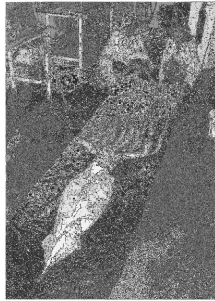


The Diversity of Animals 1: invertebrates

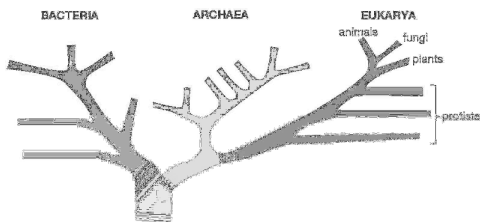
Chapter 23



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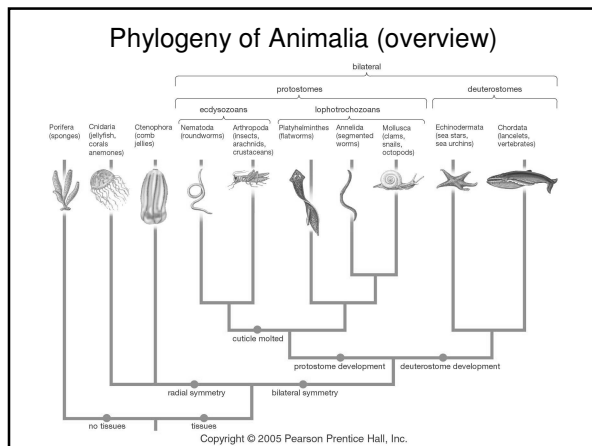
Animals are in Domain Eukarya

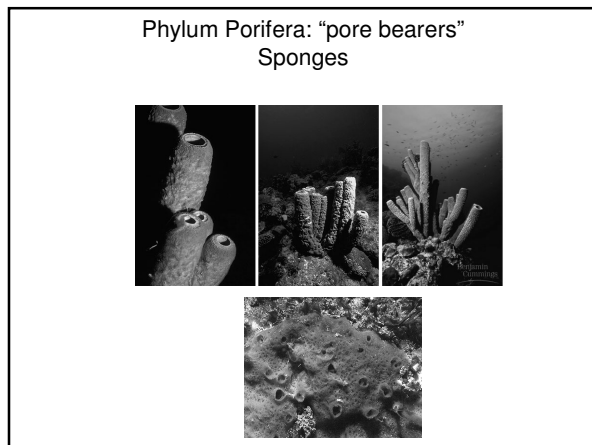
- Immediate ancestors are a type of Protista



Kingdom Animalia

- Key features
 - ❖ Multicellular
 - ❖ Heterotrophic: gain energy by consuming other organisms
 - ❖ No cell walls
 - ❖ Motile at some stage of their life
 - ❖ Most (but not all) can respond actively to stimuli due to their nerves and muscles





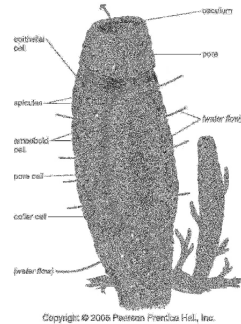
Phylum Porifera: “pore bearers”

- Key features
 - ❖ **No tissues**
 - Tissues are groups of similar cells that work together
 - Example: Groups of muscle cells form muscles
 - All other animals have tissues
 - ❖ **Lined with flagellated collar cells**
 - Flagella beat to create water current
 - Function in food collection, digestion and gas exchange

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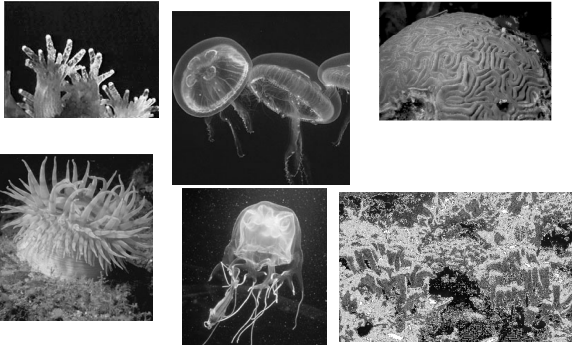
Phylum Porifera: "pore bearers"

- Water flows in through small pores, and out through osculum
- **Spicules:** Spiky structures that provide structure and some protection



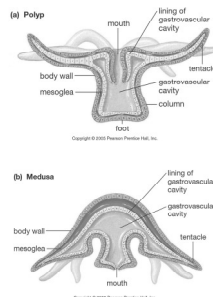
Phylum Cnidaria:

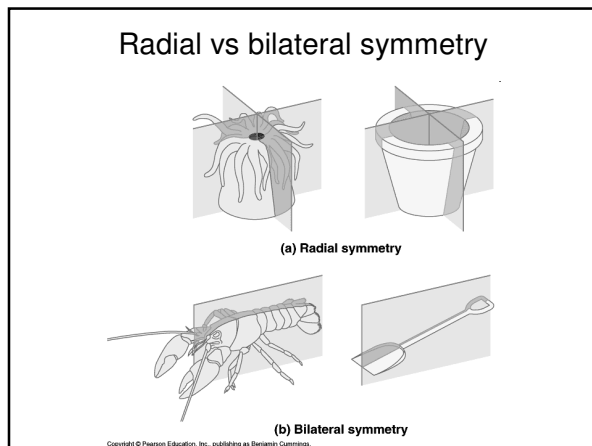
"cnid" = nettle; all have stinging cells

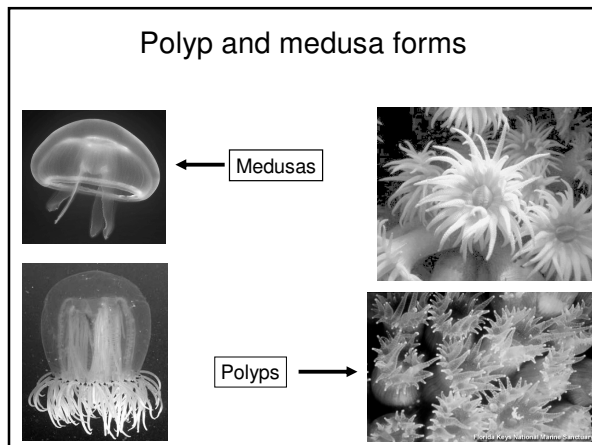


Phylum Cnidaria: Key features

- **Radial symmetry**
- **Polyp and medusa forms**
- **Tentacles**
- **Two tissue layers**
 - ❖ Body wall (=epidermis) from **ectoderm**
 - Ecto = outside
 - ❖ Lining of gastrovascular cavity from **endoderm**
 - Endo = inside







Phylum Cnidaria: Key features

- Gastrovascular cavity
 - ❖ Feeding/digestion
 - ❖ Gas exchange
 - ❖ Hydrostatic skeleton
 - Water pressure only
 - ❖ Only one opening
 - Mouth
- Simple nervous system: nerve net
 - ❖ No brain or nerve cords
- Cnidocytes = stinging cells

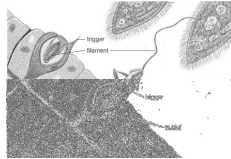
(a) Polyp

(b) Medusa

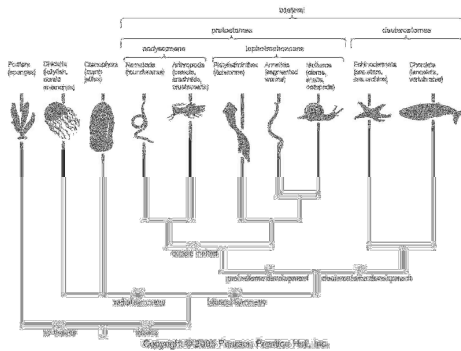
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Phylum Cnidaria

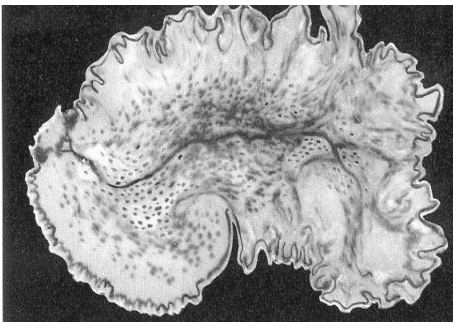
- Focus on cnidocytes
 - ❖ Contain a specialized stinging structure within a toxin-filled sac.
 - ❖ Stinger forcibly ejects
 - Hollow; injects toxins
 - Barbed; hangs on
 - ❖ Most toxic:
 - box jellies = sea wasp
- **Dead cnidarians can still sting!**



Phylogeny of Animalia (overview)

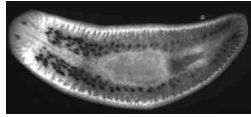


Phylum Platyhelminthes: The flatworms



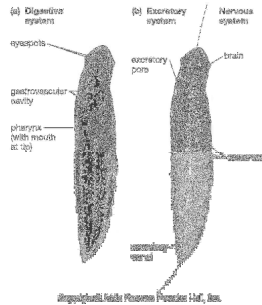
Phylum Platyhelminthes: Key features

- Bilateral symmetry
 - all the rest of Animalia have bilateral symmetry
- ❖ Distinct head
 - concentration of sensory organs (i.e. eyespots)
- ❖ Promotes active, directional movement
- True muscle
 - ❖ from mesoderm;
 - all the rest of Animalia have this



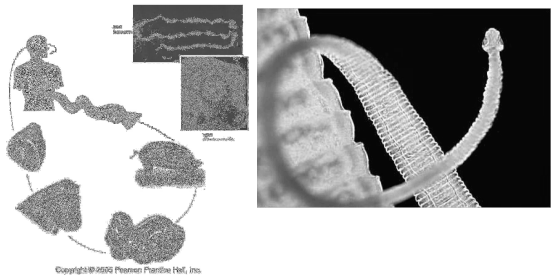
Phylum Platyhelminthes: Key features

- Pharynx: for feeding
 - ❖ Dissolves food with enzymes, sucks it up!
- Gastrovascular cavity is highly branched
- Gas exchange via diffusion
- Nervous system: simple brain & nerve cords
- Simple excretory system: water balance
- Some flatworms have penises:
 - ❖ use both for reproduction and food capture!



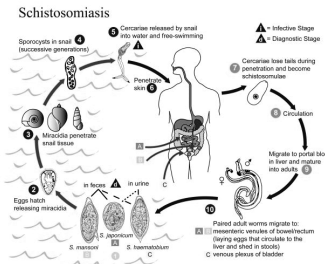
Parasitic flatworms

- Example: human pork tapeworm

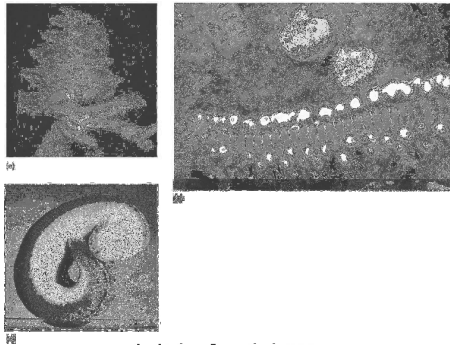


Parastic flatworms

- *Schistosoma*
 - ❖ Causes swimmer's itch
 - ❖ Also causes the more severe schistosomiasis
- Schistosomiasis
 - ❖ Enabled Taiwan to avoid invasion by Mainland China

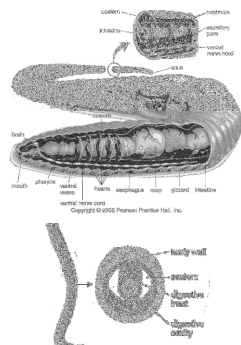


Phylum Annelida: "ringed"



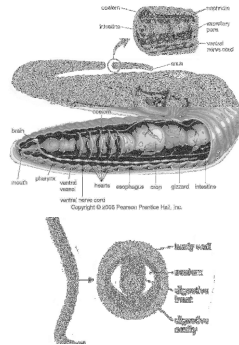
Phylum Annelida: Key features

- Bilateral symmetry and true muscle.
- Segmentation: allows for independent movement of muscles in each segment
 - ❖ More effective movement
- Coelom: fluid-filled body cavity
 - ❖ Hydrostatic skeleton
 - ❖ Increased surface area for gas exchange



Phylum Annelida: Key features

- Tubular gut; one-way digestive path
 - ❖ Specialized regions; more efficient digestion
- Circulatory system; closed, with hearts
- Nervous system with brain, paired ventral nerve cords, one ganglion per segment (concentrations of nerve cells)



Phylum Annelida diversity



Marine Polychaetes



Leeches



Earthworms (Photo courtesy of Marietta University)

Parasitic?

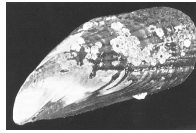
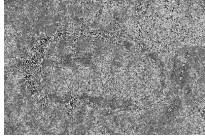
- Other than blood sucking leeches..
 - ❖ None known.
 - ❖ Blood leeches can be used medically
 - Anticoagulant, stimulates blood circulation in reattachment surgery
- But some transmit parasitic protists
 - ❖ Whirling disease in farmed fish



Leeches sometimes attach themselves to ball divers.

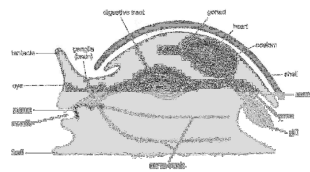


Phylum Mollusca: The “soft-bodied” animals



Molluscan body plan

- Shell
- Mantle
 - ❖ Secretes shell
 - ❖ Body covering (non-shelled mollusks)
- Head and associated sensory structures
- Foot and epipodial tentacles



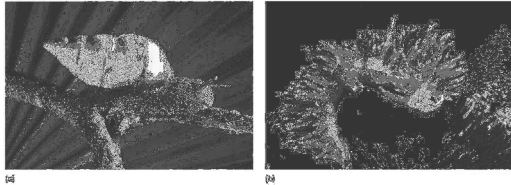
Molluscan body plan

- Radula
 - ❖ Toothed tongue-like structure
- Gill
- Visceral mass: the “guts”
 - ❖ Complete digestive system
 - ❖ Open circulatory system
- Nervous system with brain, paired ventral nerve cords, some ganglia



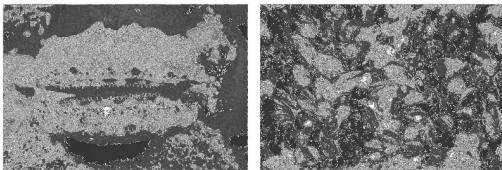
Phylum Mollusca: Gastropods

- Gastropods are one-footed crawlers
- Examples: snails; sea and landslugs
- Some have no shell (slugs)
- Land snails use their mantle as a kind of "lung"



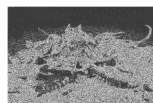
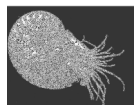
Phylum Mollusca: Bivalves

- Bivalves are filter feeders
 - ❖ Their gill is used for feeding as well as respiration!
- Examples: scallops, oysters, mussels and clams (a scallop and mussels are shown)
- They have "lost their heads"



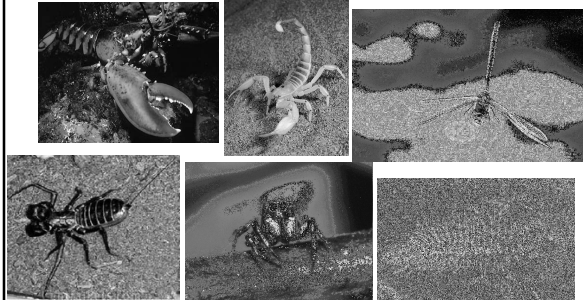
Class Cephalopoda: "Head-footed"

- Cephalopods are marine predators
- Examples: Nautilus, squid, octopus
- Notable features
 - ❖ Shell reduced (pen in squid)
 - ❖ Foot gives rise to arms and funnel
 - ❖ Head with well-developed eyes and beak
 - ❖ Mantle forms thick, protective body covering
 - Functions in jet propulsion
 - Chromatophores: rapid, accurate color change
 - ❖ Circulatory system closed!
 - ❖ Nervous system highly developed



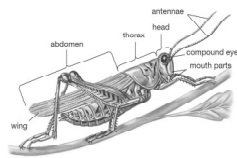
Phylum Arthropoda: "jointed foot"

- Arthropods dominate the earth: more species and more individuals than any other phylum!
- Representative members shown here...



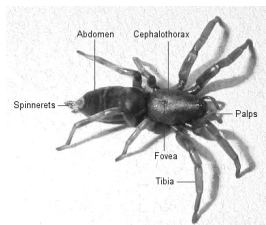
Phylum Arthropoda: Key features

- Exoskeleton
 - ❖ Secreted by epidermis
 - ❖ Strengthened with **chitin**
 - What other organisms are strengthened by chitin?
 - ❖ Must molt to grow
 - How can an arthropod grow larger if it builds its new exoskeleton beneath the old one?
 - ❖ Heaviness limits size (on land)



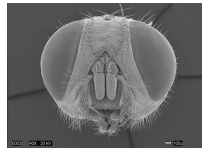
Phylum Arthropoda: Key features

- Paired and jointed appendages
 - ❖ Arthropod = "jointed leg"
- Segmentation (like Annelida)
 - ❖ Segments organized into body regions (i.e. head, thorax and abdomen of insects)
- **NOTE:** Other body systems roughly similar to Phylum Annelida and Mollusca
 - ❖ Open circulatory system



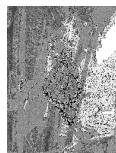
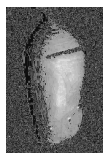
Arthropoda: Key features (cont.)

- Arthropods have well-developed sensory systems
 - ❖ Compound eyes
 - ❖ Antennae: chemosensory and tactile
 - ❖ Numerous receptors all over their bodies that detect light, odors, pressure, etc...



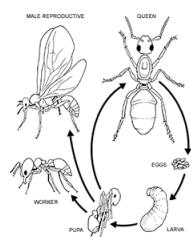
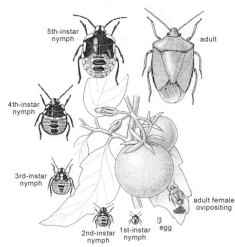
Phylum Arthropoda: Insects

- Numerous! Three times more species than all other classes of animals combined!
- One pair of antennae, compound eyes and 3 pairs of legs.
- The only flying invertebrates
 - ❖ Allows for escape from predators and efficient foraging



Phylum Arthropoda: Insects

- Three different types of metamorphosis:
 - ❖ Hemimetabolous: Nymphs look like small wingless adults
 - ❖ Holometabolous: larvae → pupae → adult



Phylum Arthropoda: Arachnids

- Most are predatory meat eaters
 - ❖ Spiders have paralyzing venom and digestive enzymes; dissolve food outside body before sucking it up!



Phylum Arthropoda: Arachnids

- No compound eyes; no antennae!
 - ❖ have simple eyes (spiders usually have 8)
- Examples:
 - ❖ Spiders
 - ❖ Harvestmen (daddy longlegs)
 - ❖ Scorpions
 - ❖ Sun spiders
 - ❖ Whip scorpions
 - ❖ Mites, ticks

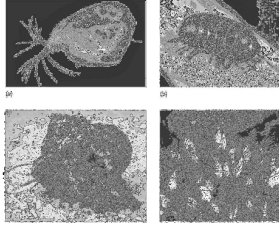
Phylum Arthropoda: Myriapoda

- Myriapods have many legs
 - ❖ Centipedes have 1 pair per segment, millipedes have 2 pairs per segment.
- All have one pair of antennae
- Most have simple eyes only
- Centipedes are always venomous, millipedes are not.



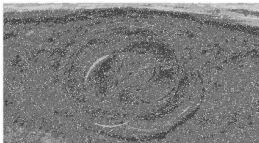
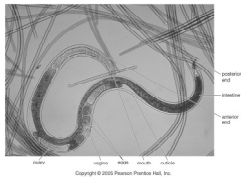
Phylum Arthropoda: Crustaceans

- Mostly aquatic
- Two pair of antennae and compound eyes
- Number of legs varies
- Examples: water fleas, pill bugs, crabs &, yes, barnacles!



Phylum Nematoda: roundworms

- Nematodes are everywhere!
- Important decomposers: billions in every acre of topsoil!
- Like the Arthropoda, they have an exoskeleton with chitin that they molt in order to grow.
- Some are parasitic
 - ❖ Example: *Trichinella* worms (trichinosis) and heart worms

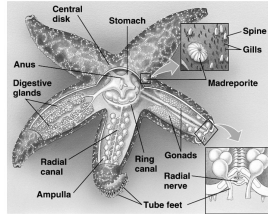


Phylum Echinodermata: Spiny-skinned



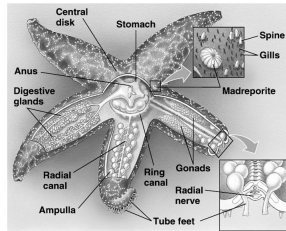
Echinodermata: 4 key features

- Calcareous internal skeleton
 - ❖ Why considered "internal"?
- Water vascular system
 - ❖ Controls tube feet
- Symmetry
 - ❖ Bilateral symmetry (larvae)
 - ❖ Pentamerous radial symmetry (adults)
- Mutable connective tissue



Body plan: Other aspects

- Digestive system
 - ❖ Can be highly branched
 - ❖ Complete in some
- Nervous system
 - ❖ No brain
 - ❖ Branches parallel water vascular system
 - ❖ Sensory (sea stars)
 - Eye spots
 - Receptors on tube feet
- No circulatory system
- Gas exchange via tube feet and gills



Sea stars

- Feeding
- Regeneration