UG CBCS Semester-I

Entamoeba histolytica

Apart from tree-living forms, certain amoebae lead a commensal or parasitic life in the intestine of man and other animals. The common parasitic genera are *Entamoeba*, *Endamoeba*, *Endolimax*, *Iodamoeba* and *Dientamoeba*. Of the species belonging to these genera, *Entamoeba histolytica* (Gr., entos, within + amoeba, change + histos, tissue + lysis, dissolve), which is the causative organism of amoebic dysentery or amoebiasis in man, is undoubtedly the most studied of all parasitic amoebae.

Entamoeba histolytica was first discovered by Lambl in 1859, and its pathological nature was described by Friedrick Losch, a Russian zoologist in 1875. He discovered this protozoan in the faeces and intestinal ulcers of a dysentery patient and succeeded in transferring it to puppies.

Distribution and Incidence

Entamoeba histolytica is cosmopolitan (world-wide) in distribution, but greater in tropics and subtropics than in the temperate zones. It has been reported that incidence of infection is high Mexico, China, India and parts of South America. The incidence is considerably higher in rural and densely populated urban areas. Infants under a year old are rarely infected with it, while children and young adults are very susceptible to the parasite. It is estimated that 10% of world population is suffering from amoebiasis.

Habits and Habitat

Entamoeba histolytica is a microscopic endoparasite of man. It is commonly found in the upper part of the large intestine (colon) and is very often lodged in the liver, lungs, brain and testes. Parasitologists believe that this parasite lives as a harmless commensal but, for reasons which are unknown, it invades the mucosa and sub-mucosa of the intestinal wall and causes amoebic dysentery or amoebiasis. In a person suffering from this disease, the intestinal wall exhibits, in large numbers, minute ulcers which are formed as a result of the dissolution and destruction of the mucous lining of intestine. This is accomplished with the aid of a tissue-dissolving substance secreted by the parasite.

Morphology

Entamoeba histolytica is a small microscopic parasitic amoeba. In its life cycle, it occurs in three distinct forms: (i) trophozoite or magna form, (ii) precystic or minuta form, and (iii) cystic forms.

1. **Trophozoite or Magna.** Trophozoite of *E. histolytica* is also known as the trophic or magna form. It is the most active, motile and feeding form which is pathogenic to man. It lives in the mucous and submucous layers of the large intestine of man. It usually measures 20 to 30μ in diameter and, more or less, resembles the common amoeba in all structural details. The Outermost body covering or plasmalemma is a thin, elastic and semi-permeable membrane. The cytoplasm is differentiated into the outer clear and non-granular ectoplasm and the central more fluid and granular endoplasm.

   (a) Nucleus. Endoplasm contains a nucleus which is seldom visible in a living organism. After being fixed and stained, it appears as a vesicular structure 4 to 6μ in size. It is bound by a thin and delicate nuclear membrane, whose inner surface is encrusted with fine chromatin granules, arranged in a peripheral ring. In the centre of nucleus is a small dot-like endosome or

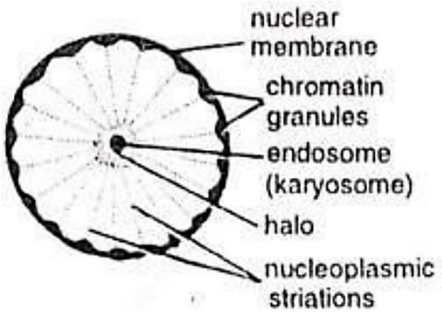

Fig. 2. *Entamoeba histolytica.* Vesicular nucleus.

karyosome, often surrounded by a clear area or `halo'. The fluid-filled space between nuclear membrane and endosome is marked by spoke-like striations of chromatin material.

Other inclusions of the endoplasm are food vacuoles that enclose the ingested red blood corpuscles (erythrocytes), white blood corpuscles (leucocytes), fragments of epithelial cells and bacteria. Contractile vacuoles are wanting in *E. histolytica* since it inhabits an isotonic environment. The osmotic concentration of its body protoplasm equals to that of the intestinal fluid of the host and hence no water enters the organism by osmosis. Thus, there is no need for osmoregulation.

(b) Pseudopodium. When moving, *E. histolytica* produces anteriorly a large, broad and blunt pseudopodium. Hence the parasite is typically monopodial (Gr., mono:, single + podos, foot). It is only at this anterior end that the outer clear ectoplasm is sharply differentiated from the inner granular endoplasm. With a single pseudopodium the trophozoitc moves with a forward-flowing movement. This resembles the crawling of a garden slug (Liman spp.) and hence the movement is sometimes called ‘limax-type movement'.

Nutrition in trophozoitc is holozoic. It feeds by phagocytosis. Food particles are engulfed at the posterior end, where plasmalemma is more sticky. Food particles adhere to it and plasmalemma is invaginated into cytoplasm carrying the food particles along with it. The invaginated plasmalemma now separates off from the main plasmalemma to become food vacuole.

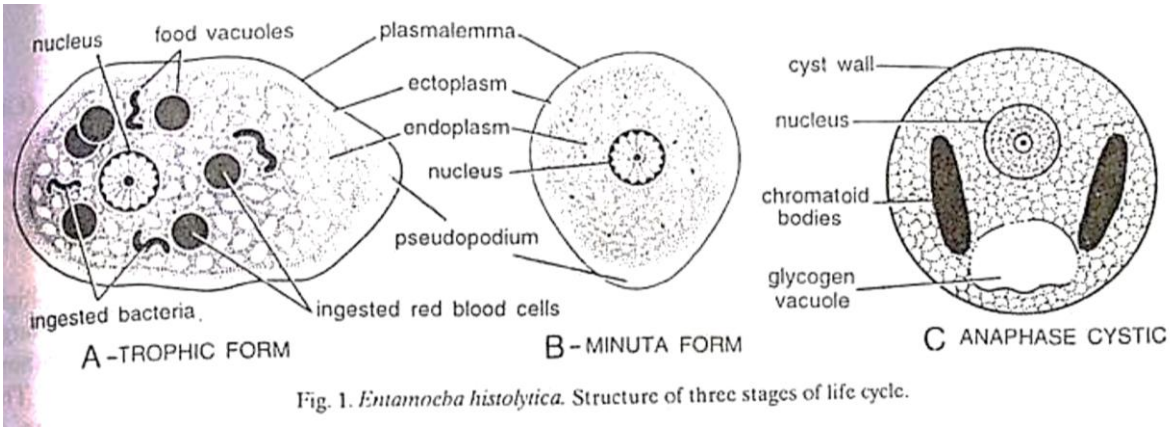

Fig. 1. *Entamoeba histolytica.* Structure of three stages of life cycle.

2. **Precystic or minuta.** Precystic or minuta form of *E. histolytica* is small, spherical, non-motile and non-feeding form. It measures 12 to 15μ in diameter. In structural details, it resembles the trophozoite except that it is smaller in size and the food vacuoles are absent. It lives in the lumen of large intestine and is non-pathogenic to man. But when resistance of host's body is low, it changes into magna form and invades the tissues of intestine.
3. **Cysts.** Under normal condition, minuta forms undergo encystation. It becomes rounded and surrounded by a thin, highly resistant and refractile cyst wall. A mature cyst is a spherical body 10 to 12μ in diameter. Its cytoplasm is clear and contains one or two glycogen masses (reserve food) and one or more characteristic, retractile, bar-like chromatoid bodies or chromidial bars with rounded ends. Both glycogen masses and chromidial bars gradually disappear. Chromidial bars are made of ribonucleoprotein which disperses throughout cytoplasm with their disappearance. Nucleus retains the characters of the trophozoite. To start with, the cyst is

uninucleate but its nucleus divides to form a binucleate and finally a tetranucleate or quadrinucleate cyst.

Reproduction and Life Cycle

1. **Hosts.** *E. histolytica* is monogenetic (Gr., *monos*, one + *genos*, race), i.e., only one host is required for its complete life cycle. Pigs, dogs, rats and rabbits are supposed to be the reservoir host. It undergoes reproduction and completes its life cycle only in man.
2. **Binary fission.** Trophozoites multiply asexually by binary fission within the wall of large intestine. Its nucleus undergoes mitosis without the disappearance of the nuclear membrane. The mitosis is followed by cytokinesis or division of the cytoplasm. As a result, two daughter organisms are formed. They grow rapidly in size, feeding upon bacteria and host tissue elements, and, in their turn, again multiply by binary fission. Some of them invade fresh host cells, while others become the precystic or minuta forms.

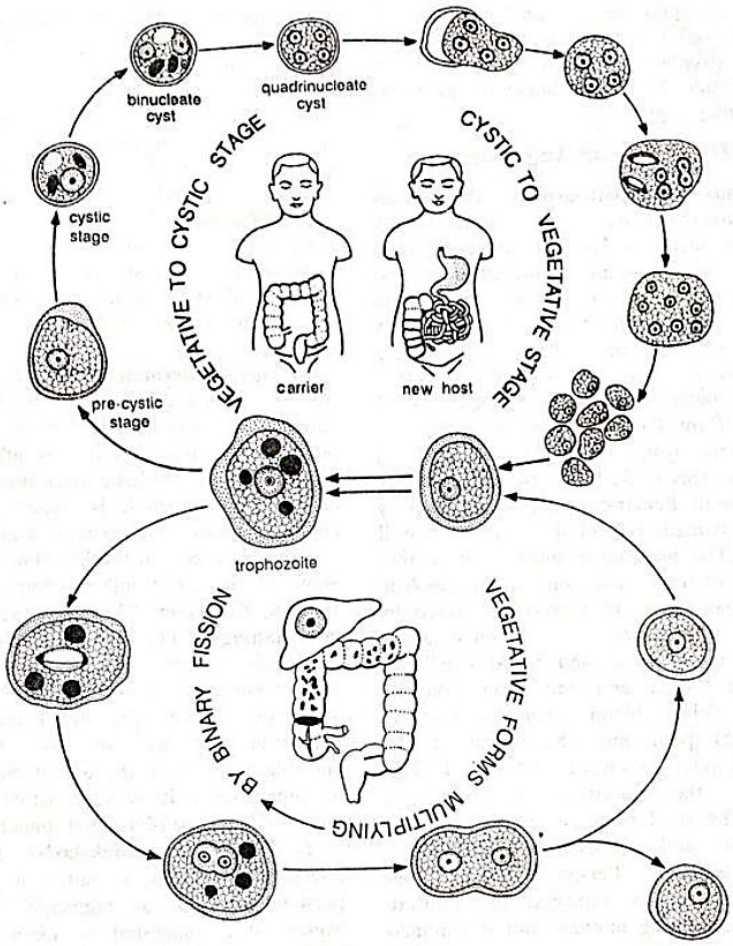

Fig. 3. *Entamoeba histolytica.* Reproduction and life history.

3. **Encystation.** The precystic or minuta forms encyst only in the lumen of the intestine and not in the tissues. They round up and secrete a thin, refractile, tough and flexible cyst wall around them. The cysts at this stage are uninucleate. The single nucleus of the cyst soon undergoes a mitotic division to form two nuclei, leading to the formation of binucleate cysts. A second mitotic division divides the two nuclei into four and thus tetranucleate cysts are formed. The whole process of encystation is completed within a few hours. Tetranucleate cysts constitute the transmissive or infective stage. They do not develop further but pass out of the host in the faeces. They can remain alive for 10 days in moist stool. They are very susceptible for desiccation and die at a temperature of 50ºC.
4. **Transmission and infection.** Infection depends upon intake of food or water contaminated with faecal matter containing tetranucleate cysts of *E. histolytica*. The food handlers, like cooks, sweetmeat sellers, hawkers, etc., who themselves are infected and unhygienic by nature, act as cyst passers. Untreated human faeces voided by children and adults on open grounds or in crop and vegetable fields (which is the usual practice in rural areas in India) is a common source of infection. Houseflies and cockroaches, which are coprophagous (feeding upon faecal matter), carry viable cysts on their legs or in their intestine and transfer them to unprotected foodstuffs.

5. **Excystation.** In the new host, the ingested cysts pass down the alimentary canal and reach the small intestine. The cyst wall protects them from the action of host's gastric juice during their passage through the stomach. After 5 or 6 hours, excystation takes place as the cyst wall is digested by trypsin in small intestine releasing the tetranucleate amoeba, called the excyslic amoeba or metacyst.
6. **Metacystic development.** Each metacyst immediately proceeds to divide by binary fission. Its nuclei divide in a specific pattern, accompanied by simultaneous cytoplasmic divisions, to produce 8 small, uninucleate amoebulac or metacystic trophozoites. These metacystic trophozoites pass into the large intestine, invade the mucous lining and grow into mature trophozoites.

Amoebic Dysentery or Amoebiasis

1. **Symptoms and pathogenesis.** As already noted, *E. histolytica* lives in the lumen of large intestine of man as harmless minuta forms. Whenever resistance of gut is lowered in infected people, these become pathogenic, change to magna forms and invade the intestinal wall. They make their way deep into sub-mucosa by eating through mucosa of the intestinal wall. Here they multiply by binary fission and spread radially outward to form flask-shaped ulcers containing cellular debris, lymphocytes, blood corpuscles and bacteria. This causes formation of abscesses in intestinal wall. Penetration into sub-mucosa by trophozoites is made possible by histolysis as well as cytolysis. The mechanism involves dissolution and necrosis of tissues and cells by a proteolytic enzyme of the nature of histolysin secreted by trophozoites themselves. As sub-mucosa is eroded, the ulcers burst and blood capillaries rupture. The blood and the ulcer contents (mucus, cell debris, blood corpuscles, bacteria and amoebae) pour into the lumen of the intestine and pass to outside with stool. This characterizes the amoebic dysentery or amoebiasis. The stool of a dysenteric person is usually acidic and consists of swarms of entamoebac as well. Person suffering from amoebic dysentery has repeated blood-mixed, slimy and foul-smelling motions and is confined to the lavatory. Sometimes, the trophozoites make their way, through blood circulation, into the brain, liver, spleen, lungs and gonads. Here also they destroy the tissues and cause formation of abscesses, or cavities containing pus. The affected liver becomes enlarged, congested and painful to touch. This pathological condition is referred to as amoebic hepatitis. Formation of abscesses in lung and brain usually prove fatal.
2. **Modes of transmission.** It mainly occurs by ingestion of cysts in food or drinks. The contamination of food or drinks occurs by (i) unhygienic habits of food handlers who by habit scratch the anus and then put fingers in the food which they serve, (ii) habit of defecating in open fields causing contamination of vegetables and then washing the bottom in ponds causing the contamination of water, (iii) transmission of cysts from stools to food and drinks by flies and cockroaches.
3. **Diagnosis.** Diagnosis, in a simple way consists in the microscopical detection of trophozoites or cysts in faecal smears. The presence of white, stone-shaped ‘Charcol-Leyden’ crystals in faeces suggests the *E. histolytica*. infection.
4. **Therapy (treatment).** Treatment of amoebic dysentery is not very difficult but the permanent cure is sometimes hard to achieve as relapses do occur. For temporary relief, an alkaloid Emetine is effective. A synthetic derivative of Emetine called Dehydroemetine, is equally effective. The antimalaria drug, Chloroquine is effective again amoebic abscesses in the liver but not elsewhere. Some of the latest iodine compounds, such as Vioform, Chiniofon,

Diodoquin, etc., have shown more lasting results. Certain antibiotics, such as Fumagillin Terramycin, Erythromycin and Aureomycin have proved to be effective in the eradication of the parasite. Perhaps the most significant advance in the treatment of amoebiasis has been the use of metronidazole an amoebicide. It is very active against bar intestinal and extra-intestinal amoebiasis.

5. **Prevention (prophylaxis).** Prevention of infection is entirely a matter of hygiene, both personal as well as municipal. For personal hygiene it is suggested to adopt the following habits: (1) Washing hands with soap and water after handling dirty articles, before taking meals and after using toilet. (2) Cutting finger nails regularly. (3) Avoiding use of unboiled water and improperly washed vegetables and raw salads. (4) Protection of foods and drinks from contamination by houseflies, cockroaches, etc. (5) Avoiding passing out of stool on open grounds, street sides or vegetable fields.

   The municipal hygiene is the responsibiltv of the town areas, municipalities or other local bodies. They must take the following preventive measures: (1) Proper sanitation of roads, streets, lanes and open drains. (2) Purification of drinking water. (3) Proper disposal of sewage. (4) Covering of the food articles by the traders. (5) Chemical treatment of human faeces to be used as fertilizer. (6) Periodical examination of food handlers to find out whether they are infected with *E. histolytica*. On positive findings they should be treated properly.

References:

Kotpal RL (2013). Modern Text Book of Zoology: Invertebrates (10^{th} edition). Rastogi Publications, India.