General Protozoology 3

Relationship between Protozoa and host

- The protozoan species must be taken by a suitable host in order for infection to take place.

Relationship between Protozoa and host

- The factors belonging to host
  - Age
  - Nutritional status
  - Sensitivity or resistance
  - Genetic structure

Relationship between Protozoa and host

- The factors belonging to parasite
  - The size of protozoa
  - number
  - pathogenicity
  - movement
  - Developmental style

Relationship between Protozoa and host

- It is also important to take of pathogens with a proper way in order for diseases to occur.
- The appropriate entry path of the protozoa usually depends on the organ in which the protozoa is placed.

Relationship between Protozoa and host

- For example,
- Protozoa living in digestive system enter from mouth (*Entamoeba histolytica*, *Giardia* spp., *Eimeria* spp.),
- Protozoa located in genital system with coitus (*Trypanosoma equiperdum*, *Trichomonas vaginalis*, *Tritrichomonas foetus*),
- Protozoa living in blood with vectors (*Plasmodium* spp., *Theileria* spp., *Babesia* spp.)

Development, contamination and spread of protozoa

- Parasitic protozoa need one or more hosts in their developmental stages.
- The developmental route is direct in one-hosted protozoa, and indirect in the others.
  - One-hosted protozoa are called **monoxene**
  - Two-hosted protozoa are called **heteroxene**

Monoxene

- A developmental stage occurs in the host body, and the other stage in the nature.
- They usually live in the digestive system of the site.
- It is necessary to take the durable forms (cyst or oocyst) with feed-food and water. They enter the body by mouth.
- They leave the host as cyst or oocyst after a developmental period in the digestive tract.
- For example, *Eimeria* spp. *Giardia* spp., *Entamoeba* spp.

Monoxene

- *Trichomonas vaginalis, Tritrichomonas foetus* and *Trypanosoma equiperdum* also develop directly.
- They locate in genital organs of their host.
- They pass from one host to another by coitus.

Heteroxene

- Is two-hosted and it is seen in indirect developed protozoan species
  - obligate heteroxene
  - facultative heteroxene

Heteroxene

- **Obligate heteroxene** species, for example, *Trypanosoma, Leishmania, Theileria, Babesia* and *Plasmodium* species.
  - *Plasmodium* species cause disease in humans along with animals.
  - Their intermediate host is mosquitoes belonging to *Culicidae* family.
  - They are found in different organs and tissues of vertebrate hosts, mainly in erythrocytes.

Heteroxene

- The vectors of *Trypanosoma* species are tsetse flies (*Glossina* spp.).
- Humans and various mammalians are hosts of these protozoa.
- They are found in various organ and tissue of hosts, mainly in the circulatory system.

Heteroxene

- *Theileria* and *Babesia* species are found mainly in domestic animals.
- The vectors of these protozoa are Ixodid ticks.
- In vertebrate hosts, *Babesia* spp. develop into erythrocytes, whereas *Theileria* spp. develop into both erythrocytes and lymphocytes.

Heteroxene

- **Facultative heteroxene**
- Best example is *Toxoplasma gondii*.
- Definitive hosts of *T. gondii* are felidae
- Intermediate hosts can be all mammalian, birds and reptiles.
- However, cats and other felidae may also play a role as intermediate host.

Vector

- Vector is a arthropod which can transmit pathogens protozoa from a host to another host.

Mechanical Vector

- A vector that conveys parasitic protozoa to a susceptible individual without essential biologic development of the pathogens in the vector.
- The vector must give the protozoa to susceptible host within 24 hours after taking.
  - *T. evansi* and *T. equinum* are mechanically transmitted by *Tabanus* and *Stomoxis* spp.

Biological Vector

- An arthropod vector in whose body the infecting protozoa develop or multiplies before becoming infective to the recipient individual.
- Biological vectors;
- *Culicidae* for *Plasmodium* spp.
- *Phlebotomus* spp. for *Leishmania* spp.
- *Glossina* spp. for *Trypanosoma* spp.
- Ixodid ticks (Ixodidae) for *Theileria* and *Babesia* spp.

Reservoir host

- There is a reservoir host along with the vector, intermediate and definitive hosts.
- A reservoir host most obviously is a long-term carrier organism of a given pathogen that doesn't exhibit the disease caused by the pathogen.
  - Various wild mammalians are reservoir hosts for *Trypanosoma* spp. in Africa and for *Trypanosoma cruzi* in America.

Immunity against to parasitic protozoa

- The most important condition necessary for continuity is the protection of the parties themselves and each other in relationship between organisms.
- The success of a parasite in not about killing it, but about the level of adaptation in host.
  - For example, *Trypanosoma theileri*, low virulent species, can infect 100% of the cattle in a region where has vector flies, and it is not interested on host immune system.
  - *Trypanosoma congolense* and *Trypanosoma vivax*, more virulent species, can infect fewer cattle in a region because they stimulate the immune system more.

- The adaptation of protozoa to host is an evolutionary consequence of the relationship between the host and protozoa.
- In this mutual relationship, no clinical infection occurs when balance is established between parasite and host, and they continue to live together.
- When the host is superior (immunity), the parasite is thrown off the body.
- If the protozoa are superior, severe disease or death may occur depending on the protozoan's ability to make disease and resistance of the host.

Host defense and offensive forces

- The host usually responds with defense tactics against to the pressure they create on the host with the protozoa's defense and offensive tactics.
- Offensive tactical powers arise as defense products. **Natural defense mechanisms** are a priority here. And than, active defense mechanisms come into play.
- The first barrier against protozoa is the host defense system.
- If this system is overcome, the active defense power (immunity) is introduced.

Natural defense mechanisms

- **The protozoan-specific host selectivity** takes the first order. Every parasite species can not develop disease in every animal and many parasites have host selectivity at various levels.
- For example,
- *Trypanosoma congolense* and *T.vivax* are quite virulent in domestic cattle, while they can not cause disease in wild ruminants.

Natural defense mechanisms

- Although the cause of resistance seems to be species diversity, in fact, this controls with more complex evolutionary genetic factors.
- And, it is often associated with a number of molecular factors (such as differences in MHC haplotypes).

Natural defense mechanisms

- In natural defense, the second defense force manifests itself during the parasite's entry into the body.
- For example,
- Skin and mucous membranes can block many parasites from entering the body.

Immunological defense mechanisms

- The immunity formed in the protozoan infections is quite complex.
- Almost all of the mechanisms of the immune system come into play against the protozoa in the host.
- The humoral and cellular immunity are formed.
- The impact type and grade of response varies depending on host and parasite.

Immunological defense mechanisms

- Active immunity, which is shaped for infection, is mainly of the type of T lymphocyte mediated cellular immunity.
- Humoral immunity, characterized by specific antibody production for parasites, can also be introduced.
- These antibodies, which do not have a persistent effective activity, can play a role in immunity.

Immunological defense mechanisms

- Humoral immunity, which can suppress the parasites in blood circulation or tissue fluids at a certain level, is insufficient especially against intracellular protozoa, while cellular immunity is particularly involved in the fight against intracellular protozoa.
- Humoral immunity can not provide permanent protection against re-infections since it can not produce long-term memory in the elimination of the first infection.

- Antibodies can inhibit the entry into the host cell by binding to various surface antigens of protozoa.
- Some antibodies may inhibit cleavage of protozoa by binding to protozoan enzymes. Such antibodies are called **ablastin**.
- Antibodies also mediate functions of complement, macrophage and cytotoxic cells.

- Antibodies are generally effective against extracellular protozoa. Such as *Trypanosoma* spp.
- Protozoa living within the cell (such as *Plasmodium* and *Babesia* species) undergo a free period outside the cell to infect other cells. Antibodies have also been found to be effective in these forms.

- Antibodies can directly kill intracellular protozoa with complement, macrophages or cytotoxic cells.
- *Babesia* antigens on surface of erythrocytes and complexes formed by antibodies are recognized by macrophages and cytotoxic lymphocytes.
- Thus, infected erythrocytes are phagocytized by macrophages or killed by cytotoxic cells.

- Protozoa multiplying inside the cell can also stimulate cytotoxic T lymphocytes.
- Cytotoxic T cells are neutralized the parasites by killing infected cells.
- For example,
  - Malaria in humans
  - *Theileria parva* in cattle

Premunition
Active partial immunity

- A type of local immunity;
- continues as long as the parasite exists
- disappear after the parasites are totally eliminated
- and is based cellular immunity
- The parasite, which performs breading in a certain life period in the body, is numerically lowered in the following period.
- In this way, the parasites may survive in host for many years.

Premunition

- In such animals, an infection that develops with the same protozoa in the following period either does not reach the clinical diseases or the animals are overtaken it with mild manifestations.
- The **endemic stabilized** regions originating from premunition in persistent infections have a major importance in the epidemiology of protozoan diseases.

The ways to get rid of immune response

- **Defensive power in protozoa:**
- The most important is the intracellular localization and the active exchange at the molecular level.

The ways to get rid of immune response

- **Escape from immunological control:** Some protozoa locate in tissues, especially those that the immune system can not actively intervene.
- Intracellular localization of a parasite is also an action that helps to escape from the immune system.
- Some protozoa choose the way to get rid of immunization by changing their antigenic structures instead of hiding. (*Trypanosoma* spp.)

The ways to get rid of immune response

- **Antigenic variation:**
- In the life cycle of protozoa, they can have antigenically different life stages (trophozoite, schizont, merozoite, sporozoite, cycst).
- This difference is the body surface covering of the glycoprotein structure.

The ways to get rid of immune response

- **Attack power of protozoa:**
  - Immunosuppression
  - Usage of the immune system

Immunosuppression

- Protozoa can specifically suppress host immunity by secretion of an immunosuppressive agent.
  - And can damage to
    - Cytokine production
    - T cell activation
    - Macrophage killing mechanisms

Usage of the immune system

- Some protozoa may have the ability to use of the host's physiological activity and products for their own benefit.
  - *Babesia* species require the activation of the host's complement system in order to enter the erythrocytes.
- An another way to get rid of immune response in protozoa is that the parasite entering the cell is covered by host cell membrane.

Vaccination

- It is become increasingly important that vaccination may be the most appropriate method of combating with protozoan diseases.
- There are important problems that need to be solved both in the genetic structure of the parasite and in the parasite-host relationship.
- For this reason, the number of vaccines offered for protozoa controlling purpose is very inadequate.

Inefficiencies in the production of effective vaccines against protozoa

- Unresolved tactics used by parasite to protect against host immunity
- Complex life cycle
- Complex antigenic structure
- Selection of the strain to be used for vaccine
- High cost in vaccine production
- Need for cold chain in distribution and storage
- Short shelf life
- Limited market
- Consumers prefer chemicals that looks cheaper

- Almost all of the protozoan vaccines (coccidiosis, cryptosporidiosis, toxoplasmosis, neosporosis, babesiosis, malaria, leishmaniasis, trypanosomiosis, giardiosis, pneumocystiosis vaccines) that have been tried or used in practice are attenuate live vaccines.
- These types of vaccines could be achieved at certain level, but the ideal level was not reached.

The vaccines used against protozoan infections

- **Inactive vaccines:** Such as inactive vaccine obtained from *Neospora caninum* tachyzoites.
- **Live attenuated vaccines:** this vaccines are obtained from protozoa that are produced by passaging in embryotic chicken egg or splenectomised animals, also by using the radiation or making changes in the biological cycle of the parasite.

- **Protein subunit vaccines:** These vaccines are obtained from purified or recombinant proteins.
- **Recombinant vector vaccines:**
  - **DNA vaccines:** These vaccines induce strong humoral and cellular immunity.
  - Adjuvants are used to enhance of immune reactions.

Taxonomy

- Regnum: Protista (Eukaryota)
- Phylum: special name (Euglenozoa)
- Subphylum: special name (Kinetoplasta)
- Class: "-ea" (Trypanosomatidea)
- Order: "-ida" (Trypanosomatida)
- Suborder: "-ina"
- Upper family: "-idea"
- Family: "-idae" (Trypanosomatidae)
- Subfamily: "-inae"
- Genus: special name (*Trypanosoma)*
- Species: special name (*Trypanosoma brucei brucei, T. b. equinum, T.vivax)*

- Disease –ose or osis
- Trypanasomiosis or Trypanasomiasis,
- Leishmaniosis or Leishmaniasis
- Giardiosis