Chapter 7

Marine Animals without Backbones
Invertebrates

- 97% of all animals on earth are invertebrates
- Animals without a backbone
Animals are eukaryotic, multicellular organisms with ways of moving that help them reproduce, obtain food, and protect themselves.
- Suspension feeding (filter)- feed on particle matter suspended in the water
- Deposit feeding - feed on particle matter that settles to the bottom
Most animals have specialized cells that form tissues and organs—such as nerves and muscles.

Animals are composed of cells that do not have cell walls.
Levels of Organization in Organisms

- Cells
- Tissues
- Organs
- Organ Systems
- Organism
- Species
- Genus
- Family
- Order
- Class
- Phylum
- Kingdom
One characteristic common to all animals is that they are heterotrophic, meaning they must consume food to obtain energy and nutrients.

All animals depend either directly or indirectly on autotrophs for food.
Animals obtain food

- Organisms that are permanently attached to a surface are called sessile.
What is symmetry

- Symmetry is a term that describes the arrangement of body structures.
- Different kinds of symmetry enable animals to move about in different ways.
Asymmetry

- An animal that is irregular in shape has no symmetry or an asymmetrical body plan.
- Animals with no symmetry often are sessile organisms that do not move from place to place.
- Most adult sponges do not move about.
Radial symmetry

- Animals with radial symmetry can be divided along any plane, through a central axis, into roughly equal halves.
Radial symmetry

- Radial symmetry is an adaptation that enables an animal to detect and capture prey coming toward it from any direction.
An organism with bilateral symmetry can be divided down its length into similar right and left halves.
Bilateral symmetry

- Bilaterally symmetrical animals can be divided in half only along one plane.

- In bilateral animals, the anterior, or head end, often has sensory organs.

- The posterior of these animals is the tail end.
General Habitat

- benthic on the bottom
  - epifauna on top of
  - infauna in the sediment
  - benthic on the bottom
- pelagic open water
- parasitic live on or off another organism
Invert or Vert ???
Symmetry???
1. Sponges – Phylum Porifera
Sponges are asymmetrical aquatic animals that have a variety of colors, shapes, and sizes.

Many are bright shades of red, orange, yellow, and green.

Porifera means “pore bearer.”
Sponges are mainly sessile organisms.

Because most adult sponges can’t travel in search of food, they get their food by a process called filter feeding.
Some sponges have sharp, hard spicules located between the cell layers.

- Spicules may be made of glasslike material or of calcium carbonate.
2. Cnidarians – Phylum Cnidaria

• Cnidarians (ni DARE ee uns) are a group of invertebrates made up of more than 9000 species of jellyfishes, corals, sea anemones, and hydras.

• They can be found worldwide, and all but a few cnidarians live in marine biomes.
A cnidarian’s body is radially symmetrical. It has one body opening and is made up of two layers of cells.
A Cnidarian

- Cnidarians display a remarkable variety of colors, shapes and sizes. Some can be as small as the tip of a pencil.

- Most cnidarians have two distinct body forms during their life cycles.

- A polyp is the sessile form of a cnidarian. Its mouth is surrounded by tentacles.

- Examples of polyps include sea anemones, corals, and hydras.
A medusa is the free-swimming form of a cnidarian.

It possesses an umbrella-shaped, floating body, called a bell, with the mouth on its underside.
A Cnidarian

Tentacles

Mouth

Bud

Prey

Nematocyst before discharge

Nematocyst after discharge
Most cnidarians undergo a change in body form during their life cycles. There are two body forms, the polyp and the medusa.
Cnidarians are predators that capture or poison their prey using nematocysts.

A nematocyst (nih MA tuh sihst) is a capsule that contains a coiled, threadlike tube.

The tube may be sticky or barbed, and it may contain toxic substances.

Nematocysts are located in stinging cells that are on tentacles.
Digestion in cnidarians

- Once captured by nematocysts, prey is brought to the mouth by contraction of the tentacles.
Cnidarians – Phylum Cnidaria

Types:

- Hydrozoans – Portuguese Man of war
- Scyphozoans - jellyfish
- Anthozoans – anemones, corals
What class am I in?
3. Comb Jellies – Phylum Ctenophore

- General Habitat – pelagic
- Level of organization – tissue
- Symmetry – radial
- Feeding Type – filter feeder
Ex. 3 Lab

- Drawings should be in color
- Drawings need to be labeled with the following terms in present: pores, osculum, nematocysts, tentacles, mouth, anus
4. Worms

- Flatworms – Phylum Platyhelminthes
- Ribbon worms – Phylum Nermertea
- Nematodes – Phylum Nematoda
- Annelids – Phylum Annelida
Flatworms – Phylum Platyhelminthes

- Distinguishing Features – flattened body
- General Habitat – benthic epifauna, infauna
- Level of organization – organ system
- Symmetry – bilateral
- Feeding Type - parasitic
Planaria

- **Head**
- **Eye spot**
- **Tail**
Flatworms
Ribbon worms
Phylum
Nermertea
Ribbon Worms

- Distinguishing Features – long proboscis
- General Habitat – benthic
- Level of organization – organ system
- Symmetry – bilateral
- Feeding Type - parasitic
Segmented Worms – Phylum Annelida

- Distinguishing Features – segmentation, setae (sharp bristles) and Parapodia (flattened extensions)
- General Habitat – benthic
- Level of organization – organ system
- Symmetry – bilateral
- Feeding Type – deposit feeders, carnivores
5. Segmented Worms

- Polychaetes
- Oligochaetes
- Leeches
Polychaetes
5. Molluscs – Phylum Mollusca

- Class Gastrapoda - snails
- Class Bivalvia - clams
- Class Cephalopoda - squid
All mollusks have bilateral symmetry, a coelom, a digestive tract with two openings, a muscular foot, and a mantle.

- Visceral mass
- Mantle
- Shell
- Foot
- Reduced internal shell
- Mantle
- Gut
- Squid

What is a mollusk?
The mantle is a membrane that surrounds the internal organs of the mollusk. In shelled mollusks, the mantle secretes the shell.
Snails, like many mollusks, use a rasping structure called a radula to obtain food. A radula, located within the mouth of a mollusk, is a tonguelike organ with rows of teeth. The radula is used to drill, scrape, grate, or cut food.
How mollusks obtain food

- Octopuses and squids are predators that use their radulas to tear up the food that they capture with their tentacles.
- Other mollusks are grazers and some are filter feeders.
- Bivalves do not have radulas; they filter food from the water.
The largest class of mollusks is **Gastropoda**, or the stomach-footed mollusks.

Shelled gastropods include snails, abalones, conches, periwinkles, whelks, limpets, cowries, and cones.

The name comes from the way the animal’s large foot is positioned under the rest of its body.
Class Gastropoda
Bivalves: Two-shelled mollusks

- Two-shelled mollusks such as clams, oysters, and scallops belong to the class Bivalvia.

- Most bivalves are marine, but a few species live in freshwater habitats.
Colorful sea slugs, also called nudibranchs, are protected in another way.

When certain species of sea slugs feed on jellyfishes, they incorporate the poisonous nematocysts of the jellyfish into their own tissues.
Class Bivalvia
Bivalves: Two-shelled mollusks

- Bivalves have no distinct head or radula. Most use their large, muscular foot for burrowing in the mud or sand at the bottom of the ocean or a lake.

- A ligament, like a hinge, connects their two shells, called valves; strong muscles allow the valves to open and close over the soft body.
Class Cephalopoda

- No shell
This class includes the octopus, squid, cuttlefish, and chambered nautilus.

The only cephalopod with a shell is the chambered nautilus, but some species, such as the cuttlefish, have a reduced internal shell.
In cephalopods, the foot has evolved into tentacles with suckers, hooks, or adhesive structures.

Cephalopods swim or walk over the ocean floor in pursuit of their prey, capturing it with their tentacles.
Cephalopods: Head-footed mollusks

- Once tentacles have captured prey, it is brought to the mouth and bitten with beaklike jaws.

- Then the food is torn and pulled into the mouth by the radula.
Cephalopods have siphons that expel water.

These mollusks can expel water forcefully in any direction, and move quickly by jet propulsion. Squids can attain speed of 20m per second using this system of movement.
Chambered Nautilus
Molluscs – What phylum?
Examples

- **Class Crustacea**
  - Copepods
  - Barnacles
  - Amphipods
  - Isopods
  - Krill
  - Shrimp, crabs, and lobsters
- **Horseshoe crabs**
- **Sea spiders**
- **Insects**
Horseshoe crabs are members of the class Merostomata.

Horseshoe crabs are considered to be living fossils; *Limulus* fossils have remained relatively unchanged since the Triassic Period about 220 million years ago.
Horseshoe Crabs: Living Fossils

- Horseshoe crabs are heavily protected by an extensive exoskeleton and live in deep coastal waters.

- They forage on sandy or muddy ocean bottoms for algae, annelids, and mollusks.
What is an arthropod?

- A typical arthropod is a segmented, coelomate invertebrate animal with bilateral symmetry, an exoskeleton, and jointed structures called appendages.

- An appendage is any structure, such as a leg or an antenna, that grows out of the body of an animal.
What is an arthropod?

- Arthropods are the earliest known invertebrates to exhibit jointed appendages.
- Joints are advantageous because they allow more flexibility in animals that have hard, rigid exoskeletons.
Arthropod exoskeletons provide protection

- The exoskeleton is a hard, thick, outer covering made of protein and chitin.
Arthropod exoskeletons provide protection

- The exoskeleton protects and supports internal tissues and provides places for attachment of muscles.
- In many aquatic species, the exoskeletons are reinforced with calcium carbonate.
Why arthropods must molt?

- A second and more important disadvantage is that exoskeletons cannot grow, so they must be shed periodically. Shedding the old exoskeleton is called molting.
Crustaceans

- Crustaceans are the only arthropods that have two pairs of antennae for sensing.

- All crustaceans have mandibles for crushing food and typically have two compound eyes.
Unlike the up-and-down movement of your jaws, crustacean mandibles open and close from side to side.

Many crustaceans have five pairs of walking legs.
The first pair of walking legs are often modified into strong claws for defense.
**Crustaceans**

- Most crustaceans are aquatic and exchange gases as water flows over feathery gills.
- Sow bugs and pill bugs, two of the few land crustaceans, must live where there is moisture, which aids in gas exchange.
Mantis Shrimp
With eggs
<table>
<thead>
<tr>
<th>Copepods</th>
<th>Nauplius</th>
<th>Copepodite</th>
<th>Adult copepod</th>
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</thead>
<tbody>
<tr>
<td>Barnacles</td>
<td>Nauplius</td>
<td>Cypris</td>
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<tr>
<td>Spiny lobsters</td>
<td>Phyllosoma</td>
<td>Adult lobster</td>
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<td>Most shrimps</td>
<td>Zoea</td>
<td>Adult shrimp</td>
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<tr>
<td>Crabs</td>
<td>Zoea</td>
<td>Megalopa</td>
<td>Adult crab</td>
</tr>
</tbody>
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7. Lophophorates – 3 phyla

- Phylum Ectoprocta - Bryozoans
- Phylum Phoronida - Phoronids
- Phylum Brachiopoda - Lamp shells or brachiopods
Lophophorates

- Distinguishing Features – lophophore (ciliated tentacles)
- General Habitat – benthic
- Level of organization – organ system
- Symmetry – bilateral
- Feeding Type – suspension feeders (filter)
9. Arrow Worms – Phylum Chaetognatha
Arrow Worms

- Distinguishing Features – transparent body with fins
- General Habitat – pelagic
- Level of organization – organ system
- Symmetry – bilateral
- Feeding Type – carnivores of plankton
10. Echinoderms – Phylum Echinodermata

- Sea stars
- Brittle stars
- Sea urchins
- Sea cucumbers
- Crinoids
• Distinguishing Features – tube feet, water vascular system
• General Habitat – benthic epifauna
• Level of organization – organ system
• Symmetry – radial
• Feeding Type – herbivores, carnivores, deposit feeders
What is an echinoderm?

- Echinoderms move by means of hundreds of hydraulic, suction-cup-tipped appendages and have skin covered with tiny, jawlike pincers.

- Echinoderms are found in all the oceans of the world.
If you were to examine the skin of several different echinoderms, you would find that they all have a hard, spiny, or bumpy endoskeleton covered by a thin epidermis.
Echinoderms have endoskeletons

- Sea stars, sometimes called starfishes, may not appear spiny at first glance, but a close look reveals that their long, tapering arms, called rays, are covered with short, rounded spines.

- The endoskeleton of all echinoderms is made primarily of calcium carbonate, the compound that makes up limestone.
Echinoderms have endoskeletons

- Some of the spines found on sea stars and sea urchins have become modified into pincerlike appendages called pedicellariae.
Echinoderms have endoskeletons

- An echinoderm uses its jawlike pedicellariae for protection and for cleaning the surface of its body.
Echinoderms have radial symmetry

- You may remember that radial symmetry is an advantage to animals that are stationary or move slowly.

- Radial symmetry enables these animals to sense potential food, predators, and other aspects of their environment from all directions.
The water vascular system

- The water vascular system is a hydraulic system that operates under water pressure.

- Water enters and leaves the water vascular system of a sea star through the madreporite, a sievelike, disk-shaped opening on the upper surface of the echinoderm’s body.
The water vascular system

- The underside of a sea star has tube feet that run along a groove on the underside of each ray.
The water vascular system

- Tube feet are hollow, thin-walled tubes that end in a suction cup.
- Tube feet look somewhat like miniature droppers.
- The round, muscular structure called the ampulla works something like the bulb of a dropper.
The water vascular system

- Each tube foot works independently of the others, and the animal moves along slowly by alternately pushing out and pulling in its tube feet.
The water vascular system

- Tube feet also function in gas exchange and excretion. Gases are exchanged and wastes are eliminated by diffusion through the thin walls of the tube feet.
Echinoderms have varied nutrition

- All echinoderms have a mouth, stomach, and intestines, but their methods of obtaining food vary.

- Sea stars are carnivorous and prey on worms or on mollusks such as clams.
Echinoderms have varied nutrition

- Most sea urchins are herbivores and graze on algae.

- Brittle stars, sea lilies, and sea cucumbers feed on dead and decaying matter that drifts down to the ocean floor.
Sea stars

Endoskeleton

Madreporite

Radial canal

Radial nerve

Ring canal

Ampullae

Mouth

Reproductive organ

Endoskeletal plates

Eye spots

Tube feet

Pedicellariae

Ray

Anus

Nerve ring

Stomach

Digestive gland
During at least part of their development all chordates possess:

- Dorsal nerve cord
- Gill slits – small openings along the anterior part of the gut
- Notochord – flexible rod for support that lies between the nerve cord and the gut
- Post anal tail – tail that extends beyond the anus
- 3 groups – 2 invert (lack a backbone) and 1 vert (have a backbone)
What is an invertebrate chordate?

- In addition, all chordates have bilateral symmetry, a well-developed coelom, and segmentation.
11. Tunicates
12. Lancets
Second group of invertebrate chordates

**FIGURE 45.7**
The structure of a lancelet. This diagram shows the path through which the lancelet’s cilia pull water.