Chapter 33B: 
An Introduction to Vertebrates II – 
The Bilateria

1. Lophotrochozoa
2. Ecdysozoa
3. Deuterostomia

Invertebrates

Characteristics of Bilaterians

Bilaterians have the following characteristics:

• body plans with bilateral symmetry
• triploblastic development – endoderm, ectoderm & mesoderm
• most have a coelom and 2 digestive openings – mouth & anus

The Bilaterians consist of 3 major clades:

LOPHOTROCHOZOA
ECDYSOZOA
DEUTEROSTOMIA
Overview of the Lophotrochozoa

The clade Lophotrochozoa is based largely on molecular (DNA) data, however there are other features that members of this group tend to share:

- some have a *lophophore* – a ring of ciliated tentacles surrounding the mouth
- some have a *trochophore* larval stage – free swimming ciliated larva
- includes the following groups of animals: flatworms, rotifers, ectoprocts, brachiopods, molluscs & annelids...

The Flatworms (Phylum Platyhelminthes)

The flatworms have the following general characteristics:

- they are triploblastic acoelomates
- they have a proctostome – a single opening to a gastrovascular cavity
- gas exchange occurs by diffusion at the body surface
- osmotic balance is maintained through protonephridia (*"pre-kidneys"*)

Flatworms have no circulatory system, so their flat shape increases the surface area for the exchange of gases and other materials.
Maximizing Surface Area

- nutrient & waste exchange are most efficient the greater the surface area relative to the volume of the organism
- increased through flattening & folding

MAKE CONNECTIONS: Maximizing Surface Area

Folding

SA: \(6 \times (3 \text{ cm} \times 3 \text{ cm}) = 54 \text{ cm}^2\)

V: \(3 \text{ cm} \times 3 \text{ cm} \times 3 \text{ cm} = 27 \text{ cm}^3\)

Flattening

SA: \(2 \times (3 \text{ cm} \times 1 \text{ cm}) + 2 \times (9 \text{ cm} \times 3 \text{ cm}) + 2 \times (3 \text{ cm} \times 9 \text{ cm}) = 78 \text{ cm}^2\)

Diagrams comparing surface area (SA) for two different shapes with the same volume (V)

Planarians

The main lineage of flatworms is the Rhabditophorans which includes the planarians, flukes and tapeworms.

- planarians live in fresh water & prey on smaller animals
- planarians have light sensitive eyespots and centralized nerve nets more complex than the cnidarians
- They are hermaphrodites that can reproduce sexually or asexually through fission (splitting in two and regrowing the missing half)

Trematodes (Flukes)

All flukes are parasites with complex life cycles involving multiple hosts.

- flukes parasitic to humans (e.g., liver flukes, lung flukes & blood flukes) have life cycles that involve snail species
Cestodes (Tapeworms)
All tapeworms are also parasites with life cycles involving multiple hosts.

- absorb digested nutrients in the host’s intestine
- attach to the intestinal wall via hooks and suckers on the scolex
- produce progressively mature reproductive segments called proglottids that detach from the distal end full of eggs and pass out with host feces

Rotifers
Rotifers (phylum Rotifera) tiny aquatic animals smaller than many protists.

- have a pseudocoelom and specialized organs

Lophophorates: Ectoprocts & Brachiopods
Lophophorates have a true coelom and ciliated tentacles around the mouth.

- ectoprocts are sessile filter feeders with a hard exoskeleton
- brachiopods have a hinged shell similar to some molluscs and are typically attached to the sea floor
The phylum Mollusca includes animals having a general body plan consisting of a muscular foot, visceral mass, and mantle.

Molluscs also have the following features:

- most species have separate sexes though some such as the snails are hermaphrodites
- many have ciliated trochophore larval stages
- most have a water-filled mantle cavity and feed with a radula

Molluscs are divided into 4 main classes:

- POLYPLACOPHORA
- GASTROPODS
- BIVALVES
- CEPHALOPODS

Polyplacophora (Chitons)

Chitons are marine animals armored with 8 dorsal plates.

- adhere to rocky surfaces via a muscular foot and feed on algae
Gastropods
Most gastropods (e.g., snails, slugs, abalone) have a single spiral shell, are herbivores, and move slowly via a muscular foot.
- ~3/4 of all molluscs are gastropods
- most are marine though some live in fresh water or are terrestrial

Bivalves
Bivalves (e.g., clams, oysters, mussels, scallops) are filter feeders with a shell divided into 2 hinged halves and a mantle cavity with gills used for gas exchange.

Cephalopods
Cephalopods have beak-like jaws surrounded by tentacles derived from a modified foot.
- includes species of octopus, squid, cuttlefish & nautilus
- have closed circulatory system and complex nervous system (considered the most intelligent invertebrates)
### Annelids

Annelids are coelomates with segmented body composed of a series of fused rings, that fall into 2 distinct clades – ERRANTIA and SEDENTARIA:

- the ERRANTIA contain pairs of parapodia on each segment, each with numerous chaetae – bristles made of chitin

### Sedentarians

Sedentarians tend to be less mobile than errantians, many of which burrow into the surrounding substrate or live in protective tubes:

- tube-dwelling sedentarians typically have elaborate gills or tentacles used for filter feeding
- this clade also includes the earthworms & leeches

### Earthworms

- earthworms are a good example of annelids, having a closed circulatory system and a complete digestive tract (mouth & anus)
Overview of the Ecdysozoa
The clade Ecdysozoa is the most diverse group of animals, most of which are covered by a tough cuticle that is periodically shed and replaced by molting.

The 2 largest phyla are the:

- NEMATODA (roundworms)
- ARTHROPODA

Nematodes
The Nematodes or roundworms have a complete digestive tract but lack a circulatory system.

- Some such as *Trichinella* are parasites that live and feed in animal tissues
Arthropods

2/3 of all animal species are arthropods which have the following general features.

- a segmented body with a hard exoskeleton made of chitin and protein that is molted as it grows
- jointed appendages that come in pairs
- open circulatory system

Arthropod Body Plan

3 Major Lineages of Arthropod

CHELICERATES
  • arachnids, horseshoe crabs

MYRIAPODS
  • centipedes, millipedes

PANCRUSTACEANS
  • insects, crustaceans
**Chelicerates**
Most marine chelicerates are extinct with the exception of the horseshoe crabs.

The vast majority of living chelicerates are the terrestrial arachnids...

**Arachnids**
Arachnids include spiders, mites, ticks & scorpions.
Arachnids have 6 pairs of appendages, 4 of which are walking legs.

**Myriapods**
- Millipedes have 2 pairs of legs per segment and eat decaying plant matter
- Centipedes have 1 pair of legs per segment and are carnivorous
Common ancestor of arthropods

Insects

Remipedians (a crustacean group)

Other crustaceans

Myriapods

Chelicerates

**Crustaceans**

- crustaceans are mostly aquatic (crabs, shrimp, barnacles, krill, etc)
- also includes the terrestrial isopods (pill bugs)

**Insects**

The clade *Hexapoda* includes all insects and their relatives, most of which are terrestrial.

- have complex organ systems
- many are capable of flight
3. Deuterostomes
Overview of the Deuterostomes

The clade Deuterostomia includes species with radial cleavage and an anus derived from the blastopore and contains 2 major lineages:

**ECHINODERMATA**
- sea stars, urchins, sand dollars, etc.

**CHORDATA (to be addressed in chapter 34)**
- all vertebrates and a few invertebrate chordates

Echinoderm Features

- adults have radial symmetry with multiples of 5 (larvae have bilateral symmetry)
- have an endoskeleton of calcareous plates

Living echinoderms fall into one of 5 clades:

**ASTEROIDIA** – sea stars & sea daisies
**OPHIUROIDIA** – brittle stars
**ECHINOIDIA** – sea urchins & sand dollars
**CRINOIDIA** – sea lilies & feather stars
**HOLOTHUROIDIA** – sea cucumbers
Asteroidia
Includes the sea stars which have 5 arms and prey on bivalves by prying them open.
Also includes the sea daisies which absorb their nutrients.

Ophiuroidia – “Brittle Stars”
Brittle stars have a distinct central disc from which 5 slender arms extend.
• some species are predatory or scavengers and others are filter feeders

Echinodea – “Sea Urchins & Sand Dollars”
Sea urchins and sand dollars lack arms but have 5 rows of tube feet.
• urchins have spines for protection and feed on seaweeds
**Crinoida – “Sea Lilies & Feather Stars”**

Sea lilies are sessile while feather stars crawl using long flexible arms.

Both are suspension feeders.

**Holothuroidea – “Sea Cucumbers”**

Sea cucumbers lack spines, have a reduced endoskeleton and 5 rows of tube feet.