

- **Chapter 33- An Introduction to Invertebrates**

- **Life Without a Backbone**

- **Invertebrates** are animals that lack a backbone.
 - They account for 95% of known animal species.
- Except for sponges and a few other groups, all animals have tissues and are in the clade Eumetazoa.
- **Porifera (5,550 Species)**
 - Animals in this phylum are informally called sponges.
 - Sponges lack true tissue and are sessile animals.
 - They live as suspension feeders, trapping particles that pass through the internal channel of their body.
- **Cnidaria (10,000 Species)**
 - Cnidarians include corals, jellies, and hydras.
 - These animals have a diploblastic, radially symmetrical body plan that includes a gastrovascular cavity with a single opening that serves as both mouth and anus.
- **Chordata (52,000 Species)**
 - More than 90% of all known chordate species have backbones (and thus are vertebrates)
 - Phylum Chordata also includes three groups of invertebrates: lancelets, tunicates, and hagfishes.
- **Annelida (16,500 Species)**
 - Annelids, or segmented worms, are distinguished from other worms by their body segmentation.
 - Earthworms are the most familiar annelids, but the phylum consists primarily of marine and freshwater species.

- **Concept 33.1- Sponges are basal animals that lack true tissues.**

- Animals in the phylum Porifera are known informally as sponges.
 - Sponges are monophyletic.
 - Most species of sponges are marine, though few live in fresh water.
 - Sponges are suspension feeders—they capture food particles suspended in the water that passes through their body, which in some species resembles a sac of perforated with pores.
 - Water is drawn through the pores into a central cavity, the spongocoel, and then flows out of the sponge through a larger opening called the osculum.
 - Sponges are basal animals; they represent a lineage that originates near the root of the phylogenetic tree of animals.
 - Sponges lack true tissues, groups of similar cells that act as a functional unit and are isolated from other tissues by membranous layers.
 - The sponge body does contain several different cell types.
 - Lining the interior of the spongocoel are flagellated choanocytes, or collar cells. These cells engulf bacteria and other food particles by phagocytosis.
 - By beating flagella, the choanocytes create current that draws water in through the pores and out through the osculum.
 - The similarity between choanocytes and the cells of choanoflagellates support molecular evidence suggesting that animals evolved from a choanoflagellates-like ancestor.
 - The body of a sponge consists of two layers of cells separated by a gelatinous region called the mesohyl.
 - The cell layers come in contact with water, so gas exchange and waste removal can occur by diffusion across the membranes of these cells.
 - Amoebocytes are cells that move through the mesohyl. They take up food from the surrounding water and from choanocytes, digest it, and carry nutrients to other cells.
 - Amoebocytes make tough skeletal fibers within the mesohyl. In some sponges, these fibers are sharp spicules made from calcium carbonate or silica.
 - Other sponges produce flexible fibers composed of a protein called spongin.
 - Amoebocytes are capable of becoming other types of sponge cells. This gives the sponge body remarkable flexibility, enabling it to adjust its shape in response to changes in its physical environment (such as the direction of water currents)
 - Most sponges are hermaphrodites, meaning that each individual functions as both male and female in sexual reproduction by producing both sperm and eggs.
 - Eggs reside in the mesohyl, but sperm are carried out of the sponge by the water current.
 - Fertilization occurs in the mesohyl, where the zygotes develop into flagellated, swimming larvae that disperse from the parent sponge.
 - Crilbostatin is a compound isolated from marine sponges that can kill penicillin-resistant strains of the bacterium *Streptococcus*.

- **Concept 33.1 Summary- Sponges are basal animals that lack true tissues.**

- **Metazoa → Phylum- Porifera (sponges)**
- **Description-** lack true tissues; have choanocytes (collar cells—flagellated cells that ingest bacteria and tiny food particles)

- **Concept 33.2- Cnidarians are an ancient phylum of eumetazoans.**

- All animals except sponges and a few other groups belong to the clade Eumetazoa, animals with true tissues.
 - Most cnidarians still exhibit the relatively simple, diploblastic, radial body plan that existed in the early members of the group of some 560 million years ago.
- The basic body plan of a cnidarian is a sac with a central digestive compartment, the **gastrovascular cavity**.

- A single opening to this cavity functions as both mouth and anus.
- **Polyps** are cylindrical forms that adhere to the substrate by the aboral end of their body (the end opposite the mouth) and extend their tentacles, waiting for prey.
- **Medusa** resembles a flattened, mouth-down version of the polyp. It moves freely in the water by a combination of passive drifting and contractions of its bell-shaped body.
 - Some cnidarians exist only as polyps or only as medusa; others have both a polyp stage and a medusa stage in their life cycle.
- Cnidarians are carnivores that often use tentacles arranged in a ring around their mouth to capture prey and push the food into their gastrovascular cavity, where digestion begins.
 - The tentacles are armed with batteries of **cnidocytes**, cells unique to cnidarians that function in defense and prey capture.
 - **Cnidae** are capsule like organelles that are capable of exploding outward.
 - **Nematocysts** are specialized cnidae containing a stinging thread that can penetrate the body wall of the cnidarian's prey.
- Cnidarians have the simplest form of contractile tissues and nerves.
 - The gastrovascular cavity acts as a hydrostatic skeleton.
 - Cells of the epidermis (outer layer) and gastrodermis (inner layer) have bundles of microfilaments arranged into contractile fibers.
 - Movements are coordinated by a nerve net.
 - Cnidarians have no brain, and the non-centralized nerve net is associated with sensory structures that are disrupted around the body.
- **Hydrozoans**
 - Most hydrozoans alternate between the polyp and medusa forms.
 - The polyp stage, a colony of interconnected polyps in the case of *Obelia*, is more conspicuous than the medusa.
 - Hydras, among the few cnidarians found in fresh water, are unusual hydrozoans in that they exist only in polyp form.
 - When environmental conditions are favorable, a hydra reproduces asexually by budding, forming outgrowths that pinch off from the parent and live independently.
- **Scyphozoans**
 - The medusa is the predominant stage in the life cycle of most scyphozoans.
 - Most coastal scyphozoans go through a stage as small polyps during their life cycle, whereas those that live in the open ocean generally lack the polyp stage altogether.
- **Cubozoans**
 - Cubozoans have a box-shaped medusa stage.
 - They have complex eyes embedded in the fringe of their medusae.
- **Anthozoans**
 - Sea anemones and corals belong to the clade Anthozoa, meaning flower animals.
 - These cnidarians occur only as polyps.
 - Many species secrete a hard external skeleton of calcium carbonate.
 - Each polyp generation builds on the skeletal remains of earlier generations.
- **Concept 33.2 Summary- Cnidarians are an ancient phylum of eumetazoans**
- **Metazoa → Eumetazoa → Phylum- Cnidaria (hydraz, jellies, sea anemones, corals)**
- **Description-** unique stinging structures (nematocysts) housed in specialized cells (cnidocytes); diploblastic; radially symmetrical; gastrovascular cavity (digestive compartment with a single opening).
- **Concept 33.3- Lophotrochozoans, a clade identified by molecular data, have the widest range of animal body forms.**
- The vast majority of animal species belong to the clade Bilateria, whose members exhibit bilateral symmetry and triploblastic development.
 - Most bilaterians also have a digestive tract with two openings, a mouth and an anus, and a coelom.
- There are three major clades of bilaterally symmetrical animals: Lophotrochozoa, Ecdysozoa, and Deuterostomia.
 - Some Lophotrochozoans develop a structure called a **lophophore**, a crown of ciliated tentacles that functions in feeding, while others go through a distinctive stage called the **trochophore larva**.
- **Flatworms- Phylum Platyhelminthes**
 - Flatworms live in marine, freshwater, and damp terrestrial habitats.
 - They include many parasitic species, such as flukes and tapeworms.
 - Flatworms have thin bodies that are flattened dorsoventrally (between the dorsal and the ventral surfaces)
 - Although flatworms undergo triploblastic development, they are acoelomates, animals that lack a body cavity, and they have a gastrovascular cavity with only one opening.
 - Their flat shape places all their cells close to water in the surrounding environment or in their gut.
 - Gas exchange and the elimination of nitrogenous waste (ammonia) can occur by diffusion across the body surface.
 - Flatworms have no organs specialized for gas exchange, and their relatively simple excretory apparatus functions mainly to maintain osmotic balance with their surroundings.
 - Their apparatus consists of **protonephridia**, networks of tubules with ciliated structures called **flame bulbs** that pull fluid through branched ducts openings to the outside.
 - **Free-Living Species**

- Planarians are the best-known members of free-living rhabditophorans—important predators and scavengers in a wide range of freshwater and marine habitats.
 - They move by using cilia on their ventral surface, gliding along a film of mucus they secrete. Some other rhabditophorans also use their muscles to swim through water with an undulating motion.
- A planarian's head is equipped with a pair of light-sensitive eyespots and lateral flaps that function mainly to detect specific chemicals.
 - The planarian nervous system is more complex and centralized than the nerve nets of cnidarians.
- Some planarians can reproduce asexually through fusion.
- Sexual reproduction also occurs. Planarians are hermaphrodites, and copulating mates typically cross-fertilize each other.
- **Anatomy of a planarian**
 - **Pharynx**- the mouth is at the tip of a muscular pharynx. Digestive juices are spilled onto prey, and the pharynx sucks small pieces of food into the gastrovascular cavity, where digestion continues.
 - **Ganglia**- at the anterior end of the worm, near the main sources of sensory input, is a pair of ganglia, dense clusters of nerve cells.
 - **Ventral nerve cords**- from the ganglia, a pair of ventral nerve cords runs the length of the body.
 - Digestion is completed within the cells lining the gastrovascular cavity, which has many fine sub-branches that provide an extensive surface area.
 - Undigested wastes are egested through the mouth.
- **Parasitic Species**
 - More than half of the known species of rhabditophorans live as parasites in or on other animals. Many have suckers that attach to the internal organs or outer surfaces of the host animal.
 - Reproductive organs occupy nearly the entire interior of these worms.
- **Trematodes**
 - As a group, trematodes parasitize a wide range of hosts, and most species have complex life cycles with alternating sexual and asexual stages.
 - Many trematodes require an intermediate host in which larvae develop before infecting the final host, where the adult worms live.
- **Tapeworms**
 - The tapeworms are a second large and diverse group of parasitic rhabditophorans.
 - The adults live mostly inside vertebrates, including humans.
 - In many tapeworms, the anterior end, or scolex, is armed with suckers and often hooks that the worm uses to attach itself to the intestinal lining of its host.
 - Tapeworms lack a mouth and gastrovascular cavity; they simply absorb nutrients released by digestion in the host's intestine.
 - Posterior to the scolex is a long ribbon of units called proglottids, which are little more than sacs of sex organs.
 - After sexual reproduction, proglottids loaded with thousands of fertilized eggs are released from the posterior end of a tapeworm and leave the host's body in feces.
 - Large tapeworms can block the intestines and rob enough nutrients from the human host to cause nutritional deficiencies.
- **Rotifers (phylum Rotifera)**
 - Rotifers are tiny animals that inhabit freshwater, marine, and damp soil habitats.
 - In contrast to cnidarians and flatworms, which have a gastrovascular cavity, rotifers have an alimentary canal, a digestive tube with two openings, a mouth and an anus.
 - Internal organs lie within the pseudocoelom, a body cavity that is not completely lined by mesoderm.
 - Movement of a rotifer's body distributes the fluid throughout the body, circulating nutrients.
 - Rotifers have a crown of cilia that draws a vortex of water in to the mouth.
 - Posterior to the mouth, a region of the digestive tract called the pharynx bears jaws called trophi that grind up food, mostly microorganisms suspended in the water.
 - Some species consist of only females that produce more females from unfertilized eggs, a type of asexual reproduction called parthenogenesis.
 - Some rotifers can also reproduce sexually under certain conditions, such as high levels of crowding.
 - When this occurs, a female produces two types of eggs—one type develop into females, and the other eggs of the other type develop into males.
- **Lophophorates: Ectoprocts and BrachloPods**
 - Lophophorates have a lophophore, a crown of ciliated tentacles around their mouth.
 - They also have a U-shaped alimentary canal and the absence of a distinct head, reflect these organisms' sessile existence.
 - Lophophorates have a true coelom that is completely lined by mesoderm.
 - Ectoprocts are colonial animals that superficially resemble clumps of moss that live in the sea, lakes or rivers.
 - In most species, the colony is encased in a hard exoskeleton studded with pores through which the lophophores extend.