

Host-Parasite Relationship

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INTRODUCTION

- Microorganisms may be divided into three types based on their potential to cause diseases; pathogens, commensals, and nonpathogens

NORMAL FLORA

- The composition of the normal flora varies in different body sites
- Ultimately, the microbiota composition is determined by ecological factors including the presence of receptors of host cell surface for bacterial adherence, pH, oxygen, availability of nutrients, water, host defense, personal hygiene.

TYPES OF PARASITIC RELATIONSHIPS

- **A. SYMBIONT:**
Has a mutualistic relationship with the host.
Both benefit from this relationship
- **B. COMMENSAL**
Only the parasite benefits from this relationship but the host is not harmed (i.e. Normal Flora)
- **C. PATHOGEN**
The parasite benefits from this relationship at the expense of the Host
The Host is harmed by this interaction and the parasite induces a pathological response in the host

TYPES OF PATHOGENS

A. EXTRACELLULAR PATHOGENS

- These pathogens cause disease by growing outside host cells
- They are generally killed by the host's phagocytes
- Virulence is usually determined by an antiphagocytic capsule

B. FACULTATIVE INTRACELLULAR PATHOGENS

- These pathogens usually cause disease by growing inside host cells
- But they can also grow outside the host cell and they can be grown in artificial culture medium in the laboratory
- They are usually not killed readily by the host's phagocytes
- Virulence is usually determined by many factors

TYPES OF PATHOGENS

C. OBLIGATE INTRACELLULAR PATHOGENS

- These pathogens cause disease by growing inside host cells
- They will not grow outside living cells
- Virulence is usually determined by many factors

D. TOXIGENIC PATHOGENS

- Cause disease primarily by producing exotoxins that are essential for the virulence of the pathogen

HOST MECHANISM FACTORS

- Physical barriers
- Cleansing mechanism
- Antimicrobial substances
- Normal flora
- Phagocytosis
- Inflammation

Physical barriers

- Healthy skin, intact skin, mucous membranes
- Normal flora → low pH, competition for nutrients, production of bactericidal substances → prevent colonization
- Acid environment of the skin

Table 1. Protective Characteristics of The Skin

Skin Structure	Protective Activity
<i>Outer layer</i>	Physical barrier to microbial penetration Sloughing of outer layers remove attached bacteria Provide dry, acidic, and cool conditions that limit bacterial growth
Hair follicles, sweat glands, sebaceous glands	Production of acids, alcohols, and toxic lipids that limit bacterial growth
Conjunctival epithelium covering the eyes	Flushing action of tears removes microorganisms Tears contain lysozyme that destroys bacterial cell wall
<i>Skin-associated lymphoid tissue</i>	Mediated specific and non-specific protection mechanisms against microorganisms that penetrate outer layers

Sumber: Bailey & Scott's diagnostic microbiology, 1998.¹

Table 2. Protective Characteristics of Mucous Membranes

Mucous Membrane Structure	Protective Activity
Mucosal cells	Rapid sloughing for bacterial removal Tight Intercellular junctionprevent bacterial penetration
Goblet cells	Mucus production: <ul style="list-style-type: none"> • Protective lubrication of cells • Bacterial trapping • Contain specific antibodies with specific activity against bacteria • Provision of antibacterial substances to mucosal surface : <ul style="list-style-type: none"> * Lysozym: degradesbacterial cell wall * Lactoferrin: competes for bacterial iron supply * Laktoperoxidase: production of substances toxix to bacteria
<i>Mucosa-associated lymphoid tissue</i>	Mediates specific responses against bacteria that penetrate outer layers

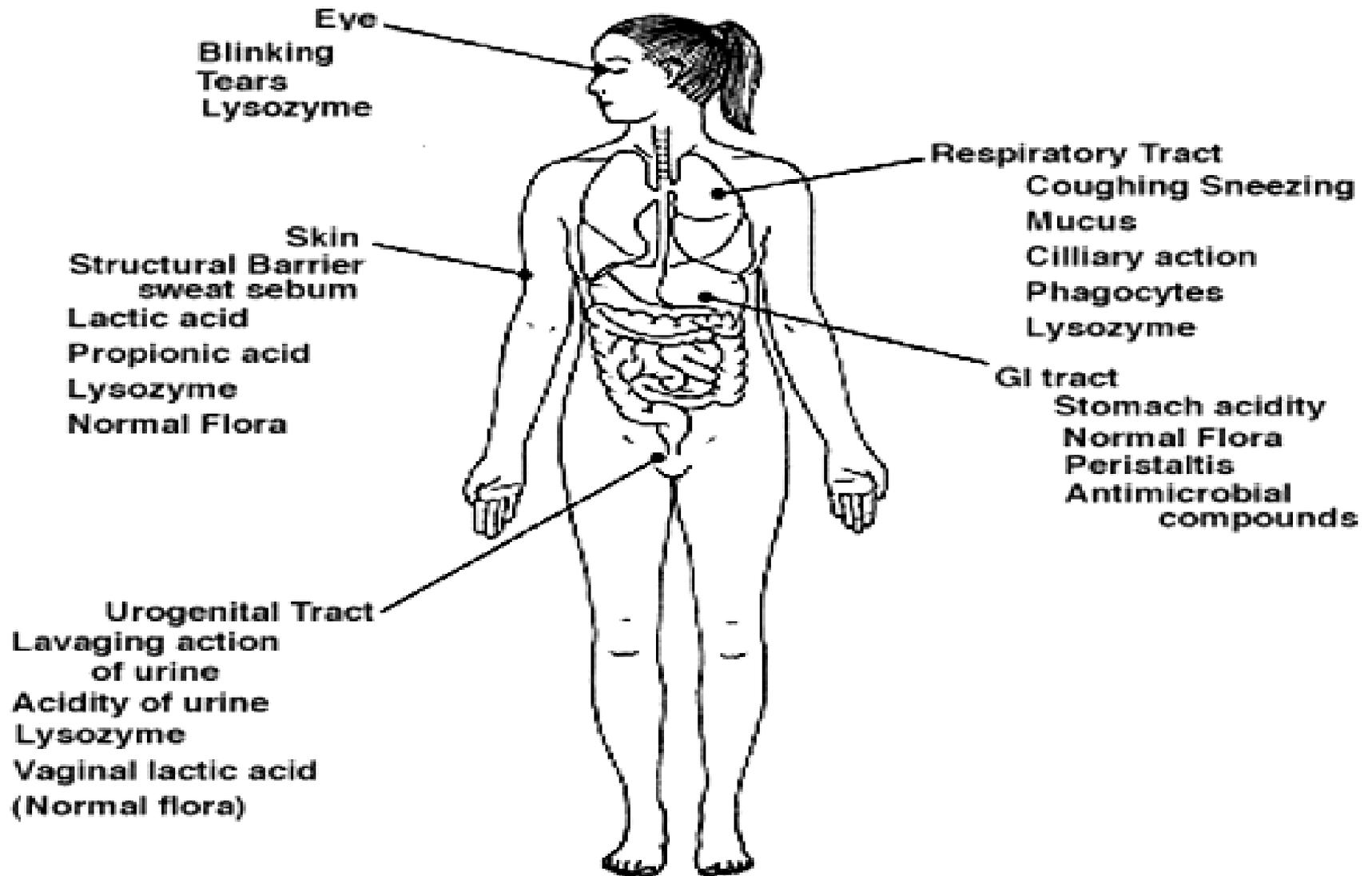


Figure 1. Anatomical defenses associated with tissue surfaces
 Source: Todar, University of Wisconsin Department of Bacteriology, 2002.⁴

Cleaning Mechanisms

- Desquamation of the skin surface
- Fluids of the eye, respiratory, digestive, urinary, genital tracts
- Nasal hairs, ciliary epithelium, mucous membrane
→ Respiratory tract
- Mucus secretions & peristalsis → prevent the organisms from attaching to the intestinal epithelium
- Genitourinary tract → cleansed by the voiding urine
- Vagina → acidity

Antimicrobial substances

- Lysozyme: hydrolyzes peptidoglycan layer bacterial cell walls
- Found in serum, tissue fluids, tears, breast milk, saliva, and sweat
- Antibodies (esp. secretory IgA) are found in mucous secretions of the respiratory, genital, and digestive tracts → serve as opsonin → enhancing phagocytosis or fix complement and neutralize the infecting organism

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- Serum → β -lysins → lethal against Gram+ bacteria
 - β -lysins are released from platelets during coagulation

Normal Flora

- Nonpathogenic microorganisms compete with pathogens for nutrients and space



lessen the chance that the pathogen will colonize the host

- Some flora normal bacteria produce bacteriocins
→ inhibit growth of closely related bacteria →
eliminate other bacteria that would compete for
nutrients and space

Phagocytosis

- Primary mechanism in the host defense against extracellular bacteria, virus, fungi
- First line defense → polymorphonuclear neutrophils (PMN) and macrophages

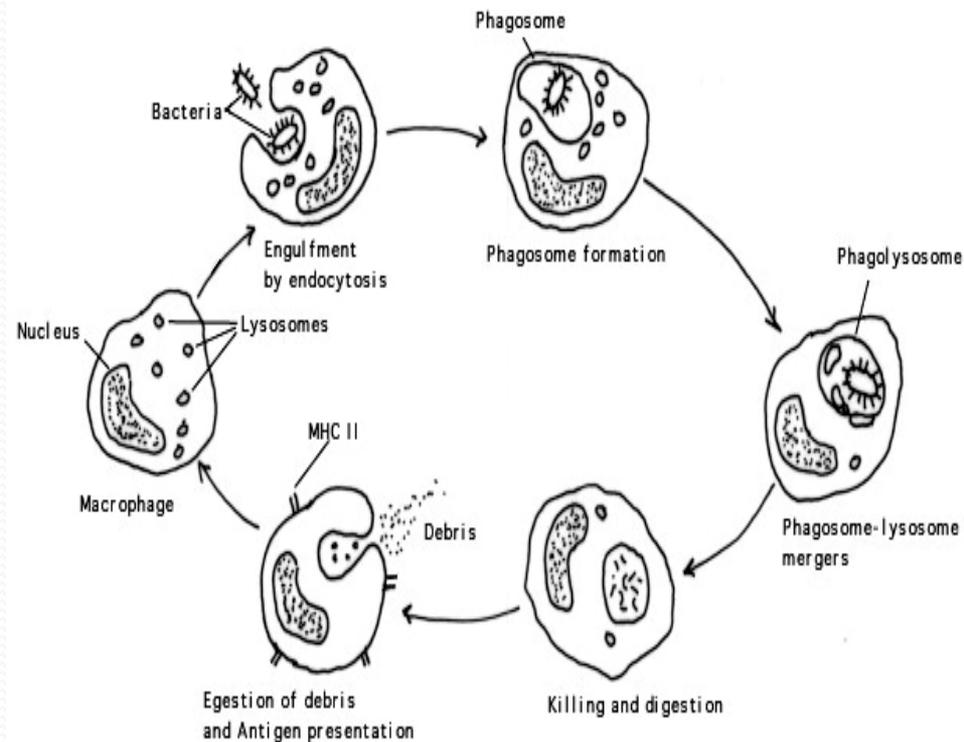
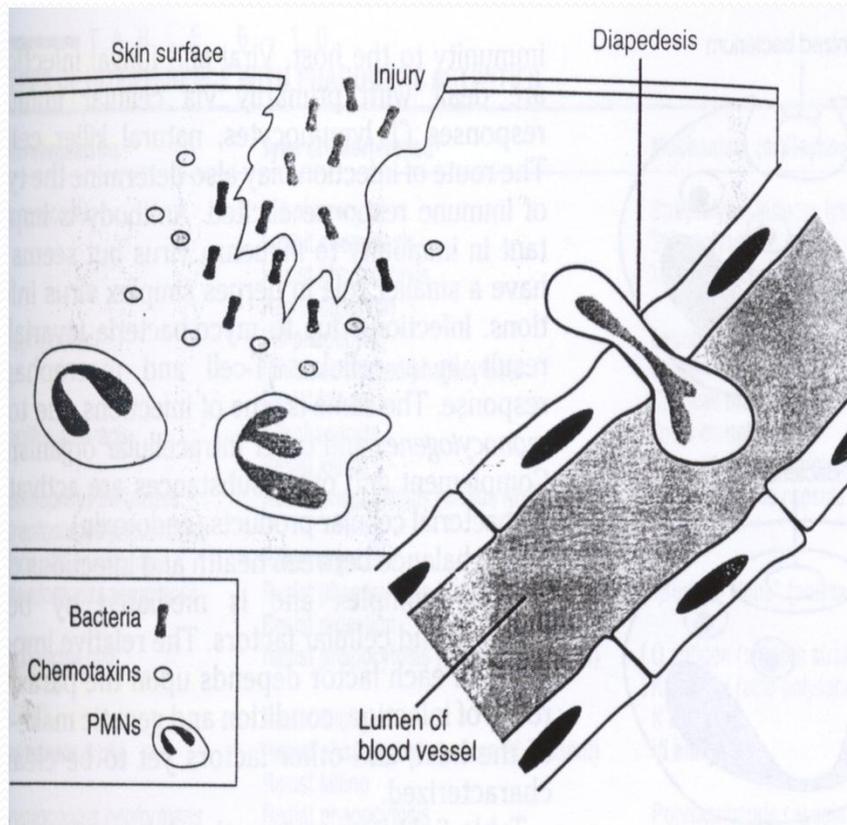


Figure 2. Phagocytosis

Sourcer: Todar, University of Wisconsin Department of Bacteriology, 2002.⁴

- Four activities must occur for phagocytosis to take place and be effective in host defense:
 1. Migration to the area of infection
(chemotaxis)
 2. Attachment to the particle of the phagocyte
 3. Ingestion
 4. Killing

Chemotaxis

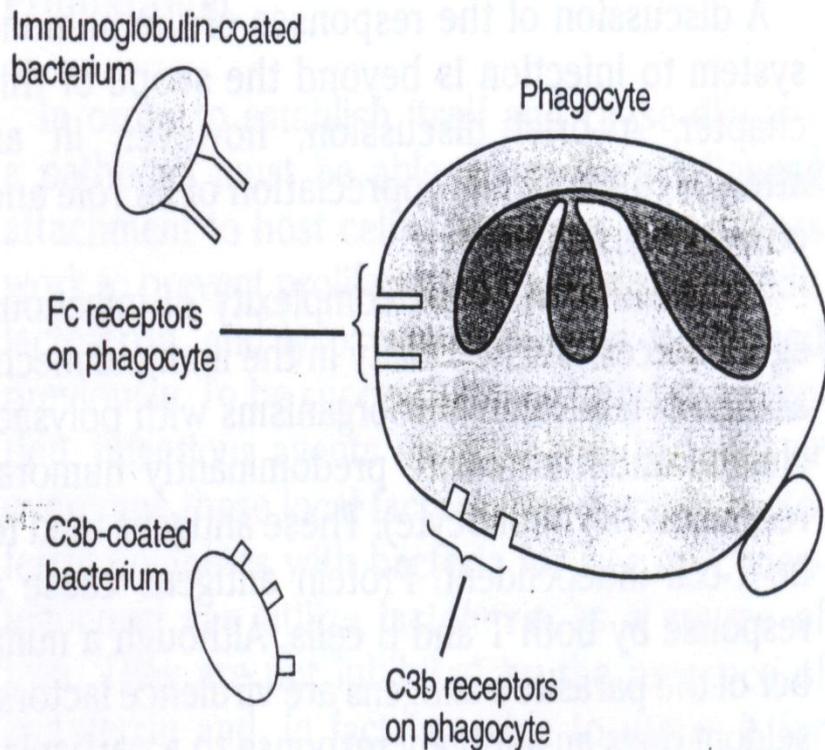


- PMNs circulate through the body → diapedesis
- When infections occur → massive number of PMNs accumulate at the site
- Migration of PMNs to the area needing their service → chemotaxis

Figures 3. Phagocytosis: chemotaxis

Source: Bailey & Scott's Diagnostic microbiology, 1998.¹

Attachment



Gambar 4. Phagocytosis: *attachment*

Source: Bailey & Scott's Diagnostic microbiology, 1998.¹

- Attachment is facilitated by specific antibodies to the microorganism
- Neutrophil has variety of receptors: Fc portion of IgG₁, IgG₃, C₃B component of complement
- These 3 factors can and do bind to the invading microorganism
- The coating of the bacterium → enhanced phagocytosis
PMN → opsonization

Ingestion

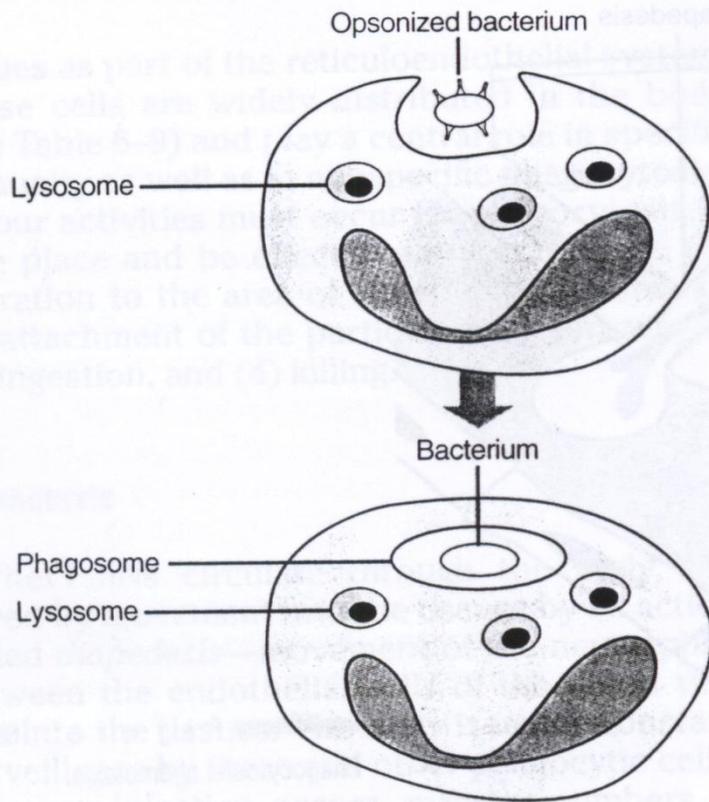


Figure 5. Phagocytosis: ingestion

Source: Bailey & Scott's Diagnostic microbiology, 1998.¹

- The cell membrane of the phagocytic cell invaginates and surrounds the attach particle
- Particle is taken into the cytoplasm and enclosed within a vacuole called a phagosome
- The phagosome fuses with lysosomes (vacuole containing hydrolytic enzymes)

Killing

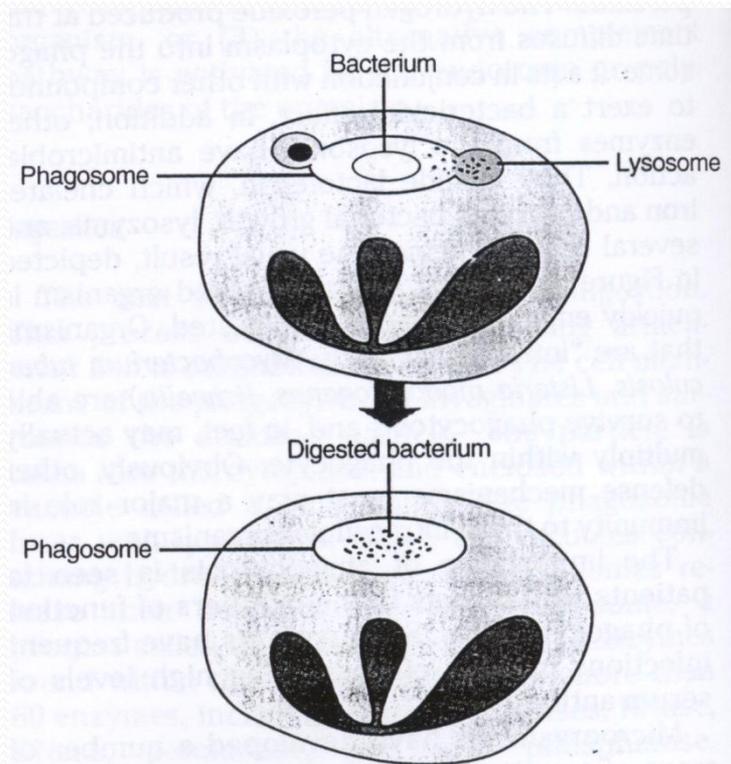


Figure 6. Phagocytosis: killing
Source: Bailey & Scott's Diagnostic microbiology, 1998.¹

- Metabolic or respiratory burst → metabolic activity of the neutrophil and macrophage → glycolysis, the hexose monophosphate shunt pathway, oxygen utilization, and production of lactic acid and H_2O_2
- H_2O_2 → bactericidal
- Lysosome enzymes: lactoferrin, lysozyme

Inflammation

- Body's response to injury or foreign body
- Accumulation of large numbers of phagocytic cells
- These leukocytes release mediators or cause other cell types to release mediators → cause edema, erythema, etc
- The enzymes released by the phagocytes digest the foreign particles, injured cells, and cell debris

Immune Response

- Humoral immune response
- Cellular immune response
- Factors determine immune response
 - Parasite
 - Route of infection
 - Host condition

INFECTIOUS AGENTS FACTORS

- Adherence
- Proliferation
- Tissue damage
- Invasion
- Dissemination

Adherence

- Most infectious agents must attach to host cells before infection occurs
- In some diseases due to exotoxin, adherence is not important
- The cell surface structures that mediate attachment are called adhesins
- Host cells must possess necessary receptors for the adhesins
- If the host or infectious agent undergoes a mutation that changes the structure of the adhesins or receptor → adherence will not take place

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- Main adhesins in bacteria are the pili (fimbriae) and the surface polysaccharides
 - Pili enable bacteria to adhere to host cell surface

Proliferation

- In order to establish itself and cause disease, a pathogen must be able to replicate
- Numerous host factors work to prevent proliferation (secretory antibody, lactoferrin, lysozyme)

Tissue Damage

- Disease from infection is noticeable only if tissue damage occurs
- The damage may be from: toxins or inflammatory substances → immunologically mediated damage

Invasion

- Process of penetrating, and growing in tissues
- Localized and involves only a few layers of skin

Dissemination

- Spread of organisms to distant sites (organ, tissues)

ROUTES OF TRANSMISSION

- Airborne transmission
- Transmission by food and water
- Close contact
- Cuts and bites
- Arthropods
- Zoonoses

Airborne Transmission

- Respiratory infectious disease
- Droplet nuclei

Transmission by Food and Water

- Fecal-oral route
- Infection →
 - invasion
 - toxin

Close Contact

- Passage of organisms by salivary, skin, and genital contact

Cuts and Bites

- Bites → wound → infection
- eg. rabies

Arthropods

- Direct infection
eg. scabies
- Vector
eg. malaria

Zoonoses

- Disease of animals that is transmitted to human