Invertebrates

BRANCH PARAZOA - Phylum Porifera - Sponges

- Sponges have no true tissue: The germ layers of sponges are loose collections of cells, which are not really tissues because the cells are relatively unspecialized.
- Sponges are sessile animals as adults (free-swimming larvae) that lack nerves or muscles.
  - However, individual cells can sense and react to changes in the environment.
- The body of a simple sponge resembles a sac perforated with holes.
  - Water is drawn through the pores into a central cavity, the **spongocoel**, and flows out through a larger opening, the **osculum**.
- Nearly all sponges are suspension feeders, collecting food particles from water passing through food-trapping equipment.
  - Flagellated **choanocytes,** or collar cells, line the spongocoel (internal water chambers) and create a flow of water through the sponge with their flagella, and trap food with their collars.
- The body of a sponge consists of two cell layers separated by a gelatinous region, the **mesohyl**.
- Wandering though the mesohyl are **amoebocytes**.
  - They take up food from water and from choanocytes, digest it, and carry nutrients to other cells.
  - They also secrete tough skeletal fibers within the mesohyl.
    - In some groups of sponges, these fibers are sharp spicules of calcium carbonate or silica.
    - Other sponges produce more flexible fibers from a collagen protein called spongin.
  - We use these pliant, honeycombed skeletons as bath sponges.
- Most sponges are **hermaphrodites**, with each individual producing both sperm *and* eggs.
  - Gametes arise from choanocytes or amoebocytes.
  - The eggs are retained, but sperm are carried out the osculum by the water current.
  - Sperm are drawn into neighboring individuals and fertilize eggs in the mesohyl.
  - The zygotes develop into flagellated, swimming larvae that disperse from the parent.
  - When a larva finds a suitable substratum, it develops into a sessile adult.
- Sponges are capable of extensive regeneration, the replacement of lost parts.
  - They use regeneration not only for repair but also to reproduce asexually from fragments broken off a parent sponge.

BRANCH EUMETAZOA (Radiata) - Phylum Cnidaria – Hydra, jellyfish, sea anemones, corals

- The basic cnidarian body plan is a sac with a central digestive compartment, the **gastrovascular cavity**.
- This basic body plan has two variations: the sessile polyp and the floating medusa.
- The cylindrical **polyps**, such as hydras and sea anemones, adhere to the substratum by the aboral end and extend their tentacles, waiting for prey.
- **Medusas** (also called jellies) are flattened, mouth-down versions of polyps that move by drifting passively and by contacting their bell-shaped bodies.

- Cnidarians are carnivores that use tentacles with nematocysts that sting arranged in a ring around the mouth to capture prey and push the food into the gastrovascular chamber for digestion.
- Muscles and nerves exist in their simplest forms in cnidarians.
- Cells of the epidermis and gastrodermis have bundles of microfilaments arranged into contractile fibers.
  - True muscle tissue appears first in triploblastic animals.
  - When the animal closes its mouth, the gastrovascular cavity acts as a hydrostatic skeleton against which the contractile cells can work.
- Movements are controlled by a noncentralized nerve net associated with simple sensory receptors that are distributed radially around the body.

Phylum Ctenophora – Comb jellies

- Comb jellies, or ctenophores, superficially resemble cnidarian medusas.
- Some species are spherical or ovoid, others are elongate and ribbonlike.
- *Ctenophora* means "comb-bearer" and these animals are named for their eight rows of comblike plates composed of fused cilia.
- Most comb jellies have a pair of long retractable tentacles.
  - These tentacles are armed with adhesive structures (**colloblasts**) that secrete a sticky thread to capture their food.

BRANCH EUMETAZOA (Bilateria-Protostomia-Lophotrochozoa)
Phylum Platyhelminthes – Flatworms (Planaaria)

- This phyla also includes many parasitic species, such as the flukes and tapeworms.
- Flatworms and other bilaterians are triploblastic, with a middle embryonic tissue layer, mesoderm, which contributes to more complex organs and organs systems and to true muscle tissue.
- While flatworms are structurally more complex than cnidarians or ctenophores, they are simpler than other bilaterans.
  - Like cnidarians and ctenophores, flatworms have a gastrovascular cavity with only one opening (and tapeworms lack a digestive system entirely and absorb nutrients across their body surface).
  - Unlike other bilaterians, flatworms lack a coelom.
- Planarians and other flatworms lack organs specialized for gas exchange and circulation.
  - Their flat shape places all cells close to the surrounding water and fine branching of the digestive system distributes food throughout the animal.
  - Nitrogenous wastes are removed by diffusion and simple ciliated flame cells help maintain osmotic balance.

- Planarians move using cilia on the ventral epidermis, gliding along a film of mucus they secrete.
- A planarian has a head with a pair of eyespots to detect light and lateral flaps that function mainly for smell.
- The planarian nervous system is more complex and centralized than the nerve net of cnidarians.

- Planarians can reproduce asexually through regeneration.
- Planarians can also reproduce sexually.
- The monogeneans (class Monogenea) and the trematodes (class Trematoda) live as parasites in or on other animals.
  - Many have suckers for attachment to their host.
  - A tough covering protects the parasites.
  - Reproductive organs nearly fill the interior of these worms.
- Trematodes parasitize a wide range of hosts, and most species have complex life cycles with alternation of sexual and asexual stages.
  - Many require an intermediate host in which the larvae develop before infecting the final hosts (usually a vertebrate) where the adult worm lives.

Phylum Rotifera – Pseudocoelomates with jaws, crowns of cilia, and complete digestive tracts

- Rotifers have a **complete digestive tract** with a separate mouth and anus.
- Internal organs lie in the pseudocoelom, a body cavity that is not completely lined with mesoderm.
  - The fluid in the pseudocoelom serves as a hydrostatic skeleton.
  - Through the movements of nutrients and wastes dissolved in the coelomic fluid, the pseudocoelom also functions as a circulatory system.
- Some rotifers exist only as females that produce more females from unfertilized eggs, a type of **parthenogenesis**.
- Other species produce two types of eggs that develop by parthenogenesis.

Phylum Nemertea – Proboscis worms

- The members of the Phylum Nemertea, proboscis worms or ribbon worms, have bodies much like that of flatworms.
  - However, they have a small fluid-filled sac that may be a reduced version of a true coelom.
  - The sac and fluid hydraulics operate an extensible proboscis which the worm uses to capture prey.
- Proboscis worms and flatworms have similar excretory, sensory, and nervous systems.
- However, nemerteans have a complete digestive tract and a **closed circulatory system** in which the blood is contained in vessels.

Phylum Mollusca – Mollusks have a muscular foot, visceral mass, and a mantle

- Includes snails and slugs, oysters and clams, and octopuses and squids.
- Mollusks are soft-bodied animals, but most are protected by a hard shell of calcium carbonate.
  - Slugs, squids, and octopuses have reduced or lost their shells completely during their evolution.
- Despite their apparent differences, all mollusks have a similar body plan with a muscular **foot** (typically for locomotion), a **visceral mass** with most of the internal organs, and a **mantle**.
  - The mantle, which secretes the shell, drapes over the visceral mass and creates a water-filled chamber, the **mantle cavity**, with the gills, anus, and excretory pores.
  - Many mollusks feed by using a straplike rasping organ, a **radula**, to scrape up food.
- Most mollusks have separate sexes, with gonads located in the visceral mass.
  - The life cycle of many marine mollusks includes a ciliated larvae, the **trophophore**.
  - This larva is also found in marine annelids (segmented worms).
- Gas exchange in mollusks occur through gills or the mantle surface
- Most mollusks have an ***open circulatory system*** with a dorsal heart that pumps circulatory fluid through arteries into sinuses (body spaces) bathing the organs.
- Excretory organs, called **nephridia**, remove metabolic wastes.

Phylum Annelida – segmented worms

- Earthworms, sandworms, leeches
- All annelids ("little rings") have segmented bodies, partitioned by septa.
- True coelom
- Gas exchange through skin or gills
- Excretion by pair of nephridia per segment
- Closed circulatory system – blood stays within vessels
- The coelom of the earthworm, a typical annelid, is partitioned by septa, but the digestive tract, longitudinal blood vessels, and nerve cords penetrate the septa and run the animal's length.
- Annelids are cross-fertilizing hermaphrodites.
  - Two annelids exchange sperm and then separate.
  - The received sperm are stored while a special organ, the clitellum, secretes a mucous cocoon.
  - As the cocoon slides along the body, it picks up eggs and stored sperm and slides off the body into the soil.
- Some earthworms can also reproduce asexually by fragmentation followed by regeneration.
- The evolutionary significance of the coelom cannot be overemphasized.
  - The coelom provides a hydrostatic skeleton that allows new and diverse modes of locomotion.
  - It also provides body space for storage and for complex organ development.
  - The coelom cushions internal structures and separates the action of the body wall muscles from those of the internal organs, such as the digestive muscles.
- Segmentation allows a high degree of specialization of body regions.
  - Groups of segments are modified for different functions.

BRANCH EUMETAZOA (Bilateria-Protostomia-Ecdysozoa)

Phylum Nematoda – Roundworms, pinworms, hookworms, ascaris

- The cylindrical bodies of roundworms are covered with a tough exoskeleton, the cuticle.
- They have a complete digestive tract and use the fluid in their pseudocoelom to transport nutrients since they lack a circulatory system.
- Nematodes usually engage in sexual reproduction.
  - The sexes are separate in most species and fertilization is internal.
- Abundant, free-living nematodes live in moist soil and in decomposing organic matter on the bottom of lakes and oceans.
  - They play a major role in decomposition and nutrient recycling.

Arthropods are segmented coelomates with exoskeletons and jointed appendages

Arachnids – *spiders, ticks, mites*, Crustaceans – *crabs, crayfish, daphnia,* Diplopods and chilopods - *millipedes/centipedes*, Insects – *bugs, fruit flies, ants*

- The world arthropod population has been estimated at a ***billion billion*** (10^{18}) individuals.
- Nearly a million arthropod species have been described - two out of every three organisms known are arthropods.
- On the criteria of species diversity, distribution, and sheer numbers, arthropods must be regarded as the most successful animal phylum.
- The diversity and success of **arthropods** is largely due to three features: body segmentation, a hard exoskeleton, and jointed appendages.
- Groups of segments and their appendages have become specialized for a variety of functions, permitting efficient division of labor among regions.
- The body of an arthropod is completely covered by the **cuticle**, an **exoskeleton** constructed from layers of protein and chitin.
  - The exoskeleton protects the animal and provides points of attachment for the muscles that move appendages.
  - It is thick and inflexible in some regions, such as crab claws, and thin and flexible in others, such as joints.
- The exoskeleton of arthropods is strong and relatively impermeable to water- helped the move of these creatures onto land
- Arthropods have well-developed sense organs, including eyes for vision, olfactory receptors for smell, and antennae for touch and smell.
- Arthropods have an **open circulatory system** in which hemolymph fluid is propelled by a heart through short arteries into sinuses (the hemocoel) surrounding tissues and organs.
- Arthropods have evolved a variety of specialized organs for gas exchange such as gills, tracheal systems, and book lungs (spiders).

BRANCH EUMETAZOA (Bilateria-Deuterostomia-Echinodermata)

- Sea stars and other echinoderms would seem to have little in common with the phylum Chordata, which includes the vertebrates (and us)!!
- However, these animals share the ***deuterostome*** characteristics of radial cleavage, development of the coelom from the archenteron, and the formation of the anus from the blastopore.
- Sea stars and most other **echinoderms** are sessile, or slow-moving animals.
- The internal and external parts of the animal radiate from the center, often as five spokes.
- A thin skin covers an endoskeleton of hard calcareous plates.
  - Most echinoderms are prickly from skeletal bumps and spines that have various functions.
- Unique to echinoderms is the **water vascular system**, a network of hydraulic canals branching into extensions called **tube feet**.
  - These function in locomotion, feeding, and gas exchange.
- Sexual reproduction in echinoderms usually involves the release of gametes by separate males and females into the seawater.
  - The radial adults develop by metamorphosis from bilateral larvae.
- The radial appearance of most adult echinoderms is the result of a secondary adaptation to a sessile lifestyle.
  - Their larvae are clearly bilateral and even echinoderm adults are not truly radial in their anatomy.
- All 7,000 or so species of echinoderms are marine.
- They include Asteroidea (sea stars), Ophiuroidea (brittle stars), Echinoidea (sea urchins and sand dollars), Crinoidea (sea lilies and feather stars), Holothuroidea (sea cucumbers), and Concentricycloidea (sea daisies).