Common
INTESTINAL PROTOZOA
of Man

Life Cycle Charts

Prepared by
M. M. Brooke and Dorothy M. Melvin
Laboratory Consultation and Development Section
Laboratory Branch

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
Communicable Disease Center
Atlanta, Georgia 30333

These charts were originally issued in 1960 as an unnumbered publication by the Laboratory Branch of the Communicable Disease Center for use in training courses.

Public Health Service Publication No. 1140
April 1964

U.S. Government Printing Office, Washington: 1964

For Sale by the Superintendent of Documents
U.S. Government Printing Office, Washington, D.C. 20402

Price 15 cents

Contents

00104875

COMMON INTESTINAL PROTOZOA OF MAN

I. Introduction

The life cycles of the intestinal protozoa, except *Isospora*, are simple as compared to those of the helminths. In general, only two stages are present, trophozoite and cysts and the cycle is an asexual one. Only the coccidia (*Isospora* spp. in humans) have a more complicated life history involving asexual and sexual generations. All of the protozoa are microscopic forms ranging in size from a few microns to a hundred or more. Size variations may be considerable between different groups.

Transmission of intestinal protozoan infections is essentially man to man thus requiring no intermediate hosts and, with the possible exception of *Balantidium coli*, reservoir hosts also are unimportant.

Life cycle charts of the more common intestinal protozoa and of *Isospora hominis*, which is less common than some of the other organisms, and *Trichomonas vaginalis*, an inhabitant of the uro-genital system, are presented here for use by students of parasitology, laboratory technicians, public health workers, and practicing physicians. They are designed as simple, basic patterns that purposely omit details of epidemiology, incubation periods, patent periods, and exceptions to the usual pattern. The individual user can add whatever details he may need, obtaining this information from lectures or from the literature. Excluded from this presentation are *Entamoeba gingivalis* and *Trichomonas tenax*, both found in the mouth.

The design of these charts conforms to the following general rules, insofar as possible:

1. The diagnostic and infective stages are indicated and emphasized. These stages are in proportion with regard to species within a given group, using average sizes as recorded in the literature. Because of the variations in size between groups, no attempt was made to draw all of the species to a single scale.
2. Morphological details are included in a diagrammatic fashion.
3. Survival times, pre-patent and patent periods, and modes of transmission are omitted.

4. No general references are listed since the material incorporated into the charts is commonly found in most parasitology textbooks.

Acknowledgements

The authors wish to express their appreciation to the PHS Audiovisual Facility, CDC, for their cooperation in preparing these charts, in particular to Mrs. Margery Borom for the drawing of the organisms and the chart lay-outs.

II. Amebae

At least five species of amebae live in the intestinal tract of man, *Entamoeba histolytica, Entamoeba coli, Endolimax nana, Iodamoeba butschlii* and *Dientamoeba fragilis.* Their life cycles, illustrated in this publication, are simple, involving only asexual reproduction. The most important species from the standpoint of pathology, is *E. histolytica.*

With the exception of *D. fragilis* the intestinal amebae have two stages in their life cycles, a motile trophozoite and a cyst. Either stage may serve as the diagnostic form but only the cyst is infectious. *D. fragilis* does not encyst so the trophozoite is both the diagnostic and the infective stage. Since nuclear structure in the trophozoite and cyst is a primary differential characteristic, particular attention has been given to this feature of the organism.

Both trophozoites and cysts may be passed in feces but the trophozoites are rather fragile and soon disintegrate. Encystation does not occur outside the body, although immature cysts will mature. In the case of *D. fragilis,* the trophozoites are fairly resistant to environmental conditions and may remain viable for some time.

In general, ingested cysts excyst in the lumen of the small intestine; the exact location and the process involved are not known in most cases. After excystation, the resultant trophozoites grow, divide repeatedly by binary fission, and establish infections in the colon. Encystation occurs in the lumen of the large intestine in the species producing cysts and is necessary for survival outside the body and for protection against the digestive juices of the upper gastro-intestinal tract of the new host. The process and conditions for encystation are not completely understood.

In the case of *E. histolytica, E. coli,* and *E. nana,* multiplication of the nucleus occurs within the cyst. Upon excystation, division of the cytoplasm takes place, thus producing several small amebulae. In *D. fragilis* and *I. bütschlii,* however, multiplication is only by trophozoite division. *D. fragilis* has no cyst stage, and *I. bütschlii* cysts usually contain only a single nucleus. All of the amebae multiply by binary fission in the trophozoite stage.

No intermediate or reservoir hosts are involved and no developmental period outside the body is necessary. The cysts (or trophozoites in the case of *D. fragilis*) are infective upon passage from the body. Transmission of the infections therefore, may be by direct contact or by contaminated food and drink. *E. histolytica* outbreaks for the most part have been shown to be water-borne while endemic cases are probably acquired by a number of means, including contaminated water. The infective stages are fairly resistant and in moist, cool environment, may survive for some time (see table below). Since *D. fragilis* has only a trophozoite form, which is destroyed by water, it would not be expected to be water-borne but rather would depend upon direct contact for transmission.

E. histolytica is the only proven pathogen among the ameba, producing both intestinal and extra-intestinal lesions. *D. fragilis* is possibly pathogenic and *I. bütschlii* has been demonstrated as the cause of one fatal case of generalized amebiasis.

There are two other species of intestinal amebae, *Entamoeba hartmanni* and *Entamoeba polecki,* which have not been illustrated since their life cycles and morphology are similar to *E. histolytica. E. hartmanni* forms quadrinucleated cysts but is smaller than *E. histolytica.* It is somewhat smaller than 10 microns in diameter and has been reported by various investigators as "small race *E. histolytica.*" *E. polecki* is apparently a parasite of pigs, having been reported rarely from man. It produces only uninucleated cysts. Both of these species are probably non-pathogenic to man.

Entamoeba gingivalis, which is located in the buccal cavity is not included in this publication. It is not found in the intestinal contents since its trophozoites (only stage) are destroyed by the digestive juices of the intestinal tract.

SURVIVAL TIME FOR *ENTAMOEBA HISTOLYTICA*

Stage	Medium	Temperature		
		37°C.	20-25°C.	5°C.
Trophozoites*	Feces	2 - 5 hours	6 - 16 hours	48 - 96 hours
Cysts**,***	Feces	1 - 2 days	3 - 4 days	14 - 40 days
	Water	2 days	10 days	42 days

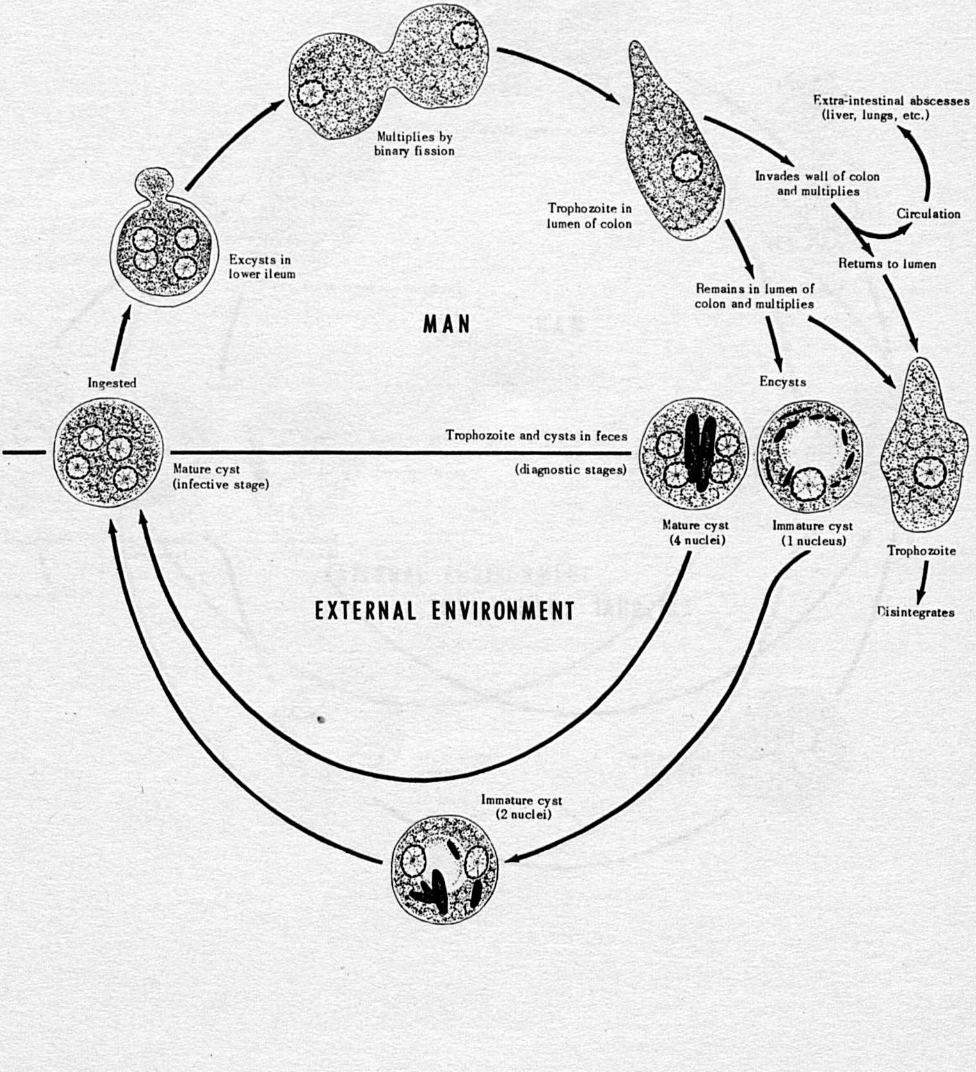
* Tsuchiya, H. 1945. Survival time of trophozoites of *Endamoeba histolytica* and its practical significances of diagnoses. Amer. J. Trop. Med. 25:277-279.

** Chang, S. L. and Fair, G. M. 1941. Viability and destruction of the cysts of *Endamoeba histolytica.* J. Amer. Water Works Assoc. 33:1705.

*** Simitch, T., Petrovitch, Z. and Chibolitch, D. 1954. La vitalite des kystes de *Entamoeba dysenteriae* in dehors de l'organisme de l'hote. (Viability of cysts of *Entamoeba histolytica* outside the host.) Arch. Inst. Pasteur d'Algerie *32*(3):223-231.

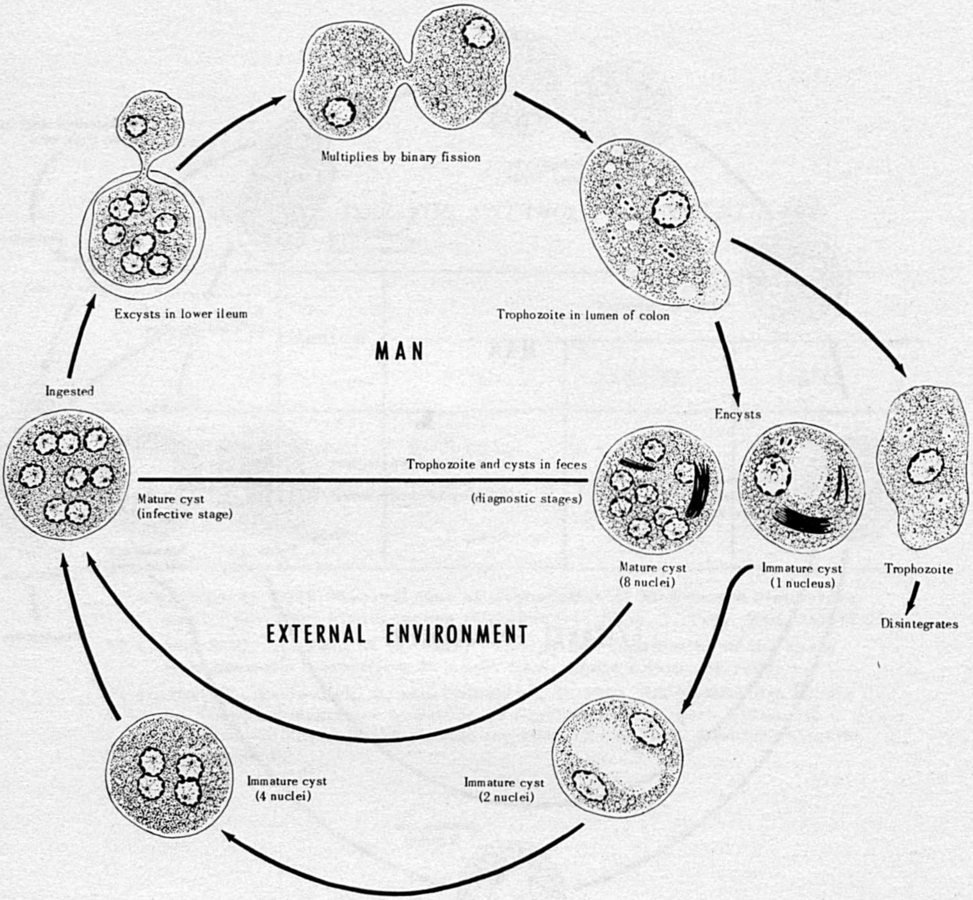
LIFE CYCLE of—

Entamoeba histolytica



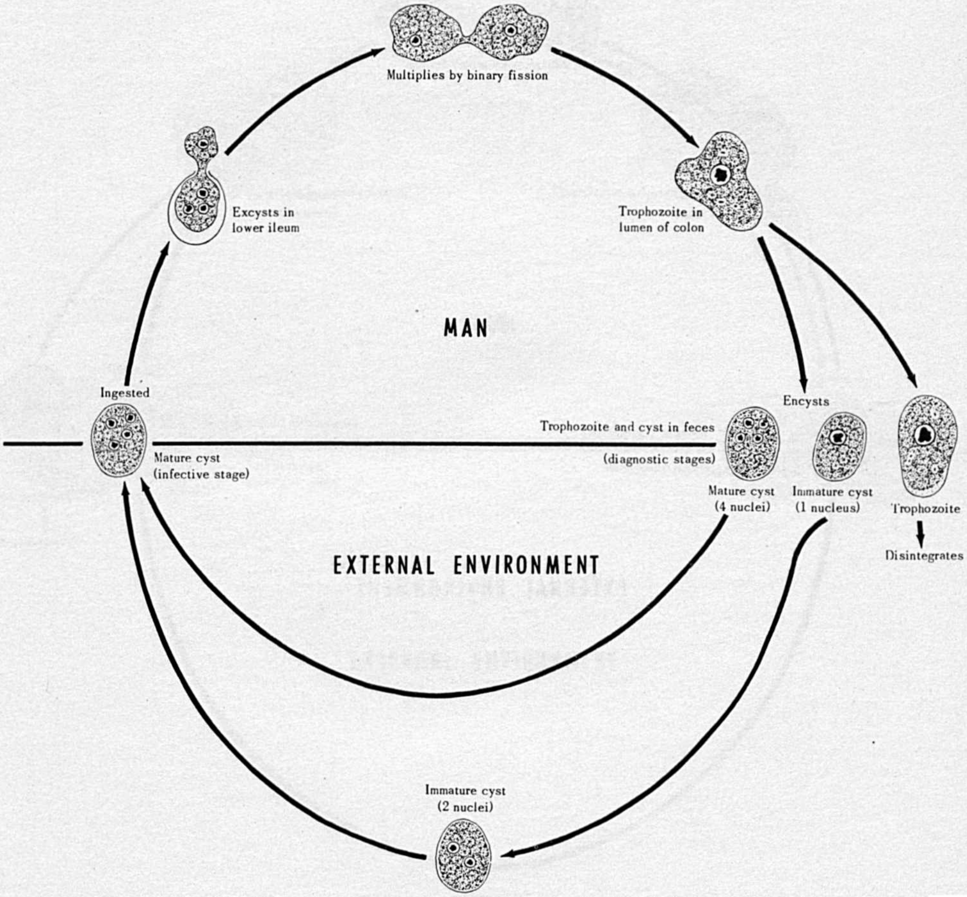
LIFE CYCLE of—

Entamoeba coli



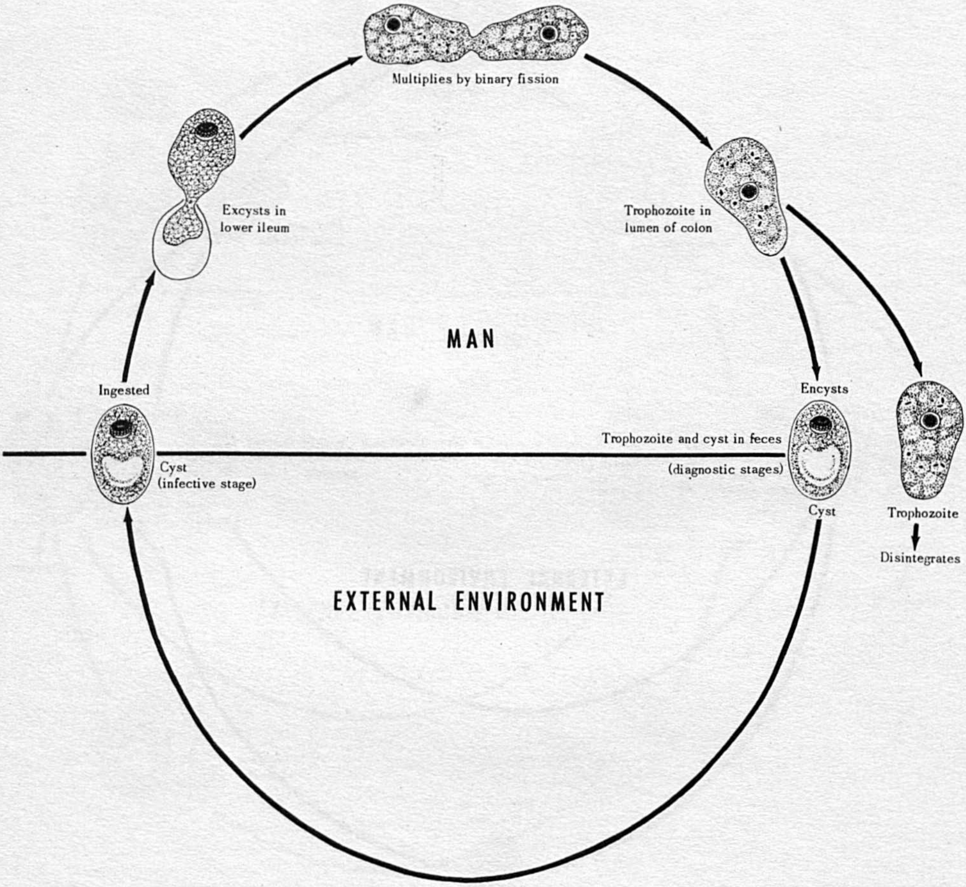
LIFE CYCLE of—

Endolimax nana



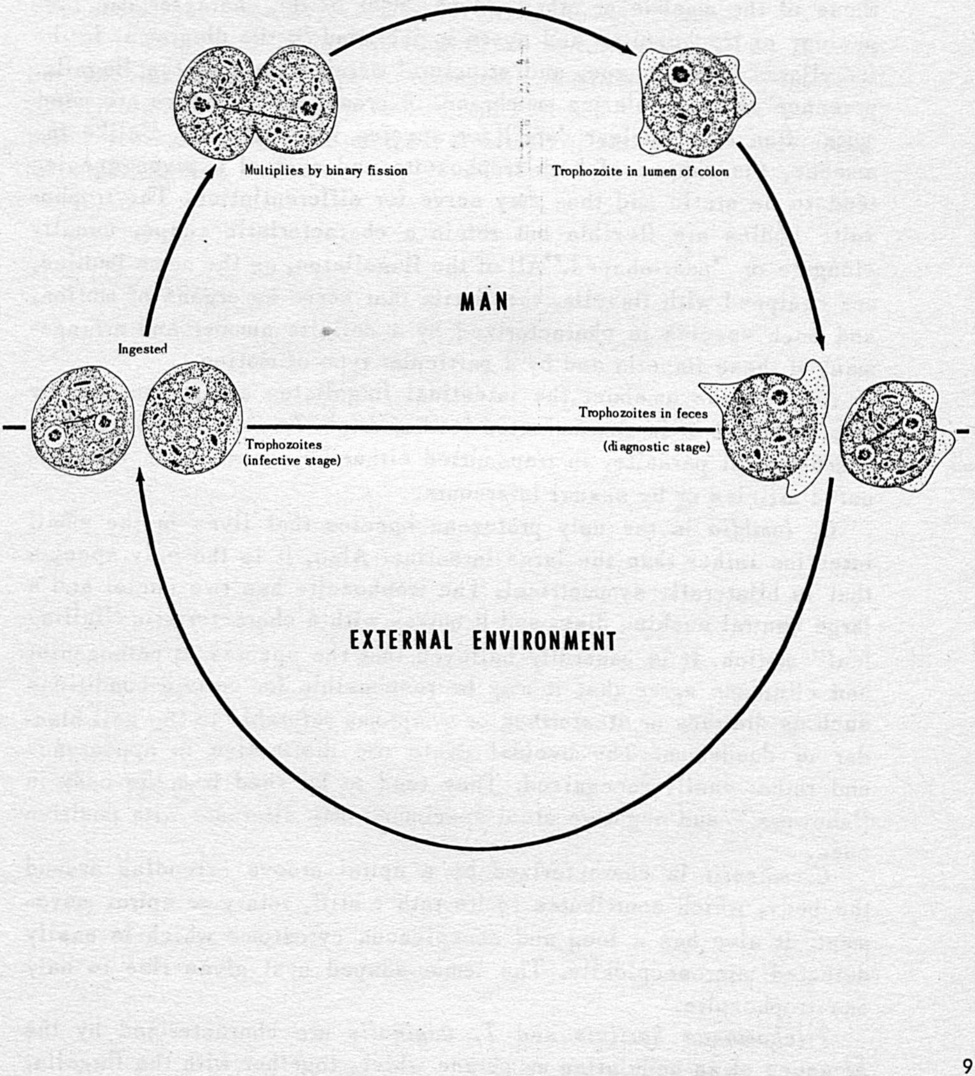
LIFE CYCLE of—

Iodamoeba bütschlii



LIFE CYCLE of—

Dientamoeba fragilis



III. Flagellates

Like the amebae, the flagellates also have a simple, direct life cycle that involves no intermediate hosts. Two of the species included here, *Giardia lamblia* and *Chilomastix mesnili*, have both the trophozoite and the cyst stage. As with the amebae, both stages are passed in feces, but the trophozoites disintegrate after leaving the body so only the cyst is infective. The *Trichomonas* species, however, occur only as trophozoites which therefore serve as both the diagnostic and the infective stage.

Although the drawings of the flagellates are roughly proportional within the group, they are not necessarily in correct proportion to those of the amebae or other groups. Most of the characteristic morphology of trophozoites and cysts is included in the diagrams. In the flagellates, size, shape, and structural details such as the flagella, presence of an undulating membrane, or prominent cytostome are used more often than nuclear detail for species identification. Unlike the amebae, the shapes of both trophozoite and cyst of a given species tend to be static and thus may serve for differentiation. The trophozoite bodies are flexible but retain a characteristic shape, usually elongate or "pear-shaped."All of the flagellates, as the name implies, are equipped with flagella, the fibrils that serve as organs of motion, and each species is characterized by a definite number and arrangement of these flagella and by a particular type of motion.

As with the amebae, the intestinal flagellates are transmitted by direct contact or in contaminated food or drink. *Trichomonas vaginalis*, a uro-genital parasite, is transmitted either by contact with contaminated articles or by sexual intercourse.

G. lamblia is the only protozoan species that lives in the small intestine rather than the large intestine. Also, it is the only species that is bilaterally symmetrical. The trophozoite has two nuclei and a large ventral sucking disk, and it moves with a characteristic "falling leaf" motion. It is generally believed that the species is pathogenic, and clinicans agree that it may be responsible for certain conditions such as diarrhea or steatorrhea or symptoms referable to the gall bladder or duodenum. The ovoidal cysts are distinctive in appearance and rather easily recognized. They tend to be shed from the body in "showers," and negative stool specimens may alternate with positive ones.

C. mesnili is characterized by a spiral groove extending around the body, which contributes to its rather stiff, rotary or spiral movement. It also has a long and conspicuous cytostome which is easily detected microscopically. The lemon-shaped cyst gives rise to only one trophozoite.

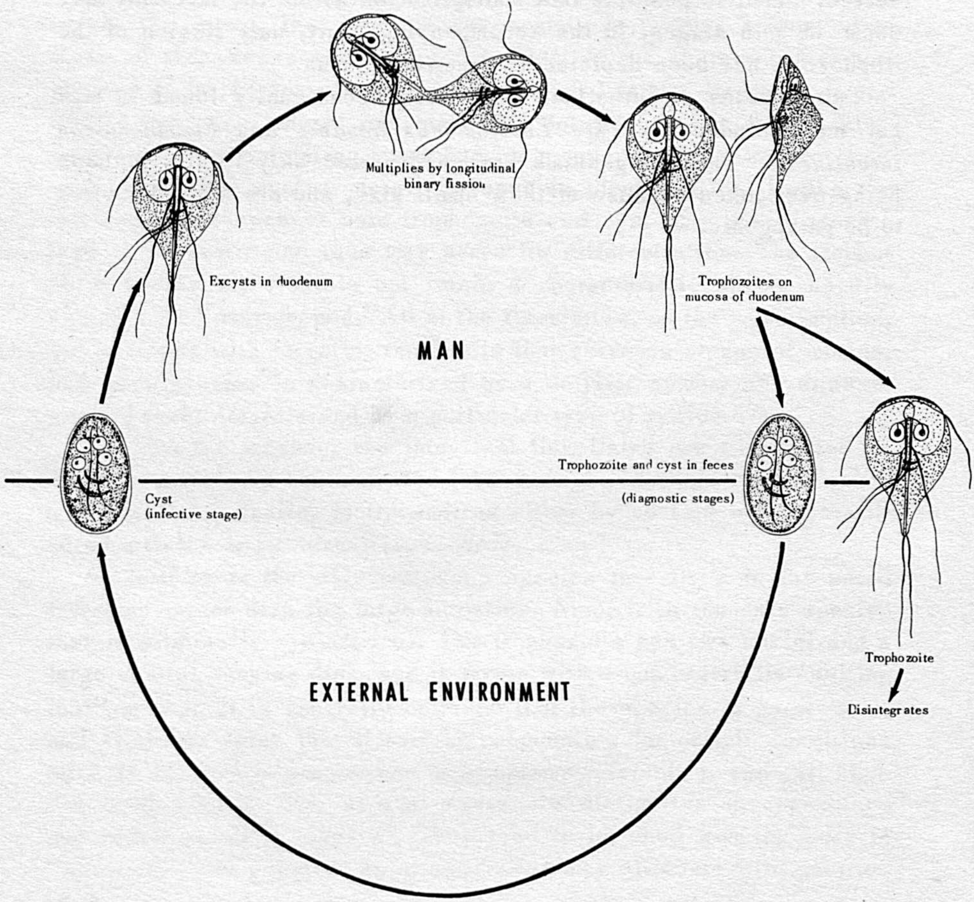
Trichomonas hominis and *T. vaginalis* are characterized by the presence of an undulating membrane which, together with the flagella, gives the organism a peculiar "nervous, jerky" type of motion. No cyst stages are known in the human species. A third species, *Trichomonas tenax*, found in the mouth, also parasitizes man but is not included here. Its life cycle is similar to those of the other two and transmission is through direct contact (kissing).

In general, multiplication of the flagellates occurs through longitudinal binary fission of the trophozoites within the host. *Giardia* can multiply in the cyst stage also – usually two organisms being produced upon excystation. It has been suggested that *Giardia* may reproduce chiefly in the cyst stage, encysting and excysting within the same host. However, binary fission of the free trophozoites has been observed, and it is possible that multiplication within the intestine may occur in both stages. In the accompanying chart, only fission of the trophozoite has been depicted as occurring in man.

Two species of intestinal flagellates occasionally found in man but not included here are *Enteromonas hominis* and *Embadomonas intestinalis*. These organisms are encountered only rarely, perhaps being overlooked because of their small size, and are not considered to be pathogenic.

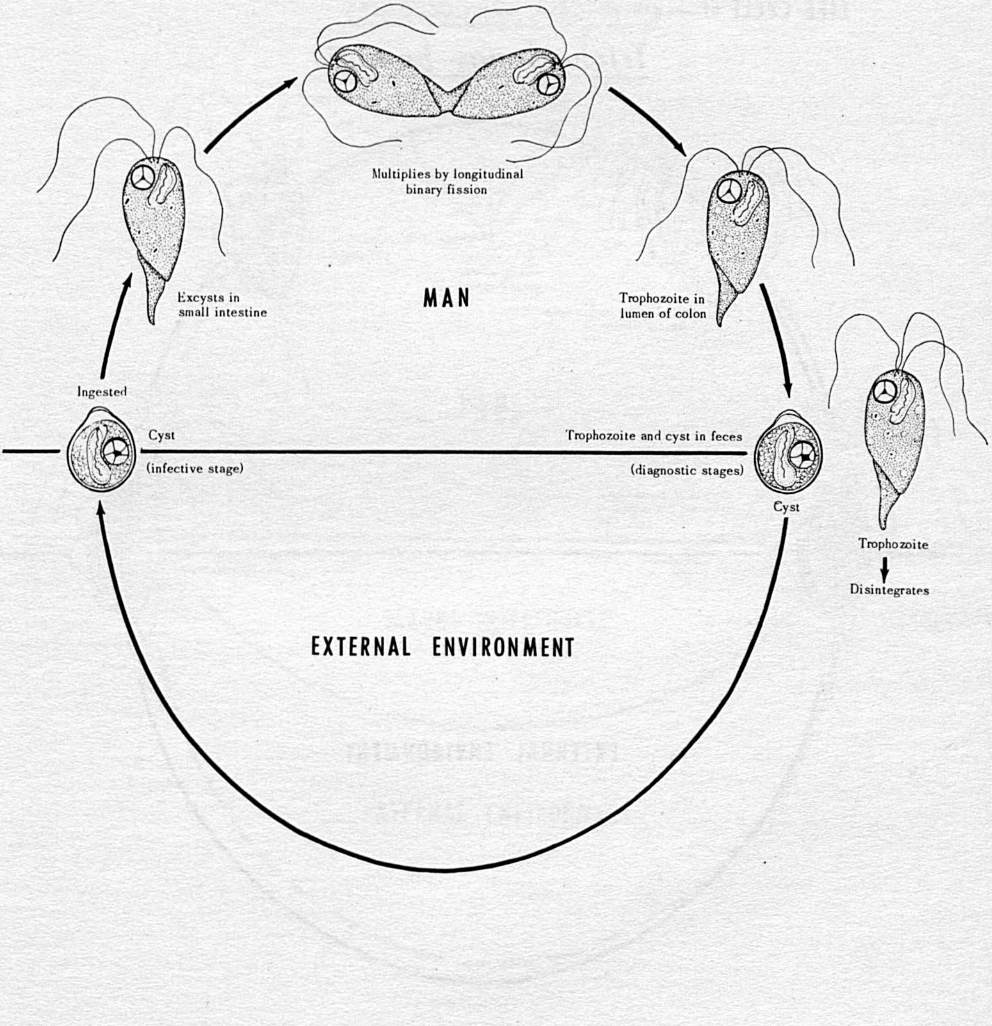
LIFE CYCLE of—

Giardia lamblia



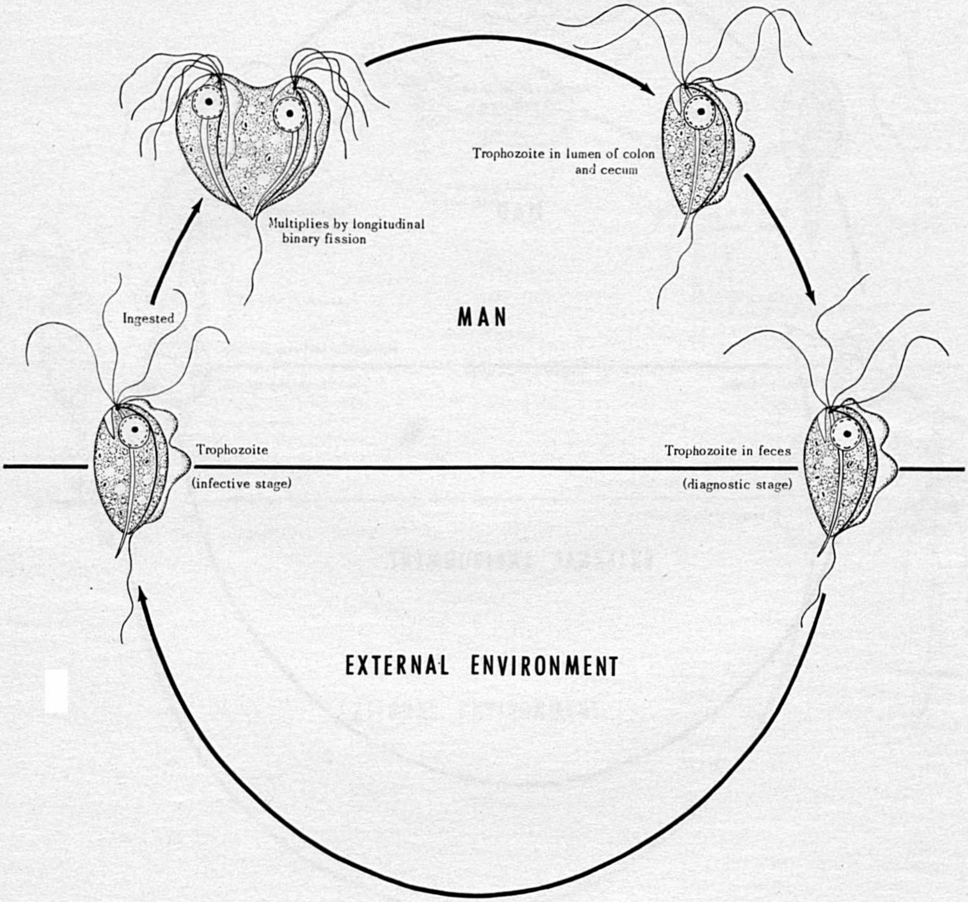
LIFE CYCLE of—

Chilomastix mesnili



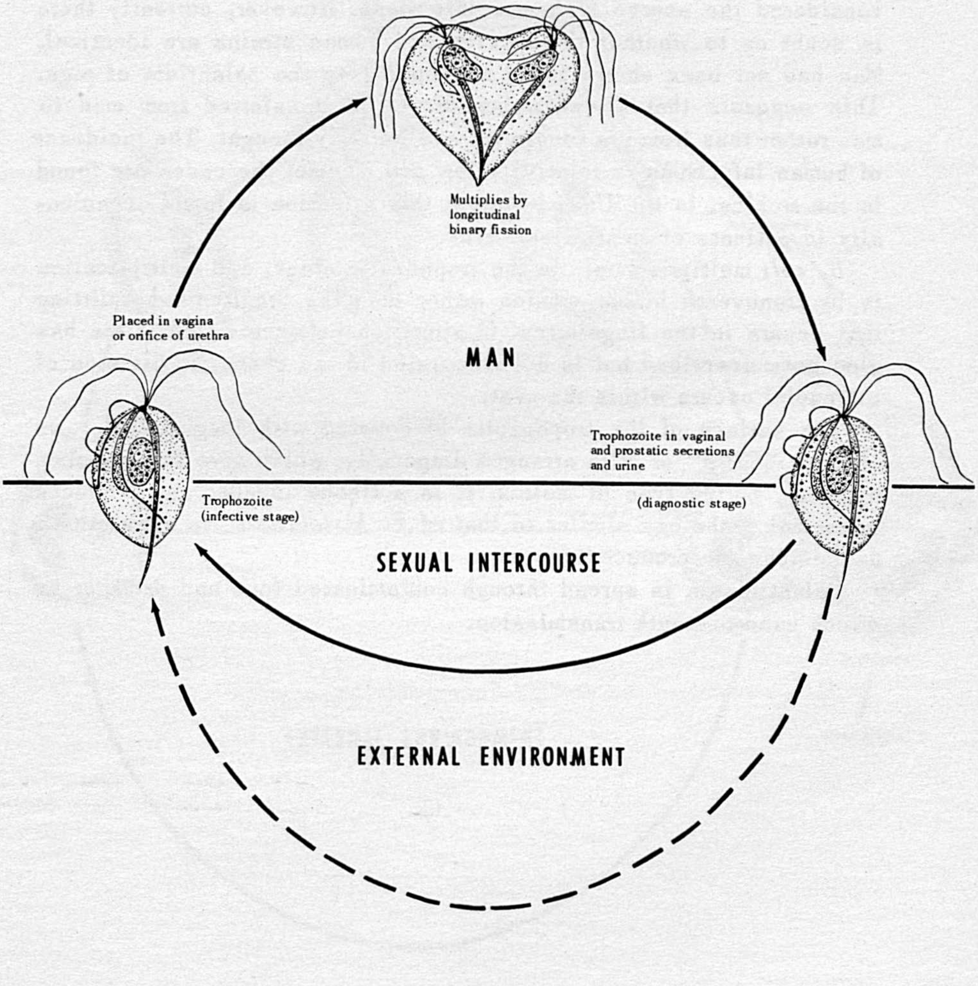
LIFE CYCLE of—

Trichomonas hominis



LIFE CYCLE of—

Trichomonas vaginalis



IV. CILIATES

Balantidium coli, the only ciliate that parasitizes man, is distinctive in several respects. It is the largest of the human protozoan parasites (from 50µ to over 100µ), is the only one having contractile vacuoles and the only one possessing both a macronucleus and a micronucleus. Both cyst and trophozoite are found in the life cycle and, like most of the protozoa, either may serve as the diagnostic stage but only the cyst is infective.

B. coli is a common parasite of pigs, which have sometimes been considered the source of human infections. However, currently there is doubt as to whether the porcine and human strains are identical. Man has not been shown to be susceptible to the balantidia of pigs. This suggests that human balantidiasis is transferred from man to man rather than from pig to man as was formerly thought. The incidence of human infections is relatively low and most of the cases are found in the tropics. In the United States, this infection is found occasionally in patients of mental institutions.

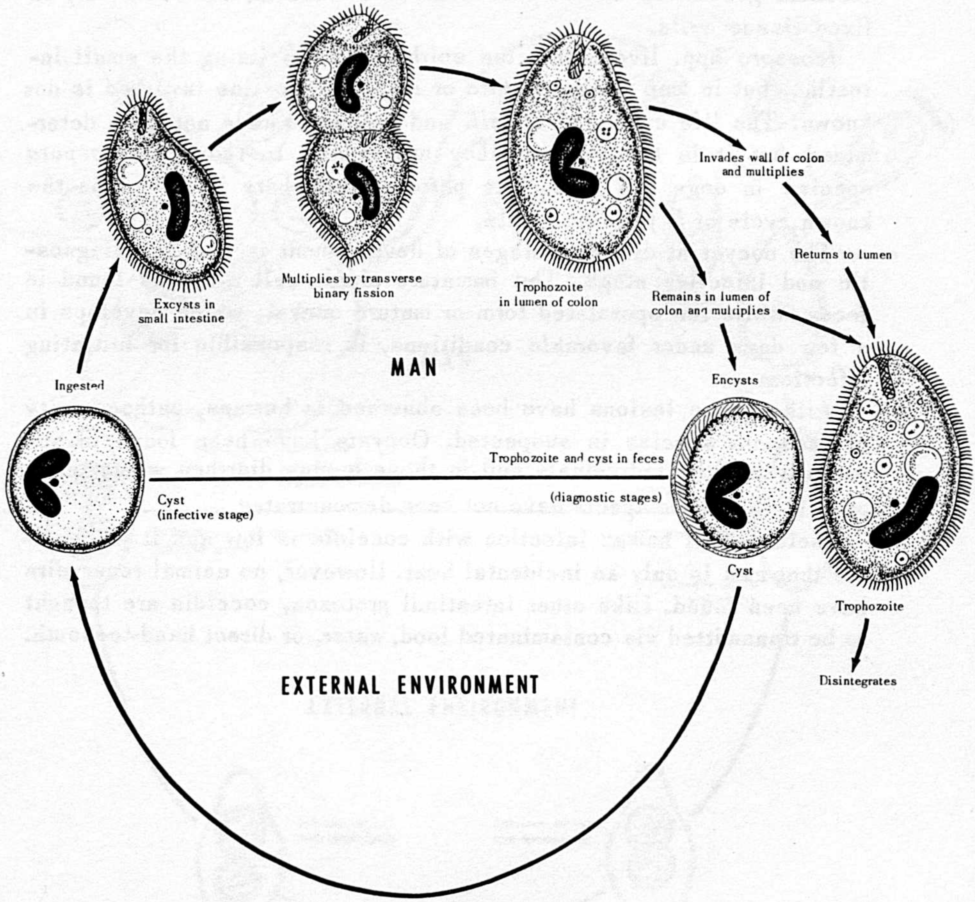
B. coli multiplies only in the trophozoite stage, and multiplication is by transverse binary fission rather than the longitudinal splitting that occurs in the flagellates. Conjugation between trophozoites has also been described but is not illustrated in the chart. No division of the nuclei occurs within the cyst.

The surface of the trophozoite is covered with longitudinal rows of short "hairs" or cilia arranged diagonally, which give the organism a rotary, boring type of motion. It is a tissue invader and produces intestinal pathology similar to that of *E. histolytica*. No extraintestinal lesions are produced.

Balantidiasis is spread through contaminated food and drink or by direct hand-to-mouth transmission.

LIFE CYCLE of—

Balantidium coli



V. Coccidia

Most of the sporozoa are blood parasites, the only intestinal representatives being the coccidia (primarily *Isospora* and *Eimeria* spp.). Man is parasitized by two species of the genus *Isopora, I. belli* and *I. hominis.*

The life cycle of the coccidia resembles that of the malaria parasites and involves an asexual and a sexual generation. Unlike malaria, however, no intermediate host is necessary to complete the sexual cycle. Sporogony takes place in the external environment rather than in an arthropod host. The various stages of the schizogenous cycle (asexual generation) are similar to those of malaria, but occur only in fixed tissue cells.

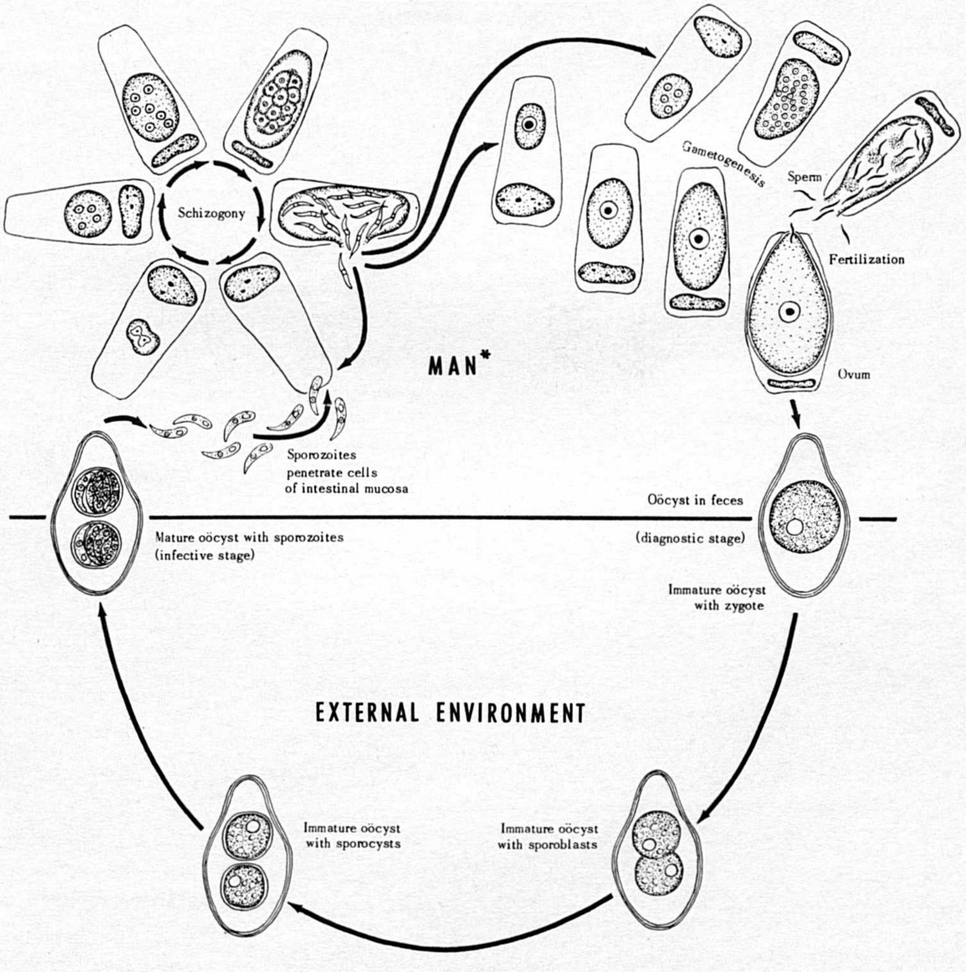
Isospora spp. live within the epithelial cells lining the small intestine, but in man the exact site or level of intestine involved is not known. The life cycles of *I. belli* and *I. hominis* have not been determined but it is thought that they are similar to those of *Isospora* species in dogs and cats. The pattern given here is based on the known cycle of *I. felis* from cats.

The oocyst at different stages of development is both the diagnostic and infective stage. The immature single-cell stage is found in feces, while the sporulated form or mature oocyst, which develops in a few days under favorable conditions, is responsible for initiating infection.

Although no lesions have been observed in humans, pathogenicity of *Isospora* species is suspected. Oocysts have been found in apparently healthy individuals and in those having diarrhea where other possible etiologic agents have not been demonstrated.

Incidence of human infection with coccidia is low and it is possible that man is only an incidental host. However, no animal reservoirs have been found. Like other intestinal protozoa, coccidia are thought to be transmitted via contaminated food, water, or direct hand-to-mouth.

LIFE CYCLE of— *Isospora hominis*



---

*Probable development in intestinal mucosa based upon life cycle of *I. felis.*

☆ U. S. GOVERNMENT PRINTING OFFICE : 1964 O - 733-162

00104875