**PHYLUM PLATYHELMINTHES**

Members of the phylum are commonly called flatworms. Platyhelminthes are triploblastic (body is formed from the three germ layers), bilaterally symmetrical, dorso-ventrally flattened, acoelomate flatworms with organ grade of construction without definite anus, circulatory, skeletal or respiratory systems but protonephridial excretory system and mesenchyme filling the space between the various organs of the body. The phylum contains free-living forms such as the common planarian as well as parasitic flukes and tapeworm. Flatworms are the largest group of acoelomate worms. Although their body plan is relatively simple, it is a great deal more complex than that of sponge or cnidarian. They have a middle tissue layer, the mesoderm. And unlike sponges and cnidarians, the flatworms have tissues that are organized into organs. The flatworm’s body is bilaterally symmetrical with distinct anterior (cephalic) end with a concentration of sensory organs and is dorso-ventrally flattened. As a result, each cell in the animal’s body lies very close to the exterior environment. This permits dissolved substances such as O2 and CO2 to pass efficiently through the flatworm’s solid body by diffusion. These animals are commonly regarded as primitive on account of a number of negative characters: the mouth is the only opening to the gut, and they have no body cavity, no respiratory system, no appendages and no hard skeleton. The main ganglia, or nerve centre, of the nervous system and the major sense organs are generally concentrated at the anterior end. Typically, the primitive brain of the flatworm consists of a bi-lobed mass of tissue with lateral longitudinal nerve cords connected by transverse connectives, thus forming a rather ladder-like structure or grid running the greater length of the organism.

Platyhelminthes is divided into four classes: Turbellaria, Trematoda, Monogenea, and Cestoda. Class Turbellaria contains the free-living flatworms. Most turbellarians are bottom dwellers in marine or freshwater, living under stones or other hard objects. All members of classes Monogenea, Trematoda and Cestoda are parasitic. Most Monogenea are ectoparasites, but all trematodes and cestodes are endoparasitic. But some authors combine Monogenea and Trematoda into class Trematoda.

**CLASS TURBELLARIA:** Almost all members of class Turbellaria are free-living marine flatworms. Most turbellarians have a cellular, ciliated epidermis resting on a basement membrane. It contains rod-shaped rhabdites, which swell and form a protective mucous sheath around the body when discharged with water. Single-cell mucous glands open on the surface of the epidermis. In the body wall below the basement of planarians are layers of muscle fibres that run circularly, longitudinally, and diagonally. A meshwork of parenchyma cells developed from endoderm fills the spaces between muscles and visceral organs. However, most studies are done on the freshwater turbellarian such as *Dugesia*, one of a group of flatworms commonly called planarians.

***Dugesia* species:** It is of average length of 3-15 mm and is worldwide in its range. It is a common free-living, freshwater flatworm. It is found on the underside of leaves, logs, debris and rocks submerged in cool, clear and running water of streams, ponds and lakes. The body is broad and blunt at the anterior end and pointed at the posterior end. Its anterior end forms an obvious head which is triangle with two laterally projecting head lobes called auricles. On the head are two cup-shaped black eyes, present between the auricles. The ventral surface has mouth, adhesive zone and the genital opening in sexually mature forms. The mouth opens into a cavity surrounded by a muscular tube, the pharynx.

The body wall is made of an outer epidermis and inner muscle layers. Both of these layers are separated by a basement membrane. And between muscle layers and the alimentary canal is the mesenchyme. Thus, no coelom is found in it. The epidermis is a single cell-layered thick and has the sensory cells, mucous gland cells and the rhabdites which are actually secreted by the rhabdite gland cells in the mesenchyme. The rhabdites are believed to be protective or nutritive in function. The basement membrane acts as an attachment for underlying muscle layer and to maintain the body form of the organism. The muscle layer is made up of circular, dorso-ventral (diagonal), longitudinal muscles. The mesenchyme contains the formative cells and is fluid-filled spaces between various internal organs and the body wall. It transports digested food and excretory wastes.

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**LOCOMOTION:** It moves by gliding which is made possible by slime tract and the ventral cilia and by crawling, using its adhesive organ and its muscles

**FEEDING:** The flatworms are the first in animal kingdom to have the alimentary canal, though, it is incomplete. Its alimentary canal is made up of mouth, pharynx and intestine. The intestine is divided into three: a branch is upward and two branches are downward. Planarians are mainly carnivorous; they feed largely on small crustaceans, nematodes, rotifers and insects. They can detect food from some distance by means of chemoreceptors. The entangle prey in mucous secretions from the mucous glands and rhabdites. They extend their muscular pharynx out of its centrally located mouth in order to feed. They grip prey with their anterior end, wrap their body around the prey item, extend its pharynx and suck up food in small amounts. The highly branched intestine enables nutrients to pass close to all the flatworm’s tissue. Intestinal secretions contain proteolytic enzymes for some extracellular digestion. Bits of food are sucked into the intestine, where phagocytic cells of the gastrodermis complete digestion (intracellular). Undigested food is expelled through the mouth. It can also live without food for long periods.

**RESPIRATION:** There is no respiratory organ. It is by diffusion through the body surface.

**EXCRETION & OSMOREGULATION:** Excretion is by protonephridia or flame cells. Because *Dugesia*’s body cell contains more solutes than freshwater does, water continually enters its body by osmosis. Excess water moves into a network of tiny tubules that run the length of its body. Side branches are lined with many flame cells (specialized cells with beating tufts of cilia that resemble a candle flame). The beating cilia draw water through pores to the outside of the worm’s body. Flame cells use their flagella to collect excess water and salts from the body tissues; these are then funneled into tubule cells and subsequently excreted through nephriopores. Although a small amount of ammonia is excreted via protonephridia, most metabolic wastes are largely removed by diffusion across the body wall.

**NERVOUS SYSTEM:** Nervous system is very primitive and is made up of nerve cells. Sensory information gathered by the brain is sent to the muscles by two main nerve cords that are connected by cross branches. Light-sensitive structures called eyespots (ocelli) are connected to the brain.

**REPRODUCTION:** It reproduces both asexually and sexually. It reproduces asexually in summer by attaching its posterior to a stationary object by means of its mucous gland, stretches itself and constrict behind the pharynx and separate into animals, each of which regenerates the missing parts.

Sexually, *Dugesia* is monoecious (hermaphrodite) but practice cross-fertilization. Reproductive organs are temporary in Dugesia. The male reproductive organs consist of testes, vasa efferentia, a pair of vas deferens and a penis. The female organs consist of ovaries, oviduct, seminal receptacle, the ovo-vitelline and copulatory sac. During breeding season turbellarians develop both male and female organs, which usually open through a common genital pore. During copulation when the male and the female come together by their ventral surfaces, the penis papilla of each emerges by elongation through the genital pore and is inserted into the copulatory sac of the other worm by which mutual insemination occurs. After copulation one or more fertilized eggs and some yolks cells become enclosed in a small cocoon. This capsule that contains several fertilized eggs is laid through the genital pore. The cocoons attached by little stalks to the underside of stones or plants. Embryos emerge as juveniles that resemble mature adults except they are smaller in size and sexually immature.

**CLASS TREMATODA:** This is the largest flatworm class and consists of parasitic worms called flukes. Some flukes are endoparasites and other flukes are ectoparasites. Endoparasites have a thick protective covering of cells called a ‘tegument.’ They are provided with suckers (oral and ventral) for attachment to the hosts but no hooks. An alimentary canal is always present in the adult, but there is no anus. Excretory pore is situated at the terminal posterior end. They are characterized by their leaf-like appearance. The gut consists of an oral aperture which leads into pharynx, when present, and then, into oesophagus. The oesophagus bifurcates into two intestinal caecae, each caeca runs on the lateral sides and terminates blindly at the posterior region of the parasite. Example is *Fasciola hepatica*.

***Fasciola hepatica*:** The adult of *Fasciola hepatica* lives as parasite in the biliary tract of the definitive host (sheep). It has a thin, dorso-ventrally flattened, leaf-shaped, elongated and oval body with the anterior end broader than the posterior end. The anterior end of the body is differentiated into oral cone or head lobe. This lobe bears the mouth and the oral sucker. There is another muscular sucker, the ventral sucker or acetabulum, behind the oral sucker. There are other openings apart from the mouth; they are gonopore on the ventral surface and the excretory pore at the posterior end. Its body wall lacks a cellular layer of epidermis. It consists of a thick layer of cuticle, a thin basement membrane and underlying muscle layers surrounding the mesenchyme. The body wall provides protection, serves as site for gaseous exchange and nitrogenous wastes and for absorption of amino acid.

 

**NUTRITION:** It feeds on bile, blood, lymph and cell debris. The oral sucker and pharynx act as an effective suctorial apparatus. Digestion is extracellular. The digestive system is incomplete, there is no anus. The alimentary canal is made up of mouth, the pharynx, the oesophagus, the intestine (divided into two intestinal caeca) and diverticula. The indigestible remains of food, if any, are ejected through the mouth.

**RESPIRATION:** Respiration is anaerobic or anoxybiotic since it is a parasite.

**EXCRETION:** This is carried out by the flame cells. The flame cells are characterized by thin elastic wall with pseudopodia-like processes or protoplasmic processes, a nucleus and intra-cellular cavity having many cilia or flagella (arising from the basal granules), which vibrate giving the appearance of a flickering flame. Hence, the name flame cell. Excretory wastes are gotten rid of through the excretory pore.

**NERVOUS SYSTEM:** This is made up of the ganglia and nerve cords which ended in small branches. Nerve cords are connected by transverse commissures. Adult *Fasciola* loses its sense organ because of its parasitic mode of life.

**REPRODUCTION:** It is hermaphrodite. The reproductive organs are well developed. The male reproductive system consists of testes, vasa deferentia, seminal vesicle, ejaculatory ducts, cirrus/penis, prostrate glands and genital opening. The female reproductive system consists of ovary, oviduct, uterus, vitelline glands, Mehliis’s glands, Laurer’s canal, genital pore.

It has digenetic life cycle. Copulation and fertilization in the bile duct of sheep, which is the primary host. During copulation, the cirrus of one *Fasciola* is inserted in the Laurer’s canal of other and the sperms are deposited into the oviduct, so that cross-fertilization occurs. Cleavage and early development start in the uterus. The fertilized eggs are later encapsulated and then leave the parent’s body through its gonopore into the bile duct of the host where they reach the intestine and pass out with the faeces. Further development takes place when the capsule finds favourable conditions to form a miracidium larva which hatches out and swims in water.

The miracidium larva does not feed, it swims about in water or moisture film, but it dies in 8hrs unless it can reach a suitable intermediate host, which is some species of amphibious snail of genus *Limnaea*. After getting a suitable host the miracidium adheres to it by the apical papilla and enters the pulmonary sac of the snail, from where it penetrates into the body tissues with the aid of penetration glands and finally reaches to snail’s digestive gland. In the tissues the miracidium casts off its ciliated epidermis, loses its sense organs and swells up and changes in shape to form a sporocyst larva. The sporocyst larva gives rise to redia larva which gives rise to cercaria larva. The mature cercaria makes its way through the host’s tissues, often migrates to its pulmonary sac, and from there escapes to the surrounding water. The cercaria swims about in water or crawl about on aquatic plants for about 2 or 3 days after which it loses its tail and become encysted as metacercaria larva. Further development of metacercaria larva takes place in the sheep which gets infested through grazing on leaves that have metacercaria larva. A young fluke emerges which finds its way to the liver of the host and another cycle begins.

 

**CLASS CESTODA:** Cestodes are segmented, tape-like, parasitic worms whose sizes vary from a few millimetres to several metres. The adult worm consists of three parts- the head (scolex), neck and trunk. The head carries grooved or cup-like suckers, which are the organs of attachment to intestinal mucosa of the definitive host, human or animal. The neck, immediately behind the head is the region of growth, where the segments of the body are being continuously generated. The trunk (strobila) is composed of a chain of rectangular body sections called proglottids or segments. Each proglottid is a complete reproductive unit, a fact that makes tapeworms easy to spread. The proglottids near the neck are the young immature segments, behind them are the mature segments and at the hind are the gravid segments. Like *Dugesia*, cestodes have rudimentary excretory and nervous systems. Tapeworms are hermaphrodites (monoecious) and every mature segment contains both male and female sex organs. In the immature segments the reproductive organs are not well developed and differentiated. They are well-differentiated in the mature segments. The gravid segments are completely occupied by uterus filled with eggs. The embryo inside the eggs is called the oncosphere (meaning ‘hooked ball’) because it is spherical and has hooklets. Common examples are beef tapeworm (*Taenia saginata*) and pork tapeworm *Taenia solium*)

***Taenia saginata*:** The adult worm lives in human intestine, usually in jejunum, where it lies in several folds in the lumen. Commonly only a single worm is present, but occasionally as many as 25 worms may be seen in a patient. The worm is an opalescent white in colour. It measures between 5-25 metres and it is the largest helminth causing human infection. The scolex is quadrate in cross-section with 4 lateral suckers. The scolex has no rostellum or hooks. Hence, the name, unarmed tapeworm. The suckers serve as the sole organs for attachment. The neck is long and narrow. The strobili contains up to 2000 proglottides-immature, mature and gravid in that order from front backwards.

The mature proglottids are broader than long. The testes are follicular and scattered on the dorsal plane. The sperm are collected by vasa efferentia which join up to form the vas deferens, the distal portion of which is the cirrus organ. The cirrus organ opens into the genital atrium, situated on the lateral surface. The ovary is bi-lobed and located on the posterior end of the proglottid. Immediately posterior to the ovary is a group of compacted follicular vitellaria. The vagina opens into the genital atrium. It passes into the middle and join up with the oviduct and the vitelline duct, before they pass into the ootype which is situated between the bi-lobed ovary. It is surrounded by the Mehlis or shell glands. The uterus runs anteriorly from the ootype as a sac-like vertical structure in the middle of the proglottid. Lateral branches arise from the uterus as it becomes filled with eggs. The gravid segments are nearly four times as long as they are broad and consist only of uterus filled eggs. The uterus characteristically possess between 18 and 30 main lateral branches. The body wall of tapeworm is made up of cuticle, subcuticular muscles, subcuticular cells and mesenchyme

**NUTRITION:** The adult worms attach themselves to the inner wall of their host’s intestine by means of their suckers. Food is then absorbed from the host’s intestine directly through the worm’s skin. There is no digestive system.

**RESPIRATION:** It is anaerobic.

**NERVOUS SYSTEM:** The nervous system is made up of ganglia and longitudinal nerves which are connected in each proglttid by a ring connective situated below the transverse excretory canal.

 

**EXCRETORY SYSTEM:** This is made up of the flame cells.

**REPRODUCTION:** Self fertilization occurs and is preceded by copulation. The encapsulated zygote passes into uterus where further development takes place. The gravids segments break away and are expelled singly, actively forcing their way out through the anal sphincter. As there is no opening, the eggs escape from uterus through its ruptured wall. The spherical eggs when freshly released from the proglottid, have a thin hyaline embryonic membrane around it, which soon disappears. The eggs when discharged contain fully developed onchosphere each with 6 hooklets, hence it is called hexacanth embryo. The onchosphere is surrounded by a thick spherical pitted embryophore which appears striated. The eggs deposited in soil remain viable for several weeks. They are infective to cattle which ingest the eggs while grazing. When ingested by cattle, the egg-shell ruptures and the onchosphere hatches out in the duodenum. The onchosphere with their hooklets penetrate the intestinal wall, reach the mesenteric venules of lymphatics and enter the systematic circulation. They get filtered out in the striated muscle particularly in the muscle of the tongue, neck, shoulder and in the myocardium. In these sites, the onchospheres lose their hooks and develop into the mature larva, the bladder-worm or cysticercus bovis. The cysticercus is an ovoid, milky white opalescent fluid-filled vesicle measuring about 5-10 mm and contains the invaginated unarmed scolex. Man is infected when he eats infected beef, raw or inadequately cooked. In his intestine, the scolex evaginates and attaches to the intestinal wall; the bladder is digested and from the neck proglottids are budded off. The worm becomes mature. The oldest proglottid becomes gravid and is detached and new ones are budded off from the neck region.

**Life Cycle of Intestinal Tapeworms *Taenia solium* (Pork Tapeworm) and *Taenia saginata* (Beef Tapeworm).** Humans acquire intestinal tapeworm infections by ingesting the tissue stage of the parasite (cysticercus) in inadequately cooked meat (1). The parasite then hatches in the intestine (2) and matures to an intestinal tapeworm (3). The pork tapeworm (outside diagram) has a crown of spines on its head and fewer pairs of lateral uterine branches in its proglottids (segments) than the beef tapeworm (4). The eggs of both tapeworm parasites are identical morphologically (5). As shown in the diagram, only the pork tapeworm (T. solium) produces human cysticercosis (6). When human feces containing viable eggs are ingested by either pigs or cattle, the eggs hatch (7) and produce the tissue (cysticercal) stage of the infection in those animals (1) to complete the cycle.

 