Phylum Arthropoda
Subphylum Crustacea

Crustaceans vary in size from microscopic plankton to enormous crabs. Smaller crustaceans such as amphipods, copepods and isopods form the basis of many ocean food chains. Although crustaceans are extremely varied in appearance most share the following characteristics:

Body divided into a head, thorax and abdomen (may be fused into cephalothorax)

Hard exoskeleton – molting

Jointed, paired appendages
Two eyes
Two pairs of antennae
Life Cycles w/ multiple stages

The Crustacea (L. *crusta* = shell) are named after the hard shell that most crustaceans bear. Familiar to most people are the edible ones: lobsters, crayfishes, shrimps, and crabs. In addition, there are less familiar forms including water fleas, whale lice, and krill. These other members fill a wide variety of ecological roles and show enormous variation in morphological characteristics.
Class Malacostraca: shrimp, lobster, crabs

The Malacostraca (mal-uh-KOS-truh-kuh) include about two thirds of all crustacean species, and contains all the larger forms, such as woodlice, shrimps, lobsters and crabs. The three main orders of Malacostracans are the Isopoda, the Amphipoda and the Decapoda.

Order Decapoda

Decapods, including crabs, shrimps, lobsters, and crayfishes, are among the most familiar of all crustaceans. Approximately ninety percent of all species live in the ocean. They are found in all kinds of habitats, including mud flats, mangrove forests, rocky shores, muddy or sandy beaches, sea grass beds, coral reefs, open water, and sea bottoms, including deep sea geysers known as hydrothermal vents. They come in a wide variety of sizes, ranging from tiny pea crabs to the giant Japanese spider crab spanning up to 12 feet across.

The head and thorax are closely joined together, or fused, to form the cephalothorax that is covered by a shield-like chitinous (protein & mineral) carapace. The carapace also covers the sides of the body and protects the gills. The first few pairs of legs often have claws that are used for feeding, mating, and defense. Many species dig burrows in these habitats and come out only under the protection of dark to look for food. Freshwater species live in a variety of habitats, including mountain streams, rivers, ponds, and along lakeshores. Only one percent of all decapods are terrestrial. All depend on water and must return there to reproduce.

Motion: In lobsters, crayfishes, and shrimps, the abdomen is long and thick, with powerful muscles used for swimming. Hard-bodied decapods, such as lobsters, snap their abdomens with fanlike tails forward.
underneath their bodies to propel themselves backward through the water. Shrimps and other softer-bodied species use their abdomens and tails to swim forward in the water. In contrast, the bodies of crabs are relatively short and compact. They have lost most of their abdominal appendages. Crabs move sideways, holding claws out in front of them. In all cases the muscles attach to the inside surface of the exoskeleton.

![Crab Image](image_url)

![Crab Diagram](image_url)
Reproduction Most decapods are dioecious (have males and females.) In some shrimps, the adults mature first as males and later develop into females. A few species are hermaphroditic. Like their insect cousins, many species have elaborate courtship rituals. In fiddler crabs, the male has claws that are much larger than those of the females. Useless for feeding, the oversized male claws are used only for fighting with other males and attracting females. The presence of these claws is evidence of Sexual Selection, an important driver of adaptation. Depending on the species, mating can be brief or may occur only after males and females have spent long periods of time together. In many of the latter cases, the female can only mate just after she molts so, as they prepare to molt, the adult females release pheromones to attract males. A male will sometimes grasp the female with its legs for several days or weeks until she finally molts. Sperm is transferred to the female as a fluid or inside packets. The sperm is deposited directly into the reproductive organs of the female or into a special storage sac in her body. In some species the male stands guard over the female to prevent other males from mating with her. The male transfers the sperm using a specialized leg. It is usually possible to i.d. gender based on external features.

Consumption: Feeding: depending on the species, mandibles are used for slicing flesh, grinding plant materials, or crushing shells. As a group, decapods are omnivorous, eating both plant and animal materials. Lobsters, shrimps, and many crabs mostly prey on other animals, including fish, worms, mollusks, and other crustaceans. Some crabs and shrimps are filter feeders. Respiration: accomplished with gills located under the carapace. In terrestrial taxa, some of the gill space is adapted to acquire oxygen from air rather than water. Circulation: the hemolymph (blood) is copper based rather than iron based as seen in vertebrates. The heart pumping system is an open circulatory system with a dorsal heart, perforated by ostea, and dorsal and ventral blood vessels. Excretion: accomplished by organs located near the antennae (antennal glands) or maxillae (maxillary glands) called green glands.
**Growth** Most female decapods hold their egg masses with their pleopods (swimmerettes) or posterior abdomen. They keep the eggs clean and make sure that plenty of oxygen-carrying water is circulated around them. Just before hatching, the eggs release a chemical that causes the female to shake the egg mass, aiding the release of the larvae into the water as they hatch. After hatching, parental care is rare. Some young crayfishes stay with their female parents for protection. Life cycles have multiple stages with molts between the stages.

![Crustacean Life Cycle Diagram](image_url)

**Environmental Response** The first pair of antennae, or antennules, is branched, (biramous). They are used mostly to detect odors. The second pair of antennae is uniramous, or not branched. This pair is used mainly as organs of touch. The compound eyes are set on the tips of stalks. Each compound eye has multiple lenses. Decapods show many complicated and even amazing behaviors. For example, Caribbean spiny lobsters form a long row of up to 65 individuals that march single-file toward deeper water. Some species form special relationships with other species. Certain shrimps establish cleaning stations where fishes line up to have their parasites removed. Other shrimps share a burrow with a fish. The fish watches for danger as the shrimp builds and maintains the burrow.

Some species make signals that are seen or heard by other members of the same species. Decapods that spend some or most of their lives on land produce sounds by rubbing one part of their body against another. Marine and freshwater species release special chemicals, pheromones, into the water through special glands on the antennae. The pheromones are used to attract mates.

Lobsters and crabs are capable of learning. They can be trained to find their way through a maze. When some crabs are offered a prey item that they have never seen before, they quickly learn, sometimes from
watching others, the most efficient way to eat it. Some species can be taught to act a certain way in response to a specific situation (trained). Others have been trained to select items based on color.
Order Amphipoda

SKELETON SHRIMP
SPERM WHALE LICE
BEACH HOPPER

PHYSICAL CHARACTERISTICS
Amphipods come in a wide variety of shapes and sizes, but most have long, c-shaped bodies that are flat from side to side. Amphipods usually measure 0.2 to 0.6 inches in length, but some deep-sea species reach up to 10 inches. All amphipods have bodies that are made up of three regions: head, thorax, and abdomen.

HABITAT
Most amphipods live on the ocean bottom and burrow in mud or debris. Some live in the open sea and are usually found on floating jellies. Others burrow into sandy beaches. About 1,200 species are found in fresh water, where they live among decaying leaves. About one hundred species live in moist habitats on land.

DIET
Amphipods eat plants, small animals, or scavenge dead bodies. One group lives on the bodies of marine mammals and eats their skin. Others attach themselves to the bodies of jellies and eat their flesh.

Order Isopoda

PILLBUGS – SOWBUGS - WOODLICE

PHYSICAL CHARACTERISTICS
Isopods are terrestrial organisms found in moist protected places. Pillbugs are easily recognized by their flattened or round-backed profile, seven pairs of legs, and sharply-angled antennae. Some species are able to roll into a ball when disturbed, hence the name, pillbugs. The head has 4 pairs of mouthparts.
followed by the 7 main trunk segments, which bear the walking limbs. Behind these are 6 smaller segments making up the pleon (abdomen). The pleon segments also carry limbs, but these are greatly modified. The first 5 pairs are called the pleopods. These are flattened and form a set of overlapping gills visible on the underside of the animal. They have many functions including reproduction, gas exchange, and excretion. The final pair of appendages, the uropods, project from the rear of the animal and are sensory and defensive in function.

HABITAT
There are nearly 4000 described species of pillbugs and they are the only crustaceans to have colonized land with appreciable success. Despite this, they did not evolve the incredible waterproofing cuticle waxes of the insects and spiders, and are quite susceptible to drying out. Woodlice kept in low humidity (<50%) will dehydrate lethally within a day. However, they have one remarkable adaptive trick to help them. Once the humidity exceeds about 87% they can absorb water vapor from the atmosphere for rehydration. During nocturnal foraging, pillbugs frequently lose a considerable proportion of their body water and can survive up to 30% dehydration. During the day, when they seek out humid retreats, they can absorb water vapor to replenish these losses. Water vapor absorption takes place across the pleopods. Only a few groups of animals share this capacity to absorb water vapor from air that is not saturated with moisture. They include flea larvae, booklice, silverfish, mealworms, and ticks.

DIET
Pillbugs feed on dead vegetation, such as wood and leaf litter.

**Class Branchiopoda: Fairy Shrimp**

The branchiopods are very small crustaceans characterized by their possession of broad leaf-like appendages fringed with bristles, that are used in many for filter-feeding. The best known examples of this group are the water fleas (e.g. Daphnia sp.) and the fairy shrimp (Artemia sp.).

**Class Copepoda: Plankton & Gill Lice**

The copepods are mostly marine. They occur in vast numbers, millions being present in a cubic meter of sea water and are important links in many food chains. The head and thorax are often fused to form a cephalothorax. Fertilized eggs are often kept in ovisacs attached to the female. The copepod group also contains a large number of parasitic species. Fresh water and marine fishes are usually the hosts and the copepods are usually ectoparasitic (skin). Many of the parasitic copepods are very highly modified and bizarrely shaped, and are not obviously identifiable as arthropods let alone crustaceans.
Class Cirripedia: Barnacles
The cirripedes (barnacles) are the only sessile (attached) group of crustaceans and they differ morphologically from other crustaceans. Barnacles attach to a variety of surfaces. The cirripedes are marine, most are free living while others are commensals or parasites on larger animals, such as fish, whales and turtles. There are two types of free-living barnacles, the stalked and the non-stalked. They occur at all depths, from deep sea to intertidal. Barnacles are hermaphroditic. The penis is projected from the body into the mantle of a nearby barnacle. Because barnacles are so tightly packed they can accomplish internal fertilization despite their sessile habitat. The free-living nauplius larva molts several times to become a cypris larva, so-called because its body is enclosed in a bivalve shell. The cypris larva is the settling stage. It cements itself to the substratum using its antennules, rotates its body to the adult position and then secretes a series of calcified plates, which enclose the body. Barnacles are filter feeders.

Sacculina is a genus of barnacles that parasitize crabs. The adults bear no resemblance to the barnacles that cover ships and piers.

The female Sacculina larva molts and injects its soft body into a crab host. The Sacculina grows inside the crab, emerging as a sac-like structure, known as an externa, on the underside of the crab's rear thorax, where the crab's eggs would normally be incubated. When a female Sacculina is implanted in a male crab it will interfere with the male crab's hormonal balance, sterilizing the male and causing it to act and look like a female. If Sacculina implants in a female crab, the female will not lay her own eggs. After the invasion of the Sacculina, the crab does not molt and develops a nurturing behavior typical of a pregnant female crab. The natural hatching process of a crab consists of the female finding a high rock and grooming its brood pouch on its abdomen and releasing the fertilized eggs in the the water through a bobbing motion. The female crab stirs the water with her claw to aid the flow of the water. When the hatching parasite eggs of the Sacculina are ready to emerge from the brood pouch of Sacculina, the crab distributes the hatchlings as if they were its own.