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Textbook for National Higher Education
全国高等学校教材

Medical Parasitology
医学寄生虫学

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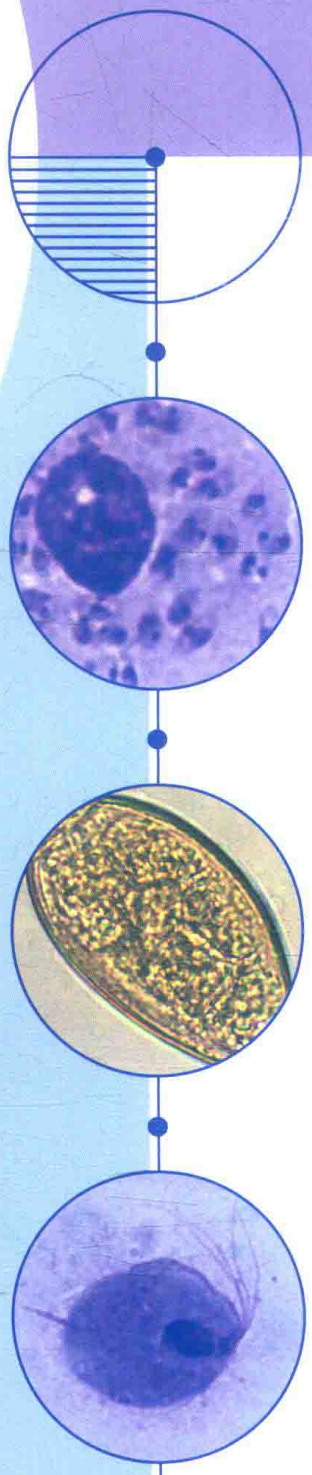

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医学寄生虫学

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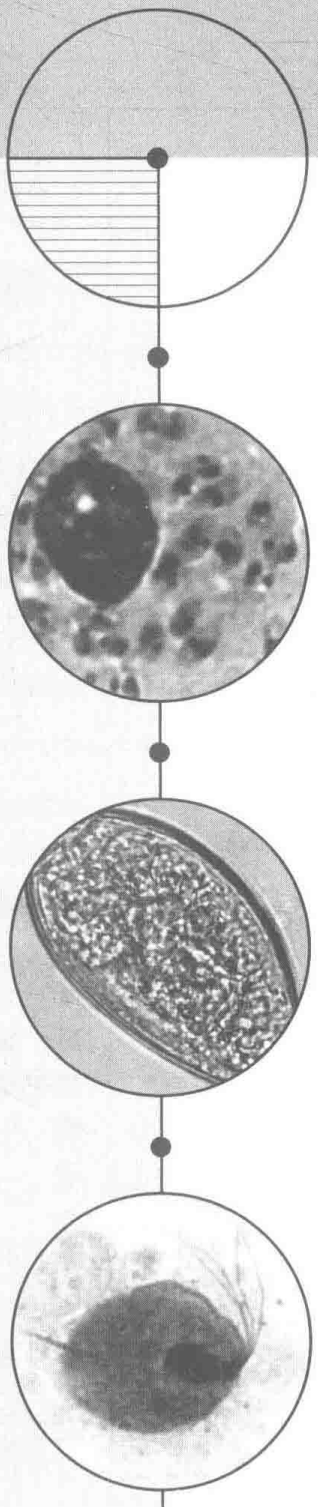

人民卫生出版社

图书在版编目（CIP）数据

医学寄生虫学 = Medical Parasitology：英文 /
司开卫，程彦斌主编 . —北京：人民卫生出版社，2018
ISBN 978-7-117-27320-6

Ⅰ. ①医… Ⅱ. ①司…②程… Ⅲ. ①医学 – 寄生虫学 – 医学院校 – 教材 – 英文 Ⅳ. ①R38

中国版本图书馆 CIP 数据核字（2018）第 191163 号

人卫智网	www.ipmph.com	医学教育、学术、考试、健康，购书智慧智能综合服务平台
人卫官网	www.pmph.com	人卫官方资讯发布平台

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主　　编：司开卫　程彦斌
出版发行：人民卫生出版社（中继线 010-59780011）
地　　址：北京市朝阳区潘家园南里 19 号
邮　　编：100021
E - mail：pmph @ pmph.com
购书热线：010-59787592　010-59787584　010-65264830
印　　刷：河北新华第一印刷有限责任公司
经　　销：新华书店
开　　本：787 × 1092　1/16　　印张：17　　插页：4
字　　数：414 千字
版　　次：2018 年 10 月第 1 版　2018 年 10 月第 1 版第 1 次印刷
标准书号：ISBN 978-7-117-27320-6
定　　价：53.00 元
打击盗版举报电话：010-59787491　E-mail：WQ @ pmph.com
（凡属印装质量问题请与本社市场营销中心联系退换）

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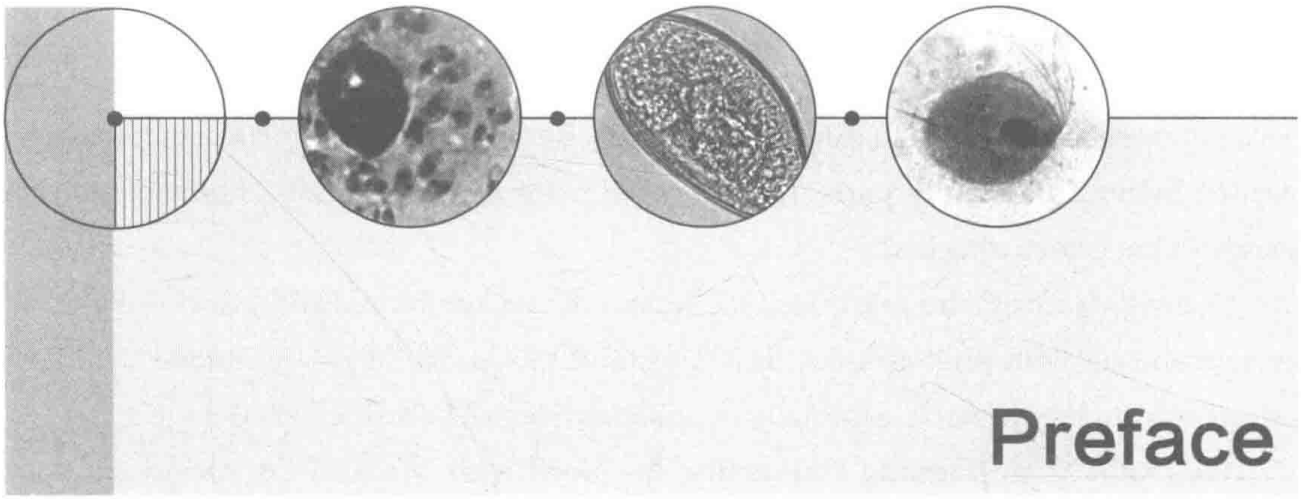


Preface

Medical Parasitology is very important for medical students. It mainly deals with the biological characteristics of medical parasites, the relationship between parasites and human, the pathogenesis of parasites to human, and the laboratory diagnosis, treatment, epidemiology and prevention of parasitic diseases. It is a discipline that bridges Basic Medicine and Clinic Medicine and a basis for Clinic Medicine and Preventive Medicine.

However, few English textbooks of medical parasitology are available for use in the Chinese students in language skills development and knowledge communication and for the surge of the number of overseas students coming to China for education.

Under the support of "Task Group for Developing Textbooks during the Thirteenth Five-Year Plan" of Xi'an Jiaotong University and the Northwest Medical Education Alliance, the People's Medical Publishing House invited 15 professors from 10 universities in China experienced in overseas students education to develop this textbook specifically for Chinese and overseas undergraduate medical and paramedical students as well as postgraduate students.

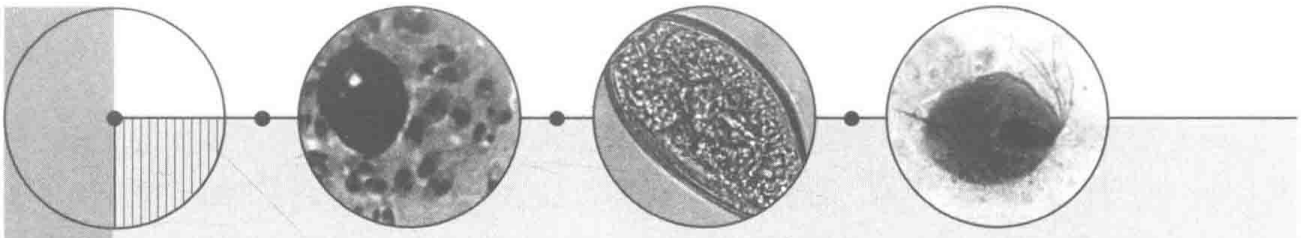
This textbook mainly introduces the major Medical Protozoa, Helminths and Arthropods. The book consists of five parts-General Introduction, Protozoology, Helminthology, Arthopodology, and Drugs for parasitic infection. Part One delineates important definitions and principles in evolution ecology, immunology, pathology, and prevention of parasites and parasitic infections. The second and third parts on protozoan, helminthes (nematodes, trematodes and cestodes) provide information about some common and important parasites in the world, especially in the countries along the "Belt and Road" region. Part Four mainly focuses on the concepts and transmissible diseases of general medical arthropods and the common species of Insect and Arachnida.

Part Five only discusses the common drugs against the parasites in mechanism, indication and side effects. But the dosages of drugs in clinic have been left untouched because those are different in different countries. Review questions and Cases have been written behind the mainly parts. At the end of textbook, color photographs of general parasites have been attached.

During drafting the textbook, we have strived for readability, and enhancing understanding with photographs, drawings, and tables. We have also added the latest progress from the research, especially in epidemiology of parasitic infections.

We thank **Xi'an Jiaotong University**, the **Northwest Medical Education Alliance** and the **People's Medical Publishing House** for the publishing of this textbook, and are indebted to the all editors' efforts. We also would be grateful if we can get the feedback about this book from the students and the teachers who use it.

Si Kaiwei
Cheng Yanbin
May 2018



前　言

医学寄生虫学是研究医学寄生虫的生物学特性及医学寄生虫病的临床诊治和流行预防的一门学科，也是由基础医学走向临床医学的一门桥梁学科，是临床医学和预防医学的基础。

随着我国改革开放的逐渐深入和“一带一路”战略的推进，我国与世界各国的交流日益增多，我国医学生双语教学及医学留学生教育迅速发展。医学寄生虫学是临床医学专业包括留学生教学的重要课程之一，但目前国内缺乏适合于双语教学及留学生英语教学的医学寄生虫学教材。在西安交通大学十三五规划教材建设项目和西北医学教育联盟的大力支持下，人民卫生出版社抓住机遇，组织 10 所大学 15 位多年从事双语教学或留学生教学的教师编写了这本英文版《医学寄生虫学》教材。

本教材主要介绍了与医学有关的常见原虫、蠕虫和节肢动物的生长发育，致病诊断，及其流行防治等内容，使学生对医学寄生虫学有一个全面的了解，为今后的临床课程学习及寄生虫病的防治奠定了基础。

本教材在编写中注重以下问题：

1. 内容编写条理清晰。根据临床医学专业培养目标，重视医学寄生虫学基本理论、基本知识和基本技能的介绍，有利于学生在有限的学时内学好医学寄生虫学这门课程。

2. 内容精简，重点突出。重点介绍全球性分布广泛或危害严重的寄生虫和寄生虫病，同时也对留学生来源国流行的寄生虫（病）作了相应介绍，为留学生今后的职业生涯做好铺垫。

3. 内容与临床紧密结合。以基础（课程）为临床服务，基础与临床融通的理念，在介绍生物学知识，如形态、生活史等部分内容时，重点介绍与诊断有关的虫期形态和与致病相关的生活史特点。

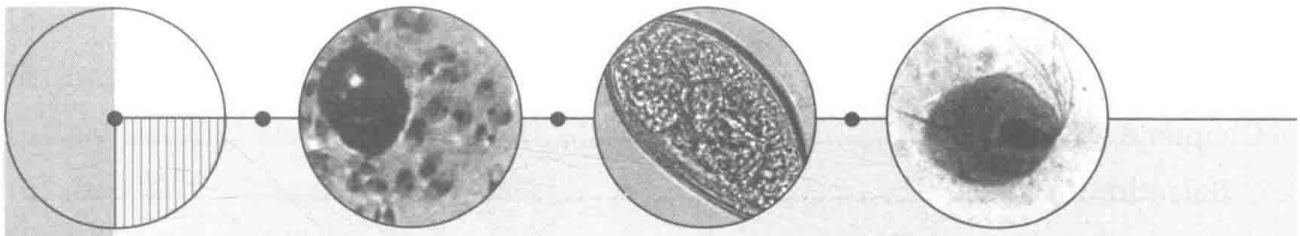
4. 以问题为导向，启发自主学习。在每篇之后都附有复习问题和常见寄生虫病病例，启发学生自主学习和协作学习，培养学生的临床思维和分析问题的能力。

5. 语言规范，通俗易懂。在编写过程之，编者重视语言书写规范、流畅、力求符合英语习惯，同时通俗易懂，有利于留学生英语教学及中国医学生的双语教学。

西安交通大学、西北教育联盟和**人民卫生出版社**为本教材的出版给予了大力支持，在此，谨向他们表示诚挚的谢意。也感谢全体编写人员为本教材的编写付出的辛勤劳动。由于编者知识水平所限，难免出现错误，殷切希望同行专家及广大师生批评指正，将发现的问题反馈给我们，以便今后加以改正，我们将不胜感激。

司开卫　程彦斌

2018 年 5 月



Contents

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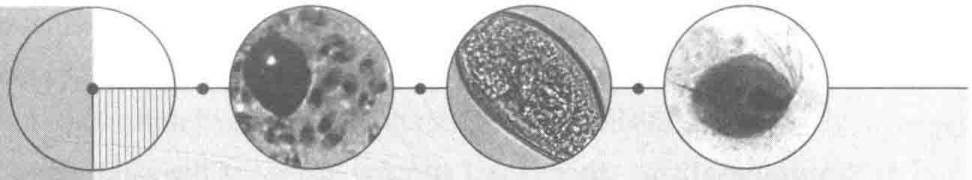

Part I

Introduction to Medical Parasitology

Medical parasitology is a branch of medical sciences dealing with members of the animal kingdom living in and/or on the body of humans and with aspects of host-parasite relationship having medical significance. It refers to the study of morphology, growth and development of the parasites, the pathogenesis and clinical manifestation caused by the parasites and its diagnosis, the vectors, reservoirs, definitive and intermediate hosts, and all factors of an ecologic and epidemiologic nature associated with disease transmission and prevention.

The parasites of medical importance may be divided into the following three major groups:

Protozoa — unicellular organisms.

Helminths — multiple cellular worms.

Arthropods — insects and their allies.

Chapter 1 Basic Concepts of Parasitology

PARASITISM, PARASITES AND HOST RELATIONS

Symbiosis

In the nature, the relationship among living things is very complex due to long term evolution. In order to improve the effect of study, we only study the relationship between two living things. This association of two species, perhaps primarily for food-getting on the part of one or both members of the group, is known as symbiosis. Symbiosis means literally "living together" and can also involve protection or other advantages to one or both partners. Different

forms of symbiosis may be distinguished by the basis of whether or not the association is detrimental to one of the two partners. Thus, symbiosis may be divided into the following three types.

1. Commensalism From the Latin for 'eating at the same table' denote an association of two different organisms, in which one partner is benefited while the other neither benefited nor harmed. Commensalism does not involve physiologic interaction or dependency between the host and the commensal. The two partners can survive independently. For example, the association between hermit crabs and the sea anemones is commensalism. Hermit crabs carry sea anemones on their borrowed shells.

2. Mutualism Denotes an association which is beneficial to both organisms. Frequently the relationship is obligatory for at least one member, even for both. The mutualistic organisms are metabolically dependent on each other and one cannot survive in the absence of the other. Termites and their intestinal protistan fauna are an excellent example of mutualism. Termites cannot digest cellulose because they cannot synthesize and secrete the enzyme cellulose. The myriad flagellates in a termite's intestine, however, synthesize cellulose and consequently digest the wood eaten by the termite. The termite uses molecules excreted as a by-product of the flagellates' metabolism. If we kill the flagellates by exposing termites to high temperature or high oxygen concentration, then the termites starve to death, even though they continue to eat wood.

3. Parasitism Denotes an association which is beneficial to one partner and harmful to the other organism. This association may be accidental and temporary or fixed and permanent. The former that is beneficial to is called parasite, the latter that is harmful to, is called host. For example, the relationship between hook worm and men is an example of parasitism. Hook worm sucks the blood as food, but causes the damage to human body. Parasitism exists from the early stage of the co-evolution of the living beings, but this relationship is not always invariable.

Parasite

Parasite is an organism (animal) which lives in or on the host in order to obtain nourishment and shelter from the host as well as does harm to the host. Parasites may cause mechanical injury, such as boring a hole into the host or digging into its skin or other tissues, stimulating a damaging inflammatory or immune response, or simply robbing the host of nutrition. There are many types of parasites.

1. Obligate parasite They must spend at least part of the time in a parasitic relationship to complete their life cycle. However, many obligate parasites have free-living stages outside any host, including some periods of time in the external environment within a protective egg shell or cyst.

2. Facultative parasite A facultative parasite is an organism which may exist in a free-living state or occasionally as a commensal parasite. When some free-living worms are accidentally eaten or enter a wound or other body orifice become parasitic, not normally parasitic in life. Two examples are certain free-living amebas, such as *Naegleria fowleri,* and free-living nematodes belonging to the genus *Micronema.* Infection of humans with either of these is

extremely serious and usually fatal.

3. Endoparasite These are the parasites living inside the host's body. For example, parasitic protozoa and helminthes often live in the organs, tissues, or cells of human body.

4. Ectoparasite It refers to the parasites live on the surface of the host's body. For example, Arthropods such as mites, ticks and lice, normally live on the skin of human body.

5. Permanent parasites Some parasites live within or on their hosts during entire adult life.

6. Temporary parasites Some parasites may be accidental or opportunistic by chance or condition available. Such as a mosquito or bed bug, only feeds on the host and then leaves.

Host

In parasitism, host supplies the parasite with nourishment and shelter, it is the injured partner. The host, in comparison to parasite, is relatively larger in size.

Hosts are of various types based on their role during the life cycle of parasite.

1. Intermediate host The host harboring the larvae or asexual stage of the parasite is known as the intermediate host. Certain species of trematodes and cestodes have two hosts, known as the first and second intermediate host.

2. Final or definitive host The host harboring the adult or sexually mature parasite is the final or definitive host. Every species of carnivorous or omnivorous animal at some time has sheltered one or more types of parasite. Man is not always the final host.

3. Reservoir host Animals that harbor the same species of parasites as man are known as reservoir host. Such hosts insure the continuity of the parasite's life cycle and act as potential sources of human infection in epidemiology. The chief among reservoir hosts are domestic animals such as dogs, cats, and pigs.

4. Paratenic host is a host which acts as a transporting agent for the parasite, usually a larval stage, and in which the parasite dose not undergo any further development, but if they could go into final host by accident it would continue to develop till sexual maturity. Paratenic hosts may bridge an ecological gap between the intermediate and definitive hosts. Such as *Paragonimus westermani,* when it invades and lives in a wild boar, it cannot grow up and remains in its larval state. However, if the larva in boar meat is ingested by a dog, it will develop into an adult in the dog. The wild boar is a paratenic host for *P. westermani*.

As a result of the co-evolution of parasite and host, parasite appeared to have highly specific requirement for the host species and residing site, stating that a given parasite can only survive in the definite species of host animal or animals. It is known as the host-specificity to the parasite or the susceptibility to the host. If the parasite can take human as well as certain kind of animals as susceptible hosts, it is known as a zoonotic parasite, and the disease evoked as zoonosis.

5. Vector Some parasitic infections may be carried from one host to another by means of arthropod vectors. A vector may also be a host if development of the parasite takes place within the body. In this instance the vector plays a role of host.

6. Carrier A person who harbors parasite has no clinical symptoms and signs; it is an

important source of infection in epidemiology.

Life cycle

Life cycle of parasite is the whole process of parasite growing, developing and reproduction. The life cycle of parasite could be classified into two types.

1. The type of direct growth Only one host is required in the life cycle. The egg and / or larva grow in the outer environment (soil and water, etc.) to become infective stage and then infect human. The majority of nematodes belong to this type.

2. The type of indirect growth The intermediate host is necessary to complete the life cycle. Human will be infected through intermediate host. All trematodes and the majority of cestodes belong to this type.

The typical course of life cycle of a protozoan or helminth may be generalized into 4 basic stages:

1. The stage of pathogenesis The parasites usually have specific site preferences and cause the damage to the final host. The stage may be adult or larva of a helminth or the proliferated generations of a protozoan.

2. The stage of discharging Parasites appeared to have their own way to discharge, but mainly through excretions and secretions of the host, such as stool, urine and sputum etc. Some species remain the discharging form in blood waiting for the blood sucking insect to bring them out or eaten by intermediate host. This stage is also important for etiological diagnosis.

3. The outside developing stage After being discharged, the parasites may be developing in the external environment, in the intermediate host or in the insect host, until the parasites gain infective capability.

4. The stage of infection The parasites with infective capability invade the final host body through their way and continue to develop. This stage of parasite may be eggs, larvae or cysts.

In the life cycles of some parasites, there are regular alternations of sexual and asexual reproductions. This phenomenon is called alternation of generation, such as the life cycle of *Plasmodium vivax*.

Chapter 2 Parasite-Host Interactions

The interactions between parasites and hosts are complex. A major barrier to fit or adapt to host's environment by parasites is the immune response. The presence of a parasite stimulates the host to destroy the parasite. In order to survive in host, parasites must have some means of avoiding this reaction. The factors that determine the initiation, development and outcome of an infection involve a series of interactions between the parasite and the host. These interactions include the following: ① The parasite's ability to breach host barriers and to evade destruction by host defenses; ② the parasite's biochemical tactics to replicate, to spread, to establish infection and to cause disease; ③ The parasite's ability to transmit to a new susceptible host; ④ The host's innate and adaptive immunological ability to control and eliminate the invading parasites.

Some kind of balance in any real case must be achieved between host and parasite. The host must adapt the parasite to survive long enough for its reproduction and remove its progeny. The damage due to parasites can be limited in colonized site or parasitic site and other organs or tissues. Pathogenesis of parasite to host is depending on the species of parasites, density of colonized parasites, and the fitness between host and parasite. The damages include direct damage, loss nutrition, toxins and allergy or hypersensitivity etc.

DAMAGE OF PARASITES TO THE HOST

Parasites may parasitize in cells, tissues, or tracts of host. Injury to the host may be brought about in a wide variety of ways. The most widespread type of injury is brought about by interference with the vital processes of the host through the action of secretions, excretions or other products of the parasite, even through invasion and destruction of parasite to the host. Thus, effects of parasites upon the hosts include the following aspects.

1. Depriving essential substance (nutrition) from host Parasites nutrition that is essential for their growth and reproduction is taken mainly from their hosts. For example, hookworms suck blood, which may deprive more iron from the host, and result in anemia.

2. Mechanical effects of parasites on host tissue Those effects result from the larger parasites e.g. the intestinal fluke, *Fasciolopsis buski*, may cause severe local damage to the intestinal wall by means of its powerful suckers. *Ascaris* may perforate the intestinal wall, and cause intestinal obstruction if there are lots of *Ascaris*, and invade the appendix, bile duct, and other organs. *Cysticercus* may cause space-occupying lesions in the cerebrum.

3. Toxic and allergic effect Arthropods introduce toxin to the host skin, and induce host reaction that may be local or systemic. Enzymes may be secreted by many parasites, some of which have digestive action. For example, *Entamoeba histolytica* secretes proteolytic enzyme, and cause necrosis of the surrounding tissues. The metabolites, secretions, excretions or other products of parasite or dead worms may act as foreign antigen to stimulate the immune system of the host to produce immune response or allergy, and to result in immediate or delayed hypersensitivity. Allergy is harmful to human body, and may be defined as a state of abnormally exaggerated response to the injection of or contact with an antigen, which may lead to severe or even fatal reactions. The sudden release of foreign protein in the host's body may result in anaphylaxis. For example, when hydatid fluid is released from the rupture of a hydatid cyst, anaphylaxis often results.

RESISTANCE OF THE HOST TO PARASITE

The resistance of the host to animal parasites depends upon the barrier that presents to the invading parasite, and finally depends upon its cellular and humoral immunity. Systemic immunity, or the protective mechanism within the host, may be cellular or humoral, general or local, and natural or acquired. Resistance is a relative affair of varying degrees. Absolute immunity, except in the natural resistance of unsuitable hosts, is rarely found. The host may be able to withstand invasion by the parasite, establish equilibrium with it, curtail its pathogenic activities, or even destroy it.

1. Innate immunity The innate immunity is a natural heritage of species, race or individual against parasites. It is established in the long-term course of evolution and is genetically controlled and relatively stable. The innate immune mechanisms are non-specific in the sense that they are effective against a wide range of parasitic infection. But generally it is not very strong. The innate immunity including: the skin, mucous membrane and placenta acting as barriers and the phagocytosis of phagocyte (e.g. the neutrophil and the mononuclear leukocyte) which play a major role in all stages of host defense.

2. Acquired immunity It is acquired naturally by previous infection or contact with parasites. The antigens of the invading parasites stimulate the immune system that leads to immune responses. The acquired immunity can wipe out or damage the specific parasite and resist the re-infection of the same parasite as well.

(1) Sterilizing immunity: The host can wipe out the parasites in human body completely. The clinical symptoms resulted from the infection of parasites also disappear completely. Meanwhile, the host may acquire long-term specific resistance to re-infection. But it is rare in parasitic infection. For example, *Leishmania tropica* invade the human body to cause *Mucocutaneous leishmaniasis*. The human with the antibody can wipe out all parasites, and acquire specious resistance to reinfection.

(2) Non-sterilizing immunity: This is a common state of immunity caused by infections

with many protozoa and helminthes in human body. Most of the parasitic infection may arouse certain degree immunity to re-infection. This immunity could wipe out most of the parasites in human body, but not completely. At this time, host has acquired the resistance to re-infection. If all of the parasites are wiped out completely, the hosts don't have the resistance to re-infection any more. For example, when the malaria parasites enter into human body, the antibody against malaria will kill some parasites to keep a low density in blood, instead of all parasites. If the parasites are killed by drug, the resistance of human to parasites will disappear. This also is named as premunition. If the non-sterilizing immunity happens in helminthes, such as *Schistosome,* the immunity cannot kill the adult lived in human body, but can refuse the reinfection. This also is named as concomitant immunity.

Worms such as *Filarial*, *Ascaris*, and *Schistosomes* induce high levels of specific IgE antibodies and eosinophilia. It is very special in clinic. Antigen of parasites is very complex, including membrane antigen, secreting antigen, excreting antigen, metabolite antigen, and egg antigen, etc. The antibodies produced by human are very weak in titer. Until now, the vaccines about parasites are very rare.

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