**PHYLUM MOLLUSCA**

This is a very successful phylum and has the largest number of living species of animals after Arthropoda. They vary from small sized molluscs to 21m giant squid- the largest invertebrate. They are bilaterally symmetrical with true coelom and usually have a differentiated head. The body wall of mollusks consists of an outer layer of **epidermis** that extends over most of the animal as a **mantle** often contains various **sense organs.** The body is unsegmented with three main body parts- muscular foot, visceral mass and mantle. The body cavity of molluscs is a true **coelom** but is greatly reduced to a small space around the heart it has become part of an open circulatory system. In mouth is tongue-like rasping organ = **radula** found in all groups except bivalves and aplacophora(solenogastres).It is hardened file-like, up to 250,000 tiny teeth(the numbers and pattern of teeth are used to identifycertain species).New rows of teeth are continually added to theback of the radula as the front teeth areworn down.The radula is supported by a cartilage-like rod (=odontophore). It is used to scrape, pierce, tear or cut food and is also acts as a conveyor belt to move food toward the digestive tract.

**Muscular Foot:** Used for locomotion, food capture and attachment. The foot may be solid or have tentacles or may be a wing or fin in pelagic forms; covered with soft epithelium or may secrete mucous to glide on. It is also used for plowing, seize prey.

**Visceral Mass:** Contains most of the internal organs; including digestive, excretory, circulatory and reproductive systems.

**Mantle:** Folds often 2 from dorsal body wall and it secretes the shell. There is a cavity between the mantle and visceral mass called mantle cavity which may act as lung or enclose gills.

**Shell:** This is secreted by the mantle and is on the outside, but on inside in some snails, squid and cuttlefish and lost in slugs, nudibranchs, and octopi. It may be one or two valves and provides protection. The shell serves both protective and supportive purposes.

**LOCOMOTION: A**ll molluscs have a thick muscular foot variously modified for locomotion.

Creeping movements- produced by waves of muscular contractions that move through the foot or by creating a slime trail from mucous glands in the foot. Snails- gliding movement.

Digging into sediment being extended from body into sediment hydraulically by engorging with blood to anchor then draw rest of body into sediment e. g. bivalves, scaphopoda.

For attachment- May secrete mucous to adhere to solid substrate e. g. limpets, chitons, land snails. The foot of many bivalves produces byssal threads (sea silk) for attachment. In some molluscs a portion of the foot is modified into a long tubular proboscis for feeding.

**FEEDING AND DIGESTION:** Detritus feeder, burrowers, grazers, carnivores, filter feeders etc. In the mouth is tongue like rasping organ (radula). Complete digestive tract divided into discrete, functionally specialized regions namely,

**Foregut**- Buccal cavity, mouth, radula, salivary glands, oesophagus receives and prepares.

**Midgut**- Stomach and associated digestive glands is sorting region, crushing region. Crystalline style in some digestion takes place in digestive gland.

**Hindgut:** Intestine usually long and coiled, absorption of nutrients, formation of faeces.

**RESPIRATION:** Most molluscs have folded, ciliated gills (ctenidia)- thin feathery sheets of tissue covered with cilia also used for feeding in bivalves. Some molluscs breathe through their skin. Many terrestrial snails lack gills (pulmonates), lung for breathing air.

**CIRCULATORY:** Open circulatory system in most- blood not entirely contained within vessels that works good for slowing animals- the most active molluscs, the cephalopods, have a closed circulatory system. A simple heart with a few vessels; heart with 2 auricles and a ventricle extending from heart is aorta reduced coelom becomes a haemocoel surrounding heart blood contains several kinds of cells: oxygen carrying cells pigments to improve efficiency of oxygen transport; haemocyanin (Cu) – most- blue; some with haemoglobin (Fe)- red; some white blood cells. Cephalopods have a closed circulatory system.

**NERVOUS SYSTEM:** CNS is a ring of ganglia in head area with paired nerves and ganglia extending to other parts of the body e. g. pedal ganglia control foot.

**EXCRETION:** Usually a pair of metenephridia often called kidneys (not really true kidneys). (Metanephridium consist of a tubule that opens into body cavity at one end and drains to the outside). In many species the nephridial tubule also acts as gonoduct. Some molluscs have several pairs of nephridia. Some excretion occurs through body wall and gills.

**REPRODUCTION:** Molluscs are dioecious. Some are monoecious. Many marine forms produce characteristic larva- trochophore. In some gastropods and bivalves, a second larval form develops- Veliger. It is also free swimming and has a foot, shell and mantle. Some freshwater bivalves produce a parasitic larva- Glochidium which attaches to gills of host fish and feeds on blood. Development is direct; no larval stage in cephalopods, many freshwater snails and some bivalves.

**Classification of Phylum Mollusca**

**Class: Aplacophora**

**Class: Monoplacophora**

**Class: Polyplacophora** (chitins)

**Class: Scaphopoda** (tusk shells, tooth shells)

**Class: Bivalvia** (mussels & clams)

**Class: Gastropoda** (snails & slugs)

**Class: Cephalopoda** (octopus and squid)

**Class: Aplacophora** (sometimes divided into 2 classes; Caudofoveata & Solenogastres)

* They have “no plate or shell’ and the features may be closer to ancestral mollusc than any other modern group.
* All are marine.
* They are soft bodied, wormlike, no shell, no distinct head and body covered with calcareous **scales** or **spicules.**
* Some are burrowers in muddy sediments
* Feed on protozoa & microorganisms and detritus others don’t burrow and live on the sediment and feed on larger organisms including cnidarian
* **Radula** is present in some, absent in others.
* some have gills for respiration
* Monoecious or dioecious

**Class: Monoplacophora**

* Small.
* Small, single, low rounded shell with ventral creeping foot
* Superficially resemble limpets (gastropods)
* Unlike other molluscs; show some evidence of **segmentation.**
* Have **radula** for scraping food
* Ladder-like nervous system similar to flatworms e. g. *Neopilina* sp.

**Class: Polyplacophora (chitons)**

* body is flattened with convex upper surface
* Clings to rocks or hard surfaces fairly sedentary; may move short distances to feed.
* head and cephalic sensory organs reduced
* **shell** contains 8 overlapping plates on dorsal surface if detached, can roll up like pill bugs/armadillo
* **Feeding-** most feed using **radula** to scrape algae from surface, one predatory species (*Placiphorella velata*) captures small invertebrates by “jumping” on them.
* broad ventral **foot** attaches firmly to substrate the grooves along sides of foot form closed “tubes” open at each end
* **Reproduction**- sexes separate (dioecious) in most produce **trochophore** larva

**Class: Scaphopoda (tusk shells, tooth shells)**

* Means “trough foot”
* Slender bodies in tubular shell, open at both ends.
* Mantle wrapped around viscera and fused to form a tube
* Foot protrudes through larger end of shell- used to burrow into sediment and as it burrows it always leaves the small end exposed to water
* **Reproduction**- dioecious**;** produces **trochophore** larva.

**Class: Bivalvia**

* Means: “two valves”
* Old name for class was pelecypoda = “hatchet foot” includes mussels, clams, scallops, oysters, shipworms
* All are aquatic mostly marine, many brackish, some freshwater
* Most are filter feeders
* No head, no radula.
* **Shell**- shell is laterally compressed; 2 valves (right & left) “bulging” part of shell on dorsal side near hinge= **umbo** is the oldest part of shell; grows from edges shell held together dorsally by **hinge** and **adductor muscles** extending between shells; shell is mainly used for **protection** but does have some other uses in some species: e. g. shipworms use shell to burrow into wood and then feed on wood particles e. g. some clams are able to bore into rock and concrete with spiny valves eg. scallops use shell for propulsion by quickly closing them together to force out water- can swim in any direction
* **Respiration- gills** used for respiration; **cilia** on gills create incurrent and excurrent flow oxygen is extracted from water passing over gills
* **Reproduction**- usually dioecious; some (eg some oyster species) are prodandrous gametes discharged into mantle cavity and out excurrent siphon in most is fertilization is external; eggs develop into characteristic **trochophore larva,** in some marine forms a second free swimming larval form is produced = **veliger** (has shell, foot and mantle) **e g. oyster:** 50 Million eggs released per seasonembryo develops into trochophore –veliger – spat. Freshwater bivalves have internal fertilization gills become brood chambers bivalved **glochidia larvae** (specialized veliger) are released some moms can “shoot” larvae into water column; others produce a structure that looks like a small fish to entice predatory fish. When fish bites the “bait” it gets a mouthful of glochidia which then attach to the lung they parasitize gills of fish for 1 - 3 weeks generally causing little harm to their host but dispersing far and wide then release and sink to bottom to become filter feeders.

**Class: Gastropoda**

* Marine, freshwater and terrestrial representatives- virtually every mode of life except aerial
* Marine: littoral to deepest ocean; some pelagic in open ocean; some brackish
* Freshwater: rivers, lakes, streams ponds, etc tropics to poles
* Terrestrial: woodlands, pastures, mosses, cliffs, some specialized for climbing usually sluggish and sedentary
* **Body Plan**- unlike clams, snails and slugs has a distinct **head** with brain, sense organs and mouth. Sense organs: simple eyes, tentacles, chemical receptors; mouth with **radula**- rasps and scrapes algae; elongated body with **foot** below for gliding
* **Mantle** secretes shell and forms dorsal surface of animal; in slugs the mantle forms a hollow breathing chamber
* **Shell**- most have a single heavy shell for defense, some shells with **operculum** and a few have no shell; snails are very well **protected**: - generally secretive habits- strong shell, some with door- some can produce toxic secretions- some can deliver an active blow with sharp operculum to deter attack- some can even redeploy stinging cells from cnidarian prey; still many are eaten by insects, fish, birds and mammals and parasitized by a variety of helminthes. **Slugs** have lost their shell (but still produce one temporarily during embryonic development); most shells show some degree of **coiling**; a few do not.
* Coiling occurred early in the fossil record of gastropods; all living gastropods, whether coiled like snails or uncoiled like limpets and slugs, descended from coiled ancestors. In addition to coiling, some animals also show **tortion. Tortion** was a separate evolutionary event from coiling; occurred later in evolution animal begins with basic bilateral symmetry but becomes assymetrical due to **tortion**
* Tortion- brings gills up front for better gas exchange; makes more room in shell for retraction; but puts anus over head; greater chance of fouling mouth; some shells also show **spiral** winding instead of straight coil; makes shell more compact but unbalanced- shell tipped over gills, auricle, and kidney on right have been lost this asymmetrical loss helped reduce fouling of tortion; water is brought into left front side of shell and out right side of shell
* **Respiration-** simple gills (=ctenidia) are variously modified in aquatic forms terrestrial snails (=**pulmonates)** lack gill but have highly vascularized mantle cavity that serves as an air breathing “lung.” Lung opens to outside through a small opening (= **pneumostome)** draw air in over moist surface of the mantle to extract oxygen.

**Class: Cephalopoda**

* Means “head foot”..
* All marine.
* **Shell-** Most fossil forms (eg. ammonites common in Texas) had very large heavy shells kept buoyant by gas filled inner chambers only a few today with large external shell **e. g. *Nautilus.* S**hell spiral as some gastropods but divided into chambers. Chambers not found in gastropods. Chambers connected by cord of living tissue = **siphuncle** can adjust gas in chambers for neutral buoyancy. Some have **internal shell** completely enclosed by mantle **e. g. cuttlefish, squid.** Some have completely lost shell and mantle encloses and protects animal **e. g. octopus.** Shell was sacrificed for speed to avoid predation.
* **Mantle-** In most cephalopods the **mantle** serves as the animals outer covering much thicker and more muscular than in other groups protects internal organs squid and cuttlefish are excellent swimmers can forcefully expel water from the mantle cavity through a ventral **funnel** (siphon) creating “jet propulsion”. The funnel can be pointed to quickly move in any direction.
* Squid are streamlined and have **lateral fins** that greatly improve their swimming ability.
* The surface of the mantle and the rest of animal is covered by pigment cells called **chromatophores.** Chromatophore is an elastic pigment cell. Tiny muscles surround each one contraction expands chromatophore and changes color of body allows animal to rapidly change color under nervous and hormonal control can produce general darkening and lightning flashes of pink, yellow, lavender can form bars, stripes, spots and blotches can indicate danger, protection, or used during courtship. Many deep sea forms are bioluminescent

**Head & Foot-** In cephalopods, the **head** is indistinguishable from the **Foot**. The “head-foot” is elongated into 8 or 10 **tentacles** (up to 90 in nautilus) and 2 longer **arms.** Mouth at center of arms; contains chitinous **beak** or **jaws.**

**Circulation- Closed circulatory system-** More efficient for gas exchange and transportaccessory (brachial) **hearts** at base of each gillimproves pumping efficiency even more.

**Nervous System and Senses-** Largest brain of any invertebrate having several lobes with millions of nerve cells**.** More elaborate than in other classes.Much of our current knowledge of nerve cell function is basedon studies of the large nerve fibers of the squid.Brain is located behind mouth**.** Octopus and cuttlefish actual “think and plan”learn and react to their environment.Level surpassed only by some vertebrates**;** generally considered the cleverest of all invertebratesand rival mammals in some ways; masters of disguise**;** most versatile use of **chromatophores** in the animalkingdom, esp. cuttlefishgreat curiosity; can solve problemscan easily learn behaviors by reward/punishment**.** If they see another rewarded for a particular choice they willdo the same thing to get the same reward**.** One octopus would short circuit the light over her tank bysquirting water at it if someone forgot to turn it off atnight. **Sensory organs are** better developed in cephalopodsthan in other mollusk classes**. Eyes**: most have very well developed eyeswith cornea, lens retina**. Statocysts**: large and more complex than in other classes**;** important in controlling eye position. **Tentacles**: use tentacles for tactile exploration.

**Protection: Ink Sac-** Most cephalopods have an **ink sac** for protection and **melanin** pigment

creates smoke screen to facilitate escape from danger.

**Reproduction- Dioecious.** Before copulation, males often make color displays tocompete against rival males; sperm encased in packets = **spermatophores** which are inserted it into female’s mantle cavity. Eggs attached to stones or brooded by female direct development; no free-swimming larvae juveniles hatch from eggs.

**The Giant African Land Snail (*Achatina*)**

This snail thrives where the climate is hot and humid. In Africa, it lives along the edges of forests but can live on the banks of rivers and streams, shrub lands, agricultural areas, plantations, gardens, wetlands and in various urban sites. It is capable of living in temperate climates too. The Giant African Land Snail is one of the largest terrestrial gastropods; can reach 10cm in diameter and up to 30cm in length. They have a light to dark brown shells with vertical stripes of a darker shade of brown on them. They have an average lifespan of about 5-7 years. When they have enough food, and the weather is satisfactory, they tend to live much longer. Some of them have been known to live up to 10 years.

The body has two short tentacles and two long ones that have the eyes. The shell has an appearance conical and narrow, with 7 to 9 spirals visible on its surface. The color is not always the same; it depends on the environmental conditions of the site where the snail dwells. It is usually slightly dark brown or reddish with yellowish vertical stripes.



An important part of the anatomy of this snail is a structure in the mouth similar to a tongue, which is called the radula. It has small teeth that allow snails to scrap the food before eating it.

They have a “muscular foot” that helps them move releasing a mucus while they move to reduce friction and avoid damage to their tissues.

The shell is the location where the Giant African Land Snail takes refuge from predators. They will also spend time inside of their shells when the temperatures begin to dip too low at night for their comfort.

**Nutrition**

This herbivore does not discriminate between living or dead plant matters. It has such an enormous appetite that it feeds on more than 500 types of plants, including those farmed by humans. The Giant African Snail eats leaves, flowers, fruits, stems, barks, wood, seeds, grains, nuts, seaweed and even lichens, fungi and other snails. Economically valuable crops for humans such as cauliflower, cocoa, papaya, peanut, cassava, banana and many other vegetables often become food for the giant African snail. They also need calcium to keep and grow hard shells, so they will consume more some types of plants to get the calcium they require. When they aren’t able to get enough calcium in their diet from plants, they may feed on bones from carcasses, sand or small stones to get it.

**Behaviour:** The Giant African Land Snails don’t seem to interact with each other except for when they are going to mate. Interaction and courtship are vital features within the lifecycle of a snail as they rarely self-fertilize. If a size difference exists between mating snails the smaller assumes the male role. They don’t produce any sounds, and they spend their time moving, eating, and resting. They communicate through giving off scents and through the vibrations that they pick up using their tentacle. Snails have tendencies to burrow into the soil, in an attempt to maintain ambient temperature and for avoiding predators. They are considered to be active between 9 C and 29 C degrees, but they can survive above 2 C degrees by hibernating inside of their shell during the colder months. During this time, they can slow down their metabolism, so they don’t need to eat or move during that period. They can remain inside of the shell for several months before they emerge again.

Sometimes, these snails estivate in the summer months to avoid the hot conditions. They can keep their moist by creating a barrier with a thin layer of mucus that their bodies create. In the case of severe drought, this process can take as long as three years.

**Reproduction**

The Giant African Land Snails are hermaphrodite which means that they have the reproduction organs for both males and females, so they have the capability to self-fertilize, but they do not usually do it. Mating is a nocturnal, non-random, highly selective process where snails decide their mates based on age and size. There is no specific mating season, larval phase or parental care. In the pre-copulation stage, both snails approach and one of them locate behind the other and position above the shell. If the one underneath accepts it, it moves back, and the top snail begins copulation to transfer sperm and fertilize the eggs of its mate. In the case of snails of similar size, both can fertilize the eggs of the other simultaneously. Coupling usually takes place during the night. “Transferred sperm can be stored within the body for up to two years; therefore these snails can lay eggs over a period of several months after only one mating. They don’t have a defined breeding period, and on average they lay 5-6 clutches of eggs per year, containing on average 200 eggs per clutch if there are the right conditions. Therefore, delivering close to 1,200 eggs per year and with a hatch success probability of 90%, this species can quickly become a pest.

About 8-20 days after intercourse, the snail puts between 100 and 500 eggs in a nest beneath the ground or between rocks and vegetation. Laying occurs every 2 or 3 months. Eggs hatch after 11-15 days, but the offspring do not receive any care from the parents.

Apart from serving as source of meat to man; fish farmers may also use giant African snails as a cheap source of bait to feed fish. These snails can also be used when making fertilizer, chicken feed, and biological compounds in laboratories. However, giant African snails are dangerous pests in that they eat agriculturally important plants • Can be a vector of fungal plant pathogens • Can consume enough biomass to alter the nutrient cycle of the habitat • Can eat the plaster off your house • Can be carriers of dangerous diseases.