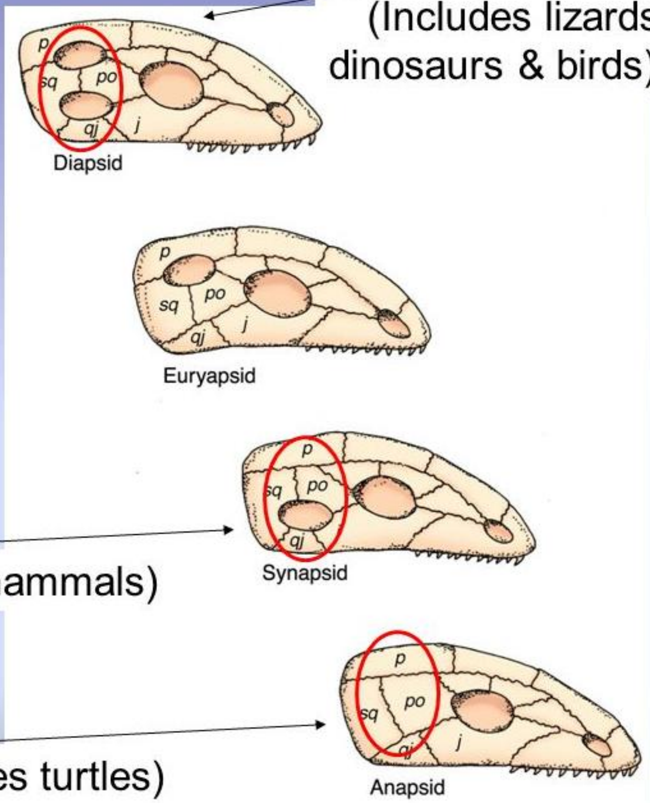

Operculum
Water flow
A
Gill rakers
Gill arch
Gill filaments
B
Filament with lamellae
Gill rakers
Gill arch
C
Blood flow
Lamella
Water flow
Filament
D



Hickman Fig. 17.2 11

The Amniotes

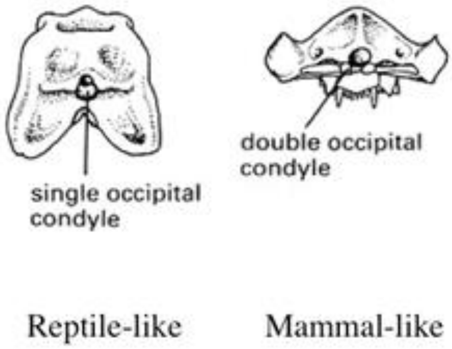
Classified based on skull structure

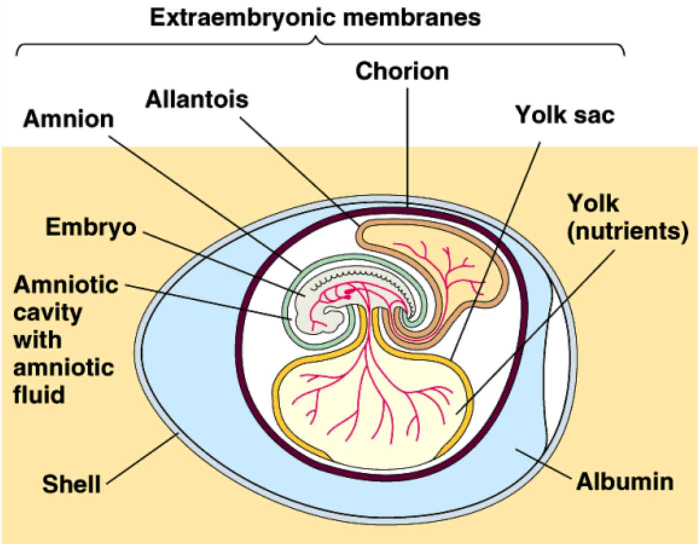


Diapsids (Includes lizards, dinosaurs & birds))

Synapsids (Includes mammals)

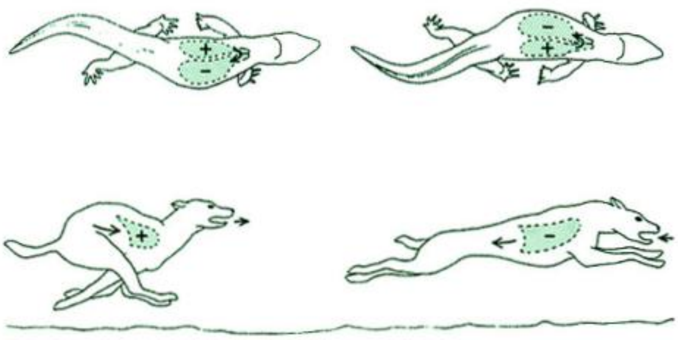
Anapsids (Includes turtles)





Four membranes present around the developing embryo of all amniotes
(whether or not there is a shell):

1.Yolk sac: contains nutrients.
2.Chorion: allows gas exchange with the environment.
3.Amnion: surrounds and cushions the embryo with fluid.
4.Allantois: stores wastes and allows gas exchange.



- Ancestral form of locomotion is by lateral undulations of trunk (e.g. lizards), which compresses lungs and limits respiration for endurance.
- Improvements include bipedal locomotion (dinosaurs, birds), movements of ribs, pelvis, and organs (crocs, birds), and limb movement independent of trunk bending (mammals).

Animal Phyla

Porifera

- **Calcarea**: calcareous sponges, mostly small
- **Hexactinellida**: possess six-rayed siliceous spicules, have continuous syncytial tissue called trabecular reticulum
- **Demospongiae**: Over 80% of sponge species, all are leuconoid, can have siliceous spicules or spongin fibres

Cnidaria

- **Hydrozoa**: generally have asexual polyp and sexual medusa stages (e.g. Obelia), often have polyp colonies consisting of individual zooids including gastrozooids (for feeding), dactylozooids (for defense), and gonangia (reproduction)
- **Scyphozoa** (jellyfishes): medusa with mouth at end of hanging manubriums drawn into oral lobes, many tentacles covered with nematocysts, radial and ring canals extend gastrovascular cavity, bell margin contains sense organs (rhopalium) including statocysts (equilibrium) and ocelli (light-sensitive), velum partly covers bell opening and used for swimming
- **Cubozoa** (box jellies): medusa square in profile with a tentacle at each end beginning with a tough pedalium
- **Anthozoa** (sea anemones and corals): no medusa stage, sea anemones have crown of tentacles surrounding oral disc, siphonoglyphs create ciliated water current through pharynx, gastrovascular cavity divided into radial chambers by septa (in multiples of six), corals are like small anemones living in inorganic skeletons they excrete, mutualistic coralline algae (zooxanthellae) help build, many corals have eight-fold symmetry
- **Ctenophora** (comb jellies): separate phylum, no nematocysts, free-swimming, surface covered with rows of ciliated comb plates for locomotion, long tentacles bear colloblast cells excreting glue for hunting small prey

Platyhelminthes

- **Tubellaria:** free living worms with simple life cycles, move by beating of cilia
- **Trematoda** (parasitic flukes): mostly parasitise vertebrates, have hooks and suckers for adhesion to host, responsible for schistosomiasis
- **Monogenea** (monogenetic flukes): small, external parasites clamping onto gills of fish using an opisthaptor, usually don't cause disease
- **Cestoda** (tapeworms): long flat bodies, no digestive system, obtain nutrients across body surface using microtiches to increase surface area, hold on by scolex organ of attachment, composed of many reproductive units called proglottids

Annelida

- **Polychaeta** (sea worms): have well-developed head with specialised appendages (parapodia) for feeding, prostomium (head) may contain sensory organs, gonads only appear temporarily
- **Oligochaeta** (earthworms): feed on vegetable matter at night, closed circulatory system, clitellum, some aquatic forms have gills
- **Hirudinea** (leeches): no setae, generally parasitic, have muscular proboscis or pharynx for feeding on blood, no internal septa, locomotion by swimming and inch-worm movement

Mollusca

- **Polyplacophora** (chitons): flattened with convex dorsal surface containing eight plates, generally sessile on rocks holding on with broad foot, subradular protrudes for sensing and radular for feeding, water flows over gills and also carries gametes
- **Gastropoda** (snails and slugs): many have shells and often coiled, operculum covers shell aperture when body withdraws into shell, during torsion mantle cavity rotates around to make anus anterior, coiling involves shell becoming asymmetrical to increase compactness and shifted over to adjust weight evenly
    - **Prosobranchia** which respire by gills and in which torsion is evident (anterior mantle cavity, gills and anus)
    - **Opisthobranchia** which display detorsion, shell and mantle cavity reduced or absent, and many species secondarily bilaterally symmetrical. Sea hares and sea slugs are familiar members
    - **Pulmonata** - include land snails, also include freshwater snails and slugs; some display detorsion, gills gone, mantle cavity now a lung
- **Bivalvia** (mussels, clams, oysters): filter feeders with incurrent and excurrent siphons on same side protruding in-between two shells, hinge ligament and adductor muscles connect shells, cilia move food particles along gill to mouth, move using extended foot or attach using byssal threads
- **Cephalopoda** (quids, octopuses, nautilus): swim by ejecting water from ventral funnel of mantle cavity, octopuses have eight suckered arms (one specialised for production called hectocotylus), squids eight arms and a pair of long tentacles, posses chromatophores in skin allowing rapid colour changes, squirt ink to confuse predators, grab prey with jaws and tear with radula, closed circulatory system, have multiple ancillary hearts, use copper-based haemocyanin oxygen transport proteins

Arthropoda

- **Chelicerata:** six pairs of appendages (a chericerae, a pedipalps, four legs), no mandibles or antennae
    - **Xiphosurida** (horseshoe crabs): unsegmented hoseshoe-shaped carapace and a long spineline telson, exposed book gills
    - **Pycognida** (sea spiders): reduced abdomen and long spindly legs, suck juices from soft-bodied prey using proboscis
    - **Araneae** (spiders): non-segmented cephalothorax and abdomen connected by narrow pedicel, chelicerae act as fangs, book lungs for respiration, air tracaea, malpighian tubules for excretion, sensory setae for sensing vibrations, silk glands connect to spinnerets
    - **Scorpionida** (scorpions): large claw-like pedipalps, bear live young, telson with poison stinger
    - **Opiliones** (harvestmen): look like spiders will long spindly legs, no pedicel
    - **Acari** (ticks and mites): fused cephalothorax and abdomen, small anterior capitulum carries mouth, feed on dermal tissues of vertebrates or suck blood
- **Crustacea:** two pairs of antennae, mandibles, two pairs of maxillae, more legs and swimmerets, all appendeges biramous, have head, thorax and abdomen, undergo ecdysis
    - **Brachiopoda** (shrimp): appendeges include uropod (paddles), swimmerets (for swimming), walking legs (five pairs), chelipeds (first pair of walking legs with large

    claw), maxillipeds and maxillae (food handling), mandible (teeth), and antennae (sensing), many have chemoreceptive aesthetascs on antennules
  - **Maxillopoda** (copepods, barnacles): no appendages on abdomen, posses maxillopodan eye
  - **Malacostraca** (crabs, lobsters, crayfish, isopods): many are decapods with ten legs, crabs have broader carapace and reduced abdomen
- **Uniramia:** unbranched appendeges (uniramous), one pair of antennae
  - **Chilopoda** (centipedes): flattened bodies, many somites each with one pair of legs, poison claws kill pray
  - **Diplopoda** (millipedes): mostly herbivorous, two pairs of legs per somite
  - **Insecta** (insects): three pairs of legs an two pairs of wings, single pair of antennae, flight muscles can be direct or indirect, crop for food storage and proventriculus for grinding, mouthparts highly variable for sucking (labrum), biting, or piercing (labium), gas exchange by tracheal system opening at spiracles, excretion by malpighian tubules, some undergo holometabolous (complete) or hemimetabolous (slow change) metamorphosis, wings evagination of cuticle

Echinodermata

- **Asteroidea** (sea stars): generally five arms (can be more), ambulacral grooves radiate under arms with tube feet protruding, can regenerate whole organism from only portion of central disk and one arm, lay eggs in water and hatch free-swimming larvae, madreporite on inner ring canal, pedicellaria have claw-like ossicles for defence or predation, prey swallowed whole or stomach everted
- **Ophiuroidea** (brittle stars): slender arms easily removed, tube feet lack suckers, lack papulae, five toothed jaws surround ventral mouth, no visceral organs in arms, water circulates around bursae sacs for gas exchange, pull themselves along with arms
- **Echinoidea** (sea urchins): body enclosed in endoskeletal shell called a test, stiff spines cover upper surface, ventral mouth surrounded by teeth
- **Holothuroidea** (sea cucumbers): elongated oral-arborally, reduced ossicles resulting in soft body, retractile oral tentacles for feeding, move by contractions of muscular upper body, respiratory tree for gas exchange
- **Crinoidea** (sea daisies): main body is cuplike on the end of a stalk/cirri, anus on same side as mouth, some can crawl on cirri

Chordates

- **Urochordata**: filter feeders, larva are free-swimming but adults sessile losing most chordate traits, exoskeletal tunic contains cellulose
- **Cephalochordata**: small benthic filter-feeders with limited mobility, segmented muscles (myomeres), gill slits and nephridia also segmented
- **Chondrichtyes**: sharks have a heterocercal (asymmetrical) tail and replaceable rows of teeth, no operculum, no swim bladder
- **Osteichthyes**: includes Sarcopterygii (lobed) and Actinopterygii (finned) varieties, most are teleosts, swim bladder adjusts volume to maintain neutral buoyancy, operculum maintains water flow over gills, freshwater fish are hyperosmotic (don't drink), marine are hypoosmotic (excrete salt), measure age by otolith growth

- **Amphibians:** ectothermic, cloaca, only partly adapted for terrestrial living, still have aquatic larvae, respiration across skin, external fertilisation in water, force air into lungs by throat, frogs brood young on back or in mouth
- **Reptiles**: evolved amniotic egg, ticker waterproof skin, stronger jaws, internal fertilisation, water-conserving excretory system, cloaca, breath by inflating ribs but no diaphragm
- **Birds**: feathers homologous to scales, no teeth in keratinized beak, endothermic, pneumatic bones, flexible S-shaped neck, keel-shaped sternum for attachment of flight muscles, adaptive zone filled with insects and absent predators, food stored in crop and ground up in gizzard to compensate for lack of teeth and hands, excrete uric acid, dual-stroke respiration cycle due to posterior air sacs
- **Mammals**: homeothermic, no cloaca (other than monotremes), mammary glands, hair of keratin, sweat, scent, and sebaceous (oil) glands
    - **Prototherians** (monotremes): egg laying (oviparous) mammals
    - **Metatherians**: pouched viviparous mammals very altricial young
    - **Eutherians**: placental viviparous mammals more precocious young

Minor Phyla

- **Onychophora** (velvet worms): similar to annelids, life in leaf litter, predators using sticky slime to catch prey, coelomate protostomes, soft cuticle with paired unjoined appendeges, cuticle molted, posses tracheae
- **Hemichordata**: all benthic marine species
    - **Enteropneusta** (acorn worm): consist of proboscis, collar, and trunk, not segmented, dorsal nerve cord and pharyngeal slits but no notochord, breaths through skin, open circulatory system, complete digestive system
    - **Pterobranchia:** ancestral to deuterostomes, small colonial animals, similar in appearance to lophophore, U-shaped digestion
- **Ectoprocta** (byrozoa): polypides (animals) live in zooecium (calcareous exoskeleton) from which lophophore is extended by muscle contractions
- **Phoronida**: solitary worms living in sediment, more developed organs, lophophore extends above surface
- **Brachiopoda** (lampshells): solitary marine bivalve-like shells, lophophore extends between shells
- **Rotifera**: grazers of algae, feed with ciliated crown
- **Chaetognatha** (arrow worms): small coelomate worms