Basic Information and Tutorial Exercises for Medical Parasitology

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Cambridge
Scholars
Publishing

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This book first published 2023

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN (10): 1-5275-3119-8
ISBN (13): 978-1-5275-3119-2

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PREFACE AND ACKNOWLEDGEMENTS

This training guide for medical students offers an introduction to the field of medical parasitology. The book will appeal to medical students, anyone involved in the teaching and research of human parasitology, and physicians dealing with human parasites.

The main text of the book consists of two parts:

The first part contains *background information* about selected human parasites, their epidemiology and control, and the most important animal vectors of human diseases. It starts with an overview of basic concepts in medical parasitology (*Chapter 1*), which is followed by a glossary of terms (*Chapter 2*). The basic information about medically important parasites and vectors of human parasitoses is given in two different forms: first, as a number of brief overviews of parasites and parasitoses they cause (*Chapter 3*), and then as a row of summary tables (*Chapter 4*). We hope that such duplication of the information allows faster analysis and memorization by the readers. Additionally, semi-diagrammatic identification keys for the most prominent human parasites (*Chapter 5*) may improve operation with the received visual information.

The second part of the book contains various *exercises* that can be used to consolidate the studied material, including training tests (*Chapter 6*), exemplary case histories (*Chapter 7*), and tables (*Chapter 8*). Working on these exercises, the reader is invited to use the background information from the first part of the book.

The readers are able to evaluate themselves by checking correct answers to exercises from Chapters 6 and 7, which can be found at the end matter of the book.

Acknowledgements. We would like to thank Dr. Yuriy Kuzmin (Department of Parasitology, I. I. Schmalhausen Institute of Zoology NAS of Ukraine) and Dr. Volodymyr Gorobchishin (Institute for Evolutionary Ecology NAS of Ukraine) for reading and editing of the early versions of this book. We are also grateful to Prof. Terry R. Spraker (Colorado State University, USA)

and Brendon E. Boudinot (University of California, Davis, USA) for the English editing of the text.

PART 1

BACKGROUND INFORMATION

CHAPTER 1

INTRODUCTION TO MEDICAL PARASITOLOGY: BASIC CONCEPTS

Parasitology is the science addressing parasites, their hosts, and the relationship between them. It combines several disciplines that study the parasites of animals and humans:

- General parasitology studies parasites as organisms, their morphology, biology, ecology, life cycles, distribution, and methods of parasite control;
- Medical parasitology studies parasites living in/on the human body that cause diseases to humans, their biology, life cycles, pathology, and methods of treatment and prevention;
- Veterinary parasitology studies parasites of wild and domestic animals, their biology, life cycles, pathology, and methods of control.

Medical parasitology is a part of the course of medical biology, which includes:

- Medical protozoology – a part of medical parasitology that studies parasitic protozoans and diseases they cause to humans;
- Medical helminthology that studies parasitic worms (or helminths): trematodes (flukes), cestodes (tapeworms) and nematodes (roundworms) and diseases they cause;
- Medical entomology or public health entomology focuses on arthropods that impact human health (as parasites and/or vectors that transmit human diseases).

Medical parasitology is focused on parasite-host systems, which include two components: a parasite and its host. A parasite is an organism that lives in or on another organism (host) and derives nutrients from it, causing detrimental effects on the host. A host is an organism (animal or human)

in/on which the parasite lives and uses the host as a shelter and a source of nutrients. Therefore, parasitism is a permanent or temporary association between two organisms of different species in which one (a parasite) derives benefit from the other (the host), usually to obtain food, shelter or physical support (Ex.: *Ascaris lumbricoides* resides in the gastrointestinal tract of human, and feeds on important items of intestinal food causing various illnesses).

Aside from parasitism, there are two more types of relationships between two organisms:

- Mutualism is an association in which both partners are metabolically dependent upon each other and one cannot live without the help of the other; however, none of the partners suffers any harm from the association. (Ex.: the relationship between certain species of flagellated protozoa living in the gut of termites. The protozoa depend entirely on the nutrients from termites; in return, they synthesize digesting enzymes (cellulases), which are utilized by the termites for their digestion).
- Commensalism is an association in which one organism (commensal) takes benefit without causing any harm to the host. (Ex.: most organisms of normal microflorae of the humans' body can be considered as commensals).

Parasites. There are several classifications of parasites, based on different approaches (their morphological organization, localization, or peculiarities of host-parasite relations).

- Microparasites are small usually unicellular microscopic parasites, which are visible under a microscope (e.g., parasitic protozoa – *Entamoeba histolytica*, *Leishmania*, *Toxoplasma gondii*, *Plasmodium*, etc.). Microparasites are characterized by short generation times; they have a tendency to induce immunity in the host to resist infections. The duration of infection with microparasites is usually short in relation to the lifespan of the host.
- Macroparasites are relatively large usually multicellular parasites that are visible to the naked eye (flukes, flatworms, roundworms, ticks, etc.). Macroparasites tend to incite a complex immune response in the host; moderate host infections can persist for long periods (months, years).

- Endoparasites are parasites that live inside the body of their host (in or on different internal organs) causing infection.
- Ectoparasites are parasitic organisms that live on the outer surface of their host (e.g., lice, ticks, mites) and cause infestations of the host.
- Obligate parasites are completely dependent on their hosts during a part or whole life cycle and, in contrast to a facultative parasite, cannot live and reproduce outside the body of its host or hosts (e.g., *Plasmodium*, *Trichinella spiralis*).
- Facultative parasites are free-living or commensal organisms that can become parasitic in certain circumstances but do not completely rely on any hosts for the completion of their life cycle (*Acanthamoeba* spp., *Naegleria fowleri*, parasitic larvae of some flies, etc.).
- Accidental parasites are organisms that affect an unusual host and survive in its body (e.g., rat tapeworm *Hymenolepis diminuta*, *Toxocara canis*). Accidental parasites usually do not live for a long time in unnatural hosts, but they may be extremely pathogenic for their unnatural hosts.
- Temporary parasites are parasites that contact their host only for feeding or reproduction and then leave it (e.g., bed bug *Cimex lectularius*, mites, lice, soft shell ticks, or flies that cause myiasis in humans and animals).
- Opportunistic parasites are parasites that are capable of occasionally parasitizing susceptible hosts (amoebic disease of immunocompromised hosts).

Hosts. The life cycle of the parasite is a process of growth, development, and reproduction, which proceeds in one or more different hosts depending on the species of parasite. Parasites that must parasitize more than one host species to complete their life cycles have complex, or indirect life cycles (trematodes such as *Fasciola hepatica*, *Dicrocoelium dendriticum*, cestodes, etc.). Parasites that infect only a single host species have direct life cycles (nematodes such as *Ascaris lumbricoides*, *Enterobius vermicularis*, etc.).

Hosts also are classified into different categories depending on the specifics of their interactions with parasites.

- Definitive hosts are organisms in which a parasite reaches the adult stage or undergoes sexual reproduction; if there is no sexual

reproduction in the life cycle of the parasite, the host most important to the parasite is considered as the definitive host.

- Intermediate hosts are organisms in which a parasite undergoes the development of its intermediate or larval stages, but does not reach sexual maturity; the intermediate host harbors asexual or immature stages of the parasite. In some cases, larval development is completed in two different intermediate hosts, referred to as the first and second intermediate hosts.
- Paratenic (transport) hosts are organisms in which a parasite survives without undergoing any development. Paratenic hosts accumulate and maintain immature stages of a parasite and serve as a temporary refuge and/or "vehicle" for reaching an obligatory host.
- Reservoir hosts are organisms that maintain a parasite/disease in nature and serve as a source of infection for other susceptible hosts. Usually, it is not affected by the infection.
- Natural hosts are hosts that are naturally infected with certain species of parasites.
- Incidental (accidental) hosts are hosts that under normal circumstances are not infected with the parasite and are not necessary for the parasite's survival or development (e.g., a human is an incidental host of *Trichinella spiralis*).
- Dead-end hosts are hosts from which the parasite cannot be transmitted to another host and, therefore, cannot complete its developmental cycle (humans as a host for *Toxoplasma gondii* and *Trichinella spiralis*).

Sources of infection. Many parasites can cause disease in humans. The source of infection is an object (human or animal) from which the infectious agent (parasite) is released into the environment and from there – to other susceptible hosts.

- The invasive (infective) stage is a stage of the parasite (eggs, larvae) which is capable of invading and living in a susceptible host.
- Transmission is the process of passing a pathogen (parasite) from an infected host (source of infection) to a particular susceptible host.
- Vector is a living carrier/transmitter (e.g., an arthropod) that transports a pathogenic organism (parasite) from an infected to a non-infected host.

Routes of parasite transmission. Medically important parasites have a variety of routes of transmission between hosts.

- Transmission route – the pathway thorugh which the parasite moves from a source of infection (a starting point) to a susceptible host (destination).
- Direct (person-to-person) transmission – transmission of pathogens (parasites) from an infected person to another one through touching, biting, kissing, droplet contact (coughing, sneezing, blood transfusions, etc.), or via sexual intercourse. It may include skin-to-skin, respiratory tract–respiratory tract, blood–blood, genital-to-genital, and oral–genital routes.
- Indirect transmission – transmission of an infectious organism (parasite) from a source of infection to a susceptible host through inanimate objects (water, food, soil, fomites, and other contaminated things), or via another organism, either a vector or an intermediate host.
- Vertical (mother-to-child) transmission – a passage of an infectious agent (parasite) from the mother to a fetus or baby during pregnancy, or childbirth; it includes cytoplasmic and transplacental transmission, during vaginal birth and breastfeeding.
- Percutaneous transmission – transmission of a parasite (pathogen) by direct penetration through the intact skin (ex.: *Schistosoma* spp.).

Types of infection/diseases. According to different routes of parasite transmission, parasitic diseases/infections are divided into the following categories:

- Food-borne disease – a disease caused by consuming food or drink contaminated with parasites or their eggs/larvae (toxoplasmosis, ascariasis, amoebiasis, taeniasis, trichinosis).
- Soil-borne disease – a disease caused by parasites whose infective stages live in the soil (e.g., trichuriasis, ancylostomiasis, strongyloidiasis).
- Vector-borne (transmissive) disease – a disease caused by any pathogens (parasites) transmitted by vectors (e.g., malaria, babesiosis, leishmaniasis, filariasis).
- Air-borne disease – a disease caused by inhalation of dust or air contaminated with infectious agents (e.g., eggs of *Enterobius*).

- Water-borne disease – a disease caused by contact with water contaminated with parasites (e.g., schistosomiasis, fascioliasis). In most cases, the water becomes contaminated by human or animal feces that carry parasites (e.g., giardiasis).
- Blood-borne disease – a disease that can be transmitted through contact with an infected person's blood or other body fluids through skin cuts, blood transfusions, or by sharing needles or syringes contaminated with blood (malaria, babesiosis, viral diseases, etc.).
- Sexually-transmitted diseases – a disease transmitted from an infected person to their sexual partners via sexual intercourse (e.g., trichomoniasis).

There are three general categories of parasitic diseases depending on the type of definitive/intermediate hosts and peculiarities of the life cycle of the human parasites:

- Anthroponosis, or an anthroponotic disease, is an infectious disease that can naturally spread between humans only (*Trichomonas vaginalis*, *Leishmania* spp., and *Enterobius vermicularis*). Primates in enclosures such as zoos and research facilities are usually at risk of anthroponosis.
- Anthropozoonosis is a parasitic disease that can be transmitted from animals to humans or vice versa (malaria, leishmaniasis).
- Zoonosis, or zooanthroponosis, is a parasitic disease in which animals are normally the hosts, but which can also infect humans (toxoplasmosis, fascioliasis, echinococcosis, trichinellosis, etc.).

CHAPTER 2

GLOSSARY OF MEDICAL PARASITOLOGY

A

Aberrant host – *see* **host, aberrant.**

Acanthamoeba – A genus of free-living amoebae that can infect humans and cause acanthamoebiasis, including Acanthamoeba keratitis and granulomatous amoebic encephalitis.

Acanthamoeba keratitis – A rare disease in which *Acanthamoeba* invade the cornea of the eye and may cause permanent visual impairment or blindness.

Acanthamoebiasis – An infection by amoebae of the genus *Acanthamoeba.*

Acarid – Any member of the subgroup Acari of the arthropod class Arachnida that includes mites and ticks.

Acariasis (= acarinosis) – Infestation with acarid parasites.

Acaricide – A chemical substance (drug) that destroys ticks and mites.

Acarinosis – *see* **acariasis**.

Accidental host – *see* **host, accidental.**

Accidental parasite – A parasite that parasitizes an organism other than its usual host.

Acute schistosomiasis – *see* **Katayama syndrome.**

African trypanosomiasis – *see* **trypanosomiasis, African.**

Air-borne disease – *see* **disease, air-borne.**

Aleppo button – *see* **leishmaniasis, cutaneous.**

Alveococcus multilocularis – A taxonomic synonym of the tapeworm *Echinococcus multilocularis.*

Alveococcosis – *see* **echinococcosis, multi-chamber.**

Alveolar echinococcosis – *see* **echinococcosis, multi-chamber.**

Alveolar hydatid cyst – *see* **hydatid cyst, alveolar**.

Amastigote (= "leishmanial" stage) – An intracellular parasitic lifecycle stage of kinetoplastid (flagellate) protozoans without any free flagellum.

American trypanosomiasis – *see* **trypanosomiasis, American.**

Amoeba (pl. amoebae) – A single-celled organism that has no rigid body shape, moves about and takes in food by extending pseudopods.

Amoebiasis (= amoebic dysentery, entamoebiasis) – An intestinal infection caused by the protozoan parasite *Entamoeba histolytica* or related amoebae.

Amoebic dysentery – *see* **amoebiasis**.

Amoebic liver abscess – An uncommon but potentially life-threatening complication of extraintestinal infection with the protozoan parasite *Entamoeba histolytica*.

Ancylostomiasis (= hookworm disease, miner's anemia, tunnel disease, brickmaker's anemia, Egyptian chlorosis) – An intestinal infection caused by blood-sucking hookworms of the genus *Ancylostoma*.

Anopheles – A genus of mosquitoes of the family Culicidae; a number of *Anopheles* species are vectors of several human diseases, including malaria and filariasis.

Anthelmintics (= dewormers) – Agents (usually chemical drugs) destructive to worms.

Anthroponosis (= anthroponotic disease) – An infection that can naturally spread between humans only.

Anthroponotic disease – *see* **anthroponosis.**

Anthropozoonosis – Any disease that is transmitted from animals to humans, or *vice versa*.

Apicomplexan – Any member of the phylum Apicomplexa comprised of obligate endoparasitic protozoans, including *Plasmodium*, *Babesia*, and *Toxoplasma*; apicomplexans are sometimes treated as synonymous with sporozoans.

Arachnid – Any member of Arthropoda from the class Arachnida, including mites and ticks.

Armed tapeworm – A common name of the cestode *Taenia solium*.

Arthropod – Any member of the phylum Arthropoda, including insects, mites, and ticks.

***Ascaris lumbricoides* (= large intestinal roundworm, giant roundworm)** – A roundworm species that causes ascariasis in humans.

Ascariasis – Disease principally caused by the roundworm *Ascaris lumbricoides*.

Autoinfection – Infection from a source within the organism itself; in parasitology, autoinfection occurs if the life cycle of the parasite completes within a single organism, without the involvement of other organisms or hosts.

B

Babesia – A genus of intracellular parasites in the protozoan phylum Apicomplexa.

Babesiosis (= piroplasmosis, tick fever, Texas fever, redwater fever) – A group of malaria-like diseases caused by the protozoans *Babesia* spp.

Balantidium coli – The only ciliate protozoan species which is an obligate parasite of humans.

Baghdad boils – *see* **leishmaniasis, cutaneous.**

Balantidiasis – Intestinal infection caused by the ciliate *Balantidium coli*.

Beaver fever – *see* **giardiasis.**

Bilharzia – *see* **schistosomiasis.**

Biohelminths – Parasitic worms for which changing hosts (definitive and intermediate) is obligatory to complete their life cycle

Biological vector – *see* **vector, biological.**

Black fever – *see* **visceral leishmaniasis.**

Blackfly – A common name of any member of the insect family Simuliidae; these small blood-feeding flies are vectors of several parasitic diseases, including the onchocerciasis.

Blackwater fever – A serious complication of malaria, characterized by the massive destruction of red blood cells, producing dark red or blackish urine, containing hemozoin.

Blood-borne disease – see **disease, bloodborne.**

Blood parasites – A general term used in referring to those parasites, which spend most of their lives in the vascular system.

Body louse – A common name of the louse *Pediculus humanus humanus*.

Brain-eating amoeba – A common name of the amoeba *Naegleria fowleri*.

Brickmaker's anemia – *see* **ancylostomiasis.**

Broad fish tapeworm – A common name of the cestode *Diphyllobothrium latum*.

C

Calabar swellings – Swollen lumps of subcutaneous tissue caused by a parasitic filarial worm *Loa loa*; a characteristic symptom of loiasis.

Carrier (= vector) – An organism that carries pathogens and can pass them on to other potential hosts; although carriers do not necessarily show symptoms of the disease.

Causative agent – see **pathogen.**

Cercaria (pl.: cercariae) – The free-living swimming non-ciliated

larval stage of flukes; usually possessing a tail.

Cercarial dermatitis (= swimmer's itch) – An itchy rash occurring in the skin of humans infected by cercariae of certain species of schistosomes whose normal hosts are birds and mammals other than humans.

Cestoda – The class of parasitic flatworms also called tapeworms.

Cestodiasis – Infection with tapeworms (class Cestoda).

Cat liver fluke – A common name of the trematode *Opisthorchis felineus*.

Chagas disease – *see* **trypanosomiasis, American.**

Chagoma – A characteristic symptom of American trypanosomiasis, which manifests as an inflammatory nodule at the bite site of the "kissing bug".

***Chrysops* (= deer fly)** – A genus of bloodsucking flies in the family Tabanidae which are vectors of some human diseases, including loiasis.

Ciliate – A group of protozoans possessing cilia.

***Cimex lectularius* (= common bed bug)** – A blood-feeding insect species that may cause cimicosis in humans.

Cimicosis – Skin manifestation due to the bite of a common bed bug *Cimex lectularius*.

Coccidia – A group of obligate intracellular apicomplexan parasites (e.g., *Toxoplasma*).

Commensal – An organism (an animal, plant, fungus, etc.) living with, on, or in another organism, without injury to either.

Common bed bug – A common name of the insect *Cimex lectularius*.

Common liver fluke (= sheep liver fluke) – A common name of the trematode *Fasciola hepatica*.

Congenital toxoplasmosis – *see* **toxoplasmosis, congenital.**

Crab louse (= pubic louse) – A common name of the louse *Pthirus pubis.*

Crusted scabies – *see* **Norwegian scabies.**

Culex – A genus of mosquitoes of the family Culicidae, which can serve as vectors for several human parasites, including filarial worms and apicomplexan parasites.

Cutaneous larva migrans (= larva migrans) – A convoluted, thread-like skin eruption in humans caused by roundworm larvae, in particular, those of *Ancylostoma* spp. And *Necator americanus*, burrowing beneath the skin.

Cutaneous leishmaniasis (= Oriental sore, Baghdad boil, Aleppo button) – *see* **leishmaniasis, cutaneous.**

Cuticle – The external non-cellular layer of the body integument of some invertebrates, including nematodes and arthropods.

Cyst – In parasitology, the term cyst may have two meanings: (1) Resistant dormant stage of protozoans. (2) A bladder-like larva of some tapeworms (e.g., hydatid cysts of *Echinococcus*).

Cystic echinococcosis – *see* **echinococcosis.**

Cysticercosis – A tissue infection of humans that is caused by cysticercus or cysticerci of the pork tapeworm *Taenia solium* that may also infect the nervous system, causing neurocysticercosis.

Cysticercus (pl.: cysticerci) – A bladder-like larva of some tapeworms (e.g., *Taenia solium*, *Taenia saginata*) that is present in tissues of the intermediate hosts and contains one protoscolex.

D

Dead-end host – *see* **host, dead-end.**

Deer fly – A common name of a fly from the genus *Chrysops*.

Definitive host – *see* **host, definitive.**

***Demodex folliculorum* (= face mite)** – A mite species which lives within the hair follicles as a component of normal fauna of the human skin; hyper-infection may cause demodicosis.

Demodex blepharitis – *see* **demodicosis ocular.**

Demodicosis (= demodectic mange, red mange) – Skin infection caused by the mite *Demodex folliculorum*.

Demodicosis ocular (= ocular demodicosis, Demodex blepharitis) – Eyelash infection caused by the mite *Demodex folliculorum*.

***Dermatobia hominis* (= Torsalo Fly, human botfly)** – A large, densely-haired fly (Oestridae) that causes furuncular myiasis; endemic in Central and South America.

Dermatobiasis (= South American myiasis, human botfly myiasis) – An obligate furuncular myiasis, the development of which is provoked by the larva of the fly *Dermatobia hominis*.

Dicrocoeliasis – Liver infection with the fluke *Dicrocoelium dendriticum*.

***Dicrocoelium dendriticum* (= lancet liver fluke)** – A liver fluke species that may rarely parasitize humans and cause dicrocoeliasis.

Dioecious – Having separate sexes (males and females).

***Diphyllobothrium latum* (= broad fish tapeworm)** – A tapeworm species that causes diphyllobothriasis in humans.

Diphyllobothriasis – Intestinal infection with the tapeworm *Diphyllobothrium latum*.

Direct life cycle – *see* **life cycle, direct.**

Disease, air-borne (= air-borne disease) – A disease caused by inhalation of dust or air contaminated with infectious agents (e.g., eggs of *Enterobius*).

Disease, blood-borne (= blood-borne disease) – A disease that can be transmitted through contact with an infected person's blood or other body fluids through skin cut, blood transfusion or by sharing needles or syringes contaminated with blood (e.g., malaria, babesiosis, viral diseases, etc.).

Disease, causative agent – see **pathogen.**

Disease, food-borne (= food-borne disease) – In parasitology: a disease caused by consuming food or drink contaminated with parasites (e.g., toxoplasmosis, ascariasis, amoebiasis, taeniasis, trichinosis).

Disease, water-borne (= water-borne disease) – In parasitology: a disease caused by contact with water contaminated with parasites (e.g., schistosomiasis, fascioliasis); in most cases, the water becomes contaminated by human or animal feces that carries parasites (e.g., giardiasis).

Disease, soil-borne (= soil-borne disease) – In parasitology: a disease caused by parasites whose infective stages live in the soil (e.g., trichuriasis, ancylostomiasis, strongyloidiasis).

Disease, vector-borne (= vector-borne disease, transmissive disease) – A disease caused by any pathogens transmitted by vectors (e.g., malaria, babesiosis, leishmaniasis, filariasis).

Dog tapeworm – A common name of the cestode *Echinococcus granulosus*.

Dumdum fever – *see* **leishmaniasis visceral**.

Dwarf tapeworm – A common name of the tapeworm *Hymenolepis nana***.**

E

Echinococcosis (= cystic echinococcosis, hydatid disease) – An infection, usually in the liver or lungs, caused by the larval stages (hydatid cysts) of tapeworms from the genus *Echinococcus*.

Echinococcosis, multi-chamber (= alveococcosis, alveolar echinococcosis, multi-chamber echinococcosis) – An echinococcosis caused by the cestode *Echinococcus multilocularis*.

Echinococcosis, single-chamber (=singlechamber echinococcosis, unilocular echinococcosis) – An

echinococcosis caused by the cestode *Echinococcus granulosus*.

Echinococcus – A genus of tapeworms (e.g., *Echinococcus granulosus, Echinococcus multilocularis*), larval stages of which may parasitize humans.

***Echinococcus granulosus* (= dog tapeworm)** – A tapeworm species in which larvae (hydatid cysts) cause single-chamber echinococcosis, primarily in the liver or lungs.

***Echinococcus multilocularis* (= fox tapeworm, *Alveococcus multilocularis*)** – A tapeworm species in which larvae (alveolar hydatid cysts) cause a tumor-like disease called multi-chamber echinococcosis.

Ectoparasite – A parasite that lives principally on the outer surface of an organism.

Egyptian chlorosis – *see* **ancylostomiasis.**

Elephantiasis – *see* **filariasis, lymphatic.**

Encystation – Formation of the cyst from the trophozoite; the term is used in relation to amoebae and *Balantidium coli*.

Endemic – Describes the presence of a disease that persists in a closed community or group of people of a specified territory.

Endoparasite – A parasite that lives inside the body of its host.

Entamoeba – A genus of amoebae of which some species are parasitic (e.g., *Entamoeba histolytica*).

Entamoebiasis – see **amoebiasis**.

Enterobiasis (= pinworm infection) – Intestinal infection with the nematode *Enterobius vermicularis*.

***Enterobius vermicularis* (= pinworm)** – An intestinal roundworm parasite, principally of children.

Epidemic – An unexpectedly large number of cases of a disease or illness that, for a limited time, affects many people in a particular region.

Epizootic – An unexpectedly large number of cases of a disease or illness in an animal population.

Excystation – Escape from a cyst (meaning 1) or envelope.

F

Face mite – A common name of the mite *Demodex folliculorum*.

Facultative parasite – *see* **parasite, facultative.**

Fecal-oral route of infection – *see* **infection, route fecal-oral.**

Fecal-oral route of transmission – *see* **route of transmission, fecal-oral.**

Fecal-oral transmission – *see* **route of transmission, fecal-oral.**

***Fasciola hepatica* (= common liver fluke, sheep liver fluke)** – A liver fluke species that may cause fascioliasis in humans.

Fascioliasis – A disease caused by infection with flukes of the genus *Fasciola*.

Filariasis – Infection with filarial worms.

Filariasis, lymphatic (= lymphatic filariasis, elephantiasis) – A disease principally caused by the filarial worms *Wuchereria bancrofti*.

Filariform larva – The infectious and nonfeeding third larval stage of some soilborne roundworms (e.g., *Ancylostoma* and *Strongyloides*).

Filarial worms – A group of long, hair-like nematodes in which the adults live in the blood or tissues of vertebrates. In some species, the larvae (microfilariae) may be found in the blood or tissues.

Final host – *see* **host, definitive.**

Fish tapeworm – A common name of the cestode *Diphyllobothrium latum*.

Flagellate – Any member of a group of protozoans, which cell bears flagellum or flagella for movement.

Flagellum (pl. flagella) – A long beating structure of a cell, which is normally used for movement.

Flatworms – A group of organisms comprising the phylum Platyhelminthes, including the flukes and tapeworms.

Flea – A small, wingless, blood-sucking insect from the order Siphonaptera that may be temporary ectoparasites of humans and act as vectors of diseases (e.g., plague, epidemic typhus, etc.).

Flesh flies – Flies of the subfamily Sarcophaginae; flesh flies from the genera *Sarcophaga* and *Wohlfahrtia* can cause myiases in humans.

Flukes – A group of parasitic flatworms of the class Trematoda.

Fomites – objects, such as clothing, bedding, towels, and other utensils that possibly harbor a pathogen/parasite and are involved in transmitting it.

Food-borne disease – see **disease, foodborne.**

Food-borne infection – *see* **disease, foodborne.**

Fox tapeworm – A common name of the cestode *Echinococcus multilocularis*.

G

GAE – An abbreviation of **granulomatous amoebic encephalitis**.

Geohelminths – Worms that spend a certain time during their life cycle living in the soil; they have a direct life cycle without any intermediate hosts.

Giardia lamblia (= Lamblia intestinalis) – A flagellate protozoan that causes the diarrheal illness known as giardiasis.

Giardiasis (= lambliasis, beaver fever) – A parasitic disease caused by the flagellate *Giardia lamblia*.

Giant roundworm – A common name of the roundworm *Ascaris lumbricoides.*

Glossina – A genus of African flies, which transmit African trypanosomiasis (the sleeping sickness).

Granulomatous amoebic encephalitis (= GAE) – A disease of the human central nervous system caused by certain species of free-living amoebae, incl. species of *Acanthamoeba*.

H

Head louse – A common name of the louse *Pediculus humanus capitis*.

Helminth – A parasitic worm.

Helminthiasis (= helminthosis) – A disease caused by helminth infection.

Helminthosis – *see* **helminthiasis.**

Hemozoin (= malarial pigment) – A black-brown pigment, that is a breakdown product of hemoglobin synthesized by *Plasmodium* and other blood-feeding parasites. In malaria patients, hemozoin is accumulated in the lymphoid tissue, liver, spleen, and bone marrow.

Hermaphrodite – An organism that possesses both male and female reproductive organs.

Heteroxenous parasite – *see* **parasite, heteroxenous.**

Hookworm – A parasitic roundworm of the genera *Ancylostoma* and *Necator*.

Hookworm diseases – *see* **ancylostomiasis**.

Host – An organism (animal or human) in/on which a parasite lives.

Host, aberrant (= aberrant host) – A host in which a parasite is not normally found and that is unsuitable for its proper development; parasite behavior (e.g., migration) in the aberrant host may be abnormal.

Host, dead-end (= dead-end host) – A host in which a parasite is unable to continue its life cycle.

Host, definitive (= definitive host, final host) – A host in which a parasite reaches the adult stage or undergoes sexual reproduction; if there is no sexual reproduction in the life cycle of the parasite, the

host most important to the parasite is the definitive host.

Host, intermediate (= intermediate host) – A host in which a parasite undergoes required development of intermediate or larval stages but not sexual maturity; the intermediate host harbors asexual or immature stages of the parasite.

Host, paratenic (= paratenic host, transport host) – A host in which a parasite survives without undergoing any development; a paratenic host accumulates and maintains immature stages of a parasite.

Host, reservoir (= reservoir host) – A host that maintains a parasite/disease organism in nature and serves as a source of infection for humans and/or domestic animals.

Host specificity – The restriction of a parasite to one or more species of its hosts.

Human flea – A common name of the flea species *Pulex irritans*.

House flea – A common name of the flea species *Pulex irritans*.

Human botfly – A common name of the fly *Dermatobia hominis*.

Human botfly myiasis – *see* **dermatobiasis.**

Hydatid cyst – The bladder-like larvae of the tapeworms *Echinococcus granulosus* or *Echinococcus multilocularis* that contain hydatid sand with daughter cysts, each of which has many protoscoleces; it is the cause of the hydatid disease.

Hydatid cyst, alveolar (= alveolar hydatid cyst, multiloculate hydatid cyst) – A tumor-like hydatid cyst of a multiloculate type, usually in the liver or lungs, caused by *Echinococcus multilocularis*.

Hydatid cyst, unilocular (= unilocular hydatid cyst) – A thick-walled fluid-filled hydatid cyst of *Echinococcus granulosus* usually in the liver or lungs.

Hydatid disease – *see* **echinococcosis.**

Hydatid sand – The protoscolices, daughter cysts, hooks, and calcareous corpuscles of *Echinococcus* tapeworms in the fluid within a primary or daughter hydatid cyst.

Hydatidosis – *see* **echinococcosis.**

***Hymenolepis nana* (= dwarf tapeworm)** – A tapeworm species infecting humans, especially children.

Hymenolepiasis – One of the most common tapeworm infections of humans is caused by the tapeworm *Hymenolepis nana*.

Hyperinfection – Infection caused by very large numbers of parasitic organisms.

I

Imago – The developmental stage in which the insect attains maturity.

Indirect life cycle – *see* **life cycle, indirect.штеукіуч**

Indirect transmission – *see* **transmission mode, indirect.**

Infection (= infestation – for ectoparasites**)** – Invasion by pathogens, which may or may not result in disease.

Infection route – *see* **route of infection.**

Infectious agent – *see* **pathogen.**

Infectious disease – Disorder caused by any pathogen (parasites, bacteria, viruses or fungi).

Infectious dose – The quantity of a pathogen (measured in a number of organisms) that is necessary to cause infection in a susceptible host.

Infective stage (= invasive stage) – Specific stage in the life cycle of a parasite that is capable of infecting a susceptible host.

Infestation – the presence of an unusually large number of ectoparasites in a place, typically to cause damage or disease.

Insect – Any member of the class Insecta, the phylum Arthropoda.

Intermediate host – *see* **host, intermediate**.

Invasive stage – *see* **infective stage.**

Intermittent parasite – *see* **parasite, temporary.**

Itch mite – A common name of the mite *Sarcoptes scabiei.*

Ixodiasis – Skin infestation with *Ixodes* ticks.

***Ixodes* ticks** – Any member of hard-bodied ticks of the genus *Ixodes*; this group includes vectors of important diseases (e.g., babesiosis, Lyme disease, etc.)

J

Japanese lung fluke (= oriental lung fluke) – A common name of the trematode *Paragonimus westermani*.

K

Kala-azar – *see* **leishmaniasis, visceral.**

Katayama syndrome (= Katayama fever, Safari fever, acute schistosomiasis) – A set of phenomena in humans, including fever, lethargy, malaise, and myalgia, associated with the penetration of the skin and invasion of the body by the cercariae of *Schistosoma* spp.

Katayama fever – *see* **Katayama syndrome.**

Kinetoplast – A network of circular DNA inside a large mitochondrion that is usually adjacent to the organism's flagellar basis; typical for kinetoplastids.

Kinetoplastid – Any member of a group of flagellated protists that is characterized by the presence of the kinetoplast (e.g., *Trypanosoma, Leishmania*).

"Kissing bug" – The triatomine bug that transmits the American trypanosomiasis; its nocturnal bite is barely felt.

L

Lamblia intestinalis – see *Giardia lamblia*.

Lambliasis – see **giardiasis.**

Lancet liver fluke – A common name of the trematode *Dicrocoelium dendriticum*.

Large intestinal roundworm – A common name of the roundworm *Ascaris lumbricoides.*

Larva – An immature stage in the life cycle of an organism, which bears little, if any, structural resemblance to the mature stage and must undergo changes in form and size to reach the adult stage.

Larva currens – A variant of cutaneous larva migrans caused by *Strongyloides stercoralis*, in which the linear progress of the lesions is much more rapid.

Larva migrans – see **cutaneous larva migrans.**

Leishmania – A genus of kinetoplastid parasites causing leishmaniasis.

Leishmaniasis – Infection with amastigotes of kinetoplastid parasites from the genus *Leishmania*.

Leishmaniasis, mucocutaneous – Infection of human skin and mucosa caused by kinetoplastid protozoans of the genus *Leishmania* (e.g., *L. brasiliensis*).

Leishmaniasis, cutaneous (= cutaneous leishmaniasis, Oriental sore, Baghdad boil, Aleppo button) – Skin infection with kinetoplastid protozoans of the genus *Leishmania* (e.g., *L. tropica*).

Leishmaniasis, visceral (=visceral leishmaniasis, kala-azar, black fever, dumdum fever) – A potentially fatal parasitic disease of the viscera due to the infection with kinetoplastid protozoans of the genus *Leishmania* (e.g., *L. donovani*).

Life cycle – A process of a parasite's growth, development, and reproduction, which proceeds in one or more different hosts depending on the species of parasite.

Life cycle, direct (= direct life cycle) – A life cycle that includes a definitive host only, with no intermediate hosts involved.

Life cycle, indirect (= indirect life cycle) – A life cycle that includes a definitive host and one or more intermediate hosts.

Liver fluke – A representative of several genera of flukes (e.g., *Fasciola*, *Opisthorchis*), which adult stage infects the liver of humans.

Loa loa – The filarial worm species that cause loiasis in human.

Loiasis – Subcutaneous and eye infection with the filarial nematode *Loa loa*.

Louse (pl.: lice) – A common name for insects of the order Phthiraptera, which are species-specific obligate blood-sucking ectoparasites.

Lung fluke – A common name of the fluke from the genus *Paragonimus*.

Lyme borreliosis – *see* **Lyme disease.**

Lyme disease (= Lyme borreliosis) – The tick-borne disease caused by the bacteria *Borrelia*.

Lymphatic filariasis – *see* **filariasis lymphatic.**

M

Maggot – A soft-bodied larva of a fly.

Malaria – An infectious disease caused by apicomplexan parasites from the genus *Plasmodium*.

Mansonella – A genus of filarial worms in which some parasites reside in the skin or certain body cavities of humans.

Mastigophora – A group of flagellate protozoans, including kinetoplastids and *Trichomonas vaginalis*.

Mechanical vector – *see* **vector mechanical.**

Medical parasitology – The study of organisms, which parasitize humans.

Metacercaria (pl.: metacercariae) – A tailless encysted late-stage larva of the flukes (class Trematoda) that is usually infective for the definitive host.

Microfilaria (pl.: microfilariae) – A larva of filarial worms of the family Onchocercidae, including *Loa loa*, *Wuchereria bancrofti*, and *Mansonella* spp.

Miner's anemia – see **ancylostomiasis.**

Miracidium (pl.: miracidia) – A free-living swimming ciliated larva of trematodes (flukes) that emerges from an egg.

Mite – A small to microscopic arachnid of the subclass Acari, including human parasites like *Demodex folliculorum* and *Sarcoptes scabiei.*

Monoxenous parasite – *see* **parasite monoxenous.**