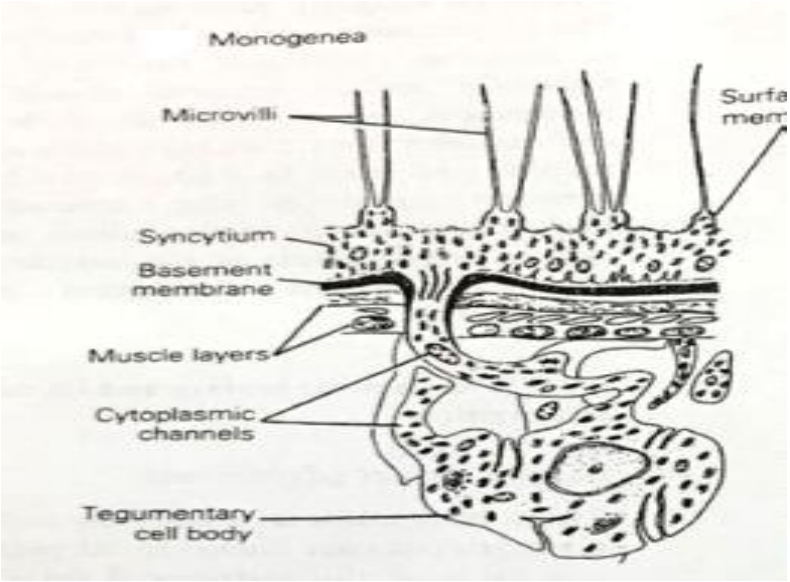
**Class: M.Sc.**
**Semester :IV ( Parasitology)**
**Course : XV A Physiology & Biochemistry of Parasites**
**Unit : 2a**
**Prof.H.S.Singh**

# External surface and Nutrition in Parasites

External body surface of parasites forms a potential nutrition interface between host and parasite. In parasitic groups, Cestodes and Acanthocephala where alimentary canal is absent external body surface forms the absolute site of nutrient uptake. Moreover, surface of all parasites with exception of Nematodes plays a significant nutritional role.
Before going into details of nutritional uptake, we must know the structure of the general body surface.

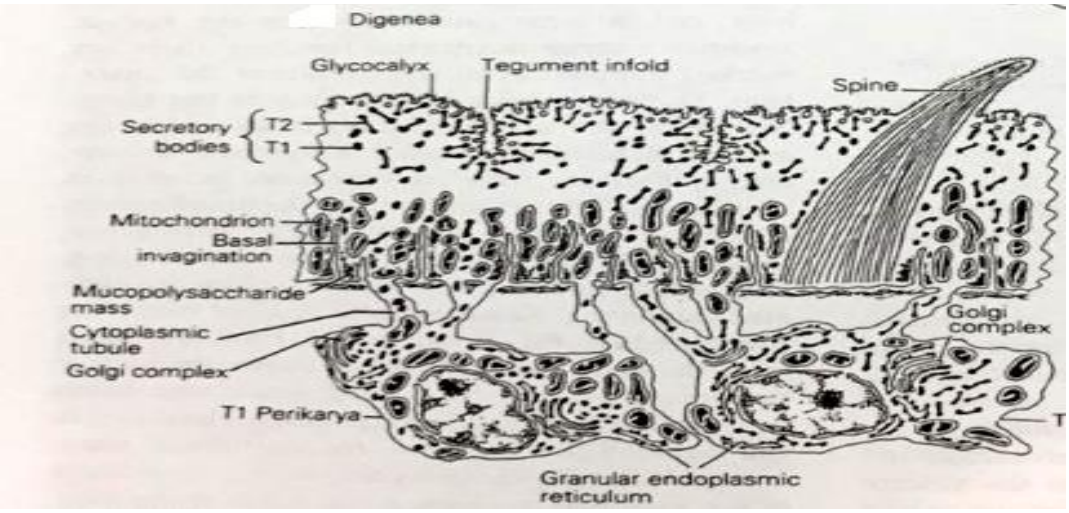
**Monogenea**
Until development of electron microscope it was believed that external covering of platyhelminth is made up of cuticle which is impermeable. Now it is a practically established that external covering of worms is metabolically active syncytium, now called as tegument from which cell bodies sunk deep into the underlying parenchyma of the worm. Externally it is bounded by plasma membrane which is thrown out in the form of microvilli. The outer syncytial layer rests upon basement membrane beneath which there is layer of circular muscles, longitudinal muscles and paranachyma.



**Digenea**

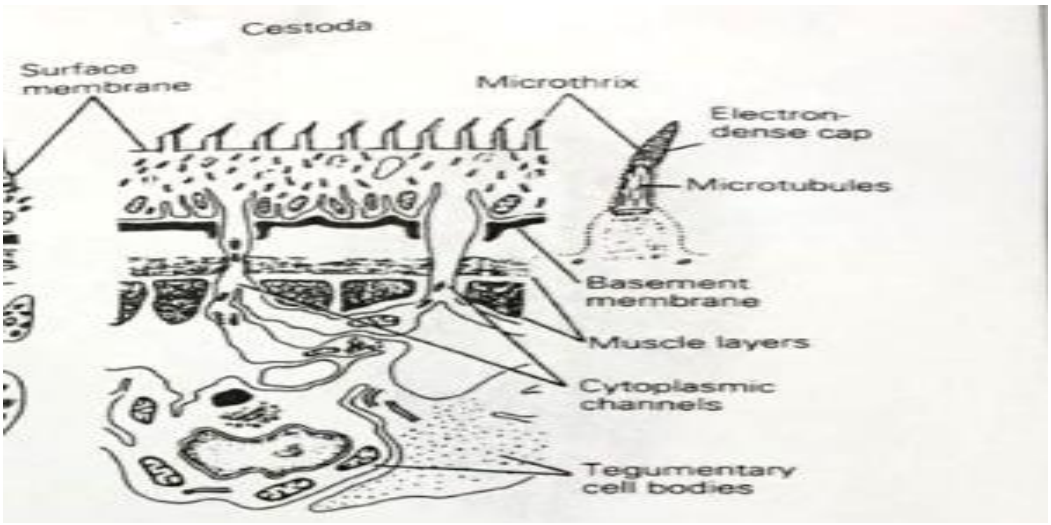
In general it is more or less similar as seen in case of monogenea but it differs in following points-

1. It is not provided with microvilli
2. In some digeaneans there are back wordly directed spines which are externally bounded by plasma membrane.
3. Cell bodies are more in number.
4. Cell bodies are communicated with syncytial layer with more than one cytoplasmic channel.




**Cestodes**

In cestodes basic structure remains same like that of monogenea but externally it is provided with numerous tough microvillus called microtrichae. It is reported from all groups of cestodes. Morphologically these microtrichae exhibit polymorphis not only in different genera and species but in different proglottids of same individual. Microtrichae of scolex and neck regions are small,mature regions are large and well developed and in gravid proglottids they are found degenerating. The mircotrichae are tough as they are supported with microtubules wich are arranged in 3 tiers (9+7+2). These microtubules help in translocation of nutrients. The tip of these microtubules are electron dense ( because it deflects the electrons being negative ). The function of this electron dense tip is still obsecure.

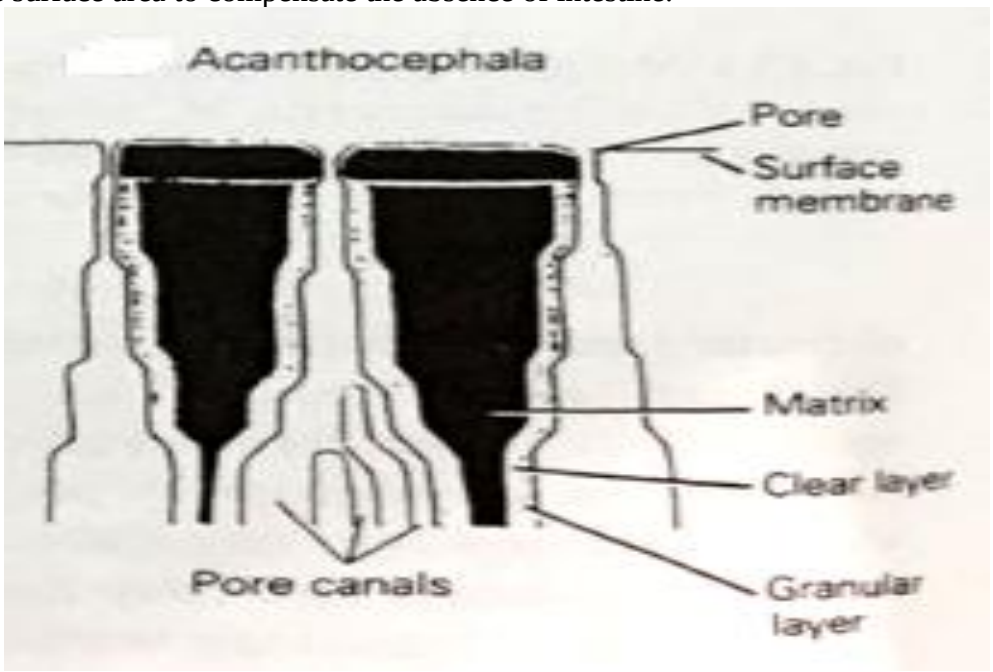



**Acanthocephala**

Body surface of acanthocephalans is considerably different from platyhelminths. It comprises of five distinct layrs

1. Epicuticle – external most, thin and made up of mucopolysaccharide.
2. Cuticle –outer striped layer, fibrous layer and inner radial layer
3. Basement membrane

The surface region or body wall is syncytial and metabolically active and is characterized by presence of nuclei, mitochondria, ribosomes and folded plasma membrane. Besides this it i s also rich in glycogen and other organic materials. The most interesting feature of acanthocephalan surface is presence of numerous pores distributed through out the body and lined by plasma membrane. They penetrate through cuticle and are branched too in order to increase the absorptive surface area to compensate the absence of intestine.

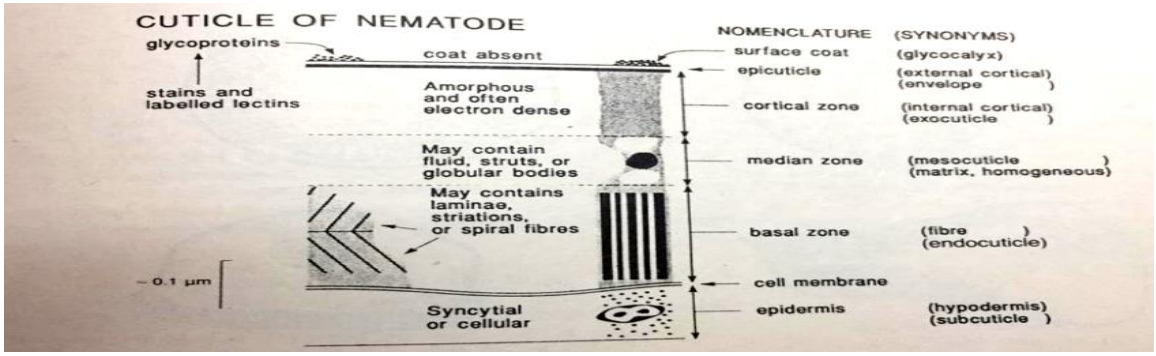


**Nematoda**

Body wall of nematodes consists of –

a. Cuticle
b. Epidermis ( = hypodermis )
c. Muscle layers

There is no evidence to suggest that nematode cuticle function as site for nutrient absorption. However, entomopathogenic nematodes are known to absorb nutrients through general body surface.




# Transtegumentary absorption of nutrients

Study of the functional morphology makes it clear that in some helminthes specially in Monogenea and Digenea, alimentary canal is involved in digestion and abosption. But the study of enzyme profile of the alimentary canal establishes that it has very limited potential of digestion. In case of *Schistosmia mansoni* there exists a single proteolytic enzyme. One can reasonably question about the precise origin of free amino acids for the synthesis of somatic proteins. Although at present there is no good answer but transtegumentary absorption plays important role in it.

**Mechanism of Solute Entry**

Various studies were performed to understand the absorptive mechanisms employed by parasites.Chppel ( 1983 ) made a comprehensive review of these studies and found that various mechanisms used by parasites are-

1. **Simple Diffusion**

   In the process of **diffusion**, a substance tends to move from an area of high concentration to an area of low concentration until its concentration becomes equal throughout a space. It obey Fick's law Which states that rate of diffusion is directly related to the concentration difference on either side of the membrane.

   dn/dt = DA. dc/dx

Where dn/dt is the number of solute molecule ( dn ) moving through membrane with surface area A in the given time ( dt). Dc is difference in concentration across membrane and D is coefficient of diffusion. This type of transport remains unaffected by other slute or metabolic poison and it also does not require energy to carry it on.

2. **Facilated Diffusion**
   Facilitated **diffusion**, also called **carrier-mediated** osmosis, is the movement of molecules across the cell membrane via special transport proteins that are embedded in the plasma membrane by actively taking up or excluding ions. Parasitologists use to call these molecules site or locus. Now a days it is also called as permiases. It is of three types- uniport ( alow movement of one solute molecule at a time ), symport (transport and conter transport of many molecules at a time) and antiport 9 transport of solute in one direction only).This type of transport requires energy many times,faster as compared to simple diffusion and can be inhibited by many chemicals and metabolic poisons.
3. **Active Transport**
   In cellular biology, active transport is the movement of molecules across a membrane from a region of lower concentration to a region of higher concentration—against the concentration gradient. Active transport requires cellular energy to achieve this movement. It requires energy and can be arrested by metabolic poisons.

4. **Pinocytosis**

| |
|---|
| I have already taught it in detail while dealing with innate immunity |

**Transport Of Macromolecules**

Although these four different types of mechanism has already been worked out and there may be some more waiting be discovered but one should bear in mind that some times more than one mehasnism is used for the import of just a single substance.

1. **Carbohydrate Transport**
   Absorption of carbohydrate has been studied in nly few parasites of different groups-
   Haempflagelates- *Trepanosoma lewisi,T.equiperdum and T. gambiense*
   Digenea- *Fasciola and Schistosoma*
   Cestodes- *Hymenolepis,Taenia Calliobothrium*
   Acanthocephala- *Polymorphus, Moniliformis*
   Nematodes- *Acaris and Trichura*
   In most of these cases carobydrate is absolved through simple diffusion and active transport however absorption by solvent drag has also been observed. In fasciola facilated diffusion has been in case of absorption of fructose mannose and glucosamine

2. **Amino Acid Transport**

   Unlike carbohydrate amino acids/ proteins are not energy giving substrate but in body of parasites it is essentially required for two reasons-

   - For maintenance and repair of body and worn out tissues.
   - Heliminths have to produce large number of eggs which also need handsome quantity of protein.

Since de novo synthesis of protein in helminth body is not possible ( ? ) thus they have to absorb it from host body. Several studies were performed to understand transtegumentary transport of amino acids. It was found that the absorption of amino acids by tegument takes palace either by simple diffusion ( which is limited to few amino acids only) or by career mediated transport. In case of *Hymenolepis* at least six kinetically active loci has been identified. Four of these loci use to bind with neutral amino acids. Some amino acids viz., alpha aminobutyric acid and cycloleucine are absorbed by active transport thus they are accumulated against concentration gradient.

Another important thing which was noticed in the absorption of amino acids. In mammals and other animals it is seen that they use to absorb L amino acids only as they have enzyme system only. But most of the helminth use to absorb both l and D amino acids. Pappas and Read ( 1995) explained that-

1. Helminth have enzyme system which metabolises both L and D amino acids.
2. They also opined that since D amino acids go waste in the host body thus parasites have adapted themselves to capitalize this waste.

3. **Lipid Transport**

   Not enough studies were conducted to understand lipid absorption and transport but it is very much clear from the studies performed so far that helminthes do not synthesise long chain fatty acids in their body and they depend on host for their supply. The detail studies reveal that in helinths ( Hymenolepis ) there are two distinct systems for fatty acid trans tegumentary transport

   a. Acetate site for the transport of short chain fatty acids ( C2 – C8)
   b. Palmintate Site for the transport of long chain fatty acids ( C14-C24 )

Rate of absorption by acetate site is four times faster than Palmiatate site.

4. **Purine and Pyrimidine Transport**

   This transport has not been a point of intrest to the parasitology as so far it was studied only in *Hymenolepis diminuta*. As far transport on these nucleotides are concerned it takes place by careear mediated diffusion. There exists 3 loci for their transport-

   ( i ) Thymine –Uracil site

   ( ii ) Hypoxanthine 1 ( Transports adinine and Guanine )

( iii ) Hypoxanthine 2 ( Transports Hypoxanthine )