

PHYLUM MOLLUSCA

The phylum **Mollusca** (from Latin *mollis*, meaning “soft”) includes soft-bodied invertebrates that are usually enclosed in a calcium carbonate shell. Molluscs are one of the most diverse animal groups, second only to Arthropoda, and exhibit a wide range of forms adapted to marine, freshwater, and terrestrial habitats.

GENERAL CHARACTERISTICS OF MOLLUSCA

1. Habitat

Mostly **marine**; a few are **freshwater** (e.g., *Pila*, *Unio*) or **terrestrial** (e.g., *Helix*).

Free-living, creeping, burrowing, or sedentary.

Many are **filter feeders**, others are **herbivorous grazers**, **carnivorous predators**, or even **parasites**.

2. Body Form and Symmetry

Bilateral symmetry, **triploblastic**, and **coelomate**.

The body is **soft**, **unsegmented**, and **divisible into three regions**:

***Head-foot** – used for locomotion and sensory functions.

***Visceral mass** – contains internal organs

***Mantle (Pallium)** – a fold of dorsal body wall that secretes the **shell**.

3. Body Covering and Shell

Most have an external **calcareous shell** secreted by the mantle.

Shell may be **univalve** (snails), **bivalve** (clams), **multivalve** (chitons), or **absent** (octopus, slug).

Shell is made of **three layers**:

***Periostracum** – outer horny layer.

***Prismatic layer** – middle layer of calcium carbonate crystals.

***Nacreous layer** – inner mother-of-pearl layer.

4. Locomotion

Performed by a **muscular foot**, used for creeping (snails), digging (bivalves), or swimming (cephalopods).

Cephalopods like *Loligo* and *Octopus* use **jet propulsion** by expelling water from the mantle cavity through a siphon.

5. Coelom and Body Cavity

True **coelomate** animals, though coelom is reduced to spaces around heart, gonads, and nephridia.

Main body cavity is a **haemocoel**, filled with blood and serving as a hydrostatic skeleton.

6. Digestive System

Usually complete and well-developed.

Mouth often bears a **radula** — a chitinous ribbon-like structure with rows of teeth for rasping food (absent in bivalves).

Digestive glands (hepatopancreas) secrete enzymes.

7. Circulatory System

Usually **open** (blood flows in sinuses), except in **cephalopods**, which have a **closed circulatory system**.

Heart is **three-chambered** (two auricles and one ventricle).

Blood contains respiratory pigment **haemocyanin** (blue, copper-based).

8. Respiration

Usually by **ctenidia** (gills) present in the mantle cavity.

In some, respiration occurs through the **mantle surface** or **secondary gills**.

Terrestrial forms (like *Helix*) use a **pulmonary sac** (lung).

9. Excretion

Excretory organs are **nephridia** (kidney-like), often opening near the anus or genital pore.

The excretory product is mainly **ammonia** or **urea**.

10. Nervous System

Consists of paired **cerebral**, **pedal**, and **visceral ganglia**, connected by nerve cords forming a nerve ring.

Cephalopods have highly developed brains with complex eyes (camera-like).

11. Sense Organs

Include **statocysts** (for balance), **osphradia** (chemical sensing of water quality), and **eyes** (ranging from simple pits to complex camera-type).

Tentacles in some molluscs act as tactile or sensory organs.

12. Reproduction

Mostly **dioecious** (separate sexes), though some like *Helix* are **hermaphrodite**.

Fertilization can be **external** (bivalves) or **internal** (cephalopods, gastropods).

Development often **indirect** with a **trochophore larva**, sometimes followed by a **veliger larva** stage.

13. Development and Larvae

Embryonic development shows spiral cleavage.

Larval stages:

- **Trochophore** → **Veliger** → Adult

These larval stages show molluscs' evolutionary link to annelids.

14. Economic Importance

Edible species: *Pila*, *Mytilus*, *Sepia*, *Loligo*.

Pearl formation: *Pinctada* (pearl oyster).

Shells and ornaments: *Turbinella*, *Murex*.

Bioindicators: Some bivalves indicate water pollution.

Pests: *Limnaea* and *Achatina* damage crops.

Medical and research value: Cephalopods used in neurobiology and physiology research.

CLASSIFICATION OF PHYLUM MOLLUSCA

According to *Barnes (1982)* and subsequent revisions, Mollusca is divided into **seven major classes** (some texts include eight).

1. Class: Aplacophora (Solenogastres)

Worm-like, shell-less molluscs with a cuticle covered by calcareous spicules.

No distinct foot.

Marine and burrowing forms.

Example: *Neomenia*, *Chaetoderma*.

2. Class: Monoplacophora

Primitive molluscs with a single, cap-like shell.

Exhibit **segmented internal organs** (serial repetition of gills, nephridia).

Once thought extinct; living fossil *Neopilina* discovered in 1952.

Example: *Neopilina galathea*.

3. Class: Polyplacophora

Body dorsoventrally flattened, covered by **eight dorsal calcareous plates**.

Broad ventral **creeping foot**.

Marine, found clinging to rocks in intertidal zones.

Example: *Chiton*.

4. Class: Scaphopoda (Tusk Shells)

Tubular, elongated shell open at both ends (tusk-shaped).

Burrowing marine molluscs.

Captacula (tentacle-like structures) used for capturing food.

Example: *Dentalium*.

5. Class: Gastropoda

Largest class of molluscs.

Asymmetrical body due to **torsion** (180° twisting of visceral mass during development).

Shell usually **spirally coiled**; head distinct with tentacles and eyes.

Respiration by gills, mantle cavity, or lung.

Example: *Pila* (apple snail), *Helix* (garden snail), *Achatina*, *Limnaea*, *Conus*.

6. Class: Bivalvia (Pelecypoda or Lamellibranchia)

Shell composed of **two valves** joined by a hinge.

No head, no radula.

Gills modified for respiration and filter feeding.

Mostly sedentary and marine.

Example: *Unio*, *Mytilus*, *Pinctada*, *Mya*, *Anodonta*.

7. Class: Cephalopoda

Most advanced molluscs; exclusively marine and predatory.

Foot modified into **arms and tentacles**.

Shell internal (*Sepia*), external (*Nautilus*), or absent (*Octopus*).

Eyes highly developed; **closed circulatory system**.

Locomotion by **jet propulsion**.

Example: *Octopus*, *Sepia*, *Loligo*, *Nautilus*.

PHYLUM ECHINODERMATA

The term **Echinodermata** comes from Greek words *echinos* (spiny) and *derma* (skin), meaning “spiny-skinned animals.” They are exclusively **marine**, triploblastic, coelomate, deuterostome animals showing a fascinating combination of **radial symmetry** (in adults) and **bilateral symmetry** (in larvae). They are unique in having a **water vascular system** and an **endoskeleton of calcareous plates**.

GENERAL CHARACTERISTICS

1. Habitat and Habit

Exclusively **marine**, found from intertidal zones to great ocean depths.

Mostly **benthic** (bottom-dwelling) and **slow-moving**, though a few (like *Ophiura*) are more active.

Some are **free-living** (*Asterias*), some **burrowing** (*Holothuria*), and some **sessile** (*Crinoids*).

2. Symmetry

Adults: Show **radial symmetry**, typically **pentamerous** (five-rayed).

Larvae: Bilaterally symmetrical — indicating a **bilaterally symmetrical ancestry**.

3. Body Organization

Triploblastic and coelomate.

The body is **unsegmented**, without head or brain.

Body is divided into **oral (ventral)** and **aboral (dorsal)** surfaces, rather than anterior–posterior ends.

The mouth usually lies on the oral side, and the anus (if present) on the aboral side.

4. Body Wall and Skeleton

Body wall has **epidermis** with cilia and **dermis** containing **calcareous ossicles**.

Ossicles form a **mesodermal endoskeleton**, often bearing **spines, tubercles, and pedicellariae** (tiny pincer-like structures).

The **spines and pedicellariae** help in protection and cleaning of the body surface.

5. Coelom

True **coelomate** animals with a spacious coelomic cavity.

Coelom is lined by ciliated peritoneum and participates in circulation of coelomic fluid containing coelomocytes.

6. Water Vascular System (Ambulacral System)

This is the **most characteristic feature** of echinoderms — unique to the group.

A **network of fluid-filled canals** derived from the coelom.

Functions in **locomotion, food capture, respiration, and excretion.**

Main Components:

1. **Madreporite** – a sieve-like plate on the aboral surface that allows water entry.
2. **Stone canal** – connects madreporite to the ring canal.
3. **Ring canal** – encircles the mouth.
4. **Radial canals** – extend along each arm.
5. **Lateral canals** – connect radial canals to **tube feet (podia).**

7. Digestive System

Usually **complete**, with a mouth, gut, and anus.

Mouth on the oral side, anus (if present) on the aboral side.

Feeding habits vary:

- *Asterias* (starfish) – carnivorous, feeds on bivalves.
- *Echinus* (sea urchin) – herbivorous, grazes algae.
- *Holothuria* – deposit feeder, ingests sand and detritus.
- *Crinoids* – filter feeders.

8. Circulatory System

Often called the **haemal or blood vascular system**, poorly developed.

Coelomic fluid, water vascular system, and perivisceral fluid together perform **transport functions** (oxygen, nutrients, wastes).

9. Respiration

By various structures depending on the class:

- **Dermal branchiae (papulae)** in starfish.
- **Tube feet** in most echinoderms.
- **Peristomial gills** in urchins.
- **Cloacal respiratory trees** in sea cucumbers.
- **Bursae** in brittle stars.

10. Excretion

No special excretory organs.

Nitrogenous wastes (mostly ammonia) diffuse through tube feet and papulae.

Coelomic cells also help in excretion by engulfing waste particles.

11. Nervous System

Nervous system is Diffused type and no central brain.

Three main nerve networks:

1. **Ectoneural system** – around the mouth (oral nerve ring and radial nerves).
2. **Hyponeural system** – controls motor functions.
3. **Aboral system** – for sensory and coordination functions.

Sense organs are poorly developed: **eyespot** at arm tips, **tentacles**, and **statocysts**.

12. Reproduction

Sexes separate (dioecious).

Gonads in each arm or body region.

Fertilization external, usually in seawater.

Development **indirect** with free-swimming **larval stages**.

Common Larval Forms:

- *Bipinnaria* and *Brachiolaria* (Asteroidea)
- *Ophiopluteus* (Ophiuroidea)

- *Echinopluteus* (Echinoidea)
- *Auricularia* (Holothuroidea)
- *Doliolaria* (Crinoidea)

13. Regeneration

Echinoderms exhibit remarkable **regenerative ability**.

Starfish can regenerate lost arms; some can even regenerate an entire body from a single arm if part of the central disc remains.

14. Development

Indirect through larval stages; **metamorphosis** leads to adult radial symmetry.

Larval forms show evolutionary connection with **Chordates and Hemichordates**.

15. Economic Importance

Beneficial Roles:

Pinctada produces pearls.

Echinus and *Holothuria* used as food in some cultures.

Echinoderm embryos used in developmental biology research.

CLASSIFICATION OF ECHINODERMATA

The phylum Echinodermata is divided into **five main living classes** and **one extinct group**.

Class 1: Asteroidea (Sea Stars or Starfishes)

Characteristics:

Star-shaped body with five (or more) radiating arms from a central disc.

Oral mouth; anus on aboral surface.

Tube feet with suckers in ambulacral grooves.

Dermal branchiae and pedicellariae present.

Carnivorous, feeding on molluscs and small animals.

Larva: **Bipinnaria** and **Brachiolaria**.

Example: *Asterias*, *Pentaceros*, *Luidia*.

Class 2: Ophiuroidea (Brittle Stars and Basket Stars)

Characteristics:

Star-shaped, but arms are **long, slender, and distinct from disc**.

Tube feet **without suckers** and used for feeding, not locomotion.

No pedicellariae or papulae.

Anus absent; wastes pass through mouth.

Filter feeders or detritus feeders.

Example: *Ophiura*, *Gorgonocephalus*.

Class 3: Echinoidea (Sea Urchins and Sand Dollars)

Characteristics:

Body **globular or flattened**, enclosed in a rigid shell (**test**) made of fused ossicles.

Movable spines and pedicellariae.

Tube feet with suckers for movement.

Mouth has a complex chewing apparatus called **Aristotle's lantern**.

Respiration by tube feet and peristomial gills.

Example: *Echinus*, *Arbacia*, *Clypeaster*, *Diadema*.

Class 4: Holothuroidea (Sea Cucumbers)

Characteristics:

Elongated, soft, leathery body; bilateral tendency.

Endoskeleton reduced to microscopic ossicles.

Tube feet present; oral ones modified into **tentacles**.

Respiration by **respiratory trees** connected to cloaca.

Capable of **evisceration** (expelling viscera for defense).

Example: *Holothuria*, *Cucumaria*, *Synapta*.

Class 5: Crinoidea (Sea Lilies and Feather Stars)

Characteristics:

Most primitive echinoderms.

Body cup-shaped with **five or more feathery arms**.

Mouth and anus on **oral surface**.

Tube feet **without suckers**, used for food collection.

Sessile (sea lilies) or free-swimming (feather stars).

Example: *Antedon*, *Metacrinus*, *Comatula*.

Extinct Class: Blastoidea

Fossil echinoderms, resembling crinoids but with different skeletal structures.

Flourished in Paleozoic seas and now extinct.