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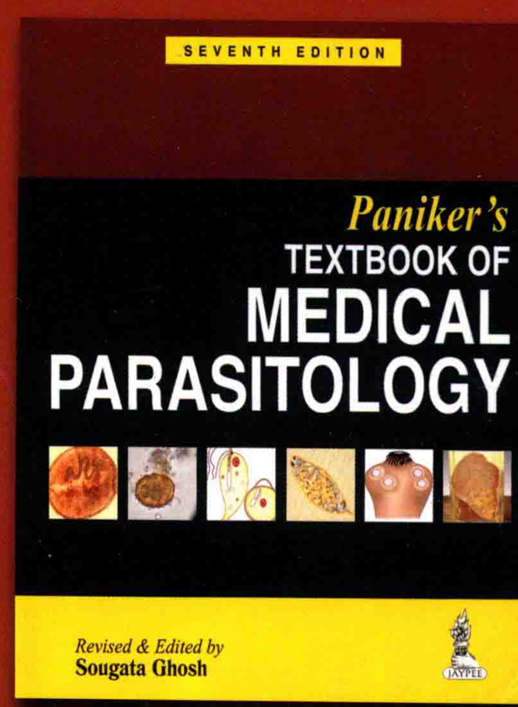
Paniker's Textbook of Medical Parasitology

医学寄生虫学

（第 7 版）

Sougata Ghosh



北京大学医学出版社

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（第 7 版）

Paniker's Textbook of

MEDICAL PARASITOLOGY

SEVENTH EDITION

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ANTONIE VAN LEEUWENHOEK

Born: 24.10.1632 - Died: 26.8.1723
Delft, Holland

This man, born poor, with little education, a draper in his hometown of Delft had surprising visitors! They included great men of science as well as the Royalty like the Tsar Peter the Great, Frederick the Great of Prussia and King James II of England. This was due to his hobby of grinding fine lenses through which he looked at various objects and brought forth the wonder world of small things that none had seen before. He kept clear descriptions and accurate drawings of what he saw and communicated them to the Royal Society in London. A strict check convinced the Society of their authenticity. The unlettered Antonie was elected a Fellow of the Royal Society! The papers sent by him over decades can still be seen in the Philosophical Transactions of the Royal Society.

The discoveries he made are legion. He described the first protozoan pathogen Giardia. He also discovered many types of bacteria, human and animal spermatozoa, and eggs of various animals realizing their importance in reproduction. He could not recognize the significance of the different types of bacteria, and to him, they were just 'little animalcules'. His fault was in being much before the time, for it took two centuries more for people to accept the microbial origin of infectious diseases. But that should not deter us from acknowledging the great contributions made by Leeuwenhoek to Biology and many other branches of Science. He was truly the **Founder of Microbiology.**

Preface to the Seventh Edition

The current edition of this book is written in a new user-friendly format in contrast to the classic narrative style of Dr. Paniker's Textbook of Medical Parasitology that has served medical students and teachers for more than 25 years since 1988.

Considering the advancement in the field of Parasitology, I have updated the text thoroughly , incorporating the recent epidemiological data and new diagnostic methods especially the molecular techniques and current treatment modalities. Almost all chapters have been revised and few new chapters like Pnemocystis jirovecil, Microsporidia, and Balantidium coli are added.

The main emphasis of the current edition is to make the text more comprehensive, colorful, and student-friendly. Diagrams of life cycle have been redrawn in a manner to facilitate the students reproduce them during examinations. Several new tables, flowcharts, and easy-to-remember boxes are given to equip the students for better answering of theory and oral questions during examinations. More microscopic view pictures, photographs of specimens, and diagnostic images have been added in a manner to favor better visible impressions of parasitic diseases. I have included "Key points" of important parasites in box formats to highlight "must know facts" that are pertinent to the topic.

Important MCQs and review questions carefully selected from various university examination papers have been added to test and reinforce understanding of the topic by the student.

The aim of the book remains to be compact, yet informative, and useful for both undergraduate and postgraduate students.

My endeavor will be successful, if the book is found to be useful for faculty and students.

Expressions and emotions fail to find words to express thanks to my parents. I thank them for a being a constant source of inspiration and motivation.

I am grateful to all the colleagues in my department for their valuable suggestions during preparing the texts.

I am especially indebted to the Director and Staff of School of Tropical Medicine, Kolkata for providing mounted specimens.

I gratefully acknowledge the help of Mr Jitendar P. Vij (Group Chairman), Mr Ankit Vij (Managing Director), Mr Tarun Duneja (Director Publishing) and Mr Sabyasachi Hazra for their professional help and guidance during the project.

The insight and skills of Dr Sakshi Arora (Chief Development Editor) along with her team helped in polishing this book to best meet the needs of students and faculty alike.

Lastly I acknowledge the support extended by my family members during revising the book.

All suggestions are welcome and may be emailed to: s_ghosh2006@rediffmail.com

SOUGATA GHOSH

Preface to the First Edition

Parasitic infections continue to account for a large part of human illness. Antimicrobial drugs and vaccines that have made possible the effective control of most bacterial and viral diseases have not been as successful against parasitic infections. The numbers of persons afflicted by parasites run into many millions. Malaria still affects over 500 millions, pinworm and whipworm 500 millions each, hookworm 800 millions and roundworm a billion persons. Filariasis, leishmaniasis and schistosomiasis remain serious public health problems. Infections due to opportunist parasites are becoming increasingly evident in the affluent countries.

In recent years there has been a resurgence in the study of parasitic infections. Much new knowledge has been gained making possible precise diagnosis and more effective control of parasites and the diseases they cause.

This textbook attempts to present the essential information on parasites and parasitic diseases, with emphasis on pathogenesis, epidemiology, diagnosis and control. Every effort has been made to incorporate recent advances in the subject.

It is hoped that medical students, teachers and physicians will find this book useful. Their comments and suggestions for improvement of the book will be most welcome.

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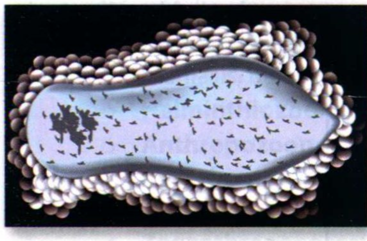
Calicut, Kerala 673 006

CK Jayaram Paniker

Contents



General Introduction: Parasitology 1

Introduction

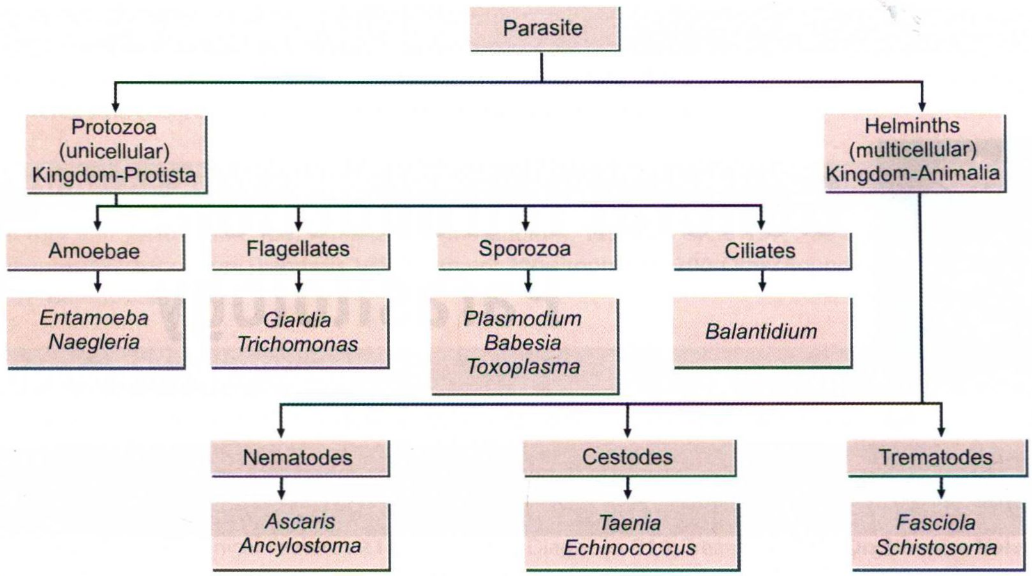
Medical parasitology deals with the parasites, which cause human infections and the diseases they produce.

- It is broadly divided into 2 parts—
  - Protozoology
  - Helminthology.
- The pioneer Dutch microscopist, **Antonie von Leeuwenhoek of Holland** in 1681, first introduced single lens microscope and obeserved *Giardia* in his own stools.
- **Louis Pastuer** in 1870, first published scientific study on a protozoal disease leading to its control and prevention during investigation of a epidemic silk worm disease in South Europe.
- A seminal discovery was made in 1878 by **Patrick Manson** about the role of mosquitoes in filariasis. This was the first evidence of vector transmission.
- Afterwards, **Laveran** in Algeria discovered the malarial parasite (1880), and **Ronald Ross** in Secunderabad and Calcutta in India, showed its transmission by mosquitoes (1897). A large number of vector-borne disease have since then been identified.
- By mid-twentieth century, with dramatic advances in antibiotics and chemotherapy, insecticides and antiparastic drugs, and improved lifestyles, all infectious diseases seemed amenable to control.

Parasites

Parasites are living organisms, which depend on a living host for their nourishment and survival. They multiply or undergo development in the host.

- The term '**parasite**' is usually applied to **Protozoa** (unicellular organisms) and **Helminths** (multicellular organisms) (Flowchart 1.1).
- Parasites can also be classified as:
  - **Ectoparasite:** Ectoparasites inhabit only the body surface of the host without penetrating the tissue. Lice, ticks, and mites are examples of ectoparasites. The term **infestation** is often employed for parasitization with ectoparasites.
  - **Endoparasite:** A parasite, which lives within the body of the host and is said to cause an infection is called an endoparasite. Most of the protozoan and helminthic parasites causing human disease are endoparasites.
  - **Free-living parasite:** It refers to nonparasitic stages of active existence, which live independent of the host, e.g. cystic stage of *Naegleria floweri*.
- Endoparasites can further be classified as:
  - **Obligate parasite:** The parasite, which cannot exist without a host, e.g. *Toxoplasma gondii* and *Plasmodium*.



Flowchart 1.1: Type of parasites

- **Facultative parasite:** Organism which may either live as parasitic form or as free living form.
- **Accidental parasites:** Parasites, which infect an unusual host are known as accidental parasites. *Echinococcus granulosus* infects man accidentally, giving rise to hydatid cysts.
- **Aberrant parasites:** Parasites, which infect a host where they cannot develop further are known as aberrant or wandering parasites, e.g. *Toxocara canis* (dog roundworm) infecting humans.

Host

Host is defined as an organism, which harbors the parasite and provides nourishment and shelter to latter and is relatively larger than the parasite.

- The host may be of the following types:
  - **Definitive host:** The host, in which the adult parasite lives and undergoes sexual reproduction is called the definitive host, e.g. mosquito acts as definitive host in malaria.

    The definitive host may be a human or any other living being. However, in majority of human parasitic infections, man is the definitive host (e.g. filaria, roundworm, hookworm).
  - **Intermediate host:** The host, in which the larval stage of the parasite lives or asexual multiplication takes place is called the intermediate host. In some parasites, 2 different intermediate hosts may be required to complete different larval stages. These are known as **first and second intermediate hosts**, respectively.
  - **Paratenic host:** A host, in which larval stage of the parasite remains viable without further development is referred as a paratenic host. Such host transmits the infection to another host.
  - **Reservoir host:** In an endemic area, a parasitic infection is continuously kept up by the presence of a host, which harbors the parasite and acts as an important source of infection to other susceptible hosts, e.g. dog is the reservoir host of hydatid disease.
  - **Accidental host:** The host, in which the parasite is not usually found, e.g. man is an accidental host for cystic echinococcosis.

Parasites with man as intermediate or secondary host

- *Plasmodium* spp.
- *Babesia* spp.
- *Toxoplasma gondii*
- *Echinococcus granulosus*
- *Echinococcus multilocularis*
- *Taenia solium*
- *Spirometra* spp.

Zoonosis

The word **zoonosis** was introduced by Rudolf Virchow in 1880 to include the diseases shared in nature by man and animals.

- Later, in 1959, the World Health Organization (WHO) defined zoonosis as "*those diseases and infections, which are naturally transmitted between vertebrate animals and man*".
- It is of following types:
  - **Protozoal zoonoses**, e.g. toxoplasmosis, leishmaniasis, balantidiasis, and cryptosporodiasis
  - **Helminthic zoonoses**, e.g. hydatid disease, taeniasis
  - **Anthropozoonoses:** Infections transmitted to man from lower vertebrate animals, e.g. cystic echinococcosis
  - **Zooanthroponoses:** Infections transmitted from man to lower vertebrate animals, e.g. human tuberculosis to cattle.

Host-parasite Relationships

Host-parasite relationships are of following types (Flowchart 1.2):

- Symbiosis
- Commensalism
- Parasitism.

Life Cycle of Parasites

- **Direct life cycle:** When a parasite requires only single host to complete its development, it is called as direct life cycle, e.g. *Entamoeba histolytica* requires only a human host to complete its life cycle.
- **Indirect life cycle:** When a parasite requires 2 or more species of host to complete its development, the life cycle is called as indirect life cycle, e.g. malarial parasite requires both human host and mosquito to complete its life cycle.

Sources of Infection

- **Contaminated soil and water:**
  - Soil polluted with embryonated eggs (roundworm, whipworm) may be ingested or infected larvae in soil, may penetrate exposed skin (hookworm)

Parasites having direct life cycle

Protozoa	Helminths
Entamoeba histolytica	*Ascaris lumbricoides*
Giardia lamblia	*Enterobius vermicularis*
Trichomonas vaginalis	*Trichuris trichiura*
Balantidium coli	*Ancyclostoma duodenale*
Cryptosporidium parvum	*Necator americanus*
Cyclospora cayetanensis	*Hymenolepis nana*
Isospora belli	
Microsporidia	

Parasites having indirect life cycle

Parasite	Definitive host	Intermediate host
Protozoa		
Plasmodium spp.	Female Anopheles mosquito	Man
Babesia	Tick	Man
Leishmania	Man, dog	Sandfly
Trypanosoma brucei	Man	Tsetse fly
Trypanosoma cruzi	Man	Triatomine bug
Toxoplasma gondii	Cat	Man
Cestodes		
Taenia solium	Man	Pig
Taenia saginata	Man	Cattle
Echinococcus granulosus	Dog	Man
Trematodes		
Fasciola hepatica	Man	Snail
Fasciolopsis buski	Man, pig	Snail
Schistosoma spp.	Man	Snail
Nematodes		
Trichinella spiralis	Man	Pig
Wuchereria bancrofti	Man	Mosquito
Brugia malayi	Man	Mosquito
Dracunculus medinensis	Man	Cyclops

Host-parasite relationships

Symbiosis	Commensalism	Parasitism
• Both host and parasite are dependent upon each other • None of them suffers any harm from the association	• Only the parasite derives benefit from the association without causing any injury to the host • A commensal is capable of living an independent life also	• The parasite derives benefits and the host is always harmed due to the association • The parasite cannot live an independent life

Flowchart 1.2: Host-parasite relationships

- Infective forms of parasites present in water may be ingested (cyst of amoeba and *Giardia*)
- Water containing the intermediate host may be swallowed (cyclops containing guineaworm larva)
- Infected larvae in water may enter by penetrating exposed skin, (cercariae of schisotosomes)
- Free-living parasites in water may directly enter through vulnerable sites (*Naegleria* may enter through nasopharynx).

➢ **Food:**
- Ingestion of contaminated food or vegetables containing infective stage of parasite (amoebic cysts, *Toxoplasma* oocysts, *Echinococcus* eggs)
- Ingestion of raw or under-cooked meat harboring infective larvae (measly pork containing cysticercus cellulosae, the larval stage of *Taenia solium*).

➢ **Insect vectors:** A vector is an agent, usually an arthropod that transmits an infection from man to man or from other animals to man, e.g. female *Anopheles* is the vector of malarial parasite.

Vectors can be:
- **Biological vectors:** The term biological vector refers to a vector, which not only assists in the transfer of parasites but the parasites undergo development or multiplication in their body as well. They are also called as **true vectors**. Example of true vectors are:
  - Mosquito—Malaria, filariasis
  - Sandflies—Kala-azar
  - Tsetse flies—Sleeping sickness
  - Reduviid bugs—Chagas' disease
  - Ticks—Babesiosis.
- **Mechanical vectors:** The term mechanical vector refers to a vector, which assists in the transfer of parasitic form between hosts but is not essential in the life cycle of the parasite. Example of Mechanical vectors is:
  - Housefly—amoebiasis

In biological vectors, a certain period has to elapse after the parasite enters the vector, before it becomes infective. This is necessary because the vector can transmit the infection only after the parasite multiplies to a certain level or undergoes a developmental process in its body. This interval between the entry of the parasite into the vector and the time it takes to become capable of transmitting the infection is called the *extrinsic incubation period*.

➢ **Animals:**
- Domestic:
  - Cow, e.g. *T. saginata*, Sarcocystis
  - Pig, e.g. *T. solium*, *Trichinella spiralis*
  - Dog, e.g. *Echinococcus granulosus*
  - Cat, e.g. *Toxoplasma*, *Opisthrorochis.*
- Wild:
  - Wild game animals, e.g. trypanosomiasis
  - Wild felines, e.g. *Paragonimus westermani*
  - Fish, e.g. fish tapeworm
  - Molluscs, e.g. liver flukes
  - Copepods, e.g. guineaworm.

➢ **Other persons**, which may be carriers of the parasite or patients, e.g. all anthroponotic infections, vertical transmission of congenital infections.

➢ **Self (autoinfection)**
- Finger-to-mouth transmission, e.g. pinworm
- Internal reinfection, e.g. *Strongyloides*.

Parasites causing autoinfection
- *Hymenolepis nana*
- *Enterobius vermicularis*
- *Taenia solium*
- *Strongyloides stercoralis*
- *Capillaria philippinensis*
- *Cryptosporidium parvum*

Modes of Infection

➢ **Oral transmission:** The most common method of transmission is through oral route by contaminated food, water, soiled fingers, or fomites. Many intestinal parasites enter the body in this manner, the infective stages being cysts, embryonated eggs, or larval forms. Infection with *E. histolytica* and other intestinal protozoa occurs when the infective cysts are swallowed.

➢ **Skin transmission:** Entry through skin is another important mode of transmission. Hookworm infection is acquired, when the larvae enter the skin of persons walking barefooted on contaminated soil. Schistosomiasis is acquired when the cercarial larvae in water penetrate the skin

➢ **Vector transmission:** Many parasitic diseases are transmitted by insect bite, e.g., malaria is transmited by bite of female *Anopheles* mosquito, filariasis is transmitted by bite of *Culex* mosquito. A vector could be a biological vector or a mechanical vector.

➢ **Direct transmission:** Parasitic infection may be transmitted by person-to-person contact in some cases, e.g. by kissing in the case of gingival amoebae and by sexual intercourse in trichomoniasis.

➢ **Vertical transmission:** Mother to fetus transmission may take place in malaria and toxoplasmosis.

➢ **Iatrogenic transmission:** It is seen in case of transfusion malaria and toxoplasmosis after organ transplantation.

Pathogenesis

Parasitic infections may remain inapparent or give rise to clinical disease. A few organisms, such as *E. histolytica* may live as surface commensals, without invading the tissue.

- Clinical infection produced by parasite may take many forms—acute, subacute, chronic, latent, or recurrent.
- Pathogenic mechanisms, which can occur in parasitic infections are:
  - **Lytic necrosis:** Enzymes produced by some parasite can cause lytic necrosis. *E. histolytica* lyses intestinal cells and produces amoebic ulcers.
  - **Trauma:** Attachment of hookworms on jejunal mucosa leads to traumatic damage of villi and bleeding at the site of attachment.
  - **Allergic manifestations:** Clinical illness may be caused by host immune response to parasitic infection, e.g. eosinophilic pneumonia in *Ascaris* infection and anaphylactic shock in rupture of hydatid cyst.
  - **Physical obstruction**: Masses of roundworm cause intestinal obstruction. *Plasmodium falciparum* malaria may produce blockage of brain capillaries in cerebral malaria.
  - **Inflammatory reaction:** Clinical illness may be caused by inflammatory changes and consequent fibrosis e.g. lymphadenitis in filariasis and urinary bladder granuloma in *Schistosoma haematobium* infection.
  - **Neoplasia:** A few parasitic infection have been shown to lead to malignancy. The liver fluke, *Clonorchis* may induce bile duct carcinoma, and *S. haematobium* may cause urinary bladder cancer.

Immunity in Parasitic Infection

Like other infectious agents, parasites also elicit immuno-responses in the host, both humoral as well as cellular (Fig. 1.1). But immunological protection against parasitic infections is much less efficient, than it is against bacterial or viral infections. Several factors may contribute to this.

- Compared to bacteria and viruses, parasites are enormously larger or more complex structurally and antigenically, so that immune system may not be able to focus attack on the protective antigens.
- Many protozoan parasites are intracellular in location, and this protects them from immunological attack. Several protozoa and helminths live inside body cavities This location limits the efficiency of immunological attack.

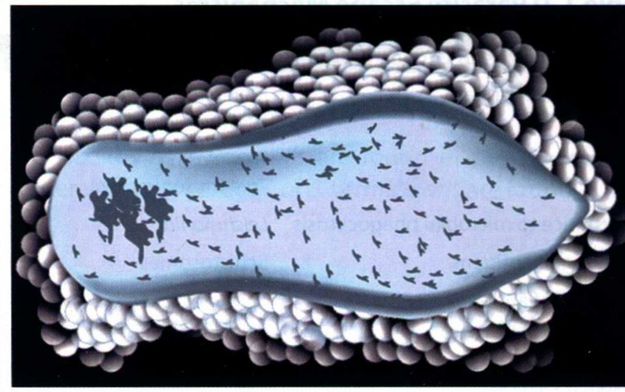


Fig. 1.1: Eosinophils surrounding schistosomulum (An example of immune attack in bloodstream)

- Once the parasitic infection is completely eliminated, the host becomes again susceptible to reinfection. This type of immunity to reinfection is dependent on the continued presence of residual parasite population and is known as **'Premunition'**.
- Antibodies belonging to different immunoglobulin classes are produced in response to parasitic infections. Selective tests for IgM are helpful in differentiating current infections from old infections.
- Excessive IgE response occurs in helminthiasis. A characteristic cellular response in helminth parasite is eosinophilia both local and systemic (Fig. 1.1).
- Parasites have evolved to be closely adapted to the host and most parasitic infections are chronic and show a degree of host specificity. For example, malarial parasites of human, bird, and rodents are confined to their own particular species.
- Parasites like trypanosomes exhibit antigenic variation within the host. This genetic switch protects them from antibodies. Similar mechanism may be operative in the recrudescences in human malaria.

Parasites exhibiting antigenic variations

- *Trypanosoma brucei gambiense*
- *Trypanosoma brucei rhodesiense*
- *Plasmodium* spp.
- *Giardia lamblia*

- Some parasites adopt antigenic disguise. Their surface antigens are so closely similar to host components that they are not recognized as foreign by the immune system.
- Some infections may produce immunodeficiency due to extensive damage to the reticuloendothelial system, as in case of visceral leishmaniasis.

Table 1.1: Parasite Escape Mechanisms

Parasite escape mechanisms	Example
Intracellular habitat	Malarial *parasite*, *Leishmania*
Encystment	*Toxoplasma* *Trypanosoma cruzi*
Resistance to microbial phagocytosis	*Leishmania*
Masking of antigens	Schistosomes
Variation of antigen	Trypanosomes *Plasmodium* spp.
Suppression of immune response Malarial parasite	*Trichinella spiralis* *Schistosoma mansoni*
Interference by polyclonal activation	Trypanosomes
Sharing of antigens between parasite and host-molecular mimicry	Schistosomes
Continuous turnover and release of surface antigens of parasite	Schistosomes

The fact that immunity normally plays an important role in the containment of parasitic infections is illustrated by the florid manifestations caused by opportunistic parasites such as *Pnemocystis jirovecii* and *T. gondii,* when the immune response is inadequate as in acquired immunodeficiency syndrome (AIDS) and other immunodeficiencies.

Immune Evasion

All animal pathogens, including parasitic protozoa and worms have evolved effective mechanism to avoid elimination by the host defence system as described in Table 1.1.

Vaccination

No effective vaccine for humans has so far been developed against parasites due to their complex life cycles, adaptive responses, and antigenic variation, great progress has been made in identifying protective antigens in malaria and some other infections, with a view to eventual development of prophylactic vaccines.

Laboratory Diagnosis

Most of the parasitic infection cannot be conclusively diagnosed. On the basis of clinical features and physical examination laboratory diagnosis depends upon:

- Microscopy
- Culture
- Serological test
- Skin test
- Molecular method
- Animal inoculation
- Xenodiagnosis
- Imaging
- Hematology.

Microscopy

An appropriate clinical specimen should be collected for definitive diagnosis of parasitic infections.

- Following specimens are usually examined to establish a diagnosis:
  - Stool
  - Blood
  - Urine
  - Sputum
  - Cerebrospinal fluid (CSF)
  - Tissue and aspirates
  - Genital specimens.

Stool Examination

Examination of stool is very important for the detection of intestinal infections like *Giardia, Entamoeba, Ascaris, Ancylostoma,* etc.

Table 1.2: Parasites and Their Developmental Stages Found in Stool

Cysts/Trophozoites	Eggs		Larvae	Adult worms
Entamoeba histolytica	**CESTODES**	*Gastrodiscoides horminis*	*Strongyloides stercoralis*	*Taenia solium*
Giardia lamblia	*Taenia* spp.	*Heterophyes heterophyes*		*Taenia saginata*
Balantidium coli	*Hymenolepis nana*	*Metagonimus yokogawai*		*Diphyllobothrium latum*
Sarcocystis spp.	*Hymenolepis diminuta*	*Opisthorchis* spp.		*Ascaris lumbricoides*
Isospora belli	*Dipylidium caninum*	**NEMATODES**		*Enterobius vermicularis*
Cyclospora cayetanensis	*Diphyllobothrium latum*	*Trichuris trichiura*		*Trichinella spiralis*
Cryptosporidium parvum	**TREMATODES**	*Enterobius vermicularis*		
	Schistosoma spp.	*Ascaris lumbricoides*		
	Fasciolopsis buski	*Ancyclostoma duodenale*		
	Fasciola hepatica	*Necator americanus*		
	Fasciola gigantica	*Trichostrongylus orientalis*		
	Clonorchis sinensis			

Cysts and trophozoites of *E. histolytica*, *G. lamblia* can be demonstrosted in feces. Eggs of roundworm and tapeworm are also found in stool. The larvae are found in the feces in *S. stercoralis* infection (Table 1.2).

For further details refer to Chapter 24.

Blood Examination

Examination of blood is of vital importance for demonstrating parasites which circulate in blood vessels (Table 1.3). Malarial parasite is confirmed by demonstration of its morphological stages in the blood.

Table 1.3: Parasites Found in Peripheral Blood Film

Protozoa	Nematodes
• *Plasmodium* spp.	• *Wuchereria bancrofti*
• *Babesia* spp.	• *Brugia malayi*
• *Tryponosoma* spp.	• *Loa loa*
• *Leishmania* spp.	• *Mansonella* spp.

Urine Examination

The characteristic lateral-spined eggs of *S. haemtobium* and trophozoites of *T. vaginalis* can be detected in urine. Microfilaria of *W. bancrofli* are often demonstrated in the chylous urine.

Parasites found in urine

- *Schistosoma haemtobium*
- *Wuchereria bancrofti*
- *Trichomonas vaginalis*

Sputum Examination

The eggs of *P. westermani* are commonly demonstrated in the sputum specimen. Occasionally, larval stages of *S. stercoralis* and *A. lumbricoides* may also be found in sputum.

Cerebrospinal Fluid Examination

Some protozoa like *T. brucei*, *Naegleria*, *Acanthamoeba*, *Balamuthia*, and *Angiostrongylus* can be demonstrated in the CSF.

Tissue and Aspirates Examination

The larvae of *Trichinella* and eggs of *Schistosoma* can be demonstrated in the muscle biopsy specimens. By histopathological examination of brain, *Naegleria* and *Acanthamoeba* can be detected. In Kala-azar, Leishman-Donovan (LD) bodies can be demonstrated in spleen and bone marrow aspirate. Trophozoites of *Giardia* can be demonstrated in intestinal aspirates. Trophozoites of *E. histolytica* can be detected in liver pus in cases of amoebic liver abscess.

Genital Specimen Examination

Trophozoites of *T. vaginalis* are found in the vaginal and uretheral discharge. Eggs of *E. vermicularis* are found in anal swabs.

Culture

Some parasites like *Leishmania*, *Entamoeba*, and *Trypanosoma* can be cultured in the laboratory in various axenic and polyxenic media.

Serological Tests

Serological tests are helpful for the detection and surveillance of many protozoal and helminthic infections. These tests are basically of 2 types:

- Tests for antigen detection,
- Tests for antibody detection.

Antigen Detection

Malaria antigen like *P. falciparum* lactate dehydrogenase (pLDH) and histidine-rich protein 2 (HRP-2) are detected by rapid immunochromatographic test. Filarial antigens are detected in current infection by enzyme-linked immunosorbent assay (ELISA) (Table 1.4).

Table 1.4: Antigen Detection in Parasitic Diseases

• Galactose lectin antigen	*Entamoeba histolytica*
• Giardia specific antigen 65	*Giardia lamblia*
• WKK and rk39 antigen	*Leishmania donovani*
• HRP-2 antigen	*Plasmodium falciparum*
• Vivax specific pLDH	*Plasmodium vivax*
• 200 KD Ag and OG4C3 antigen	*Wuchereria bancrofti*

Antibody Detection

The following antibody detection procedures are useful in detecting various parasitic infection like amoebiasis, echinococcosis, and leishmaniasis in man:

- Complement fixation test (CFT)
- Indirect hemagglutination (IHA)
- Indirect immunofluroscent antibody test (IFA)
- Rapid immunochromatography test
- ELISA test.

Skin Test

Skin tests are performed by injecting parasitic antigen intradermally and observing the reaction. In immediate