GENERAL PARASITOLOGY

PARASITISM AND PARASITES

Parasitism is a biological phenomenon where a parasitic organism benefits at the expense ofa host. It is based on a complex relationship between the parasite and the host. This relationshipcan take the form of **symbiosis**, where both host and parasite are dependent upon eachother without harm to either entity; **commensalism**, where only the parasite derives benefitbut without harm to the host, or **parasitism**, where the parasite derives benefit at the expenseof the host. In medical context, parasitism is the primarily encountered host-parasite relationship.

A **parasite** is a living organism that exists throughout its life cycle in close relationship on or in a host and uses it as source of nutrients. This relationship is harmful for the host. The term “parasite” encompasses both unicellular and multicellular organisms, from which protozoa as representative of unicellular parasites and helminths as multicellular parasites are examples of medically significant parasites stated below.

HOST

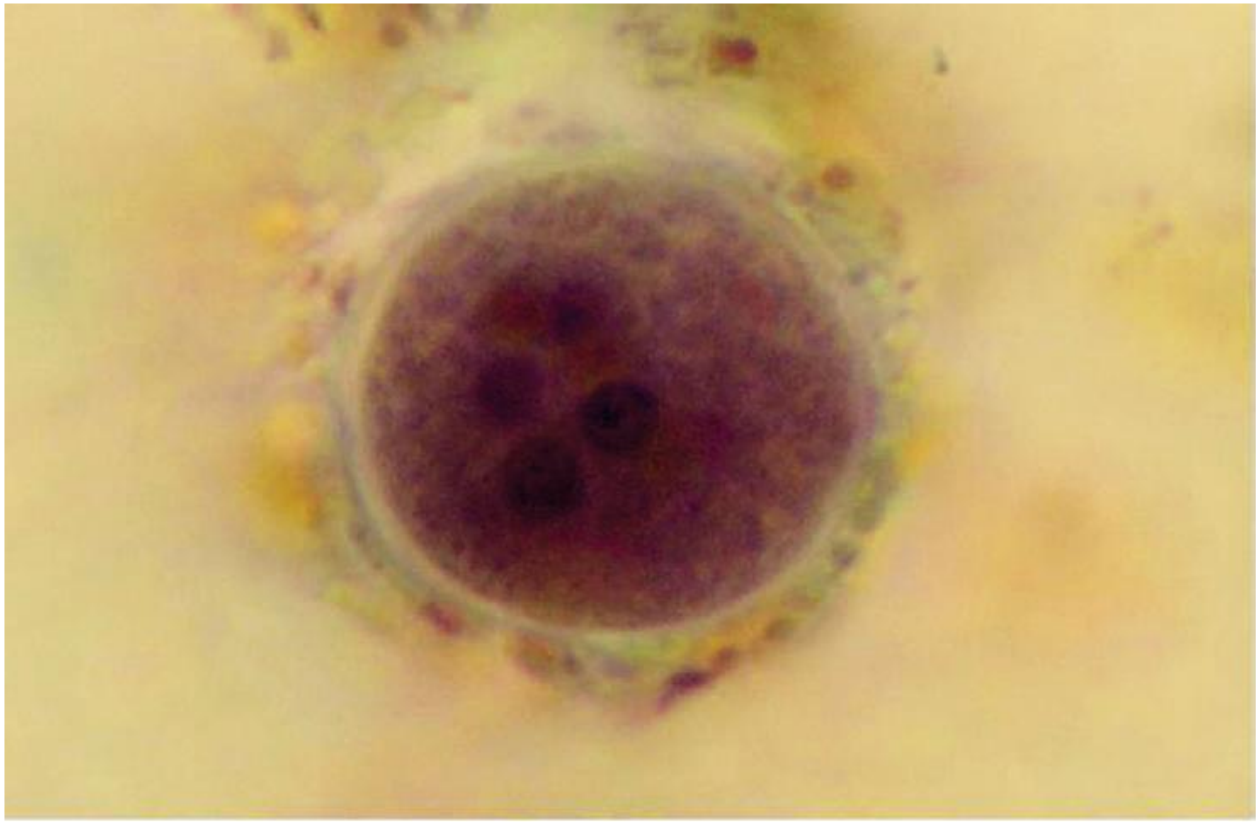
The host is defined as the organism that supplies the needs of the parasite by providing it withshelter and nutrition. The **final** or **definitive host** is a host in which a parasite develops intoan adult, reaches a sexually mature stage, and fulfills its reproductive cycle. The **intermediatehost** is an organism that hosts a parasite for part of the parasite's life cycle. The intermediatehost is used by a parasite in its larval stage, and is often the site where asexual multiplicationof the parasite occurs. In some cases, a parasite needs a first and second intermediate host tocomplete different stages of its life cycle. The parasite never fully matures in an intermediatehost. The **accidental host** is defined as a host where an infection of a certain parasite would not usually be found. The **aberrant host** is a special type of accidental host in which
the parasite cannot mature any further.

CLASSIFICATION OF PARASITES

Any parasite can be categorized as an **endoparasite**, **ectoparasite**, or **free-living parasite**. **Endoparasites** interact with their hosts from an internal location, for example, from within the blood stream. Most protozoan and helminthic parasites that cause human disease are endoparasites. These parasites always cause disease in a direct manner. Endoparasites can be **obligate** (e.g., *Toxoplasma gondii*), meaning that they cannot exist without a host, **facultative**(e.g., *Acantamoeba* spp., *Naegleria fowleri*), meaning that they may either live ina free or parasitic form, **accidental** (e.g., *Echinococcus granulosus* in man), where infectionoccurs in an unusual host, or **aberrant parasites** (e.g., *Toxocara canis* in man), meaning thatthere is no further development of the parasite after host infection. Endoparasitic arthropods(*Linguatula, Dermatobia*) are of low medical significance and therefore are not covered inthis text. **Ectoparasites** such as ticks, mites, and lice do not penetrate through surface tissues of the host and cause infection from an external location. Parasitization with ectoparasites is often referred to as an “infestation”. **Free-living parastites** are those that exist in nonparasitic stages independent of a host relationship. An example of a free-living parasite is the cystic stage of *Naegleria fowleri*.

PROTOZOA

Endoparasites included in this phylum have a **unicellular structure**. The most significant human parasites originate from groups of **Flagellates** (e.g., *Leishmania, Trypanosoma, Trichomonas*), **Amoboeae** (e.g., *Entamoeba*, **fig. 4.1**), **Spore forming protozoa** (e.g., *Toxoplasma,*
Sarcocystis, Plasmodium, Nosema) and **Ciliata** (e.g., *Balantidium*).



***Entamoeba coli* cyst** (size 25 μm). (Courtesy of Jan Urban, National Institute of Public Health, Prague)

HELMINTHS

These endoparasites are included in the phylum ***Nematoda***. The most clinically significant human parasites originate from groups of **flukes (trematodes)**, **tapeworms (cestodes)**, or **roundworms (nematodes – e.g., fig. below)**. Clinically relevant examples of parasites from each group are listed below (**table below**).

Roundworms (Nematodes)	Tapeworms (Cestodes)	Flukes (Trematodes)
Ascaris	*Taenia*	*Schistosoma*
Enterobius	*Diphyllobothrium*	*Paragonimus*
Trichuris	*Hymenolepis*	*Dicrocelium*
Trichinella	*Echinococcus*	*Fasciola*
Toxocara		*Clonorchis*
Ancylostoma		*Opistorchis*

***Ascaris lumbricoides*, adults (**length 20–30 cm**).**
(Courtesy of Jan Urban, National Instituteof Public Health, Prague)

PATHOGENESIS OF PARASITIC INFECTION

The pathogenic mechanisms of a parasitic infection are variable based on the nature of the infectious organism. Most parasitic infections enact the following mechanisms of pathogenesis.

Immune and allergic manifestations: Presence of parasitic infiltration in the human body elicits host immune activity that can lead to inflammatory sequelae such as fibrosis, lymphadenitis and granuloma formation. Pulmonary eosinophilia (Loeffler's syndrome, eosinophilic pneumonia) is an accumulation of eosinophils in the lungs that can occur in thesetting of infection with parasites such as *Ascaris lumbricoides*, *Ancylostomata duodenale*,and *Necator americanus*.

Physical obstruction: Parasites that are large or prone to forming masses can obstruct, for example, intestinal motility (e.g., *Ascaris lumbricoides*, *Taenia saginata* and *Taenia solium*).

Trauma and lytic necrosis: Parasites that utilize mechanical attachment mechanisms can lead to traumatic mucosal damage which results in bleeding. Lytic necrosis occurs as a resultof enzymes released by certain parasites. For example, the protozoan *Entamoeba histolytica*
releases proteases that elicit intestinal ulceration.

LIFE CYCLE, SYMPTOMS AND EPIDEMIOLOGY

Parasitic life cycles vary depending on the survival needs of each type of parasite; therefore, parasitic life cycles must be studied in accordance with the parasite in question. We can, however, classify parasite life cycles into **direct** and **indirect** life cycles. A **direct life cycle** occurs when a parasite requires only one host for completion of its development (e.g., *Enterobius vermicularis*), while an **indirect life cycle** implies the parasite requires two or more species of host for development completion. For example, a malarial parasite requires both the mosquito vector and the human host to fulfill its life cycle; therefore, its life cycle can be categorized as indirect.

Use the **Parasitology cycles/Flashcards** as a **guide to basic info on parasite life cycles.**

Symptoms of Parasitic Infection

Most infected individuals remain asymptomatic or present with subclinical symptoms, such as in the case of intestinal taeniasis caused by *T. solium* or *T. saginata*. Ascariasis can remainasymptomatic as well, although a small proportion of infected people develop pulmonarysymptoms such as a nonproductive cough in the second week following eggs ingestion. Usually, the infection produces only mild abdominal discomfort such as nausea or dyspepsia. Severe infections can impair the nutritional status of children, especially when combined with other causes of malnutrition. Ascariasis can interfere with the absorption of vitamin A, lactose, and proteins. Rarely, complications such as obstruction of the bile or pancreatic ducts can occur. Symptoms of parasitic infection are ultimately based on the pathogenic mechanisms utilized by the parasite and on the infected regions. For example, taeniasis, the intestinal infection caused by *T. solium*, when symptomatic, presents with digestive upset such as intestinal irritation and indigestion. Cysticercosis is also caused by *T. solium*, however, it is caused by the cysticercus form of the parasite and leads to tissue infection in muscle or skin, or neurological infection that presents with seizures and symptoms of increased intracranial pressure due to a cystic mass effect.

Epidemiology

Sources of parasitic infection are most commonly ingestion of **contaminated food**, **contaminated**
water, or through **vector transmission**. Contaminated food as a source of infection usually transmits cysts, eggs, or infective larvae to the human host. Contaminated water can transmit parasitic infection through ingestion, as well as through direct entry by free-living parasites. For example, free-living *Naegleria* in contaminated water can enter through the human nasopharynx to cause infection. Vector transmission can occur through a **biological vector**, which is a term used to define a vector that assists in both the transmission and development of the parasite, or through a **mechanical vector**, which is a vector used only for transmission. Other modes of infection include **skin transmission**, such as direct skin contact with soil contaminated with hookworm, **direct transmission**, such as *Trichomonas vaginalis* transmission during sexual intercourse, **vertical transmission** from mother to fetus as is the case in *Toxoplasma gondii* infection, or **iatrogenic transmission** where infected blood or organ transplantation is involved. *Babesia* serves as an example of an iatrogenically transmissible organism.

SPECIMEN COLLECTION

Specimen collection under suspicion of a parasitic infection involves the search for the presence of **eggs**, **larvae** or **adult parasites**. Specimens for investigation of parasitic infection are usually collected using tools such as tweezers or adhesive tape and stored in screw-capped tubes. Sometimes, ectoparasites or their lesions (burrows, erythema, papules etc.) can be seen by the naked eye. In the case of endoparasites that release eggs by a fecal route a stool sample is collected from the patient three times every other day due to discontinuous egg laying cycles. It should be stored at a refrigerated temperature. If the suspected endoparasites have affected an organ or specific tissue, the necessary material could be obtained by an **invasive** (surgical) or a **noninvasive** (endoscopic) method. Samples can be stored for a short time at room temperature before their transfer to the diagnostic lab. S**erology** is extremely helpful as noninvasive microbiological method to confirm diagnosis of numerous endoparasitic infections (e.g., *Toxoplasma gondii*, extraintestinal infections of *Entamoeba histolytica, Toxocara canis*).

LABORATORY DIAGNOSIS

The diagnosis of an infection caused by parasites starts with a valid **anamnesis**, which should contain relevant information regarding travel to an endemic area for the suspected parasite. The laboratory diagnosis is then made through the observation of morphological characteristics, which are evaluated either macroscopically or microscopically. Laboratory diagnosis of endoparasitic infection is described below.

Macroscopic Identification

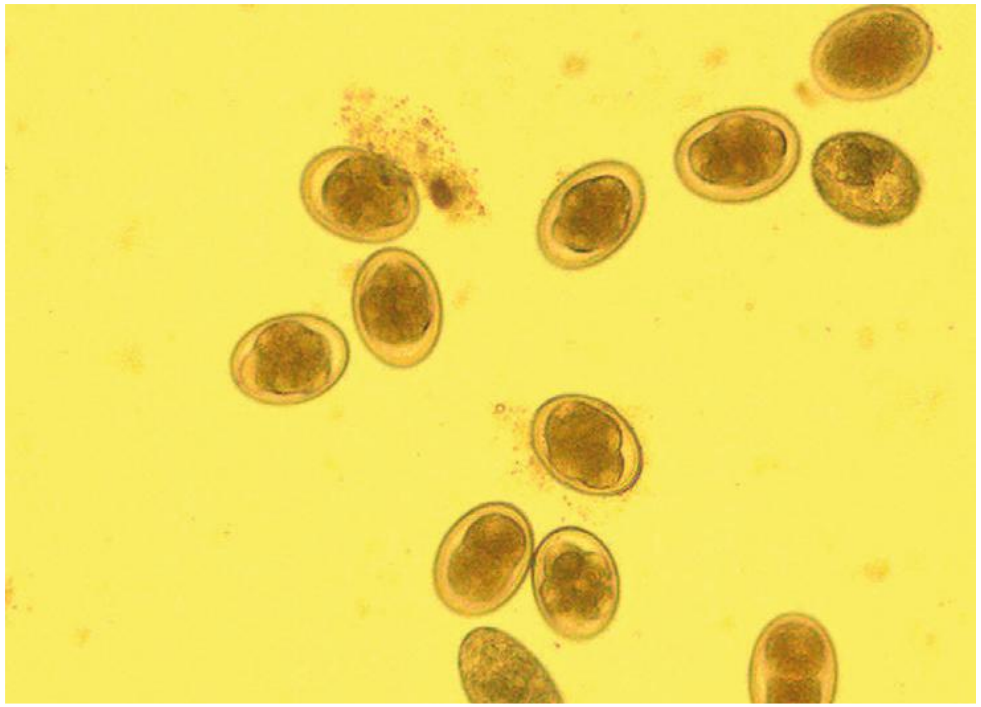
Macroscopic identification of particular species characteristics is useful in the case of larger parasites (e.g., helminths, **fig. above**).

Microscopic dentification

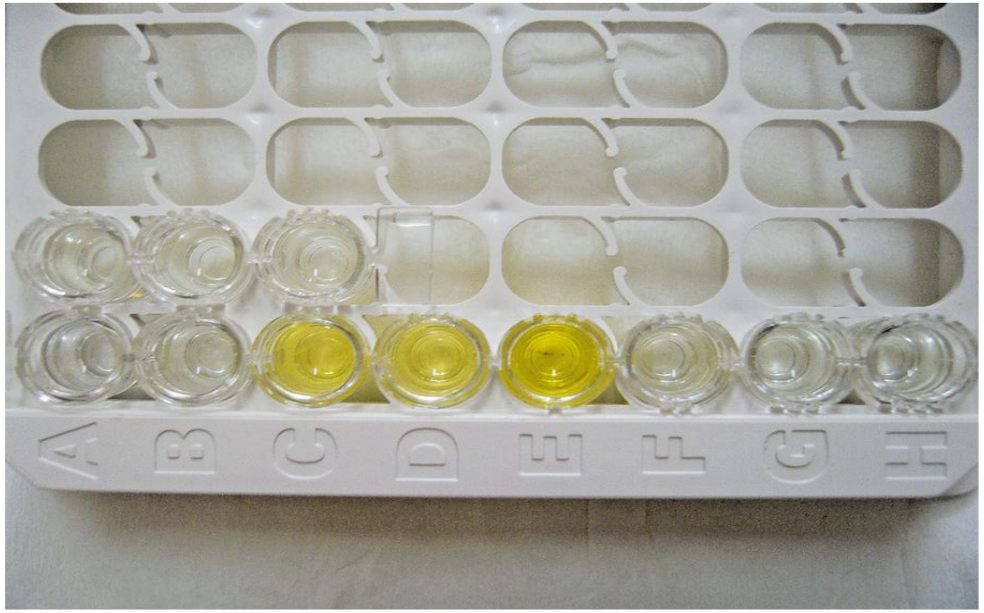
Microscopy should be used in the identification of helminthic eggs **(fig. below)** or protozoa (e.g., cysts *Entamoeba*, **fig. above**).

Using a suitable specimen (e.g., stool, blood) and methods such as wet preparation, floatation methods (e.g., Faust method), sedimentation methods (e.g., Baerman method), Graham method, Diamond method, Kato method, special stains (trichrome staining) or a blood (thick drop and thin smear), we can detect parasitic protozoa and the eggs of helminths.

Other materials used in parasitological examination can be acquired through the **punction** of liver abscesses, lymph nodes, the spleen, skin ulceration, **tissue fluids**, **muscle excision** or **serology** (**fig. above - ELISA**).



***Ascaris lumbricoides* – immature eggs** (size 45–60 μm) and Faust flotation method. (Courtesy of Jan Urban, National Institute of Public Health, Prague)



ELISA *Toxocara canis* IgG is a useful method to diagnose larval stages. (Courtesy of Jan Urban, National Institute of Public Health, Prague)