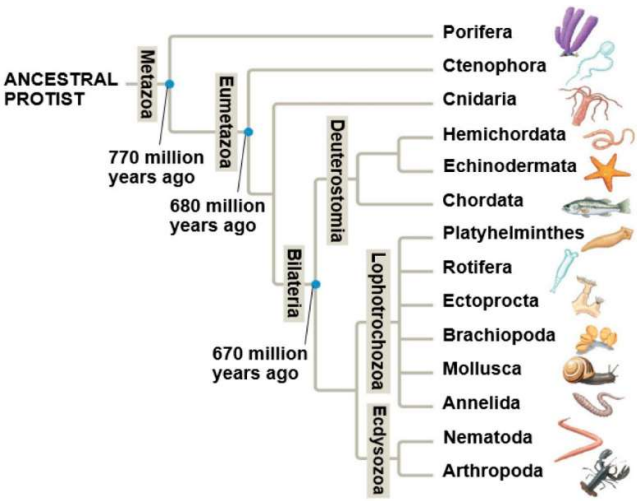
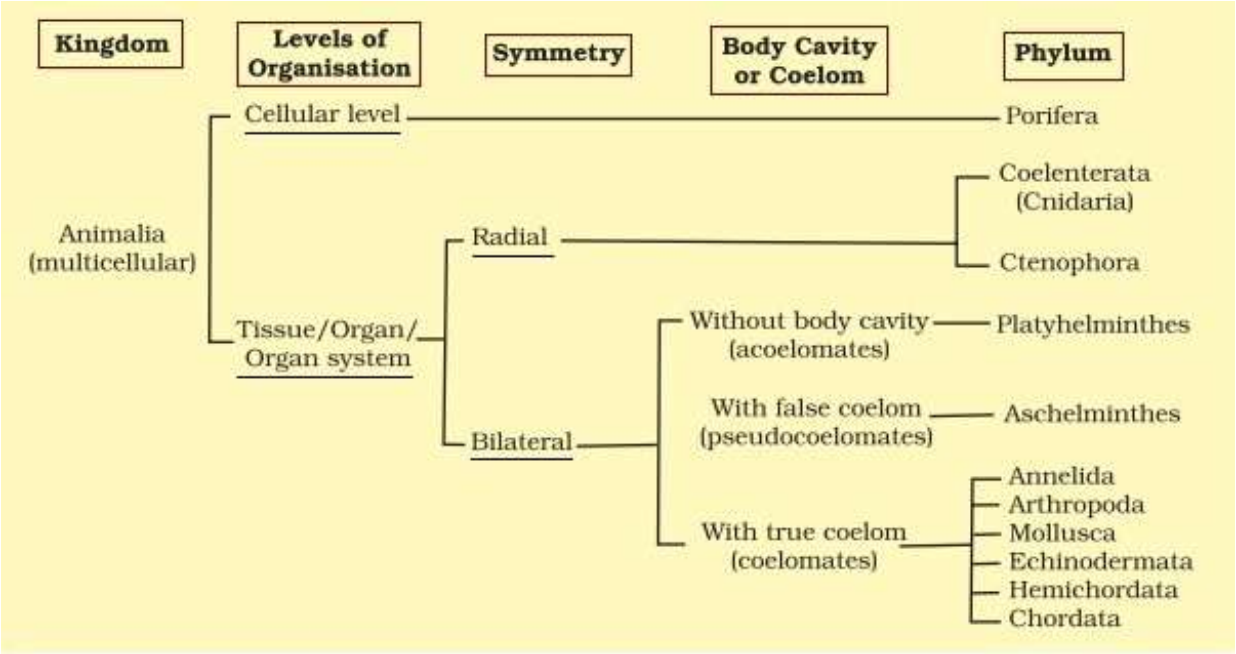
## Classification Upto Class:

**General criteria used for Classification of Invertebrates:**

I. Whether the body is Symmetrical (radial/bilateral) or Asymmetrical
II. Whether **diploblast or triploblast**
III. Whether **Acoelomate, pseudocoelom or coelom**
IV. **Segmentation** present or absent
V. Protostome or deuterostome
VI. **Molting (Ecdysozoa**) or trochophore/veliger larvae (Lophotrochozoa)
VII. Distinctive organs (lophophore, radula, water vascular system, cnidae, comb rows)
VIII. System traits (type of nephridia, circulatory system, respiratory organs)
IX. **Cuticle and skeleton type (spicules, chitin, $CaCO_3$)**
X. **Molecular phylogeny** compared to morphology



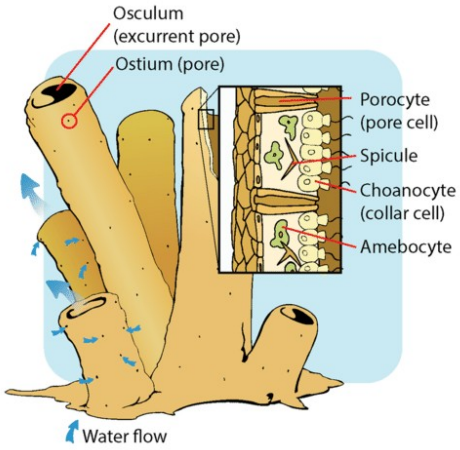
| Phylum | General Features | Classes |
|---|---|---|
| **Porifera** (Sponges) | ➢ Multicellular, asymmetrical<br>➢ choanocytes for feeding, no tissues. | I. Calcarea<br>II. Hexactinellida<br>III. Demospongiae |
| **Cnidaria** (Cnidarians; e.g., jellyfish, corals) | ➢ Diploblastic;<br>➢ cnidocytes for stinging<br>➢ polyp/medusa forms | I. Anthozoa (Sea anemones, corals; no medusa stage)<br>II. Scyphozoa (True jellyfish; dominant medusa)<br>III. Cubozoa (Box jellyfish; complex eyes)<br>IV. - Hydrozoa (Hydroids; colonial polyps) |
| **Ctenophora** (Comb jellies) | ➢ Diploblastic;<br>➢ biradial symmetry<br>➢ comb plates (ctenes) for locomotion | I. Tentaculata (With tentacles; e.g., *Pleurobrachia*)<br>II. - Nuda (No tentacles; e.g., *Beroida*) |

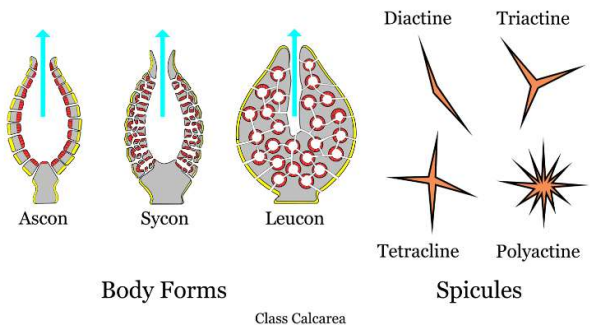
**Fig: overview of Porifera, Cnidaria and Ctenophora classification upto class**

| Phylum | General Features | Classes |
|---|---|---|
| **Platyhelminthes** (Flatworms) | ➢ Acoelomate, triploblastic;<br>➢ dorsoventrally flattened;<br>➢ hermaphroditic; | I. Turbellaria (Free-living; e.g., *Planaria*)<br>II. Monogenea (Ectoparasites on fish; e.g., *Dactylogyrus*)<br>III. Trematoda (Flukes; endoparasites; e.g., *Schistosoma*)<br>IV. - Cestoda (Tapeworms; no digestive system; e.g., *Taenia*) |
| **Nemathelminthes** (Roundworms) | ➢ Pseudocoelomate;<br>➢ cylindrical body;<br>➢ complete gut;<br>➢ many free-living/parasitic. | As per classical taxonomy:<br>I. Nematoda<br>II. Rotifera<br>III. Gastroticha<br>IV. Kinorhyncha<br>V. Nematomorpha<br>The above are treated as phylum in modern classification. |

**Fig: overview of Platyhelminthes and Nemathelminthes classification upto class**

## 1. Phylum Porifera: The Sponges




Class Calcarea

**Skeleton and Classification**

| Class | Skeleton | Body/organization | Canal type | Examples |
|---|---|---|---|---|
| **Calcarea** | **Calcium carbonate spicules** | Small, marine, all grades | Asconoid/ Syconoid/ Leuconoid | *Sycon, Leucosolenia* |
| **Hexactinellida** | **Siliceous 6-rayed (hexactine) spicules** | **Syncytial trabecular tissue**; deep-sea | Syconoid/ Leuconoid | *Euplectella* |
| **Demospongiae** | **Spongin and silica (non-hexactine)** | Largest group; diverse forms | **Leuconoid** dominant | *Spongilla, Euspongia* |

Classification of Porifera is based primarily on the composition and structure of the skeletal system, resulting in three major classes:

I. **Class Calcarea (Calcispongiae)** comprises calcareous sponges exclusively inhabiting shallow marine waters in all oceans at depths less than 100 meters. These sponges are typically small (approximately 10 cm in height), vase or cylinder-shaped, and possess radial symmetry. Their skeleton consists of free **calcareous spicules** (minute crystalline structures composed primarily of calcium carbonate ($CaCO_3$)). Calcareous spicules are differentiated into larger **megascleres** and smaller **microscleres**, which can be monaxon (single axis), triaxon (three axes), or tetraxon (four axes) types. The canal system within Calcarea can be asconoid, syconoid, or leuconoid in organization. Examples include *Sycon*, *Leucosolenia*, and *Grantia*.

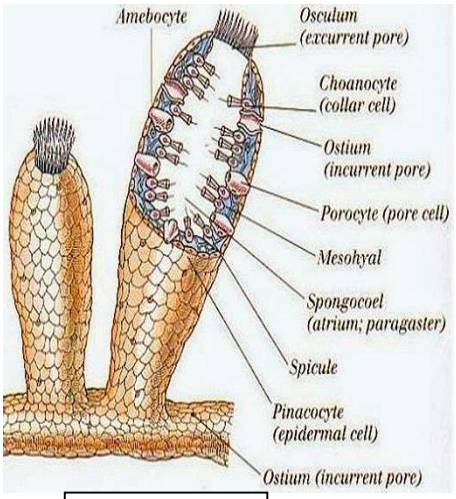



Fig.: Sycon sp.

II. **Class Hexactinellida (Hyalospongiae)** consists of glass sponges occurring exclusively in deep marine environments. These sponges possess distinctive **siliceous spicules** with six radiating rays (hexactinellid means "six-rayed"), giving them their common name of "glass sponges" due to their transparent, glass-like appearance. Unlike calcareous sponges, hexactinellids are typically solitary individuals and maintain radial symmetry.

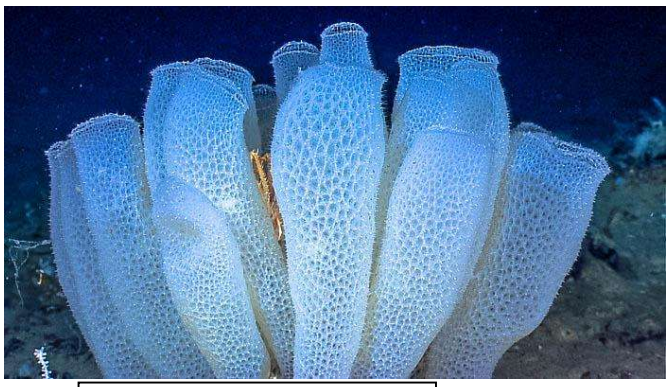
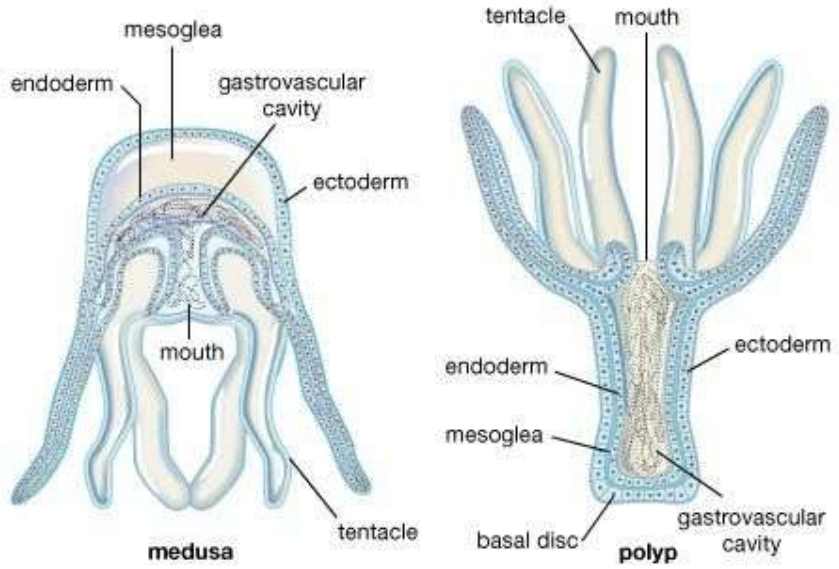


Fig.: ***Euplectella aspergillum***

III. **Class Demospongiae** represents the largest and most diverse sponge class, inhabiting both marine and freshwater environments. The skeleton of demosponges consists of either **spongin fibers** (collagenous connective tissue), **siliceous spicules** of monaxon or tetraxon type (never six-rayed), or combinations of both; some demosponges lack a skeleton entirely. Demosponges typically display asymmetrical body shape with irregular form, complicated canal systems, and total absence of the spongocoel. Examples include *Spongilla* (freshwater), *Cliona*, and *Chalina*.

Fig: *Cliona sp.*

## 2. Phylum Cnidaria: Jellyfish, Corals, Sea Anemones, and Hydra




**Classification of Cnidaria**

| Class | Life-form dominance | Main characters | Reproduction | Examples |
|---|---|---|---|---|
| **Hydrozoa** | **Polyp** dominant; medusa small | ➢ Medusa with **velum**;<br>➢ **gonads ectodermal** | Alternation polyps/medusae; colonies common | *Hydra, Obelia* |
| **Scyphozoa** ("true jellies") | **Medusa** dominant | ➢ **No velum**;<br>➢ thick mesoglea;<br>➢ **gonads endodermal** | Polyp **strobilation** to ephyrae | *Aurelia* |
| **Cubozoa** | Medusa | ➢ **Cube-shaped bell**, **velarium**, complex **rhopalia eyes**;<br>➢ strong swimmers | Small benthic polyp; potent venom | *Chironex* |
| **Anthozoa** | **Polyp only** | ➢ **Mesenteries/septa;**<br>➢ **siphonoglyph**;<br>➢ hexamerous/octamerous plans | Sexual and asexual budding; reefs | Sea anemones, corals |

Cnidarians are traditionally divided into four classes based on morphological characteristics, life cycle patterns, and reproductive strategies:

I. **Class Hydrozoa** comprises approximately 3,700 species distinguished by their complex life cycles involving both polyp and medusa stages, though medusae develop from buds rather than from strobilation. Most hydrozoans are marine colonial organisms in which multiple polyps form interconnected colonies through living tissue called the **coenosarc**. Colonial polyps frequently exhibit **polymorphism**: different specialized morphologies performing different functions such as feeding, reproduction, or defense. The medusa stage is

Fig. : *Aequorea sp.*

typically the sexually reproducing form, producing gametes from ectodermal (rather than endodermal) tissue.

II. **Class Scyphozoa** consists primarily of free-swimming jellyfish, representing the sexually mature medusa form as the dominant stage, with the polyp stage typically much reduced or absent. Scyphozoans are exclusively marine and vary tremendously in size, from tiny species to giant jellyfish reaching several meters in diameter.

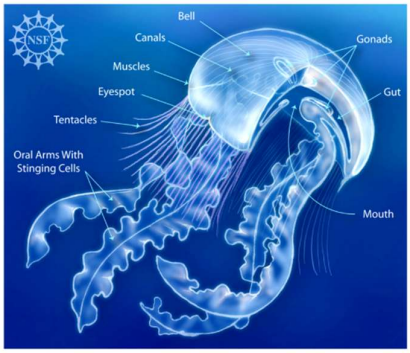



Fig: Aurelia sp.

III. **Class Anthozoa** includes sea anemones, corals, and sea pens, all characterized by the complete absence of a medusa stage and the dominance of the polyp form. Most anthozoans are colonial, and many form the ecological foundation of coral reef ecosystems. The internal gastrovascular cavity is divided by radial septa (partitions), and gonads develop from endodermal tissue.

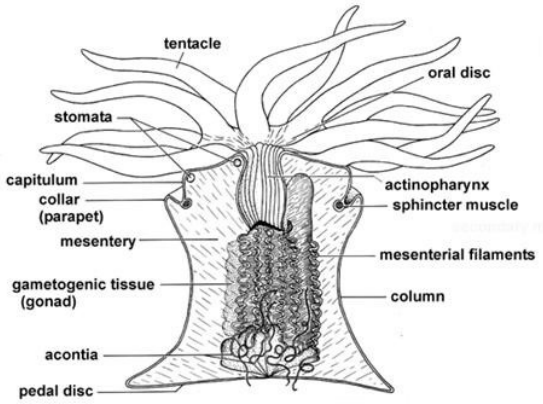
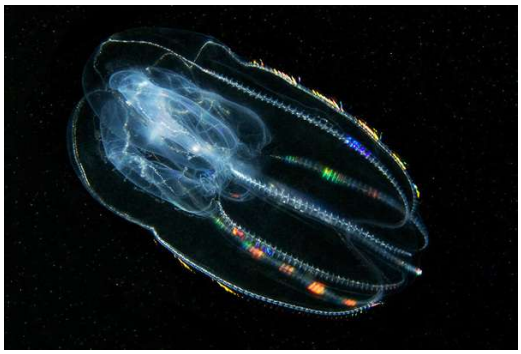



Fig.: *Metridium* sp.

IV. **Class Cubozoa** comprises the venomous box jellyfish and sea wasps (*Chironex*, *Carukia*, and related genera), characterized by cubic-shaped bells, advanced visual systems with true eyes, and highly potent venomous nematocysts capable of causing serious harm to humans.

Fig: Carybdea sp.

## 3. Phylum Ctenophora: Comb Jellies



**Classification and Diversity**

| Class | Distinct Character | Feeding | Examples |
|---|---|---|---|
| **Tentaculata** | **Tentacles present** with **colloblasts**; retract into sheaths | capture plankton | *Pleurobrachia, Cydippea* |
| **Nuda (Beroida)** | **No tentacles** | Broad mouth | *Beroe* |

The classification of Ctenophora is primarily based on presence or absence of tentacles (the tentacular apparatus).

I. **Class Tentaculata** comprises the comb jellies that possess tentacles, at least at some point during their life cycle. These tentacles are typically long and feathery and are armed with specialized sticky cells called colloblasts, which they use to trap and ensnare planktonic prey. The tentacles can usually be retracted into sheaths on the body. This class is very diverse and includes species with a variety of body forms, from the spherical "sea gooseberries" (*Pleurobrachia*) to species with large oral lobes (*Mnemiopsis*) and flattened, ribbon-like forms (*Cestum*).

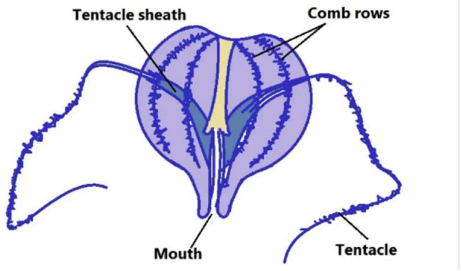
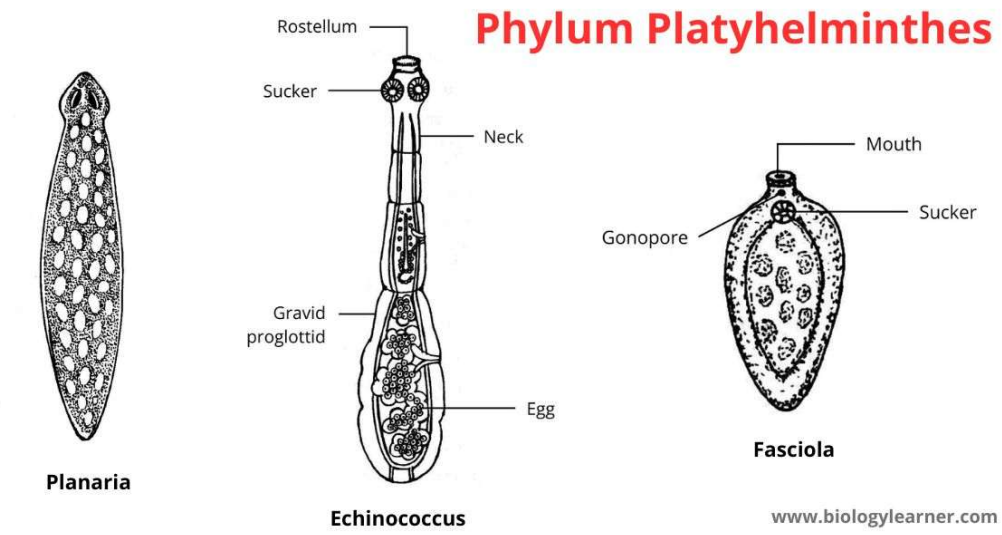



Fig: *Pleurobrachia* sp.

II. **Class Nuda,** also known as Atentaculata, includes comb jellies that **completely lack tentacles** at all stages of life. To feed, they have evolved a very different strategy: they possess a massive, cavernous mouth and a muscular pharynx that can be expanded to swallow prey whole. Members of this class, such as the common genus *Beroe*, are active predators that feed almost exclusively on other comb jellies and gelatinous zooplankton, engulfing them with their wide mouths.


Fig: *Beroe sp.*

**4. Phylum Platyhelminthes: Flatworms**




**Classification of Platyhelminthes**

| Class | Habitat | Gut & attachment | Distinctive Life-cycle | Examples |
|---|---|---|---|---|
| **Turbellaria** | ➢ **Free-living;**<br>➢ **ciliated epidermis** (rhabdites) | ➢ Gastrovascular cavity<br>➢ **no anus** | Mostly direct; **regeneration** strong | *Planaria, Dugesia* |
| **Monogenea** | **Ectoparasites** (mostly fish) | **Opisthaptor** with hooks/clamps | **Direct (single-host)** | *Gyrodactylus* |
| **Trematoda (Digenea)** | ➢ **Endoparasites**;<br>➢ syncytial **tegument** | **Oral and ventral suckers** | ➢ **Indirect (2 or more hosts)**;<br>➢ **snail first intermediate**;<br>➢ miracidium to cercaria to metacercaria | *Fasciola, Schistosoma* |
| **Cestoda** | **Endoparasites**; **no gut** | ➢ **Scolex** with suckers and hooks<br>➢ **strobila** of proglottids | ➢ **Indirect**;<br>➢ nutrient absorption via **microtriches** | *Taenia, Echinococcus* |

Platyhelminthes are traditionally divided into four classes based on habitat, morphology, and life cycle characteristics:

I. **Class Turbellaria** comprises mostly free-living flatworms inhabiting marine, freshwater, or moist terrestrial environments, though some species are epiparasitic or endoparasitic. The ventral epidermis is typically ciliated, facilitating locomotion through water or across substrates. Many turbellarians demonstrate remarkable regeneration abilities, capable of developing complete bodies from body fragments. Examples include *Dugesia* (common planarian) and marine polyclads.

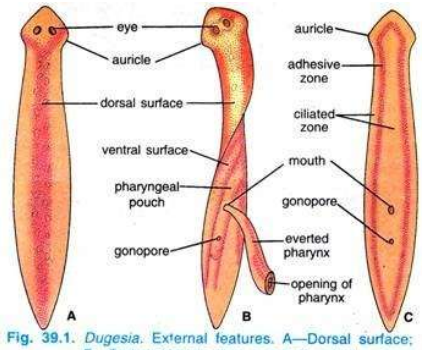
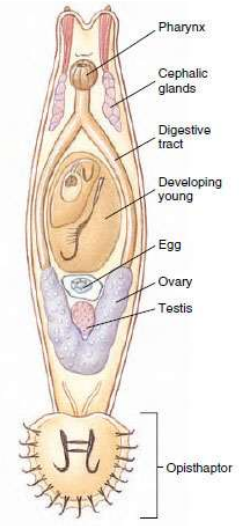


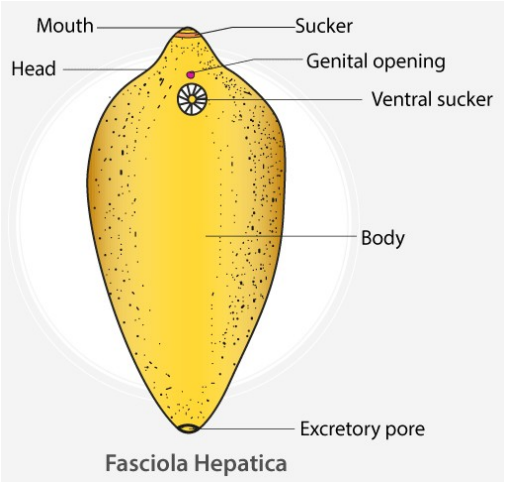
Fig. 39.1. *Dugesia*. External features. A—Dorsal surface; B—Body twisted to show a part of ventral surface; C—Ventral surface.

II. **Class Monogenea** consists of ectoparasites, primarily of fish, with relatively simple life cycles lacking intermediate hosts. Larvae are free-swimming and attach directly to fish to begin transformation into parasitic adults. These worms may produce enzymes that digest host tissues or simply graze on surface mucus and skin particles.

Fig: Gyrodactylus sp




III. **Class Trematoda** comprises internal parasites, primarily of mollusks and various vertebrates including humans, characterized by highly complex life cycles. Trematodes are generally hermaphroditic except for blood flukes (*Schistosoma* species), which are dioecious. These parasites possess evolved suckers for attachment and undergo alternating asexual and sexual reproduction in different hosts. The life cycle typically involves miracidium larvae, sporocyst and redia stages within intermediate snail hosts, cercariae larvae, and adult forms in vertebrate definitive hosts. Examples include *Fasciola hepatica* (liver fluke) and *Schistosoma* species (blood flukes) that cause serious human diseases.



Fasciola Hepatica

IV. **Class Cestoda** comprises ribbon-like tapeworms that are exclusively internal parasites, mostly of vertebrates. These distinctive parasites lack entire digestive systems, instead absorbing nutrients directly across their body wall from the host's intestinal contents. Tapeworms feature a characteristic body structure consisting of a **scolex** (anterior attachment organ with sucker), a **neck**, and numerous **proglottids** (segments), each potentially containing both male and female reproductive organs. The entire anterior portion remains attached to the host's intestinal epithelium while proglottids detach and are excreted with host feces, dispersing eggs. Examples include *Taenia solium* (pork tapeworm) and *Diphyllobothrium* (fish tapeworm).

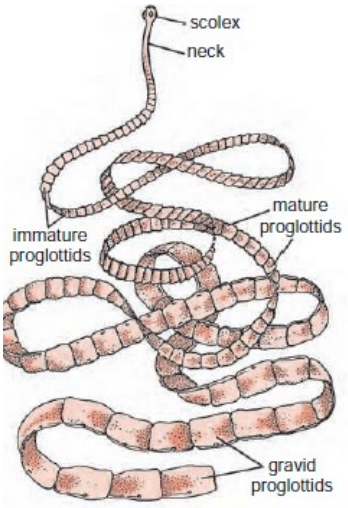



Fig. *Taenia solium* (pork tapeworm)

**5. Phylum Nemathelminthes (Aschelminthes): Roundworms and Related Organisms**

**Classification of Nemathelminthes**

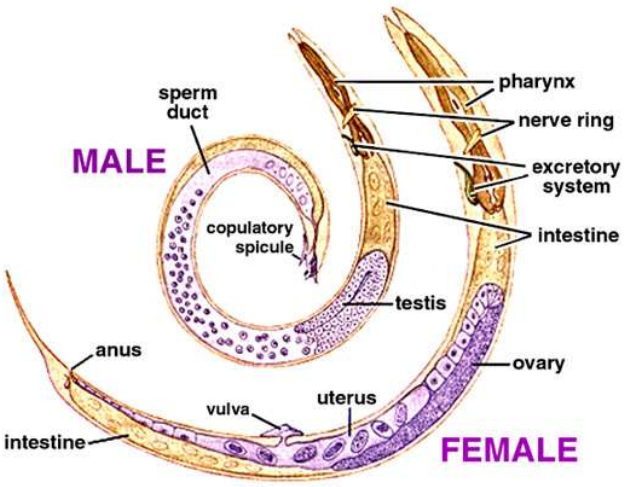
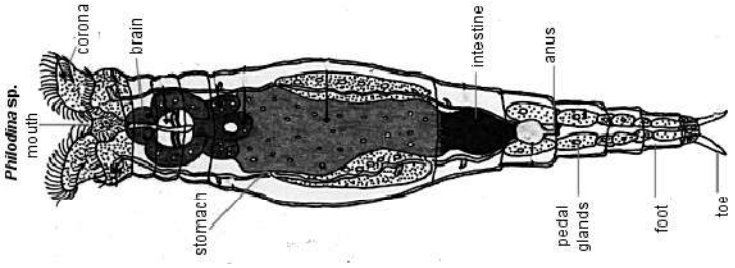



**Fig: *Ascaris lumbricoides* (Nematodes)**

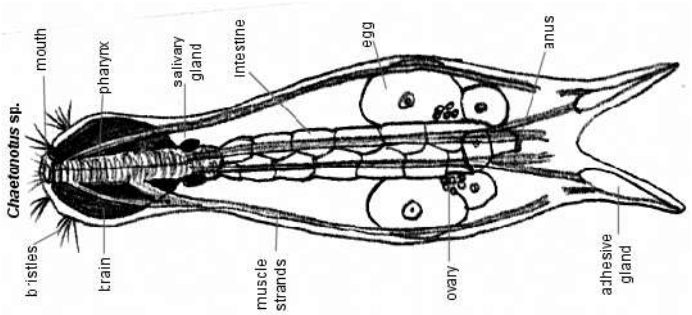
The phylum Nemathelminthes is traditionally divided into five classes (as per classical taxonomy) based on morphological characteristics:

I. **Class Nematoda** (the roundworms) comprises endoparasites and free-living worms with bilaterally symmetrical vermiform bodies covered by complex cuticles. Sexes are separate. Examples include *Ascaris lumbricoides* (large intestinal roundworm in humans), *Ancylostoma duodenale* (hookworm), and *Enterobius vermicularis* (pinworm).

II. **Class Rotifera** consists of microscopic aquatic organisms with separate sexes and a specialized wheel-like feeding apparatus. Two protonephridia tubes function in excretion. Examples include *Brachionus*, *Colotheca*, and *Philodina*.




III. **Class Gastrotricha** comprises minute free-living aquatic organisms with either separate or hermaphroditic sexes. Excretory organs may be present or absent. Examples include *Urodasys*, *Macrodasys*, and *Chaetonotus*.



IV. **Class Kinorhyncha** features minute microscopic marine organisms with internally segmented bodies and separate sexes. Development is indirect, proceeding through larval forms. Examples include *Echinoderes* and *Centroderes*.

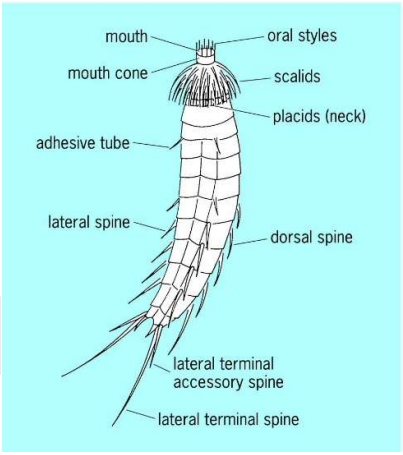



Fig: *Centroderes sp.*

V. **Class Nematomorpha** comprises long slender unsegmented worms commonly called hair worms. Sexes are separate. Examples include *Gordius* and *Nectonema*.

Fig.: a cooked tanner crab with a coiled-up *Nectonema* worm inside of it.