Mycology

The fungi are now considered a separate kingdom of Eukaryota domain, distinct from both plants and animals. A characteristic that places fungi in a different kingdom from plants, bacteria and some protists, is chitin in their cell walls. The fungal cell wall is composed of glucans and chitin. While the first compounds are also found in plants and the second in the exoskeleton of arthropods, fungi are the only organisms that combine these two structural molecules in their cell wall. In contrast to plants and the oomycetes, fungal cell walls do not contain cellulose. As other eukaryotes, fungal cells contain membrane-bound nucleus with chromosomes that contain DNA with noncoding regions called introns and coding regions called exons. Fungi possess membrane-bound cytoplasmic organelles such as mitochondria, sterol-containing membranes, and ribosomes of the 80S type, Goldi bodies, endoplasmatic reticulum. Similar to animals, fungi are heterotrophic organisms, requiring preformed organic compounds as energy sources. Similar to plants, fungi possess a cell wall and vacuoles. They reproduce by both sexual and asexual means, and like basal plant groups (such as ferns and mosses) produce spores. Similar to mosses and algae, fungi typically have haploid nuclei. In common with some plant and animal species, more than 60 fungal species display the phenomenon of bioluminescence. Similar to bacteria, fungi contain cell wall, cytoplasmic membrane, ribosomes, capsules and flagella.

The cells of most fungi are tubular, elongated, and filamentous structures called *hyphae*, which group together to form a conglomerate called *mycelium.* Hyphae can be either *septate* (higher fungi) or *non-septate* (lower fungi). Septate hyphae are divided into uninuclear cell-like units separated by cross walls, with each compartment containing one or more nuclei. The mycelium can be vegetative (grows into the medium) and the aerial (projects from the surface).

Fungi can be a single-celled (yeasts) or multicellular organism. Depending on the cell morphology, *fungi are divided*:

1. Yeast are unicellular spherical fungi, reproduce by budding (e.g. Cryptococcus neoformans).

2. Yeast-like fungi are elongated cells resembling hyphae (pseudohyphae - buds that do not separate from the mother cell), which form pseudomycellium (e.g. Candida albicans).

3. Moulds or filamentous fungi form true mycelium (Dermatophytes and opportunistic fungi such as Aspergillus, Penicillum and Mucor). Moulds are multiplied by sexual and asexaul spores and by fragmentation of mycelium.

4. Dimorphic fungi can switch between a yeast phase and a hyphal phase in response to the environmental conditions. Most fungi, causing systemic mycoses, are dimorphic fungi.

Fungi are also used for the development of antibiotics, antitoxins, and other drugs used for treatment of human diseases.

Fungi reproduce asexually by fragmentation or production of asexual spores. Two types of spores can be produced asexually: *conidiospores (conidia*) – a

unicellular or multicellular spore that is not enclosed in a sac; *sporangiospores* – formed within a sporangium (sac).

Conidia are produced in a chain at the end of the aerial hyphae called conidiophores (Aspergillus). Arthrospores (arthroconidia) are formed by fragmentation of septate hyphae into single cells (Coccidioides immitis). Blastospores (blastoconidia) are buds from parent cell, found in some yeasts (Cryptococcus). Chlamydospores (chlamydoconidia) are thick-walled spores, formed by rounding and enlargement within a hyphael segment (Candida albicans).

Sporangia are formed at the end of aerial hyphae called sporangiophores (Rhizopus).

Fungi can be true pathogens (e.g. histoplasmosis and coccidioidomycosis) that cause infections in healthy persons called mycoses, or they can be opportunistic pathogens (e.g. aspergillosis, candidiasis) that cause infections in immunocompromised persons.

Medical important phyla of fungi:

Zygomycota phylum has non-septate hyphae, sexual spores are zygospores, asexual spores are sporangiospores. Zygomycota include human pathogens Rhizopus, Mucor, which are ubiquitous, opportunistic pathogens, cause systemic mycoses.

Ascomycota phylum has septate hyphae, sexual spores are ascospores, asexual spores are usually conidiospores except Trichophyton (produces arthroconida). Examples are Aspergillus, *Blastomyces dermatitidis*, *Histoplasma capsulatm*, Microsporum, Trichophyton.

Basidiomycota phylum has septate hyphae and includes fungi that produce fruiting structures called *mushrooms.* Sexual spores are basidiospores formed externally on a base pedestal called a *basidium*, asexual spores in some are conidiospores. Basidiomycota phylum includes Cryptococcus neoformans.

Anamorphs produce asexual spores only and have septate hyphae. *Spore types* are conidia, arthroconidia, and chlamydoconidia. Examples are Pneumocystis carinii, Epidermophyton, Sporothrix schenckii, Stachybotrys, Coccidioides immitis, Candida albicans, Penicillium (formerly Ascomycota, mutation in the telomorphic form produced the anamorph).

Teleomorphic fungi produce sexual and asexual spores, *anamorphic fungi* produce only asexual spores. Deuteromycota was formerly used as a holding category for fungi without sexual spore.

Depending on the site of infection and degree of tissue involvement, mycoses are classified as superficial, cutaneous, subcutaneous, and systemic (deep) infections. Superficial mycoses are characterized by lesions of hair and superficial horny layer of the epidermis, and include black piedra (*Piedraia hortae*), white piedra (*Trichosporon beigelii*), pityriasis versicolor (*Malassezia furfur*), and tinea nigra (*Phaeoannellomyces werneckii*).

Cutaneous mycoses may be classified as dermatophytoses (infect skin, hair and nails) or dermatomycoses. *Dermatophytoses* are caused by the fungi of the genera Microsporum, Trichophyton,and Epidermophyton. Dermatomycoses are

cutaneous infections caused by other fungi, the most common of which are Candida spp.

Subcutaneous mycoses are characterized by lesions of the skin, subcutaneous tissue, bone, tendon, or muscle and include chromoblastomycosis, mycetoma, and sporotrichosis.

Deep mycoses are caused by primary pathogenic and opportunistic fungal pathogens. The primary systemic fungal pathogens include *Coccidioides immitis*, *Histoplasma capsulatum*, *Blastomyces dermatitidis*, and *Paracoccidioides brasiliensis*. The opportunistic fungal pathogens include *Cryptococcus neoformans*, *Candida* spp., *Aspergillus* spp., *Penicillium marneffei*, the *Zygomycetes*, *Trichosporon beigelii*, and *Fusarium* spp.

The diagnosis of mycotic infection is dependent on the proper selection, collection and transportation of the appropriate clinical sample. Skin scraping, hair, nails, blood, SCF, putum, bronchial washings and tracheal aspirates, tissue biopsies may be specimens for examination. Specimen volume must be adequate to perfom all the tests. In case of inadequate sample, at least two swabs should be taken for microscopy and culture. Skin scraping and hair should be transported in dry container. Specimens must be collected aseptically from the deeper part of the wound, because superficial contaminating fungi or bacteria will overgrow or supress pathogenic fungi. Specimen must be transported and processed within two hours. To minimize the overgrowth of commensals, antibiotics may be added to the specimens (penicillin, streptomycin). Blood and SCF may be stored at 30-37°C, dermatological samples are stored at 15-30°C. Hair, skin scraping, subungual debris can be directly inoculated on the appropriate media (Sabuaroad dextrose agar) to study fungal colonies. The material is examined by microscopy by potassium hydroxide (KOH) preparation, stained with blue or black ink, unstained wet-mount smear, stained dried smear (Gram or Giemza stain), histopathology of biopsy with special stains (periodic acid schiff or Gomori's methanamine silver staining). Microscopy can identify the presence of fungal hyphae, spores, conidia, spores inside a hair (endothrix) or outside a hair (ectothrix), yeast cells, which may be dividing by budding, pseudohyphae. The more recent development involves use of calcofluor white, fluorochrome, with affinity to chitin and glucan, which makes demonstration of fungal elements possible with the fluorescent microscope.

Serological tests for detection of antibodies (histoplasmosis, coccidioidomycosis) or antigen (cryptococcosis, aspergillus, candidosis, histoplasmosis) may be used.

Opportunistic mycoses

Candidiasis

Candidiasis is a primary or secondary mycotic infection caused by members of the genus Candida generally *C.albicans*. The genus Candida encompasses more than 150 species, only a few of which cause disease in humans. With rare exceptions, the human pathogens are C. albicans, C. guillier-mondii, C. krusei, C.

parapsilosis, C. tropicalis, C. kefyr, C. lusitaniae, C. dubliniensis, and C. glabrata. Ubiquitous in nature, these organisms are found on inanimate objects, in foods, and on animals and are normal commensals of humans. They inhabit the gastrointestinal tract (including the mouth and oropharynx), the female genital tract, and the skin. Although cases of candidiasis have been described since antiquity in debilitated patients, the advent of Candida species as common human pathogens dates to the introduction of modern therapeutic approaches that suppress normal host defense mechanisms. Of these relatively recent advances, the most important is the use of antibacterial agents that alter the normal human microbial flora and allow nonbacterial species to become more prevalent in the commensal flora. With the introduction of antifungal agents, the causes of Candida infections shifted from an almost complete dominance of C. albicans to the common involvement of C. glabrata and the other species listed above. The non-albicans species now account for approximately half of all cases of candidemia and hematogenously disseminated candidiasis. Recognition of this change is clinically important, since the various species differ in susceptibility to the newer antifungal agents. In developed countries, where medical therapeutics are commonly used, Candida species are now among the most common nosocomial pathogens. In the United States, these species are the fourth most common isolates from the blood of hospitalized patients.

Acute oral candidiasis is rarely seen in healthy adults but it is often associated with severe immunological impairment due to the diabetes mellitus, leukemia, lymphoma, malignancy, neutropenia and HIV infection (a marker of clinical progression to AIDS). A risk factors include also the use of broad-spectrum antibiotics, corticosteroids, cytotoxic drugs, radiation therapy, trauma, burns, catheter using.

Clinically, white plaques that resemble milk curd form on the buccal mucosa, on the tongue, gums, the palate, the pharynx. Symptoms may be absent or include burning or dryness of the mouth, loss of taste, and pain on swallowing. Skin candidiasis includes lesions which consist of a moist, macular erythematous rash with typical satellite lesions present on the surrounding healthy skin. Diaper candidiasis is common in infants under the unhygienic conditions of chronic moisture and local skin maceration associated with ammonitic irritation due to the irregularly changed unclean diapers. Once again characteristic erythematous lesions with erosions and satellite pustules are produced, with prominent involvement of the skin folds and creases. Paronychia of the finger nails are characterized by the development of a painful, erythematous swelling about the affected nails. In chronic cases the infection may progress to cause onychomycosis with total detachment of the cuticle from the nail plate. Vulvovaginal candidiasis symptoms include intense vulval pruritus, burning, erythema associated with a creamy white, curd-like discharge. Pulmonary candidiasis can be acquired by either hematogenous dissemination causing a diffuse pneumonia or by bronchial extension in patients with oropharyngeal candidiasis.

The clinical manifestations may be acute, subacute or chronic to episodic. Involvement may be localized to the mouth, throat, skin, scalp, vagina, fingers,

nails, bronchi, lungs, or the gastrointestinal tract, or become systemic as in septicemia, endocarditis and meningitis. Systemic candidiasis is usually seen in immunocompromised patients, and those receiving aggressive cancer treatment, immunosuppression, or transplantation therapy.

Morphology. Candida is a small, thin-walled, ovoid yeast that measures 4–6 μm in diameter and reproduces by budding. Organisms of this genus occur in three forms in tissue: blastospores, pseudohyphae, and hyphae. Candida grows readily on simple medium; lysis centrifugation enhances its recovery from blood. Species are identified by chemical testing (currently with automated devices) or on special agar.

Laboratory diagnosis. The material for the study are: skin and nail scales, separated by the affected areas of the mucous membranes, pus, feces, urine, blood, cerebrospinal fluid, tissue biopsies.

Diagnosis is based on methods: microscopic, mycological, serological and allergological.

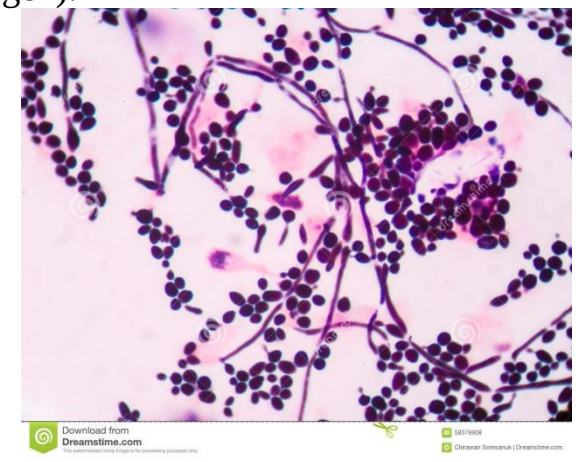
The microscopic method is based on staining smears with methylene blue and / or Gram, followed by microscopy.

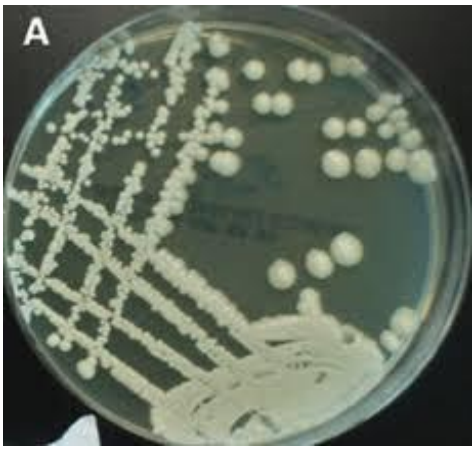
The mycological method is the sowing of the test material on nutrient media (Saburo agar, wort agar or candida agar).

Obtaining only the Candida culture by sowing pathological material does not give a basis for the diagnosis of candidomycosis, with the exception of the isolation of the pathogen from the blood.

Serological method: detection of antibodies in the serum of patients in the reactions of agglutination, precipitation, complement fixation with soluble antigens. However, due to cross antigens common with other fungi, these reactions are not always informative, therefore, they currently use the reaction of immunodiffusion, immunoelectrophoresis, indirect hemagglutination and latex agglutination reaction.

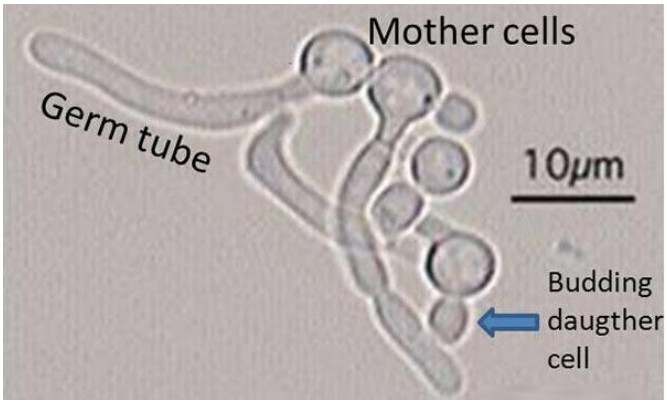
Allergological method - formulation of an allergy test with candida antigen (allergen).





C. albicans **budding yeast cells with pseudohyphae** ***C.albicans*** **on Sabouraud agar**

Germ tubes test is used for differentiation of C. albicans from other *Candida* (after the incubation of the culture in the serum within 2-3 hours at 37°C, germ tubes are formed).



Germ tubes *C. albicans*

Serological tests to detect the presence of *Candida* antibodies (immunodiffusion, immunoelectrophoresis, ELISA, RIA) may be used, but these are often negative in the immunocompromised patient.

For the ***treatment*** nystatin, fluconazole, itraconazole and amphotericin B (in invasive forms) are used. In chronic recurrent candidiasis, auto-vaccines are sometimes used.

Prevention: Maintaining the balance of the normal bacterial flora of the intestine and oral cavity, increasing the body's defenses, observing the rules of personal hygiene. Methods of specific prevention are not developed.

Protozoa

Protozoa are eucaryotic unicellular microscopic organisms. As unicellular eucaryotes, they have the same essential life activities as higher multicellular eucaryotes: they move about to survive, feed and breed. Protozoa may multiply by asexual division (fission/splitting or internal/endogenous budding) or sexual reproduction (formation of gametes and fertilization to form zygote, or unique process of conjugation where ciliates exchange micronuclei). Life cycle of the protozoa is specific to each species. In the protozoa of sexual reproduction, cycle of the formation of the mature form is in certain types, which are called definitive hosts. The rest of the species, where there are other stages of the parasite development, are called intermediate hosts.

Protozoa are divided into obligate and facultative parasites. For obligate parasites (trichomonads, lamblia) parasitism is the only way of existence, for facultative free-living parasites (acanthamoeba, naegleria) this stage is not a must to save the species.

The reservoirs of protozoa are animal (zoonosis), human (anthroponosis), environment (sapronosis) They can be transmitted by direct, fecal-oral, vector-borne and predator-prey ways.

On the basis of their locomotion they are divided on the four main groups:

- amoebae use pseudopodia (thread-like extensions of the cell membrane into which the protoplasm streams) to creep or crawl over solid substrates;
- flagellates use elongate flagella which undulate to prompt the cell through the liquid environments;
- ciliates use numerous small cilia (hair-like' extensions of the cell membrane) which undulate in waves allowing cells to swim in fluids;
- sporozoa ('spore-formers') is a group of parasitic protozoans, in general without flagella, cilia, or pseudopods, which are motile by use of a gliding mechanism.

Pathogenic for human protozoa belong to the domen Eukaryota, kingdom Protozoa and are representatives by four species: Sarcomastigophora, Apicomplexa, Ciliophora, Microspora.

Sarcomastigophora species

Species Sarcomastigophora is divided into the subspecies Sarcodina and subspecies Mastigophora.

Subspecies Sarcodina includes pathogenic amoeba – genus Entamoeba, genus Naegleria, genus Acanthamoeba, genus Balamuthia.

Entamoeba histolytica

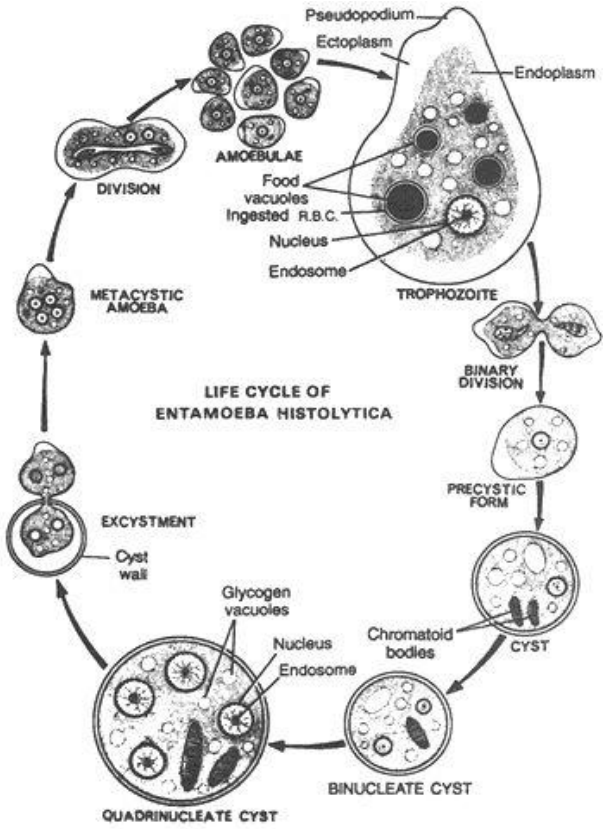
Entamoeba histolytica belongs to the species Sarcomastigophora genus Entamoeba. *E. histolytica* causes amebic dysentery and liver abscess.

Morphology, life cycle. There are two life cycles of this parasite: a large trophozoite (forma magna, tisssue' vegetative form) that is motile by means of pseudopods and smaller (forma minuta) compact, nonmotile cyst. The trophozoite lacks most of the organells of other eucaryotes and it has a large single nucleus that contains a prominent nucleolus called a karyosome. The mature cyst is encased in a thin, yet tough wall and contains four nuclei.

Epidemiology. Humans are primary hosts of *E. histolytica.* Infection is usually acquired by ingesting food or drink contaminated with cysts released by an asymptomatic carrier.

Pathogenesis. Cysts arrive in the small intestine, the alkaline pH and digestive juices of this enviroment stimulate excystment and from cyst four trophozoites emerge. The trophozoites attache to the mucosa with pseudopods, multiply and actively move about and feed. The ameba secretes enzymes that dissolve tissues and actively penetrates deeper layers of the mucosa, leaving erosive ulcerations.

Clinical symptoms include bloody mucus-filled stools, abdominal pain, fever, diarrhea, weight loss. In 90% of patients infection is asymptomatic and the trophozoites do not invade beyond the most superficial layer.



Entamoeba histolytica : Reproductive and life history

Diagnosis. Microscopic examination of clinical samples (fecal smears, biopsies, serum, aspirate) is used for trophozoites or cysts detection. Serological tests include CFT, ELISA, IF, neutralization.

Treatment. Metronidazole, dehydroemetine, tinidazole, ornidazole, tetracycline delagil and chloroquine act systematically, iodoquinolon act in the feces.

Prophylaxis. There is no specific prophylaxis.

Flagellates

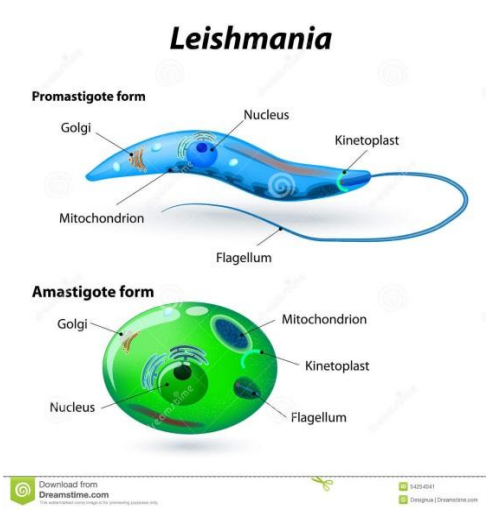
Subspecies Mastigophora

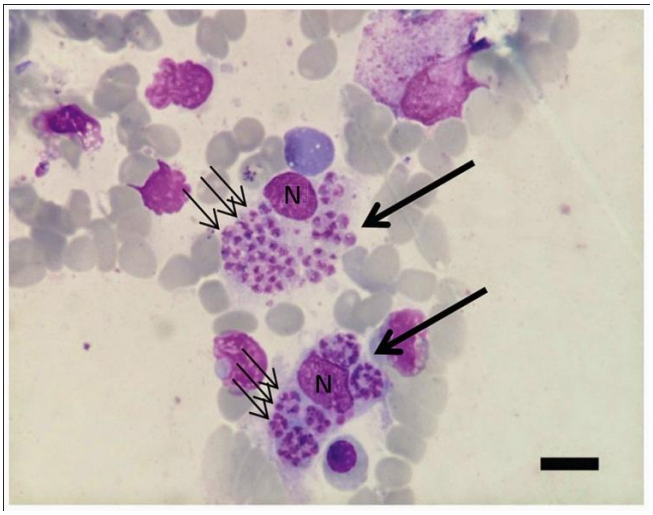
Subspecies Mastigophora include genera Leishmania, Trypanosoma, Giardia, Trichomonas. Common feature is the presence of flagella as move organ.

Leishmania genus

Leishmania are flagellated insect-transmitted protozoa. Three species produce human diseases*: L. donovani* (visceral leishmaniosis), *L. tropica* (cutaneous) and *L. braziliensis* (mucocutaneous).

Morphology, life cycle. Leishmania are round-to-oval cells with a nucleus and a small, rod-shaped kinetoplast. In humans and other vertebrates, Leishmaniaspp. parasitize in mononuclear phagocytic cells (macrophages, monocytes, Langerhans cells) in the amastigote form.





Leishmania amastigotes in the macrophages

The promastigote stage is present in the saliva of infected sandflies. The bite of infected sandfly injects the promastigotes into the skin where they lose their flagellum and become amastigote (rudimentary flagellum) and invade reticuloendothelial cells. After phagocytosis by macrophages or monocytes, amastigotes multiply, filling the cytoplasm of the cell. The infected cells burst, and the released parasites are again phagocytosed. This process is repeated, producing a cutaneous lesion or visceral infection depending on the species of parasite and the host response.

Ingested amastigote transform in the sandfly into the promastigote stage, which migrate to the fly proboscis where new human infection can be introduced during the feeding. Promastigotes are fusiform, have flagellum.

Epidemiology. Reservoir host in cutaneous antroponosis leishmaniosis is human, in cutaneous zoonotic leishmaniosis are rodents, in visceral leishmaniosis are human, dogs, foxes, jackals. The vector of transmission is Phlebotomus sandfly.

Pathogenesis. The disease can be presented in three main ways: cutaneous, mucocutaneous, or visceral leishmaniasis. The cutaneous form manifests as skin ulcers, while the mucocutaneous form presents with ulcers of the skin, mouth, and nose, and the visceral form starts with skin ulcers and then later presents with fever, low red blood cells, and enlarged spleen and liver.

Laboratory diagnosis. Specimens for investigation are blood, serumpunctate of bone marrow, punctate lymph nodes. Methods of diagnosis include microscopic investigation, bacteriological, serological tests (ELISA, IF), leishmanin skin allergic test.

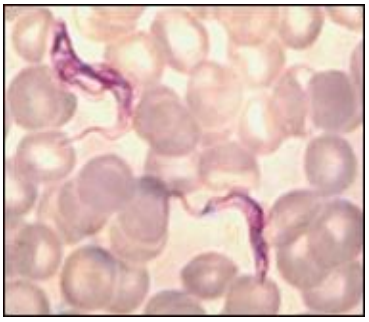
Treatment. Medications used for visceral disease include liposomal amphotericin B, a combination of pentavalent antimonials and paromomycin, and miltefosine. For cutaneous disease, paromomycin, fluconazole, or pentamidine may be effective.

Prophylaxis. There is no specific prophylaxis.

Trypanosomagenus

Trypanosomes is a genus of parasitic flagellate protozoa, which infect a variety of hosts and cause various diseases. Trypanosoma brucei is the agent of African sleeping sickness, Trypanosoma cruzi is the agent of Chagas disease endemic to Central and South America.

Morphology, life cycle. Trypanosomes have elongated body, nucleus in the central part, kinetoplast from which departs flagellum, and an undulating membrane.Life cycle takes part in vertebrate (trypomastigote, amastigote) and in invertebrate (epimastigote) hosts. Intracellular life cycle stages are normally found in the amastigote form.



Trypanosomes

Epidemiology. Reservoir and source of sleeping sickness are antelope, pig, lion, hyena, cow, goat or human. Vector of transmission is tsetse fly.

Reservoir and source of Chagas disease are rodents, monkeys, chickens, squirrels, opossums. Vector of transmission are bugs of Reduviidae family.

Pathogenesis. The infective stage of ***T. brucei*** is the trypomastigote. The cycle begins when a tsetse fly becomes infected after feeding on an infected reservoir host. The trypanosome is taken into the gut with a blood meal, where it multiplies by binary fission, migrates to salivary glands where an epimastigote form develops into the infectious stage. At the site of vector bite a sore called the primary chancre is produced. From there, the pathogens move into the lymphatics and the blood. Symptoms include intermitten fever, enlarged spleen, swollen lymph nodes and joint pain. When the parasite invades the central nervous system by passing through the blood–brain barrier, disruption of the sleep cycle begins (a leading symptom that gave the disease the name 'sleeping sickness'). Infected individuals experience a disorganized and fragmented 24-hour rhythm of the sleep-wake cycle, resulting in daytime sleep episodes and nighttime periods of wakefulness.

T.cruzi has the life cycle parallels that of T.brucei, exept that its development tissue form is called amastigote (intracellular form with no flagellum and no undulating membrane). The insect hosts are “kissing” bugs that harbor the trypanosome in the hind gut and discharge it in feces. The organisms in the feces of the bug enter the wound. Trypanosomiasis in humans progresses with the development of the trypanosome into a trypomastigote in the blood and into an amastigote in tissues. The acute form of trypanosomiasis is usually unnoticed or as

a localized swelling at the site of entry. The chronic form may develop 30 to 40 years after the infection and affect internal organs (e.g., the heart, the oesophagus, the colon, and the peripheral nervous system). Affected people may die from the heart failure.

Laboratory diagnosis. Specimens for investigation are blood, aspirate of chancre, CSF. Microscopic, serological tests (IF, ELISA, AT, IHT), biological, PCR methods are used for diagnosis.

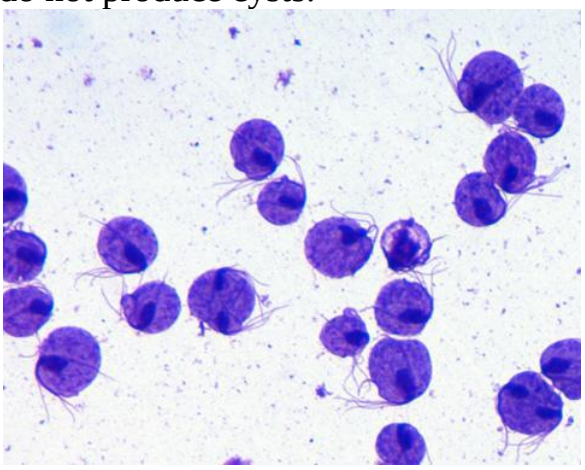
Treatment. Difluoromethylornithine, melarsoprol, solyusurmin, neostybozan, pentamidine may be used for treatment.

Prophylaxis. There is no specific prophylaxis.

Trichomonas genus

The most important species *Trichomonas vaginalis* is a pathogen of the reproductive tract that causes a sexually transmitted disease called trichomoniasis. *Trichomonas tenax* causes gingivitis, parodontosis. *Trichomonas hominis* causes ulcerative colitis.

Life cycle, morphology. Trichomonads are small, pear-shaped protozoa. Five flagella arise near the cytostome. Four flagella freely extend forwards and one extends backwards, forming the outer edge of the undulating membrane, which reaches back only just beyond the middle of the cell. Barb-like axostyle projects opposite the flagella bundle. It may be used for attachment to surfaces and may also cause the tissue damage seen in trichomoniasis infections. They exist only in the trophozoite form and do not produce cysts.



Trichomonads

Epidemiology. The reservoir and source of *T. vaginalis* is sick human or carrier. Mechanism of transmisiion is contactly (sexual, during childbirth, items of common consumption).

Pathogenesis. *T.vaginalis* is a common cause of vaginitis in women, while men with this infection can display symptoms of urethritis. 'Frothy', greenish vaginal discharge with a 'musty' malodorous smell is characteristic.

Laboratory diagnosis. Discharge from the vagina, urethra are samples for diagnosis. Microscopic method is used for demonstration of the "corkscrew"

motility of trichomonads in a wet film of exudate (native smear), or for trichomonads detection in the smears stained by Romanovskyi-Gimza. Bacteriological method, PCR are used also.

Treatment. metronidazole, trichopol, furazolidone, tinidazole may be used for treatment.

Prophylaxis. There is no specific prophylaxis.

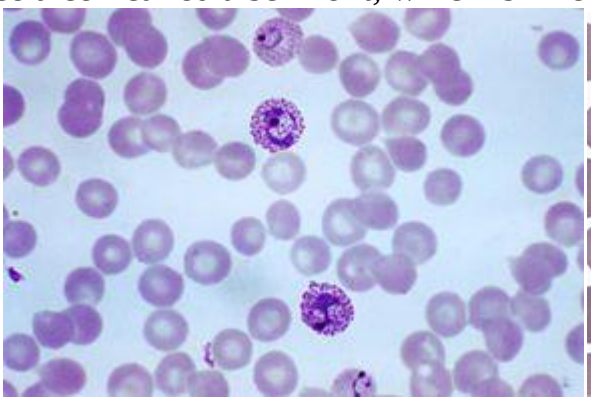
Sporozoans

Sporozoans are strictly parasitic protozoans of Apicomplexa species class Sporozoa. 7 genera of this class include human pathogens: Plasmodium, Toxoplasma, Sarcocystis, Isospora, Cryptosporidium, Cyclospora, Babesia.

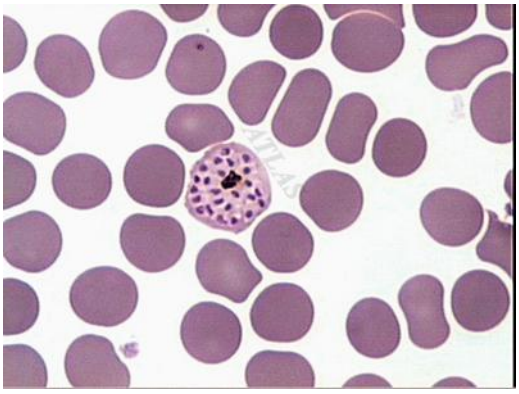
Plasmodium genus

The agent of malaria is an obligate intracellular sporozoan in the genus Plasmodium, which contains four species: *P. malariae* (quartan or malarial malaria), *P. vivax* (tertian malaria), *P. falciparum* (malignant tertian malaria) and *P. ovale* (tertian or ovale malaria).

Life cycle, morphology. Development of the malarial parasite is divided into two distinct phases: the asexual phase, carried out inthe human and the sexual phase, carried out in the mosquito. The asexual phase and infection begin when infected female Anopheles mosquito extracts the blood that is necessary to develop her eggs. She injects saliva containing anticoagulant into the capillary she has punctured, an event that also inoculates the blood with motile, spindle – shaped asexual cells called sporozoites. The sporozoites are carried to the liver where asexual division called schizogony generates numerous daughter parasites or merozoites (exoerythrocytic cycle lasts 5-16 days depending on the plasmodium species). During the erythrocytic phase merozoites infect red blood cells and transform into a circular (ring) trophozoite, which undergoes multiple divisions produce a cell called a schizont, which is filled with more merozoites.



***P. vivax* trophozoites**



***P. vivax* schizont**

Merozoites differentiate into two types of specialized gametes called macrogametocytes (female) and microgametocytes (male). The sexual phase is in the mosquito's stomach where after diploid meiotic divisions they form haploid sporozoites that migrate to the salivary glands and lodge there. This event

completes the sexual cycle and makes sporozoites available for injection when the mosquito feeds on her next victim.

Epidemiology. The reservoir and source of infection are sick human or carrier. All forms are spread primarily by the female Anopheles mosquito. Malaria is usually found in tropical and subtropical climates where the parasites, that cause it, live.

Pathogenesis. The mosquito bite introduces the parasites from the mosquito's saliva into a person's blood. The parasites travel to the liver where they mature and reproduce. Symptoms of the disease usually begin ten to fifteen days after being bitten and include fever, fatigue, vomiting, and headaches. If not properly treated, people may have recurrences of the disease months later. Reinfection usually causes milder symptoms. In severe cases it can cause yellow skin, seizures, coma, or death.

Laboratory diagnosis. Microscopy blood smears, serological tests (IF), PCR.

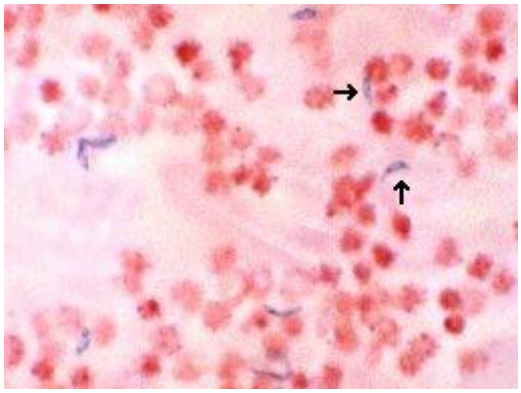
Treatment. Artemisinin, lumefantrine, chloroquine, mefloquine, primaquine are medications for treatment.

Prophylaxis. There is no specific prophylaxis. Chemoprophylaxis is recommended for risk group.

Toxoplasma genus

Toxoplasma gondii is causative agent of toxoplasmosis, which is distributed around the globe and is particularly important as AIDS-associated invasion.

Life cycle, morphology. The lifecycle of *T. gondii* includes a sexual component that occurs only within cats (definitive host), and an asexual component that can occur within virtually all warm-blooded animals, including humans, cats, and birds (intermediate hosts). The parasite undergoes a sexual phase in the intestine of the cat and is then released in feces, where it becomes an infective oocyst (thick-walled, zygote-containing cysts). Ingested oocysts release an invasive asexual tissue phase called a tachyzoite - the motile and quickly multiplying cellular stage of *T. gondii*. These forms enter an asexual cyst state in tissues called pseudocyst.



***T. gondii* tachyzoites**

Epidemiology. The reservoir hosts are the common house cat and other felines. The sources of infection are animal, birds, dogs, cats. The mechanisms of transmission are fecal –oral (ingestion of cysts), contact (transplantation), transplacental.

Pathogenesis. Most cases of toxoplasmosis are asymptomatic. Chronic, persistent toxoplasmosis can produce extensive brain lesions and can create fatal disruption of the heart and lungs. Congenital infection is associated with abnormalities such as liver and spleen enlargement, hydrocephalus, convulsions. The reactivated form is the most cause of encephalitis in AIDS patients.

Laboratory diagnosis. Microscopic method, biological, serological test (ELISA, IF, IHT, CFT), biopsy specimens for demonstration of trophozoites and cysts in tissues, PCR, allergic methods are used.

Treatment. Pyrimethamine, sulfadiazine.

Prophylaxis. There is no specific prophylaxis.

Pathogenesis. The trophozoites burrow into the epithelium with their cilia. The resultant erosion of the intestinal mucosa produces varying degrees of irritation and injury, leading to nausea, vomiting, diarrhea, dysentery and abdominal colic.

Laboratory diagnosis. Microscopic method is used many times for feces investigation (“wet drop”).

Treatment. Medications for treatment include metronidazole, tinidazole, delagil, oral tetracycline, paromomycine, nitrimidazine.