Phylum Platyhelminthes (Characters, Classification and Types)

Platyhelminthes, (Gr., *platys* = flat; *helmins* = worms), *i.e.*, the flatworms are dorsoventrally flattened, triploblastic, bilaterally symmetrical acoelomates with blind sac body plan and organ grade of body organization. These primitive eumetazoans are without definite anus, circulatory, skeletal or respiratory systems but with protonephridial excretory system and mesenchyma (parenchyma) filling the space between various organs of body (see Box 23.1).

The term Platyhelminthes was first proposed by **Gaugenbaur** (1859). Flatworms help biologists to understand animal evolution.

Box 23.1 Primitive characters of flatworms

Phylum Platyhelminthes contains about 13,000 species and has following three primitive characters:

1. Absence of circulatory system.
2. The use of cilia rather than muscles for locomotion.
3. Presence of protenephridia.

These features are now believed to be the result of small body size.

23.1 GENERAL CHARACTERS

Phylum Platyhelminthes is characterized by the following characters:

1. Multicellular body shows **organ grade organization.**
2. Platyhelminthes are bilaterally symmetrical and dorso-ventrally flattened.
3. They are **triploblastic** worms, *i.e.*, their body is derived from three embryonic germ layers namely ectoderm, mesoderm and endoderm.
4. Body shape varies from moderately elongated flattened shape to long flat ribbons and leaf-like.
5. Most parasitic flatworms are white and colourless; some of them derive colour from the ingested food. The free-living forms are brown, grey, black or brilliantly coloured.
6. Animals have soft bodies and are unsegmented.
7. Anterior end of body is differentiated into the so called **head.**
8. Exoskeleton and endoskeleton are absent and hard parts of body such as spines, thorns, hooks, teeth, etc., are formed of scleroproteins.
9. Body is covered with syncytial or single layered, partly ciliated epidermis (*e.g.* Turbellaria). In parasitic forms (trematodes and cestodes) epidermis is absent and the body is covered with cuticle.

10. Great variety of adhesive secretions, organs of attachment and adhesion (*e.g.*, hooks and suckers) are present. Body surface of flatworms bears two kinds of glands: 1. **Cyanophilous glands** (*e.g.*, frontal glands) which secrete slime; 2. **Eosinophilous glands** (*e.g.*, glanduloepidermal adhesive organs) which secrete adhesive substances.

11. The **mouth** is typically the only opening to the digestive tract when the latter is present. The round or slit-like mouth appears at the site of blastopore (called **protostomia**). It may occur anywhere on the midventral surface.

12. A true body cavity or coelom is absent; so they are called **acoelomates**. Space between the organs is filled with a loose mesodermal tissue called **parenchyma** or **mesenchyma**.

13. Parenchyma helps in internal transport of materials from cell to cell distribution. Parenchymal tissue fluid is typically circulated as muscular movements squeeze and distort the parenchyma.

14. Digestive system is totally absent in Acoela and tapeworms but in other flat worms it consists of mouth, pharynx and blind and highly branched intestine. It is incomplete due to absence of **anus**.

15. No special organ for respiratory exchange or transport occurs. Respiration is **aerobic** in turbellarians but **anaerobic** in parasitic flatworms (see Box 23.2).

Box. 23.2.

In turbellarians, the aerobic respiration releases energy mainly by a **cyanide-sensitive system**, *i.e.*, after dehydrogenation, hydrogen is transferred by a cytochrome-oxidase system to the final acceptor oxygen. A small cyanide-resistant fraction is probably maintained by iron-free oxidases.

Anaerobic respiration of parasitic flatworms involves glycogen degradation and formation of carbon dioxide and various organic acids. Different species release different combinations of acids, which indicate diversity among the array of respiratory enzymes.

16. Platyhelminthes are **ammonotelic**, releasing their nitrogenous waste in the form of ammonia.

17. Excretory system consists of single or paired **protonephridia** with **flame cells** or **solenocytes**. Protonephridia are absent in Acoela (see Box 23.3).

Box. 23.3.

A **flame cell** is a hollow cell that has a tuft of vibratile cilia. The protonephridium has traditionally been thought of as a primitive precursor to more complex structures of excretion seen in higher invertebrates (**Wilson** and **Webster**, 1974). Recent work indicates, however, that rather than being primitive, protonephridia are a unique solution to the filtration of extracellular fluid in a body that has no coelom or blood-vascular system (**Ruppert** and **Smith**, 1985). In this case, the solenocytes must **actively transport** selective materials out of the body fluids into the protonephridial weir (=river dam).

18. Flatworms contain a primitive ladder-like nervous system. The main nervous system consists of a pair of **cerebral ganglia** or **brain** and one to three pairs of longitudinal **nerve cords** connected to each other by transverse commissures.

19. Turbellarians have a variety of sensory organs such as **photoreceptors** (for light reception), **chemoreceptors** (for food recognition), **tangoreceptors** (for touch reception), **rheoreceptors** (for orientation to water currents) and **statocysts** (for orientation to gravity). Sense organs are greatly reduced in parasitic forms.

20. Sexes are mostly united, *i.e.*, **hermaphrodite** or **monoecious**.

21. Asexual multiplication takes place by **fission** in many freshwater Turbellaria. Endogenous or exogenous budding is common in some tapeworms.

22. Flatworms have a remarkable power of **regeneration**.

23. Reproductive system is complex and highly evolved in most of the forms. Flatworms produce two types of eggs: 1. **Endolecithal** or **entolecithal ova** with yolk reserves stored in the egg cytoplasm; 2. **Ectolecithal ova** are free of yolk but encapsulated with special **yolk cells** containing the needed food reserve (Fig. 23.1).

24. Fertilization is **internal**. It is cross-fertilization in Turbellaria and Trematoda and self-fertilization in Cestoda.

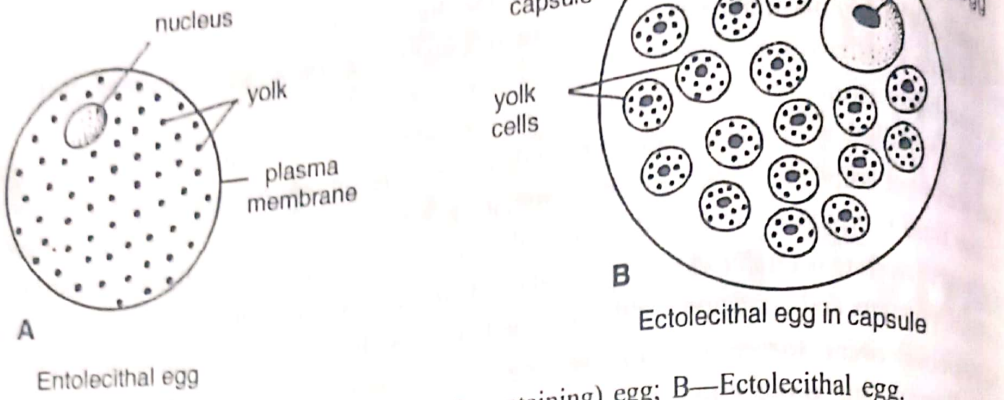


Fig. 23.1. A—Entolecithal (yolk-containing) egg; B—Ectolecithal egg.

25. Development may be direct (Turbellaria) or indirect. Life cycle is complicated and involves one or more hosts. **Digenetic life cycle** (*e.g.*, *Fasciola*) involves a **primary** or definitive **host** and an **intermediate host. Monogenetic life cycle** involves only one host.
26. Phenomena of **parthenogenesis** and **polyembryony** are common in trematodes and cestodes. Alternation of generation or **metagenesis** is also found in some cases (*e.g.*, *Fasciola*).
27. The flatworms are either **free-living** or **ecto-** or **endocommensals** or **endoparasites**.

23.2 OUTLINE CLASSIFICATION

Phylum Platyhelminthes

Classes (4)

- **1. Turbellaria**
- **2. Trematoda**
- **3. Monogenea**
  Examples: *Polystomoidella, Polystoma*
- **4. Cestoda**

Class 1. Turbellaria

Groups (2)

1. Archoophorans

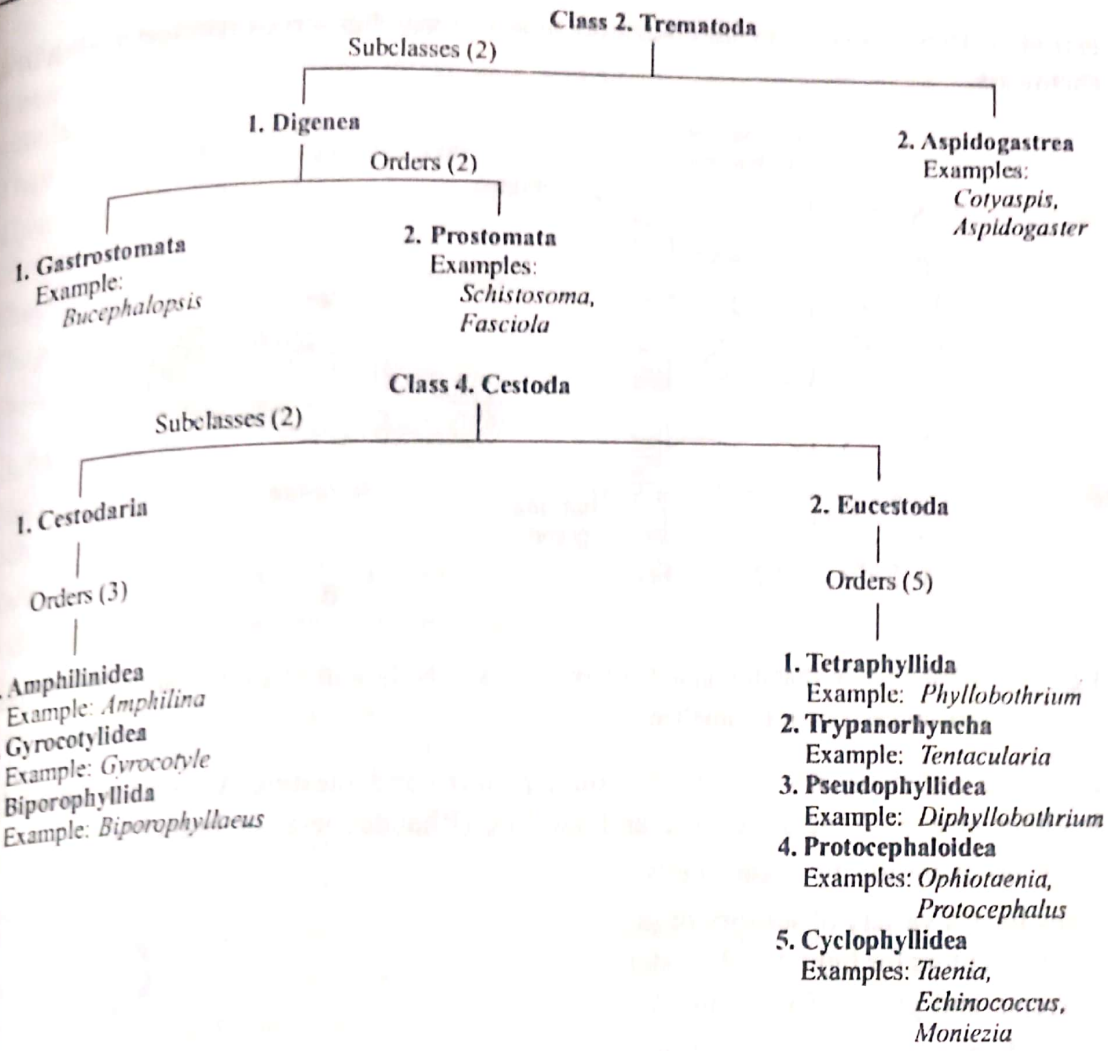
Orders (6)

1. **Acoela**
   Examples: *Convoluta, Afronta, Amphiscolops*
2. **Nemertodermatida**
   Example: *Nemertoderma*
3. **Macrostomida**
   Examples: *Macrostomum, Microstomum*
4. **Haplopharyngida**
   Example: *Haplopharynx*
5. **Catenulida**
   Examples: *Catenula, Stenostomum*
6. **Polycladida**
   Examples: *Notoplana, Leptoplana*

2. Neoophorans

Orders (5)

1. **Lecithoepitheliata**
   Example: *Protorhyncus*
2. **Prolecithophora**
   Example: *Hydrolimax*
3. **Proseriata**
   Example: *Octoplana*
4. **Rhabdocoela**
   Example: *Mesostoma*
5. **Tricladida**
   Example: *Planaria*



23.3 CLASSIFICATION

Phylum Platyhelminthes is divided into **four** classes of worms. Three classes are entirely parasitic and include the Trematoda, the Monogenea and the Eucestoda. The fourth class, the Turbellaria, is free-living and is certainly the group from which arose the ancestors of three parasitic classes.

Class 1. Turbellaria

(L., *turbella* = a little string)

1. Mostly free-living and carnivorous ciliated flatworms; a few are parasitic.
2. They are either aquatic, may be freshwater or marine, or terrestrial. Most aquatic forms are bottom dwellers or benthic, living in sand or mud.
3. They are mostly small but range in size from microscopic to more than 60 cm long (*e.g.*, the Lake Baikal triclad, *Rimacephalus arecepta*).
4. Body is unsegmented, dorsoventrally flattened and leaf-like, rounded or oval.
5. Body is covered with a cellular or syncytical **epidermis.**
6. Terrestrial species have strong epidermal ventral cilia and weak or no dorsal cilia. Epidermis of the ventral surface contains many unicellular **cyanophilous** or slime glands. Slime secretions tend to lubricate the surface; they increase water viscosity and provide resistance against which the cilia can thrust.
7. Suckers are absent, but adhesive organs are abundantly present.
8. Epidermal and subepidermal glands also form **rhabdites.** A rhabdite is a rod-shaped secretion, microscopically composed of successive lamellae (Fig. 23.2). Rhabdites dissolve rapidly when

extruded. They probably do not contribute to
chemicals.

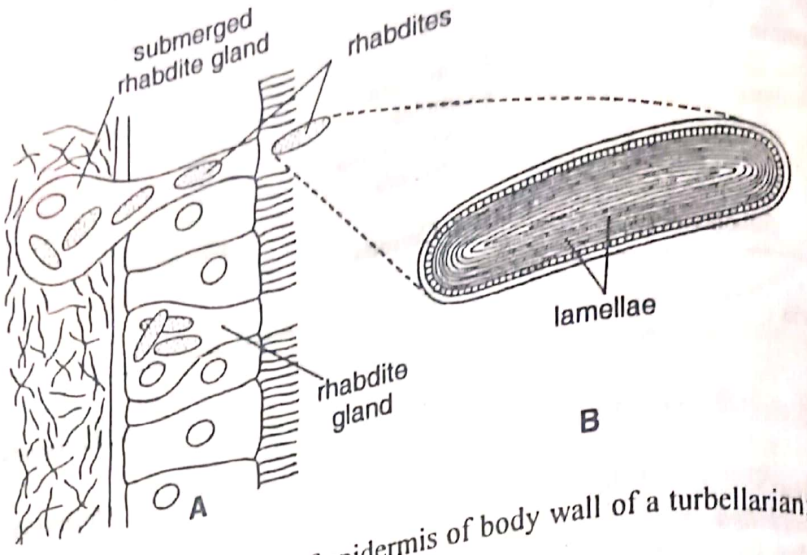


Fig. 23.2. A—Rhabdites in rhabdite glands of epidermis of body wall of a turbellarian; B—Ultra
of a rhabdite showing lamellae.

9. Digestive system usually consists of mouth, pharynx and intestine. Anus is not found. Inte
is either absent (Acoela), simple and sac-like (Rhabdocoela) or branched.
10. They do excretion by **flame cells**.
11. They have a variety of sensory orga-
ns or receptors for light, touch, water
currents and gravity (or balance).
12. They do reproduction by sexual and
asexual means. Asexual reproduction
occurs by **paratomy** (or strobilati-
on), **architomy** (= fission) and **part-
henogenesis**. They have a remarka-
ble power of regeneration.
13. Mostly hermaphrodite. Life cycle is
simple. Development is **direct** in
most turbellarians, but some polycl-
ads produce free-swimming larvae
that feed on plankton (**planktotro-
phic**). These larvae are of two types:
Goette's larvae (having four arms or
lobes) and **Mueller's larvae** (having
eight arms) (Fig. 23.3). The larvae
become metamorphosed into
juvenile.

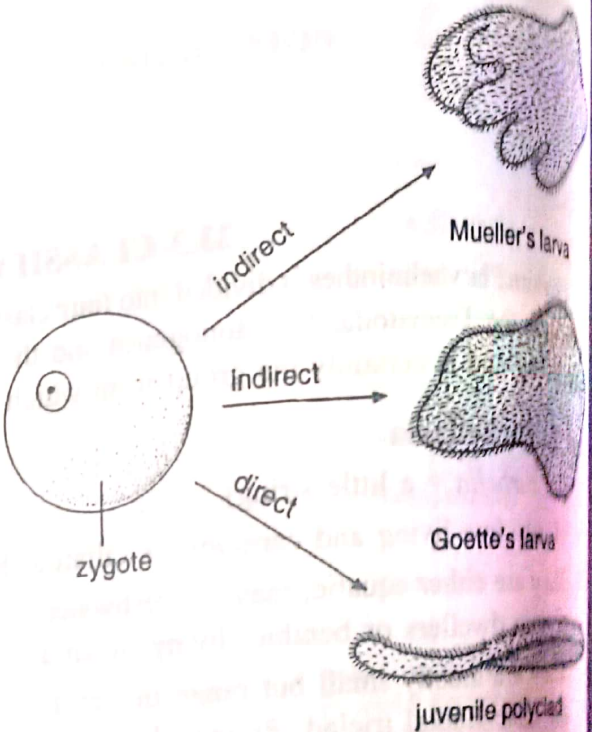


Fig. 23.3. Direct and indirect development of turbell

14. About 3000 species of turbellarians have been described.

Class 2. Trematoda

(Gr., *trematodes* = having pores)

1. They are commonly called **flukes**.
2. They are **ectoparasites** or **endoparasites**.

3. Body unsegmented and worm-like.
4. Their body wall is without epidermis and cilia; instead it is covered with a thick cuticle.
5. They contain well developed suckers.
6. Their incomplete digestive system lacks anus but contains mouth, pharynx and branched intestine.
7. They are mostly **monoecious** or **hermaphrodite.**
8. They contain single ovary and two or many testes.
9. Their life history may be simple or complicated including many larval forms.

Class 3. Monogenea

1. This class includes flatworms which are mostly ecto- or endoparasites of aquatic vertebrates such as fishes, amphibians and reptiles (turtles).
2. Their body is dorsoventrally flattened and composed of a head, trunk and haptor.
3. Oral sucker is either absent or weak. Instead of it a pair of adhesive glands (head organs) are present.
4. Posterior end of body is provided with large posterior attachment organ called **opisthaptor** or **haptor**. Haptor bears **hooks** and **suckers**, allowing the parasite to cling tenaciously to the skin of fast-moving host.
5. Excretory pores are paired and situated anteriorly on the dorsolateral sides. In some species a urinary bladder is associated with each pore.
6. They have complex hermaphrodite reproductive system. Most contain a single circular or oval testis and a single ovary and extensive vitellaria.
7. Male and female gonopores are usually separate.
8. During copulation, there is a mutual exchange of sperm being passed into single or paired vagina. Males use a protrusible penis-like structure bearing hooks in copulation.
9. Their life cycle includes only **one host** (there is no intermediate host).
10. One egg (by way of a free-swimming ciliated larva called **oncomiracidium**) gives rise to only one adult worm. Hence the name **monogenea**, meaning "one generation."

Examples. *Polystomoidella oblongum* (parasite in urinary bladder of turtles); *Benedenia melleni* (ectoparasite of fish); *Polystoma integerrinum* (endoparasite of urinary bladder of frogs and toads); *Dactylogyrus vastator* (ectoparasite on the gills of freshwater fishes).

Class 4. Cestoidea (Cestoda)

(Gr., *kestos* = girdle + *eidos* = form)

1. All are highly specialized endoparasites of vertebrates, commonly called **tapeworms**.
2. Body is flattened and ribbon-like.
3. Body is without epidermis and cilia but covered by a syncytial tegument (cuticle) having microvilli-like projections called **microtrichia**. Microtrichia plays a vital role in active transport of food molecules of various carbohydrates and amino acids.
4. Body of tapeworms is differentiated into **scolex, neck** and **body** or **strobila**.
5. Scolex is provided with adhesive structures (hooks, suckers) which are absent in subclass Cestodaria.
6. Neck is very short and narrow. It is **proliferative** giving rise to the body or strobila. Neck keeps on adding new proglottids to body by mitotic growth followed by transverse constriction.