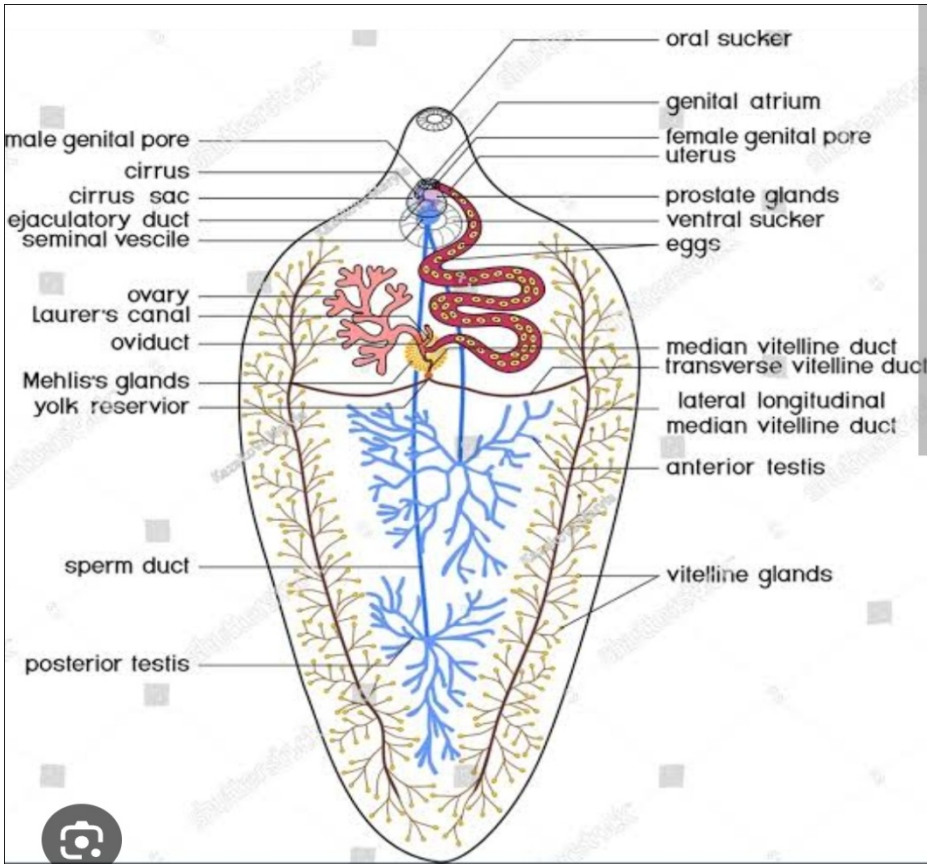
# FASCIOLA REPRODUCTIVE SYSTEM

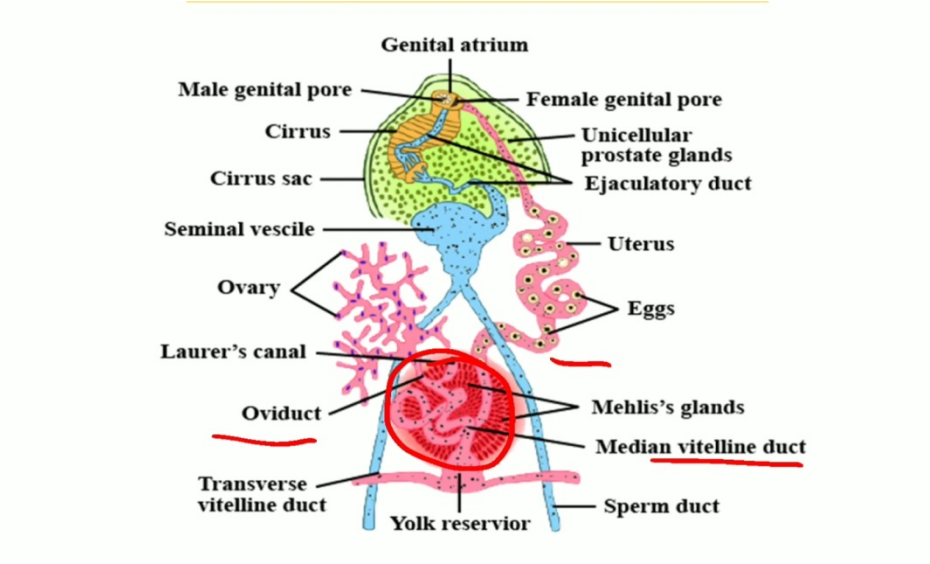
Fasciola hepatica is hermaphrodite. The female and male genital ducts open into common chamber called genital atrium. The gonads in these liver flukes are well developed. The genital atrium is situated in the anterior part of the body and it open out through common genital aperture or gonopore. The gonopore is located just in front of the acetabulum.

## Male reproductive system

The following are the organs of the male reproductive system,

- **Testes** are paired and highly lobed structures arranged one behind the other in the large space in the middle and posterior regions of the body. The epithelial lining of these testes gives rise to sperms.
- **Vas deferentia** are the narrow slender ducts arising from the testis. They are two in number and these two run side by side anteriorly up to the level of acetabulum. And at the acetabulum they unite and form a pear-shaped seminal vesicle which stores sperms.
- A narrow twisted tube arising from the **seminal vesicle** called as ejaculatory duct. The ejaculatory duct extends forward and enters the eversible copulatory organ called **cirrus**. The cirrus extends up to the genital atrium and opens there as male **genital aperture**. Genital atrium in turn opens out through a common gonopore.






## Female reproductive system

The following are the parts of the female reproductive system,

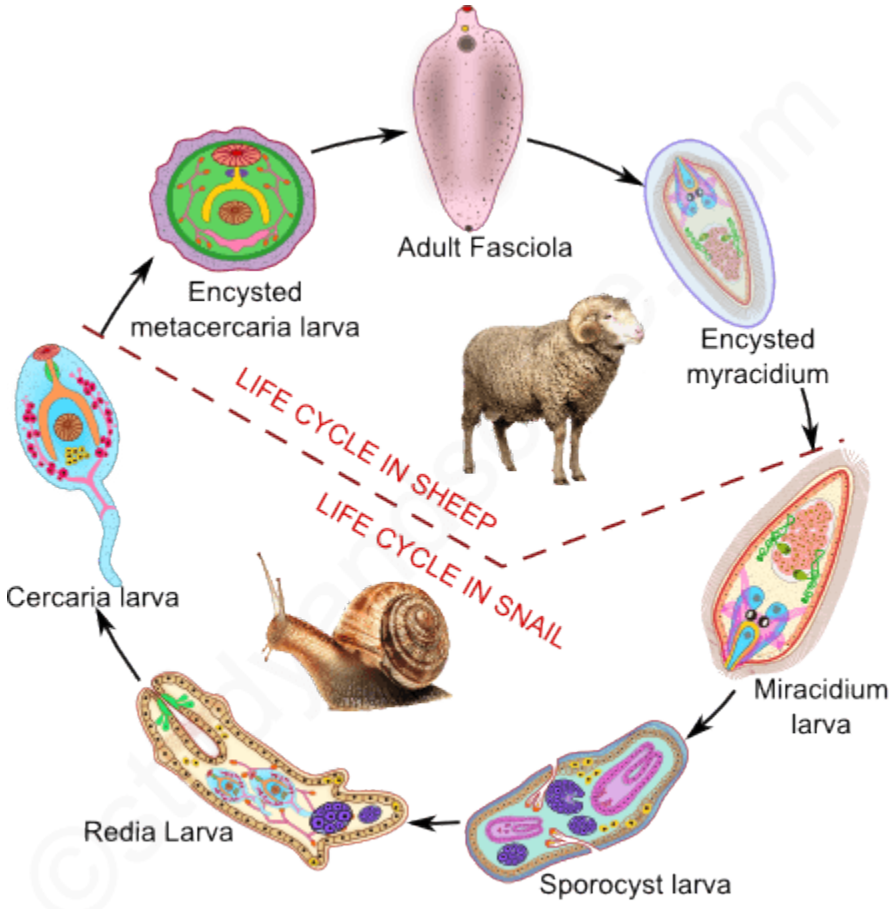
- **Ovary** is a solitary, highly branched and tubular structure. It lies anterior to the testes.
- **Oviduct** is the gathering of all the branches of the ovary. It is short and narrow. It extends backwards to join the median vitelline duct to form the uterus. Uterus is long and convoluted which extends up to the genital atrium and opens out through female genital aperture. Uterus contains large number of capsules with fertilized eggs.
- A short muscular copulatory tube called **Laurer's canal** arises from the oviduct. This canal serves as vagina during copulation.
- **Vitelline glands** occur as clusters of follicles along entire length of the body. Follicles on each side are connected by fine ductules and these ductules are finally connected to the vitelline duct. The longitudinal ducts of both sides are connected by a transverse duct. The transverse duct swells up in the center to form yolk reservoir and from this median vitelline duct arises and it joins the oviduct to form the uterus. These vitellaria produce special yolk cells or vitelline gland cells. These cells contain abundant yolk for the nourishment of the embryo and also numerous shell globules which form egg shells.
- **Mehlis's glands** These are also known as the shell glands but as per the name they do not have any role in the formation of the shell. These are the clusters of unicellular glands present at the junction of the oviduct, median vitelline duct and uterus. The secretions of these glands help in lubricating the uterus for smooth passage of eggs and in activating the sperms.

## FASCIOLA LIFE CYCLE IN SHEEP

The life cycle of *Fasciola hepatica* is complex and it is completed in two different hosts as it is a digenetic parasite. The primary host is sheep in which the adult liver flukes live. Whereas the intermediate or secondary host is a snail in which all the larval stages are developed. The following are the stages in the life cycle of *Fasciola hepatica.*

### Copulation

Though liver flukes are hermaphrodite, they undergo cross fertilization preceded by the process of copulation. Self-fertilization occurs very rarely. The copulation of Fasciola hepatica takes place in bile ducts of the host. The two flukes in copulation bring their general pores opposite to each other. The cirrus of one fluke everts out through the gonopore and penetrates through the Laurer's canal of the other fluke and injects the spermatozoa. The secretions of the Mehlis's glands and prostate glands help in fertilization.




FASCIOLA HEPATICA - LIFE CYCLE

### Fertilization

The fertilization in these liver flukes is internal type. In cross fertilization, the sperms received in the Laurer's canal during the copulation, enter the distal end of the oviduct. And in the oviduct the fertilization takes place. And in self-fertilization, the sperms enter the uterus of the same fluke through female genital aperture and pass down to fertilize the eggs.

**Capsule formation**
Each of the fertilized eggs is surrounded by the yolk cells. These yolk cells provide nourishment and shell material to the developing eggs. The shell globules of the yolk cells contain protein and a phenol.

**Capsules**
All the shelled eggs are called as capsules. The shell of the capsule is yellow or brown in color and oval in shape. The capsules are also provided with a lid called as operculum. Beneath the operculum a viscous and granular cushion is present. About 200 flukes are present in one sheep and each of these flukes produces around 500,000 eggs and a single infected sheep may disperse 100 million fertile eggs. Such a vast capacity of egg production is necessary as the life of these flukes is complicated and there are very less survival chances.

**Cleavage**
While the eggs are still in the uterus, the process of cleavage starts. The cleavage is holoblastic and unequal type. First the zygote divides to form two unequal cells; the larger called the somatic cell and the smaller called propagatory cell. Somatic cell divides further to form larval ectoderm and tissues. Propagatory cell divided further to produce two daughter cells. One of these daughter cells produces the larval body and the other daughter cell undergoes further divisions to form mass of germ cells. These germ cells cluster in the posterior part of the larval body.
These embryos get capsulated and cannot develop further in the fluke's uterus. Numerous capsules leave the fluke's body through the gonopore into the host's intestine and are finally ejected out through its faeces. The further development of these capsules takes place when these come in contact with the water which is slightly acidic.

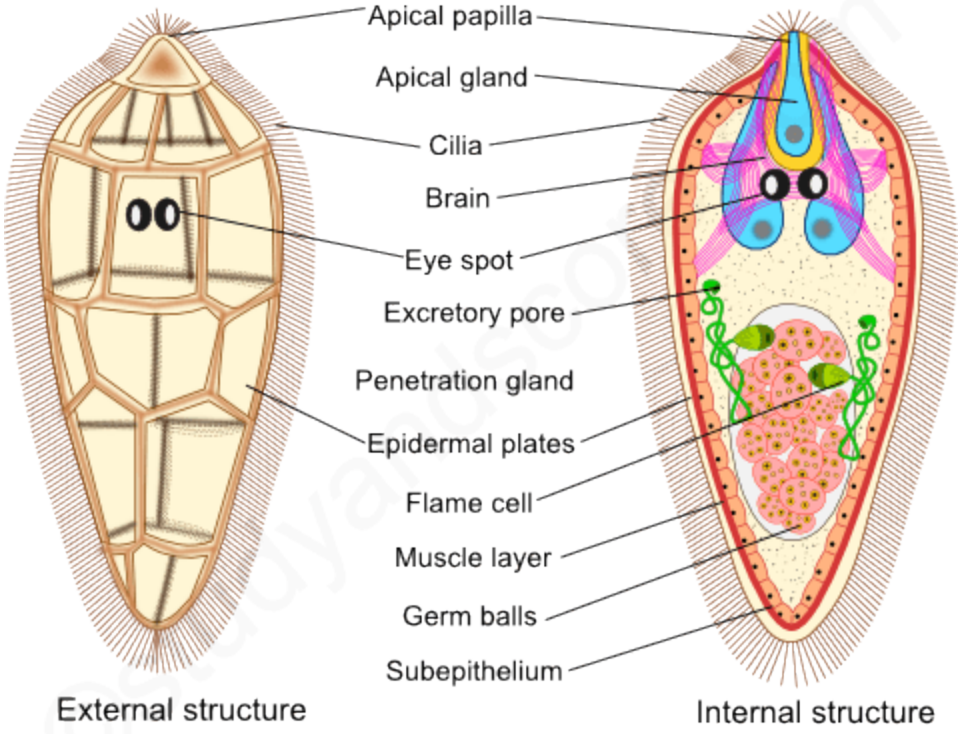
# FASCIOLA LIFE CYCLE IN SNAIL

**Miracidium larva**
When the conditions turn favorable, the encapsulated embryos get differentiated into miracidium larva. It is the first larval stage in the life cycle of liver fluke. These larvae are hatched out with the help of hatching enzyme. This enzyme dissolves the cementing material of the operculum.
**External structure of miracidium larva:** Miracidium larva is small, oval, elongated and richly ciliated. The anterior end produces mobile, non-ciliated apical papilla. This larva is multicellular. Its body is covered with ciliated epidermal plates which are total 21 in number arranged in five rows or tiers. The number of plates in each tire is fixed.

- Tier I: 6 plates. Two dorsal, two lateral and two ventral
- Tier II: 6 plates. Three dorsal and three ventral
- Tier III: 3 plates. One dorsal and two ventro-lateral

- Tier IV: 4 plates. Two right and two left
- Tier V: 2 plates. One left and one right

Under these epidermal plates, a fine layer of sub-epidermal musculature is present. Thus, musculature consists of outer circular and inner longitudinal fibers. Under this musculature another layer called sub-epithelium is present. Epidermal plates, sub-epidermal musculature and sub-epithelium together form the body wall of miracidium.




FASCIOLA- MIRACIDIUM LARVA

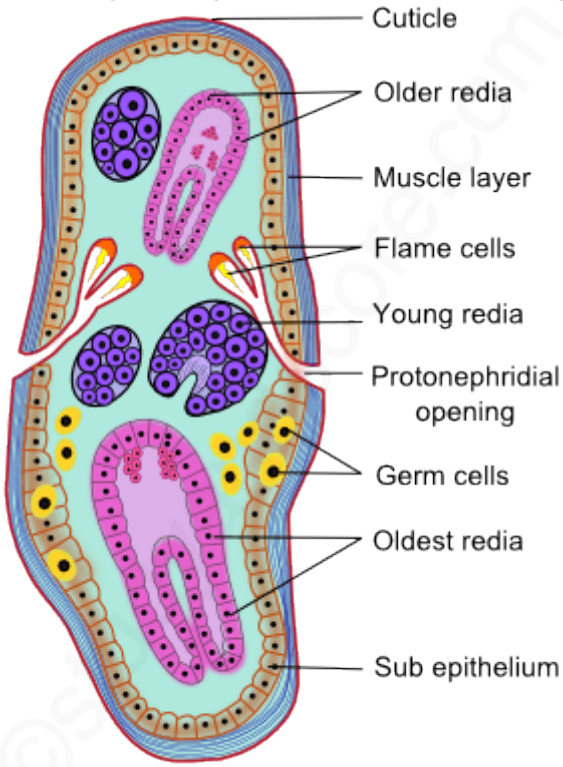
**Internal structure of miracidium larva:** Inside the body of miracidium, numerous glands, nervous tissue and protonephridia and germ cells are present. A sac-like multinucleated mass of granular protoplasm is attached to the center of apical papilla. A large brain with several associated nerve fibers lies dorsally below the epidermal cell of the second tier. Above the brain, an "X" shaped larval eye with two crescentic pigmented cells called as eye spots are present. The concavities of these eyes face each other. These concavities contain refractile material serving as lens. A pair of long tubular protonephridia or flame cells opens to the exterior through excretory pores. The germ cells lie in groups called as germ balls in the rear part of the body of miracidium larva.

Miracidium larva does not feed but swims about desperately are tries to penetrate any object it may come across. But it can succeeds only if it comes in contact with the specific intermediate host, snail. All the larvae which do not come in contact with the suitable host would die within 24 hours. After finding the suitable host, the larva attaches itself with the apical papilla and performs boring movements. This movement along with the flesh-dissolving secretions of the larva, it created a minute bore in the host tissue. Through this minute the larva squeezes itself into the host body. After entering the body of the host it sheds of its ciliated epidermis

and then enters into the digestive gland of the sheep to undergo further changes and finally develops into next larval stage called as sporocyst larva.

**Sporocyst larva**

Sporocyst larva is an elongated structure which retains the body layers of the previous larval stage except the ciliated epidermis. This ciliated epidermis is replaced by a thin cuticle. The glands, brain, eye spots and apical papilla which are present in the miracidium larva get degenerated in this stage.

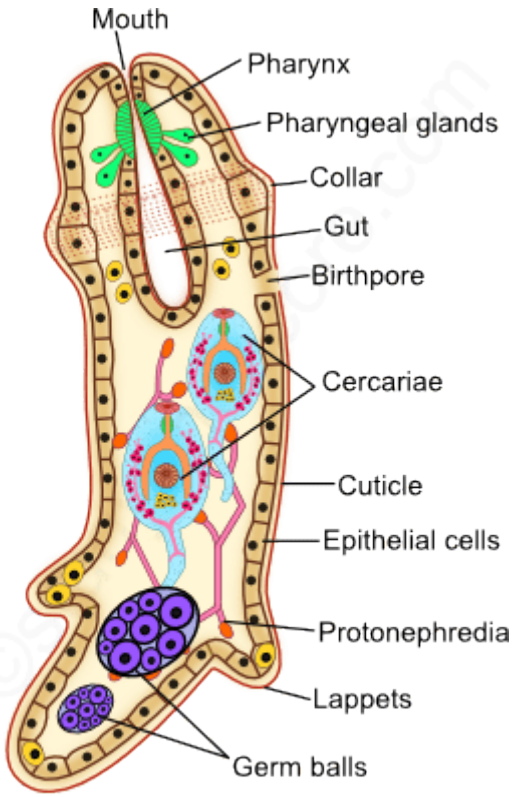



FASCIOLA- SPOROCYST LARVA

The protonephridia of both the sides divides into two flame cells which finally open out through a common excretory pore. This larva moves about in the host tissue absorbing nutrition. The germ balls present in the sporocyst further develop in to the next larva form called as Redia.

**Redia larva**

The germ balls present in the sporocyst larva develop into redia larva. The redia larvae come out of the sporocyst by rupturing its body wall. Redia larvae are elongated and cylindrical structures. They have mouth at the anterior end, also a ring of collar cells along with the birth pore are present at the anterior end. The body wall of this larva consists of cuticle, circular, longitudinal muscles and sub-epithelium. The mouth leads into pharynx which further leads into intestine lines by single later of cells. Numerous pharyngeal glands open into pharynx. Protonephridia are highly branched and all the flame cells open out through a common excretory pore. The body of this larva is packed with germ balls and mesenchyme cells.



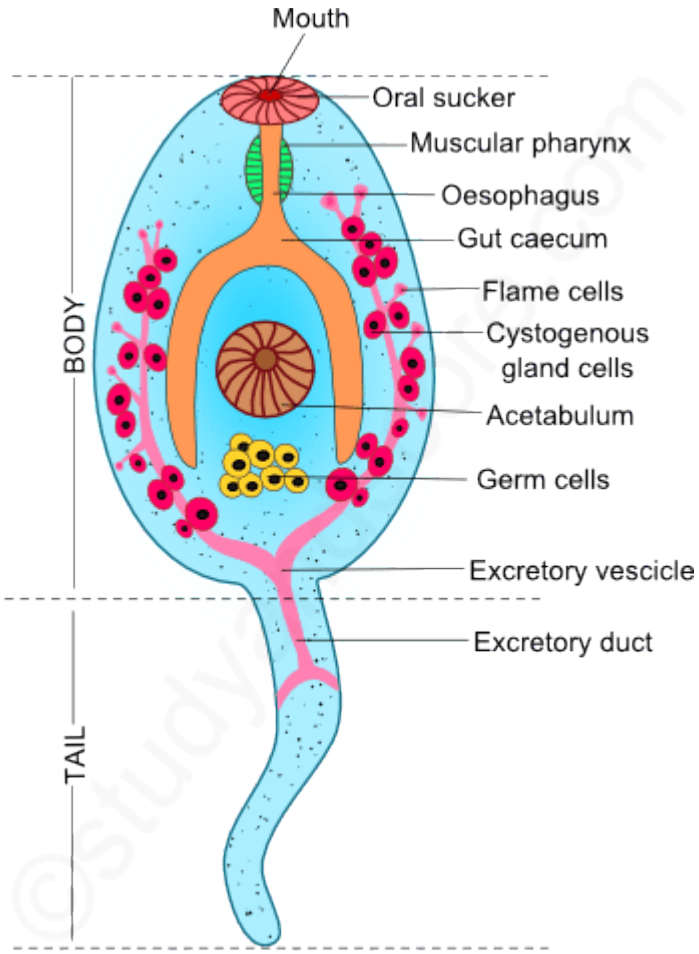
FASCIOLA- REDIA LARVA

Redia larva moves and feed through the host tissue. The movement of this larva is brought about by the muscular contractions assisted by collar and lappets. This moving redia larva prefers to move into the digestive glands. During summer, when sufficient nourishment is available, the germ balls of this larva give rise to second generation of redia larvae. And during winter season, the germ balls of rediae of second generation develop into next larval stage called as Cercaria larva.

**Cercaria larva**

Each of the Redia larvae of the second generation gives rise to around 20 cercaria larva. They leave the body of redia from the birth pore present at the anterior end and then enter the digestive glands of the snail. Cercaria larva is oval in structure with a long and simple tail. The tail helps in swimming movement of this larva. The body layers are much similar to the previous two larval forms. Cuticle has backwardly directed spines. Body wall consists of numerous cystogenous gland cells which secrete cyst for the next larval stage.

Mouth leads into pharynx, followed by oesophagus and intestine. At the lateral zones, numerous flame cells are present, these open into a pair of excretory tubules which further unite to form an excretory vesicle. Groups of germ cells lie in the body which represents the rudiments of adult genital system.



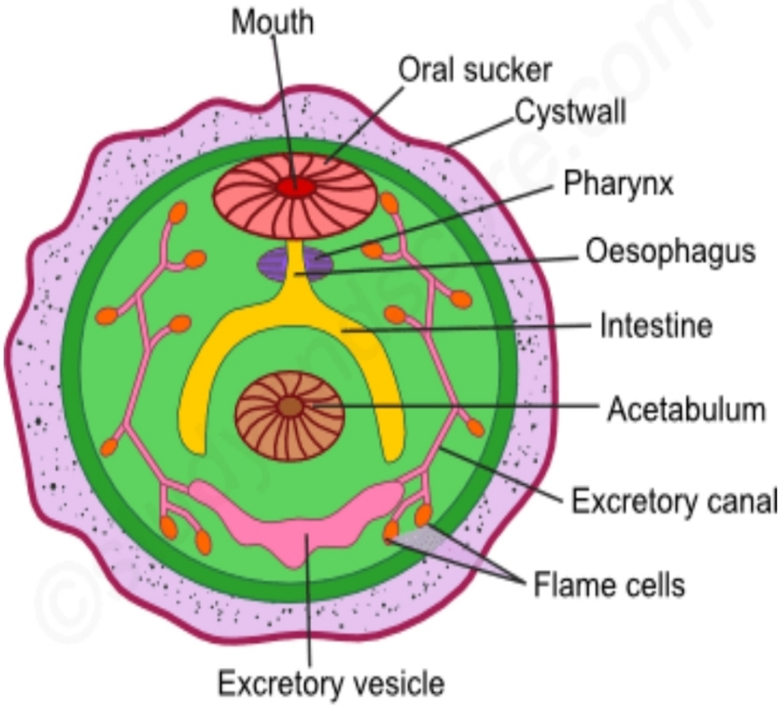
FASCIOLA- CERCARIA LARVA

A matured cercaria larva makes its way out of the host tissue, migrates to the pulmonary sac and then from there it escapes in to the surrounding water. After the entry of the miracidium larva into the body of the snail, it takes almost about 35-65 days to exit as cercaria larva.

The cercaria larva swims about in the water and gets attached to grass blades or other aquatic plants. After some time this larva loses its tail and gets encysted to form Metacercaria larva.

**Metacercaria larva**

The thick, hard and whitish cyst of the metacercaria larva is secreted by the cystogenous gland cells. After the secretion of the cyst these gland cells degenerate. This encysted larva must be ingested by the primary host again. If an uncysted larva is ingested by the sheep they would be digested by the acidic action of the sheep's gastric juice.



FASCIOLA- METACERCARIA LARVA

Metacercaria larva has rounded structure. This larva is a juvenile fluke also called as marita. This larval form has large number of flame cells. The cyst of this larva also protects it from desiccation.

# LIVER ROT DISEASE

When sheep are infected by the liver fluke or Fasciola hepatica, the liver of the sheep is seriously affected in terms of the structure and function. A single sheep may accommodate around 200 adult flukes in its liver and as a result the liver may stop to function. Consequently liver rot occurs. For this reason, this disease is known as liver rot or Fascioliasis.

**Infection**

The vertebrate host (Sheep, goat etc.) may catch the infection by grazing on the grass and leaves which have metacercaria larva attached to them. On the other hand the invertebrate host (snail) acquires the disease when a miracidium larva established contact with the suitable part of the snail body.

**Pathogenesis**

The infection in the invertebrate host results in the partial or complete destruction of the effected site (liver or gonads). Heavy infection may result in the increase in size of the snail.

The infection in the primary host is of major economic importance. In the sheep the bile ducts and the liver are damaged. In bile ducts it causes inflammation resulting

in the loss of epithelium and gall stones. Also the normal metabolism of the liver is affected by heavy infection. The infection if the sheep is called as liver rot or Fascioliasis.

**Symptoms**

The symptoms of liver rot include,

- Decline in appetite
- Anemia
- Irregular rumination
- Fever
- Increase in respiratory activity
- Conjunctiva becomes whitish-yellow
- Wool becomes dry, brittle and finally falls off
- Finally it leads to the death of the infected host

Also in some cases the parasite may escape out through the faeces and there are chances that the host recovers and survives.

**Treatment**

The treatment of this disease is not easy as it is not possible to introduce drugs into the bile passage of the infected sheep. Anti-helminth drugs namely hexachloroethane, carbontetrachloride, filcin, emetine hydrochloride, phenothiazine and tetrachloroethane are used for the treatment of the liver rot cases. These drugs are effective in killing the stages of parasite in liver.

**Prevention**

The control of the vector is the best method to prevent the disease. Also other preventive measures include the following:

- Separation and Killing of heavily infected sheep
- Destroying manure and eggs of infected sheep
- Feeding infected sheep with salt and little dry food.
- Also killing of the snail population would be effective. Snails are killed by adding copper sulphate solution in the ponds and ditches. Also ducks can be employed to eat on the snails.
- Humans can avoid the infection by thoroughly washing and adequately cooking the vegetables.

**FACIOLA PARASITIC ADAPTATION**

Liver flukes have undergone tremendous modifications both morphologically as well as physiologically to be able to suit themselves to their endoparasitic mode of life. The following are the parasitic adaptations of *Fasciola sps.*

1. A thick and permeable tegument is present in liver flukes. This tegument protects the animal from the enzymatic actions of the digestive juices of the host. On the other hand this tegument is permeable to water to be able to get the nutrients from the surroundings

2. Absence of locomotory organs as they are not needed by the animals. Some of the free swimming larval forms like miracidium has cilia which help in movement
3. Alimentary canal is without anus as there is no undigested food to be egested. Branched intestine helps in distribution of the digested food to all parts of the body
4. Oral sucker, acetabulum and spines of the body wall of the adult worm serve as the organs of attachment to the host tissues
5. The adults lack, circulatory system, respiratory system, sensory organs as they are not necessary
6. Nervous system is poorly developed as it is not completely utilized. But free swimming miracidium larva has sensory eye-spots
7. Respiration is anaerobic type, due to the lack of free oxygen
8. Of all the body systems, reproductive is well developed. It produces enormous number of eggs to increase mortality as their live is prone to several hazards
9. Egg shells of these animals are resistant to protect the developing zygote from unfavorable environmental conditions
10. Self-fertilization is ensured by hermaphroditism even in the absence of another companion for copulation.