

Epizootiology Triad-Related Concepts

Infectivity (ability to infect)

$(\text{number infected} / \text{number susceptible}) \times 100$

Pathogenicity (ability to cause disease)

$(\text{number with clinical disease} / \text{number infected}) \times 100$

Virulence (ability to cause death)

$(\text{number of deaths} / \text{number with disease}) \times 100$

All are dependent on host factors

Ecological Factors in Infections

Altered environment
{Air conditioning}

Changes in food production & handling
{intensive husbandry with antibiotic protection; deep-freeze; fast food industry}

Climate changes
{Global warming}

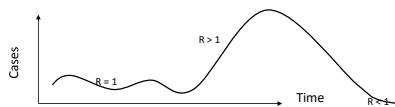
Deforestation

Ownership of (exotic) pets

Air travel & Exotic journeys / Global movements

Increased use of immunosuppressives/ antibiotics

Endemic - Epidemic - Pandemic

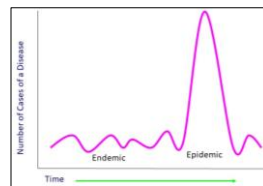


Sporadic level: occasional cases occurring at irregular intervals

Endemic level: persistent occurrence with a low to moderate level

Epidemic or outbreak: occurrence clearly in excess of the expected level for a given time period

Pandemic: epidemic spread over several countries or continents, affecting a large number of people



Endemic vs Epidemic

Expression of parasitological status via two basic parameters

1. Prevalence
2. Moderate intensity

PREVALENCE (%) is the proportion of infected individuals showing disease in a group of animals in a certain date.
 $(\text{number of infected hosts} / \text{number of hosts examined} \times 100)$;

MODERATE INTENSITY represents the average number of specimens of the parasite species on/in one infected host (total number of parasites of the species in the host sample / number of infected individuals in the host sample);

Other epizootologic expressions:

Incidence (%) - number of new disease cases in the population over a given period/number of healthy individuals in the population at the beginning $\times 100$ follow-up.

Morbidity – total **number of disease cases** within a given population of animals in a defined time period.

Mortality – total **number of deaths** within a given population of animals in a defined time period.

Lethality – total **number of disease associated cases of death** within a given population of diseased animals in a defined time period.

Epizootiology of parasitoses

ABUNDANCE = number of individuals of a particular parasite species in the total host population (calculation: average parasite prevalence \times average infection intensity).

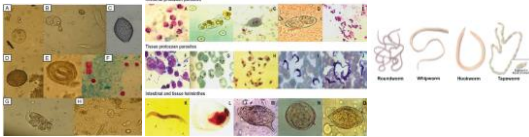
AVERAGE ABUNDANCE = total number of individuals of the given parasite species on the total number of all tested hosts;

DENSITY = number of individuals of a particular parasite species in a sample unit taken from a habitat related to unit area, volume or weight.

Epizootiology of parasitic diseases

Prepatented time: time period between infection of a host by a parasite and first release of products of reproduction – oocysts, eggs, larvae, etc.

Incubation time: time between infection and manifestation of disease symptom.



What is the Life Cycle

Life cycle describes the **ontogenesis, development** and **reproduction of the parasite**, tracking it through the various phases of its life history which will encompass both parasitic and non-parasitic stages.

The key to understanding the transmission of a parasite species and parasitic disease is its **life-cycle**;



Generalized stages of a parasite's life cycle

- Stage in human/animal host (linking to **pathogenesis**)
- Stage to discharge (**diagnostic stage**)
- Stage developing outside human/animal host (in external environment, intermediate host or insect host)--- (linking to **transmission**)
- Stage infecting human/animal (**infective stage**)

How parasites enter their hosts

PASSIVE INFECTION

Ingestion

- faecal-oral contamination with food, water, hands by cysts
- uncooked or undercooked foods
- eating paratenic or intermediate hosts
- inhalation

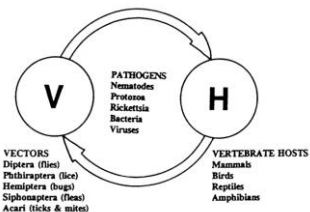
ACTIVE INFECTION

- penetration of the skin
- inoculation of infective stages by vector

Transmission mechanisms of parasites

- **HORIZONTAL** – between individuals of the same generation
 - transmission through **contact** (e.g. sexual)
 - transmission through **vectors**
 - **contamination (mechanical)**
 - **inoculation (bite; blood)**
- **VERTICAL** – from one host generation to the following generation
 - **Transplacental**
 - **Lactogenic**
- **IATROGENIC** – (G: *iatros*: physician) – transmission by physician or veterinarian; e.g. through contaminated injection needles

VECTORS



Adverse effects of parasites on hosts PATHOGENICITY



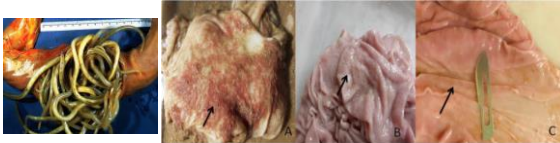
- Is a property of a species;
- Within a species – various strains can exist with different degrees of **virulence**, ranging from low to high.
- A host species is susceptible or not to certain pathogen due to its **genetic constitution**.
- Individuals may exist that are **fully susceptible** or **partially resistant**. (This **resistance** is an **innate property** and need to be distinguished from immunity.)

1. Direct damage – e.g. mechanically, blockade, tissue destruction, compression of organs, destruction cells;

- Losses of nutrients
- Inflammatory response
- Immunopathological effects
- Cytopathogenicity
- Immune responses
- Blood loss
- Toxins

1. Competition for hosts nutrients
2. Destruction of hosts tissues
3. Tissue changes
4. Toxins, poisons and secretions
5. Mechanical interference

2. Indirect effects – parasites signals with host reactions

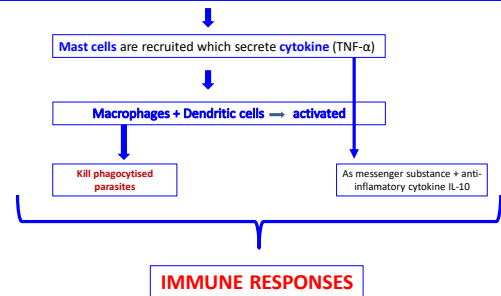


Mechanisms of pathogenicity



The adverse effects that parasites exert on their hosts are extremely diverse and complex, and represent the result of **PARASITE-HOST INTERACTIONS**.

➤ Inflammatory response – first line defence of host as part of innate non-specific defence;



Immunology of parasitoses

- Vertebrates are equipped with two functionally closely related defence systems to fight pathogens:

1. innate immune system – **non-specific**
2. acquired or adaptive immune system – **specific**

Immunology of parasitoses

➤ INNATE IMMUNE SYSTEM

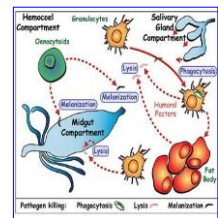
includes **physical and chemical barriers**
= first non-specific line of defense **skin, mucosa**
= secretions: **saliva, digestive enzymes, bile acids**

- Should a parasite evade these barriers, are activated:
cellular components: **phagocytes, natural killer, T-cells**

The earliest effect:

Inflammation (vasodilatation, increasing of blood flow and vascular permeability)

Phagocytosis (neutrophils and macrophages)



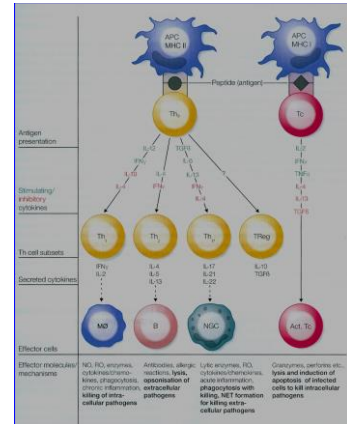
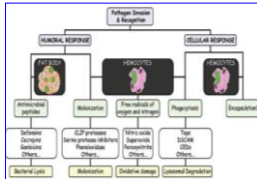
Immunology of parasitoses

ADAPTIVE IMMUNE RESPONSE

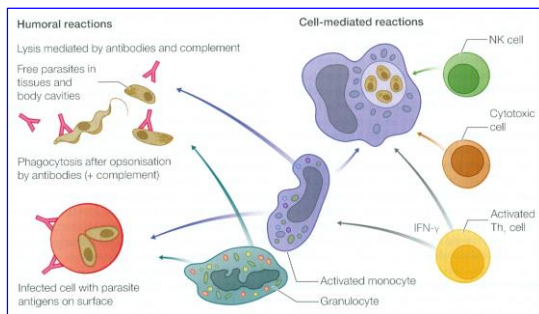
regulate and control the course of primary infections and protect an organism completely or partially from:

1. **re-infection** (anti-infectious immunity)
2. **clinical consequences of an infection** (protection from the disease)

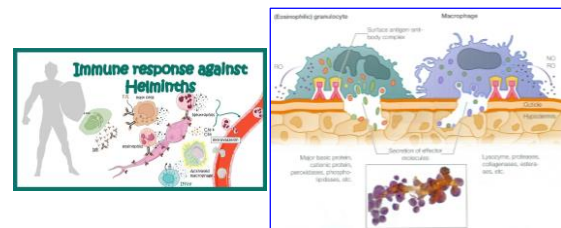
- Subsequent responses then occur at 2 broad levels:
- Cellular immune reactions – by **T lymphocytes**
 - Humoral immune reactions – by **B lymphocytes** and **B lymphocyte** derived plasma cells, producing **antibodies** (IgM, IgG, IgA, IgE...)



Immunological effector mechanisms against protozoa.



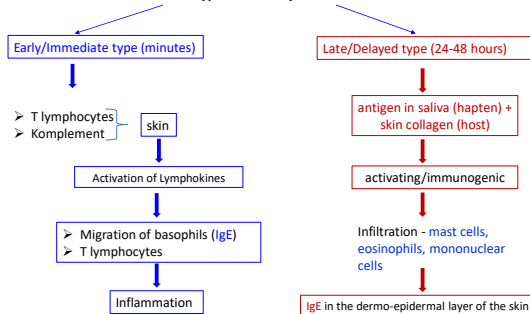
Immunological effector mechanisms against tissue stages of helminths



Self-cure reactions are a particular type of immune elimination of helminths by rapid expulsion of living larvae or adults;

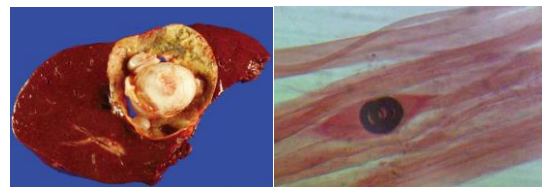
Immunity to arthropods

Local hypersensitivity reaction



Immune evasion strategies of parasites

- SEQUESTRATION – retreat of parasites into sites that are relatively unacceptable to immune effects (immunoprivileged organs/cells, formations constructed by parasites, including protective sheaths or cysts – *Echinococcus*, *Trichinella*).



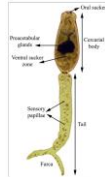
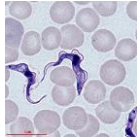
- **MASKING OR CHANGING IMMUNOGENIC PROPERTIES** – by incorporation or adhesion of host molecules or **mimicry** by synthesis of host-conatural antigens or **antigenic variation** by changing of antigenic structure.



Masking – achieved by absorption of host albumin and immunoglobulins onto surface of parasites (*Schistosoma*, nematode larva)
Stage – **specific antigens** (*Trypanosoma*)

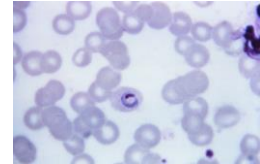
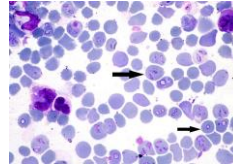


Antigenic variation – **variant surface glycoprotein (VSG)**



- **IMPAIRMENT OF IMMUNOLOGICAL EFFECTOR MECHANISMS** – shedding of antigen antibody complexes, enzymatic cleavage of antibodies, inhibition of oxidative products of effector cells.

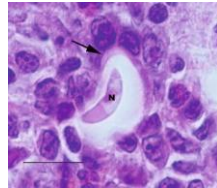
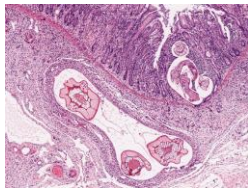
- Parasites expose their surface antigens to recognition;
- They even show the host highly antigenic surface structures that can be shed after binding to antibodies (antigen shedding) – *Babesia*, *Plasmodium*



- **MODULATION OF HOST'S IMMUNE MECHANISMS** – modulation of the immune response or immuno-suppression.

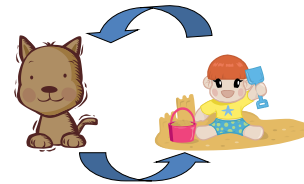
- **INFLUENCING APOPTOSIS OF HOST CELLS** – enhancement of apoptosis of immune cells or inhibition of apoptosis in infecting host cells (*Toxoplasma*, *Leishmania* – cause an enhanced apoptosis of CD4⁺ T cells).

- **FURTHER STRATEGIES** – **HYPOBIOSIS** (*Cyathostomum*), **DORMOZOITES** (*Cystoisospora*).



What are zoonotic diseases ?

- A **zoonotic disease** is any disease which may be **passed from animals to people or from people to animals** (that is, they are common to animals and humans).



Vector-borne Parasites

- A vector is an agent which transfers a parasite from one host to another;
- Typical parasite vectors: fleas, ticks, mites, mosquitoes, flies, and other insects;
- People become infected when a vector picks up the parasite from an infected animal and infects a human;



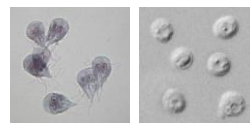
Waterborne Parasites

- Spread when humans/animals come into contact with water that has been contaminated by an infected animal/human;

- Common waterborne parasites include

➤ *Giardia*

➤ *Cryptosporidium*



Fecal-Oral Transmission

- Most common way people/animals become infected with zoonotic parasites;
- Parasites are spread to humans/animals when they **ingest the eggs from the faeces** of an infected animal;
- Parasites spread by faecal oral transmission generally live in the intestinal tract;

➤ Hookworms
➤ Roundworms
➤ Hydatid Disease
➤ Toxoplasmosis



Contaminated Meat

- Meat can be contaminated with harmful bacteria and can also **contain parasitic cysts** which may infect people.
- Common Parasites Found in Meat
 - *Toxoplasma*
 - *Trichinella*
 - *Taenia*
 - *Gnathostoma*

Summary

- Zoonotic parasites have **many routes of transmission to people/animals**
 - Vectors
 - Water, soil
 - Fecal Contamination
 - Infected Meat

INTRODUCTION TO PROTOZOOLOGY

- General taxonomy one-cell parasites;
- Intracellular structure and mode of reproduction;
- General classification of KINETOPLASTA

What are Protozoa?

proto = first

zoa = animals

uni-celled eukaryotic organisms

General Concepts

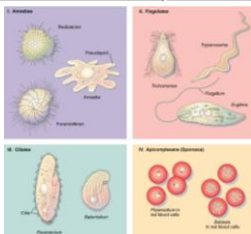
- Eukaryotic Organisms
- Generally unicellular
- Found in every conceivable damp habitat
- Approximately 60,000 living species
- Largest visible to the naked eye
- Smallest only seen with the EM
- Have all necessary life activities.

Protozoa

- Most species are free living, but all higher animals are infected with one or more species of protozoa.
- Infections range from asymptomatic to life threatening, depending on the species and strain of the parasite and the resistance of the host.

Protozoan Motility

| Mechanism | Subgroup |
|------------------|-------------|
| ameboid movement | amebas |
| flagella | flagellates |
| cilia | ciliates |
| gliding motility | sporozoa |

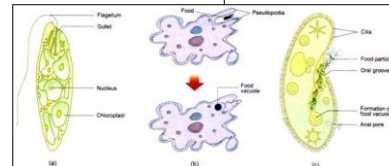
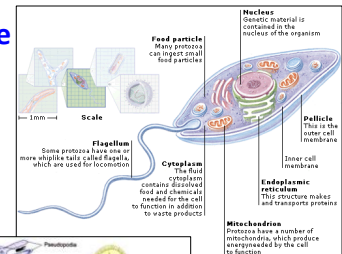


Structure

- Protozoa are microscopic **unicellular eukaryotes** that have a **relatively complex internal structure** and carry out **complex metabolic activities**.
- Some protozoa have structures for propulsion or other types of movement.

Basic structure

1. Cell membrane
2. Cytoplasmic organelles: pseudopodium; flagellum; cilium
3. Nucleus: two kinds vesicular; compact

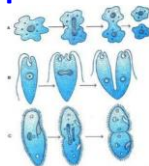


Protozoan Reproduction

1. Asexual

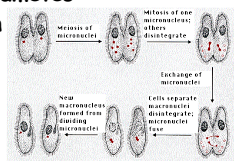
- a. Binary Fission – division into two organisms by way of nuclear division and cytokinesis [e.g. Flagellates (longitudinal); Ciliates (transverse); sarcodins (random)]

- b. Budding – portions of a parent cell differentiates and develop into a new individual



Sexual

fusion of gametes conjugation



Protozoan Life Styles

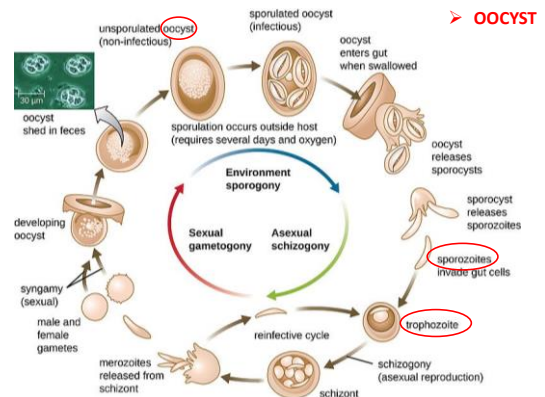
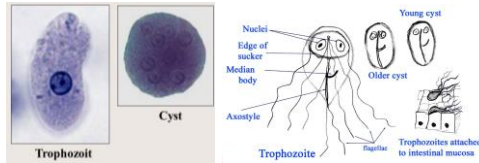
- **absorb** solutes (osmotrophy)
- **ingest** particulates (phagotrophy)
- **predation** on bacteria or other protozoa
- **pinocytosis** (fluid uptake)
- **photosynthetic** (autotrophy)
- **combinations** (heterotrophy)

free-living vs. symbiosis
parasitic

Life cycle stages

➤ The stages of parasitic protozoa that **actively feed and multiply** are frequently called **trophozoites**; in some protozoa, other terms are used for these stages.

➤ **Cysts** are stages with a **protective membrane** or **thickened wall**. Protozoan cysts that must survive outside the host usually have more resistant walls than cysts that form in tissues.



Classification

On the basis of light and electron microscopic morphology, the protozoa are currently classified into seven phyla.

Most species causing human/animal diseases are members of the phyla **METAMONADA**, **PARABASALA** and **ALVEOLATA**.

