**Establishment and growth of parasites**

After locating and gaining entry into a suitable host, whether by active or passive means, the parasite becomes established and grows either to maturity or to a larval stage whose continued development occurs in the next host. Establishment and growth require a complex series of physiological conditions to be met. These are summarized as:

• Physiological barriers include (pH, temperature. pCO2. PO2,osmoticpressure,RH,nutrientavailability,hatching and excystation).

• Biotic barriers (host defense, phagocytes, nutrients, maturation signals, migration signals,…).

**Hatching and excystation:**

Many parasites enter their hosts encapsulated either within egg membranes or within cysts. Such parasites enter the host via the alimentary canal, within which organ system they must become activated and liberated from their capsules before any further development can take place. This applies to oocysts and other cysts in the Protozoa, metacercarial cysts in the Digenea, eggs and a variety of cysts in the Cestoda, eggs and ensheathed larvae in the Nematoda. It is worth noting that not all parasites acquired through ingestion are encapsulated; many parasite larvae are found free in the tissues of a host animal that is eaten by the next host (e.g. metacercariae of several digeneans, pseudophyllideanprocercoids and pleocercoids(Diphyllobothrium) and many nematode larvae.

**(a) Protozoa**

Activation and excystation of protozoan cysts has been examined using only a small range species in vitro. It is generally found that optimum conditions include elevation of the ambient temperature to the appropriate level, employing a medium of neutral pH, high pO2 and containing reducing agents. Activation of encysted parasite may be a process distinct from excystation; the formoer depending particularly upon a high pCO2(stomach) and the latter requiring the action of proteolytic enzymes(small intestine and duodenum).

In the coccidia, excystation of the sporocyst after release from the oocyst may involve the breakdown of a localized region of the cyst wall the Stieda body. This is affected by the action of bile and trypsin (e.g. Eimeria and Isospora). Some species lack(without) a Stieda body and excyst following the action of proteolytic enzymes on the entire sporocyst wall.

* Describe coccidian excystation with draw

**(b) Digenea (need 2 host)**

The eggs of the majority of digenea hatch in water under suitable environmental conditions; temperature, salinity and light are the major factors(schistosomes).

The metacercariae of many digenea are enclosed within cysts of varying wall architecture and dimensions. Where cyst walls are particularly thin excystation is brought simply by elevation of the temperature (if the host is a bird or mammal). Metacercarial cysts of more complex structure require, in addition, serial treatment with pepsin and trypsin. Excystation in some species (e.g. Fasciola hepatica) involves the action of bile salts. In general metacercariae are activated by temperature, high pCO2 and, perhaps, bile salts, while excystation is brought about by proteolytic enzymes of exogenous(from the host) and, possibly, endogenous(from the parasite) origin.

**(c) Cestodas**

Although many tapeworm eggs hatch in the external environment on receipt of suitable stimuli, those of the cyclophyllidea hatch in the alimentary canal of the host (invertebrate and vertebrate) after oral ingestion. The cyclophyllidean egg has a thin outer capsule but the oncosphere larva is enclosed by a thick protective embryophore; this is especially thick in the Taeniidae(T.saginata and T.solium), Hatching of some cyclophyllidean eggs (e.g. Taeniidae) is normally a biphasic process:

1-The hexacanth larva is activated, it disrupts the oncospheralmembrane(embryophore) and

2-Host proteolytic enzymes digest the outer capsule.

In non-taeniids(H.diminuta of rat) hatching is largely a mechanical event dependent upon the action of the host mouth parts; hatching of these eggs in vitro can be accomplished in simple physiological saline. Hatching of the taeniid egg depends upon the presence of either pepsin (*Taeniasaginata*) or pancreatic juice (*T. pisiformis*). Bile salts are probably responsible for activation of the larval tapeworm.

Excystation of cestodes’ cysts always takes place in the alimentary canal of the vertebrate definitive host. Normally, pepsin, trypsin and bile salts are required for this process (e.g. H. diminuta), though some species require pancreatin (e.g. Echinoccoccusgranulous).

**(d) Nematoda**

The eggs of many nematodes hatch in the external environment to release infective larvae (e.g. *Ancylostoma*). Upon receipt of the environmental stimuli (water, temperature, PO2), the enclosed larva liberates digestive enzymes whose action may facilitate the uptake of water by the egg: hatching, may therefore be due to an increased pressure within the egg (e.g. Trichostrongylus).

The eggs of many species of parasitic nematodes hatch only after ingestion by a suitable host (e.gAscaris, Toxocara). Ascaris eggs hatch in vitro 37˚C in a medium with a high pCO2, neutral pH, and reducing agents,. The larva within the egg is stimulated to produce a hatching fluid, comprising enzymes capable of digesting the chitin layer of the egg shell.

Exsheathment of trichostrongyles larvae, enclosed within the cuticle of the second ecdysis, takes place in the alimentary canal of the host and in vitro under the effect of CO2, HCO3 (bicarbonate, which plays a crucial role in the pH buffering system) and reducing agents, at neutral pH and at the appropriate temperature: suitable stimuli induce production of exsheathing fluid by the larval parasite, which is thought to contain proteolytic enzymes.

**The role of bile in parasite establishment**

Sheet Question

Bile, a complex mixture of organic acids, is released into the upper small intestine of vertebrates through the opening of the bile duct. Bile saltsare of considerable importance to the establishment and development of parasites both of the alimentary canal itself, and to those of other regions of the vertebrate body that enter the host via the mouth. The effects of bile salts on parasites include

1. effects of membrane permeability,
2. initiation of activation of encysted larvae,
3. lysis of parasite surfaces,
4. synergistic action with host digestive enzymes and
5. metabolic effects.

In addition, bile salts can affect both establishing and established parasites. Experimental cannulaiton of the bile duct of rats infected with *Hymenolepisdiminuta* causes a reduction in size and fecundity of the parasite; cannulation of the bile duct before infection prevents the establishment of the tapeworm.

* Bile salts are involved in both activation and excystation of many cystic stages of parasites including protozoans (e.g. Eimeria), digencans (e.g. Fasciola), costodes. The physiology of these mechanisms is poorly understood (very complex).

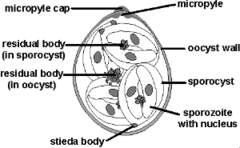
**Migration and selection** Leishmania and Schistosomacercariae

Once within the body of the host, the majority of parasites migrate away the point of entry to a preferred target organ or microhabitat. Migrations of this type are ontogenetic (normal migration) since they are normally accompanied by growth and development of the parasite. They may finish in a sexually mature adult parasite or a ‘mature larva; in either case the migration over a fixed route is mandatory for normal parasite development. The physiological determinants of these often highly complex patterns of migration are not well documented. It is probable that sequential stimuli from the host are recognized by the migrating parasite and assist with the determination of the precise migratory pattern. Aberrant ontogenetic migration may occur if a parasite enters an unsuitable host and cannot complete its normal development. Examples of this include cutaneous and visceral larva migrans. These are migratory larvae (e.g. ancylostomabraziliense and Toxocaracanis in man) that wander in the superficial and in the deep tissues (respectively) of the wrong host and eventually die. In such cases the host fails to provide the necessary physiological signals for normal migration and development to take place.

Other patterns of parasite migration within the host include diurnalmigration often associated with transmission and diurnal migration within the preferred microhabitat in a manner related to the nutritional physiology of the host. For example the rat tape worm Hymenolepisdiminuta,which migrates diurnally along the length of the host’s small intestine. It is postulated that the worm responds to various chemical gradients that develop in the rat intestine as a result of the normal feeding cycle, but the exact nature of the migratory stimuli has yet to be elucidated.

A basic feature of both ontogenetic and diurnal migrations of parasites is the ability of the parasite to recognize its where abouts within the host body. The sensory physiology associated with migrations and with site selection is virtually unknown, but it must be relatively sophisticated since ectopic parasitism is rare.

Eimeriaoocyst(tetrasporocysticdizoic)



Toxoplasma oocyst(disoprocystictetrazoic)

