Invertebrates 2

Porifera
- Jelly fish, corals, sea anemones
- Radial symmetry
- Simple tissues
- No organs

Phylum Platyhelminthes - planarians, flukes, tapeworms

- Key Innovations - bilateral symmetry, triploblastic (ecto, endo, mesoderm - muscles!), cephalized (nonparasitic ones)
- Developed nervous, digestive, and excretory systems
- Flatworms are acoelomate
- Flatworms are very flat. No circulatory system so oxygen must diffuse through the body wall.
- They have a blind, sac-like (incomplete) gut, often with branchings.

General Lifestyle:
- Often parasitic
- Why you should care:
- Primitive bilaterians
- Health hazards
Platyhelminthes

Parasitic worms
Sexual and asexual phases
Definitive host (parasite reaches sexual maturity)
Intermediate host (immature stages)

Life Cycle of Trematode Parasite
- Bird eats 2nd Intermediate hosts and parasite grows into adult trematode.
- Definitive Host - Bird
- 2nd Intermediate Hosts
- Free-swimming cercariae are released from the snail.
- 1st Intermediate Host - Snail
- Egg
- Miracidium
- Adult Trematode

Life Cycle of Tapeworm Parasite
- Larvae encysted in muscle tissue
- Scolex attaches to host intestinal wall
- Intermediate host
- Mature proglottid with fertilized eggs
Life Cycle of Tapeworm Parasite

- Platyhelminthes
  - Tapeworm scolex

- Tapeworm proglottids containing eggs

Platyhelminthes

- Tapeworm

- Bilateral symmetry
- Simple tissues
- Simple organ systems
- Complete gut
Phylum Nematoda (nematodes or roundworms)

Nematodes are the most abundant and ubiquitous multicellular organisms on earth.

Key Innovations: complete gut (has mouth and anus) and pseudocoel (fluid-filled, unlined body cavity packed with organs).

Bilateral, cephalized (though not much), triploblastic (as all are from here on).

Cylindrical worms with a thick, elastic cuticle on epidermis. Most are free-living, but many are parasites.
Warning!
If you thought the last slide was bad, the next slide is **REALLY** gross!
If you’re at all squeamish or easily offended, please close your eyes.

Nematoda - Guinea Worm

Elephantiasis
a filarial worm disease

Phylum Mollusca - snails, chitons, bivalves, and cephalopods

Soft-bodied, usually with a hard shell
Key Innovations: circulatory system (open), respiratory structures, true coelom (reduced)
Bilateral, cephalized, small coelom, short, fleshy, soft body, muscular foot. Often have shell of CaCO₃ and protein. Mantle tissue secretes shell.
Many molluscs have lost their shell.
Mollusca

radula

Mollusca

evolution of shell coiling

Mollusca

snail mating dance

Mollusca

terrestrial snail

Mollusca

radula

Limpets
Mollusca

snail laying eggs

Mollusca

Banana Slug

Mollusca

Cypraea spadicea

Chestnut Cowry

Cowries

Mate in pairs for life and some are endangered. Ironically, many “environmentalists” wear them woven into headbands, belts and hair ties.

cowrie jewelry
tsk tsk

Mollusca

veliger larva
Mollusca

*Haliotis kamtschatkana*
Pinto Abalone

Mollusca

*Phidiana hiltoni*  
nudibranch

Mollusca

*Phidiana crassicornis*  
nudibranch

Mollusca

*Anisodoris nobilis*  
sea lemon nudibranch

Mollusca

*sea hare*

Mollusca

*Phidiana crassicornis*  
nudibranch
**Nudibranch**

**Mollusca**
- **dorsal view of chiton**
- **ventral view of chiton**

**Tonicella lineata**
lined chiton

**Cryptochiton stelleri**
gumboot chiton
Abalone

Crassedoma giganteum
rock scallop

Flame Scallop

Eyes of a scallop

Mytilus edulis
common mussel

Mytilus californianus
California mussel
Mollusca

*Sepia*
cuttlefish

Mollusca
cuttlefish

Mollusca
cuttlefish

Mollusca

Mollusca

*Architeuthis*
Giant Squid

Mollusca

Octopus
**Phylum Annelida - polychaetes, oligochaetes, leeches**

Segmented worms including leeches

**Key Innovations:** segmentation, closed circulatory system

Polychaetes (marine worms) have many setae, parapodia

Oligochaetes (earthworms) have few setae, no parapodia

Leeches have no setae, no parapodia

Segmentation (repeated body units) allowed specialization and diversification

Blood contained in vessels and hearts

Nephridia, paired nerve cords

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**Mollusca**

- Octopus

**Octopus dobleini**

Giant Octopus

- Hapalochlaena

Blue-Ringed Octopus

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**Mollusca**

- Porifera
- Cnidaria
- Platyhelminthes
- Nematoda
- Mollusca
- Annelida
- Arhropoda
- Echinodermata
- Chordata

**Segmented worms, leeches, polychaetes**

- Segmentation
- Closed circulatory system
- True coelom

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**Annelida**

Segmentation

earthworm
Annelida
Closed Circulatory System

earthworm

Annelida
polychaete

Annelida - polychaete
parapodia
setae

Annelida
polychaete
larva
trochophore

Annelida
young
polychaete

Annelida
fire worm
**Annelida**

*Aphrodita*
sea mouse

*Eudistylia polymorpha*
feather duster worm

*Spirobranchus giganteus*
Christmas Tree Worm

*Lumbricus*
earthworm

burrowing with circular and longitudinal muscles
Annelida

earthworms mating

giant oligochaete worm from Costa Rica

Annelida

medicinal leeches

CASE ONE

Summary: A 65-year-old male patient who suffered a severe crush injury to his right ear. The ear was reconstructed by doing a microvascular anastomosis of a small artery anteriorly. No veins were available for anastomosis. Soon after reconstruction, there was obvious venous congestion. Medicinal leeches were used for treating venous congestion.

CASE TWO

Summary: A 22-year-old male patient who suffered a crush injury to his right ear. The ear was reconstructed by doing a microvascular anastomosis of a small artery anteriorly. No veins were available for anastomosis. Soon after reconstruction, there was obvious venous congestion. Medicinal leeches were used for treating venous congestion.
**Phylum Arthropoda** - crustaceans, spiders, insects

- **Key Innovations:** *chitinous exoskeleton* (completely enclosed) with jointed appendages. Must molt to grow. Truly terrestrial (not tied to water for reproduction).
- **Tagmatization** (specialization and fusion of segments).
- Open circulatory system, intricate eyes, gills or tracheal system for respiration.
- Crustaceans – crabs, shrimp, barnacles, etc. Mostly marine.
- Chelicerates – horseshoe crabs, spiders, scorpions. Have chelicerae (jaws) and pedipalps.
- Uniramians – millipedes, centipedes, insects. Have unbranched legs. Insects have a head, thorax, abdomen. Some with wings.

**Animal Diversity**

<table>
<thead>
<tr>
<th>Number of Species, in Thousands</th>
<th>Arthropoda</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molluscs</td>
<td>85</td>
</tr>
<tr>
<td>Insects - 1000</td>
<td></td>
</tr>
<tr>
<td>Protozoa</td>
<td></td>
</tr>
<tr>
<td>Cnidaria</td>
<td></td>
</tr>
<tr>
<td>Annelids</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Arthropods</td>
<td></td>
</tr>
<tr>
<td>Chordates</td>
<td></td>
</tr>
</tbody>
</table>
Arthropoda

- jointed appendages
- spiracle opening to tracheal system

Arthropoda

- tracheal system

Circulatory Systems

- Arthropoda: closed circulatory system
- Annelida: open circulatory system

Arthropoda

- wing venation

Arthropoda

- wing covers
Arthropoda

stomatopod
mantis shrimp

stomatopod
(mantis shrimp)
appendages

molting

molting

Limulus
horseshoe crabs mating

Extinct
Trilobites

Panulirus interruptus
California spiny lobster
Arthropoda

arthropod segments

Arthropoda

krill (euphausiids)

Arthropoda

copepod (zooplankton)

Arthropoda

zoea larva

Arthropoda

male crab

Arthropoda

Uca
male fiddler crab
Arthropoda
hermit crab

Arthropoda
Orchestoidea
(amphipod)
beach hopper

Arthropoda
Ligula (isopod)

Arthropoda
Pollicipes polymerus
gooseneck barnacles

Arthropoda
barnacles mating

Arthropoda
female scorpion
carrying eggs
Arthropoda

whiptail scorpion

Arthropoda

spiders

Arthropoda

spider “face”

Arthropoda

multiple spider eyes

Arthropoda

multiple spider eyes

Arthropoda

spider eyes
Arthropoda

orb web

spider web with warning pattern

spider spinnerets producing silk

size differences – sexual dimorphism

mite

mites on reptile’s eye
Arthropoda
dust mite
empty and full ticks
wasp segmentation
beetle
butterfly feeding
weevil feeding
**Arthropoda**

- Housefly with sponge-like proboscis
- Menacing jaws
- Jaws
- Wasp jaws
- Female mosquito with red abdomen

**Arthropoda**

- Housefly with sponge-like proboscis
- Menacing jaws
- Jaws
- Wasp jaws
- Female mosquito with red abdomen
Arthropoda
compound eyes

Arthropoda
larva or caterpillar

Arthropoda
pupa or chrysalis

Arthropoda
butterfly emerging from chrysalis

Arthropoda
adult butterfly

Porifera
Cnidaria
Platyhelminthes
Nematoda
Mollusca
Annelida
Echinodermata
Chordata

- Starfish, sand dollars, sea urchins, sea fans
- Water vascular system
Echinoderms have spines, spicules, or plates in their body wall, and a water vascular system.

General lifestyle:
Marine predators
Sea stars, sea urchins, etc.

Key Aspects of the Radial Body Plan of a Sea Star

Tube feet

The Echinoderms

Sea Cucumber

Feather Star

Echinodermata

Echinodermata
Echinodermata

Tube feet

Echinodermata

Tube feet

Echinodermata

Echinodermata
Echinodermata

Sun star (*Heliaster kubiniji*)

Regeneration

Regeneration

Crown of thorns
Echinodermata

Ophioroid – Brittle star

Echinodermata

Ophioroid – Brittle star

Echinodermata

Basket star

Echinodermata

Sea urchins

Echinodermata

Sea urchin and tube feet

Echinodermata
Subphylum Urochordata

Most are "tunicates". "sea squirts"
Larva is free-swimming filter feeder
Adult is sessile

Tunicate Life History

Larva undergoes metamorphosis to adult form
Subphylum Cephalochordata

Lancelets, Amphioxus
Fish-shaped filter feeders that lie buried in sediments
Chordate characteristics of adult:
- Notochord lies under dorsal nerve cord
- Pharynx has gill slits
- Tail extends past anus
Trends in the Evolution of Vertebrates

- Shift from notochord to vertebral column
- Nerve cord expanded into brain
- Evolution of jaws
- Paired fins evolved, gave rise to limbs
- Gills evolved, gave rise to lungs