Parasitic Adaptations

- The survival of the parasite in the body of the host depends upon its ability to adapt to the surrounding environment at the side of its infection, this is called microenvironment.
- To adapt to this microenvironment, certain morphological, anatomical and physiological changes occur and because of which the parasite survives in the host. Such changes which facilitate a parasite to adapt to parasitic mode of in the host itself are called parasitic adaptation.
- In order to lead a parasitic life complete or partial degeneration or loss of organs have taken place in the body of parasites. Such degeneration are found especially in those organs which are of little or no use to the parasite.

Different types of parasitic adaptations are as follows:

1. **Body shape and size have changed**

   In ectoparasites:

- The body shape is laterally compressed, allowing easy movement through hairs and feathers
  e.g. flea

- The body shape is dorso-ventrally flattened for clinging tightly to body surface
  e.g. tick, louse, bed bug

- Length…shortened (generally)

- Segmentation……reduced or almost disappeared.

e.g. *Ergasilus*…….segmented
e.g. *Argulus*……reduced
e.g. *Scabies*……almost disappeared

In endoparasites:

- Length/size and shape

Gastrointestinal parasites are usually long
e.g. *Taenia saginata* 4-12 m
e.g. *Ascaris lumbricoides* 15 cm
e.g. *P. equorum* 30 cm

Intracellular parasites are very small
It is not different from free-living form
e.g. Cryptosporidium sp. oocyst-cyst….2-6 µm

Hepatophagic parasites are moderately long.
e.g. *Fasciola hepatica*…. 3.5 cm
e.g. *F.gigantica*…. 7.5 cm

- ***Tetrameres*** show sexual dimorphism. Males live on the mucosal surface of the gland-proventriculus (that's why, it is slender), females are embedded deep in the mucosal gland-proventriculus (therefore, it is oval/spherical)
- Parasitic **copepods** (crustacea) in fish (1-3 cm) is bigger than free-living copepods (1-2 mm).

Parasites found **in the blood vessels** are slender and elongated.
e.g. *Schistosoma* sp. …..2 cm

- Body is segmented
  e.g. **Cestoda, *Linguatula serrata*** (transversely striated)

2. Digestive system has changed

- The gut of **arthropod** is a simple tube (from mouth to anus).
  They feed with blood. e.g. Mosquito, bed bug, flea, tick.
- The nutrition of parasitic **protozoa** usually occurs pinosytosis and phagositosis (in tissue/organ in which he lives) e.g. *Trypanosoma*, *Leishmania*

- In all **tapeworms** (missing), digestive system is absent. Tapeworm attach to the hosts intestinal wall and absorb digested food through the tegument. All adult tapeworms are covered with numerous microvilli. They rob the host nutrients. The parasites maintain osmotic pressure of their body fluid approximately same or slightly less than that of the environment in which they live inside the body of their host. This facilitate them to absorb the nourishment from the general body surface. Osmotic equilibrium also, prevents the disturbing exchange of water.

- **Nematodes** feed with different type of nutrients (mucosal fluid, products of host digestion mucosa, blood, cell debris, blood). It has mouth opening/buccal cavity, esophagus, gut, anüs. So, modification of mouthparts is seen like buccal capsule, teeth, cutting plates. E.g. Hookworm parasites burrow their buccal capsule into the mucosa of intestine.
- **In trematodes** (blind ending), have mouth and gut, not anus. Undigested material is regurgitated from the mouth. E.g. *Fasciola* sp.

- Each of the **larval stages in trematodes** (miracidia, sporocyst, rediae and cercaria) as well as the adult worms show modifications of the tegumentary surfaces.
- Sporocyst has no mouth or gut (it uptakes from snails's body walls with microvilli).
- Most rediae have a mouth and gut. Nutrients can be absorbed via the body wall.
- Cercaria is motile and non-feeding phase, most usually swim using a tail in order to reach the next host in the life cycle.

3. Attachment organs have occurred: To remain at the specific site, parasites attach to the surrounding tissues. For this purpose, all the parasites have adhesive structures like rostellum, hooks, suckers, bothria, polar filament or/and adhesive disk etc.

- **Suckers**:

Trematodes….e.g. *Fasciola* are equipped with suckers (2 or three/ oral, ventral, genital sucker) There are two suckers, an anterior sucker surrounding mouth and a large ventral sucker.

Cestodes…….e.g. *Taenia saginata* (4 suckers on the sides of the scolex=head). Front end with scolex and with adhesive organs . Rostellum with armed or without armed (*T.solium* and *T.saginata*, respectively).

Crustacean ….*Argulus* (fish louse) ….two suckers, various hooks, barbes. It uses to attach itself to the fish.

Leeches can suck blood between 5-15 ml.
For treatment of arthritis, vasculer diseases, diabetes, high blood pressure, migrain etc.

Leeches have two suckers at the ends of their body (anterior and posterior). The bite of leech is not painful as it releases an anaesthetic to prevent the hosts from feeling them.

➢ Hooks:

The cestodes and monogenic trematodes bear hooks and spines as organ of attachment.

Cestodes……..*Taenia* sp. (scolex)….Rostellum with armed or unarmed

Taenia solium is equipped with **rostellum, hooks and suckers.**

Acanthocephala…….. (proboscis)

Monogenic trematodes…..*Dactylogyrus*, *Gyrodactylus*

Arthropod

Ergasilus….2 large antennae with claws

Lernaea…. A large anchor (2 pairs of horn-shaped)…known **anchor worm**

Argulus….2 sucker (sucking disk)…..known **fish louse**

- **Polar filaments: Myxosporidia (protozoan)** have polar capsules and polar filament. Filaments in polar capsule are attachment organs
- **Adhesive/sucking disk: Giardia (protozoan)** bears adhesive disk to adhere to surface of intestinal cell.
- **Bothria: Diphllobothrium latum**…(2 longitudinal grooves)

4. Nervous system has changed: Reduction of unnecessary sensory organs and locomotor organs in adult stage. Not required as they live in protected, optimum conditions. Since the parasite reside in the host body where they live well protected and nutrition readily available, there is no need to move.

- **Endoparasites** have no sense organs. Nervous system is simple. They have ganglion/nerve ring and nerves. Endoparasites live in a well protected and more or less stable environment inside host (in permanent darkness). There is no need of complex form of nervous system consequently, the photoreceptor organs (eyes) and other sense organs have completely lost. The central and peripheral nervous system have also reduced considerably as compared to the other free living species of the same class.

- **Arthropods** have a complex nervous system associated with the well developed a sense organs, such as eyes, anntennae. Nervous system is not simple. The central nervous system consists of a brain in the head which is connected by a pair of ventral nerves which run around in the gut to a series of ventral nerve cord ganglia. The most common sense organs are hairs, bristles and setae (in antennae or legs)

5. Excretory system have not much affected* It is very primitive.

- **Trematode** ….proto-nephridium (a large number of ciliated flame cells, which push waste metabolic products along tubules, which finally join and open to the outside).
- **Cestode**….as in the trematoda, it is composed of flame cells leading to efferent canals, which run through the strobila to discharge at the last segment
- **Nematode**……..is very primitive, consist of 1 or 2 renette cells, the canal within each lateral cord joining at the excretory pore in the oesophageal region (two longitudinal canals).
- **Protozoa**…metabolic products are excreted by diffusion through the cell membrane

6. Respiratory system have changed

- **Aerobic type** (If oxygen is available….aerobic respiration): the amount of oxygen may very high (lungs).
  e.g. *Paragonimus westemanii*
- **Anaerobic type** (If oxygen is absance….anaerobic respiration): The availability of oxygen is very rare.
  e.g. *Taenia* sp., *Entomoeba histolitica*, *Fasciola* sp.
- Respiration is mostly anaerobic in protozoan
- **Both aerobic and anaerobic type** are relatively less.
  e.g. *Ascaris lumbricoides*

7. Movement organs have degenerated : Locomotor structures almost absent in the parasitic forms, as they don't need to move in search of food.

- **Louse, flea, bed bug** are wingless, but this is an adaptation to the parasitic life style. Lice is thought to be derived originally from winged ancestors.
- Legs in ***Sarcoptes*** (scabies) are short and not usually visible viewed dorsally.
- **Pentastomida** has two pairs of leg-like appendages at the extremity of the thick anterior end.

8. Reproductive ability has increased (Reproductive system)

- Since there is low chance of eggs and larvae reaching the definitive host the parasite have enormous fecundity, producing large number of eggs. Reproductive potential of parasites is very high. May produce large amounts of eggs /larvae.
  - *T. saginata* lays about 600.000 eggs/day.
  - *F. hepatica* lays about 10.000 eggs/day.
  - *A. lumbricoides* lays about 200.000 eggs/day.
  - Tapeworms lay millions of eggs each day.
  - *Entomoeba histolytica* produce 50 million cysts and they pass in human feces. Amoeba occurs after ingestion of cysts in fecally-contaminated food, water. The cysts can survive days to weeks in the external environment

- Fertilization occurs in the ootype of parasite. To overcome the problem of reaching the mate, the **trematodes** and **cestodes** have achieved **hermaphroditism** and exhibit the **self fertilization.** Each proglottid (tapeworm) / each parasite (trematode) of the body bears hermaphrodite sex-organs.

- **Hermaphrodism**

This is a form of sexual reproduction. Some parasites don't have seperated sexes. Trematode/cestode has one or two sets of reproductive organs. Each cestode (proglottid) is hermaphrodite with **one or two sets of reproductive organs**. Both cross-and self-fertilisation may occur.

Trematodes…*Fasciola sp*... Both cross-and self-fertilisation between parasites may occur.

Cestodes…*T.saginata*…one set of genital organs / *D.caninum*…two sets of genital organs). Both cross-and self-fertilisation between proglottids may occur.

- To overcome the problem of reaching the mate in some nematodes, male and female worms are **permanently in copulation forming a Y shape** (*S. trachea* in trachea).
- Male carry the female parasite **in the gynaecophoric canal** of its inside the body (*Schistosoma* in blood vessel).
- There is **asexually reproduction** in larval stage of some parasites: This process called as **polyembryony** occurs in a few trematodes and cestodes. In addition to the production of enormous number of eggs, there will be multiplication of larval stages resulting in the production of several infective forms. The life cycle of **trematode** includes five larval stages (**miracidium, sporocyst, redia, cercaria** and **metacercaria**). Of these, sporocyst exhibits polyembryony producing a number of rediae and then redia exhibits polyembryony producing a number of cercariae. Thus, the life cycles of endoparasites are very complex.

- *E.granulosus* (**cestode**) includes one larval stage (hydatid cyst) in the life cycle. One egg produce only one cyst in IH. But, one cyst produce thousands protoscolex (polyembryony). When the cyst is ingested by the final host dogs, each protoscolex form occur a new adult form.

- *Fasciola spp*. (**trematode**) includes 5 larval stage (**miracidium, sporocyst, redia, cercaria** and **metacercaria)**. But only sporocyst and redia forms produce a lot of new larvae forms (polyembryony).

9. Colour has changed

Ectoparasites are usually colourless
Endoparasites are generally white-yellow colour

- They are usually yellowish-white (e.g. ***Taenia* sp., Ascarid**)
- Some are grey-brown in color. Food, generally blood or tissue debris, is ingested and passed in to the caeca (e.g. ***Fasciola* sp.**)
- ***D. dendriticum*** is more transparent. Uterus contains dark brown eggs. That's why it is grey-brown in colour.
- ***D. renale*** is dark red in colour
- ***Acanthocephala*** worms are slightly pinkish in colour when fresh
- **Hookworm** is redish in colour, depending on whether the worm has fed

10. There have morphological changes in the egg. Shape of eggs has changed.

- When the female lays eggs, **louse** eggs are glued to the hair or feathers

For the eggs are not dispersed around the environment

- **Schistosoma eggs** are spindle-shaped and contain a spine, so eggs forced to find their way through small venules to the epithelium and lumen of the gut, bladder.