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Host Parasite Relationship

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OBJECTIVES

- Define core terms related to host-parasite relationship.
- Recall host response to parasite invasion (specific and non-specific responses).
- Know important examples of primary and secondary pathogens.
- Recognize the differences between virulence and pathogenicity and how virulence measured.
- Recall the transmissibility of pathogens.
- Describe the attributes of pathogenicity and recall examples.
- Know the infection chain &infectious disease process
- Know Koch's postulates

Host-Parasite Relationship

- Human host is normally in contact with many microorganisms *(normal flora)*
- Only a small number of these microorganism (primary and opportunistic pathogens) can cause disease.
- Host-parasite relationships (interaction) is characterized by fighting the organism to invade the body and the body defending itself by protective measures.

Definitions

Host : human (or animal or others) that support the growth and survival and protection of the parasite .

Parasite: bacteria, viruses, fungi or parasites which live in or within the host ,may cause disease or live mutually with the host.

Definitions

Pathogenicity: the ability of a microorganism to cause disease.

Pathogen: a microorganism having the capacity to cause disease in a particular host. Pathogen may infect one body organ or multiple organs. Some pathogens enter into latent state (infection but no symptoms) e.g. tuberculosis , Herpes virus.

Infection: invasion of cells and multiplication by microorganisms without tissue destruction.

Disease: is the end product of an infectious process

Definitions

Resistance:

The ability of the host to prevent establishment of infection by using its defense mechanisms.

Susceptibility:

Lack of resistance to organism and establishment of disease.

Transmissibility:

The ability to spread from one host to another. This enables the microorganism to maintain continuity of its species in the event of death of original host.

Modes of transmission :airborne, contact, vehicle or vector

Virulence is the **degree of pathogenicity** ,or the ability to invade and destroy tissue to produce disease.

Virulence is measured by the *Lethal dose 50 (LD50)* which is the number of organisms or mg of toxins that will kill 50% of susceptible lab animals (usually mice) when injected into such animals. When the **LD 50** is small, the microorganism is considered highly virulent and when it is high the organism is considered having low virulence.

eg. Shigella spp. is more virulent than Salmonella spp.

Virulence is predominantly associated with adherence and colonization, invasion, avoidance of host responses and toxin formation.

Pathogens

Can be divided according to the degree of pathogenecity into:

a) **Primary pathogens:**

an organism that is able to cause disease in an apparently healthy individual who is non- immune to that organism. **e.g.** - *Bordetella species*

- *Mycobacterium tuberculosis*

b) **Opportunistic (secondary) pathogens**:

Having low pathogenicity and infect people with low immunity. eg. *Pseudomonas & S. epidermidis*

True vs. Opportunistic Pathogen

True pathogen:

- Causes disease in healthy individuals
- Associated with a specific and recognizable disease

Opportunistic pathogen:

- Causes disease in immune compromised host
- Gain access (injury) sterile regions

Host Resistance To Parasite Invasion

1. Non specific defense is part of **natural** constitution of the host. Examples:
   - Skin mechanical barrier
   - Ciliated epithelium of respiratory tract
   - Competition by normal flora
   - Low pH of the stomach
   - Cough
   - Peristalsis
   - Lysozymes
   - Neutrophils
2. Specific defense is acquired resistance to certain organism: **e.g.** Antibodies

Determinants of Pathogenicity

Before causing disease, the microorganism should have the ability to:

a) **Adherence & colonization:** attachment to host epithelial surface .

b) **Survive (resist)** host natural defense mechanisms.

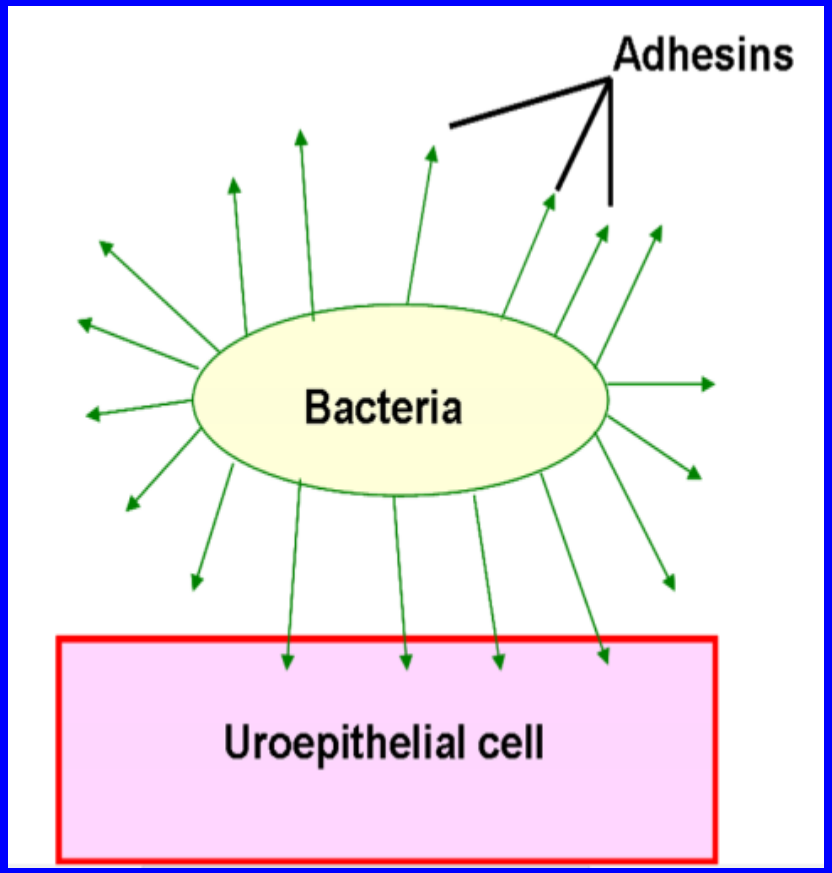
c) **Multiply** to large numbers.

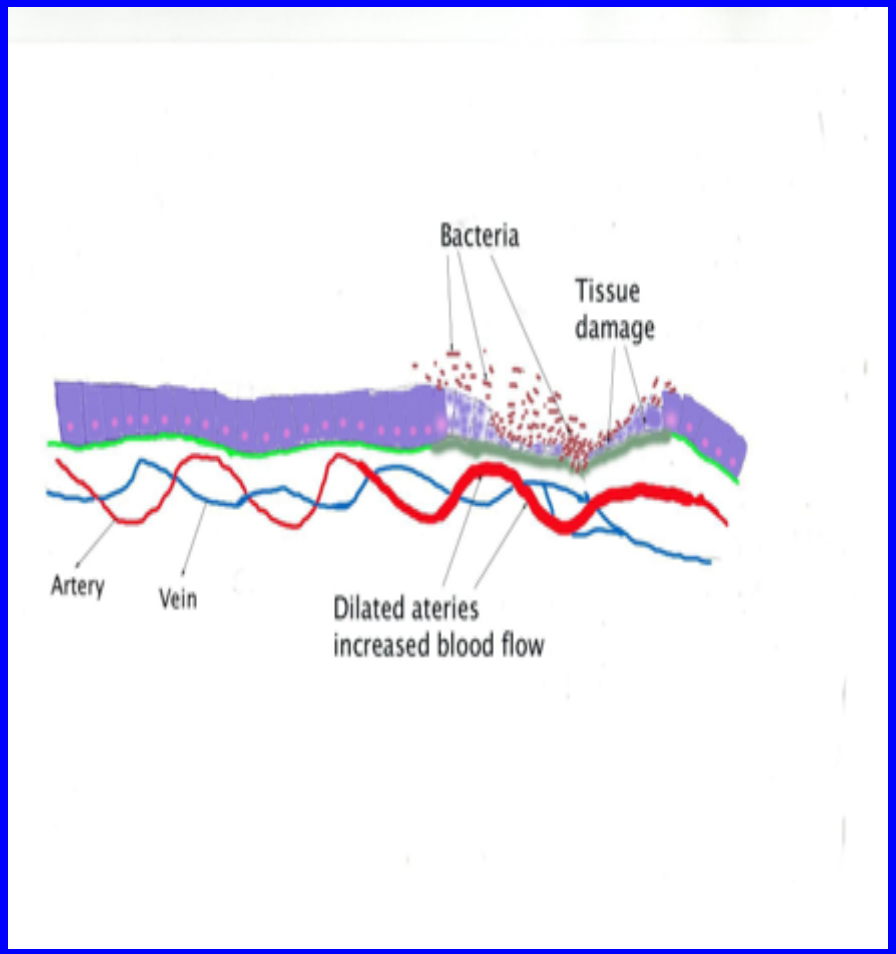
d) **Tissue Destruction:** the ability to overcome host defense, invade the tissues and cause destruction to produce clinical disease.

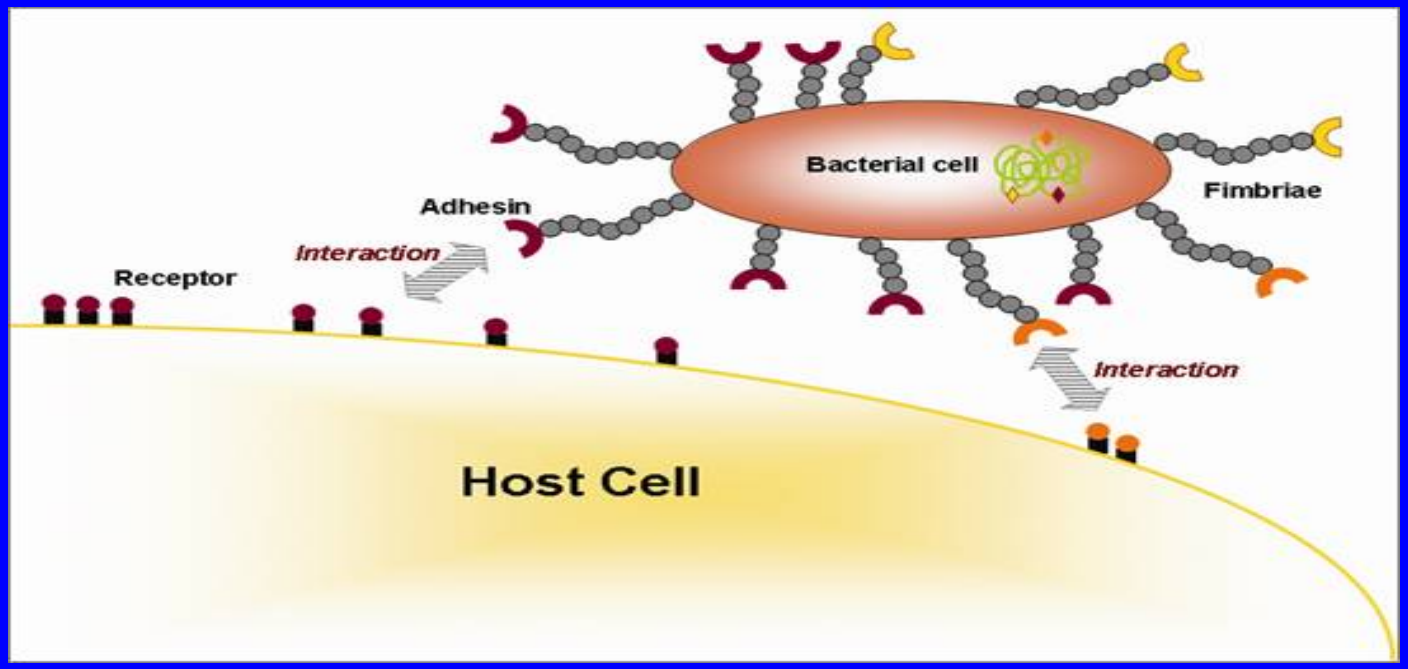
Adherence:

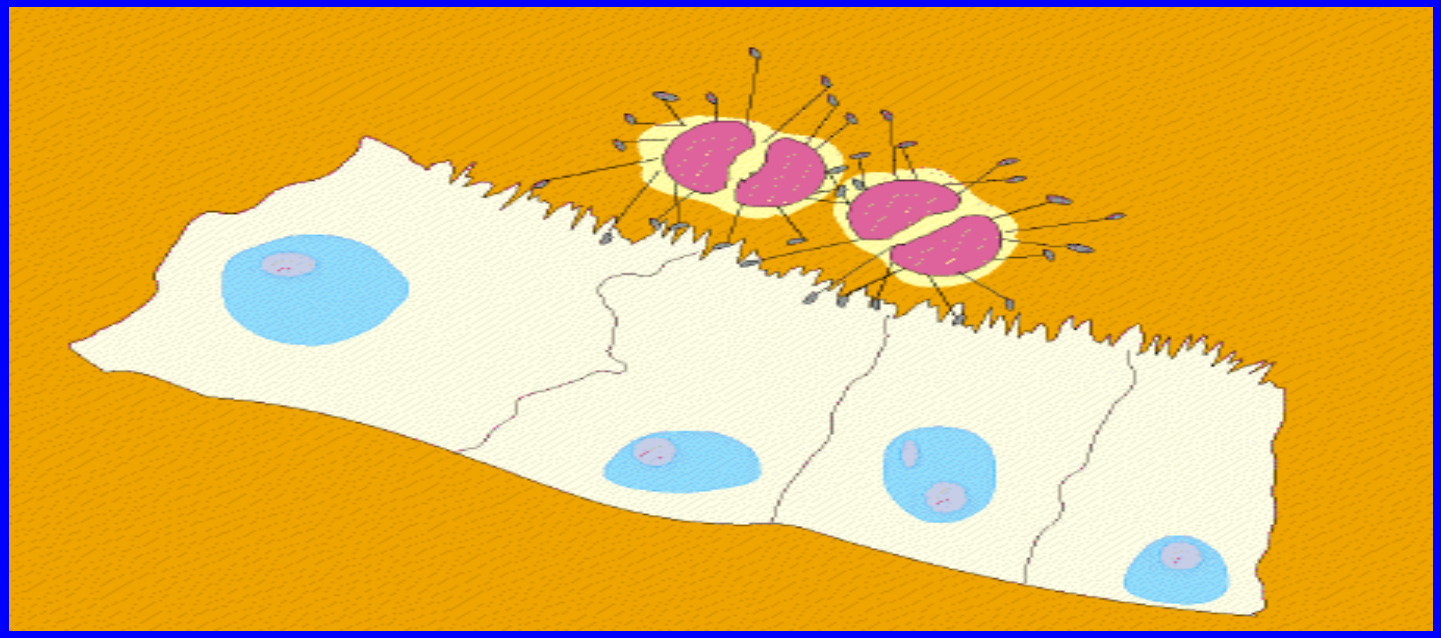
- By means of **adhesins** (adherence factors) found on bacterial surfaces.
  a) Pili
  b) Other protein surface structures
  c) Capsid spikes of viruses
- Structures **on host cells** involved in adhesion include:
  a) Fibronectin
  b) Proteins and Glycopeptide parts

Adhesion & Tissue Destruction






Bacterial cell
Fimbriae
Adhesin
Interaction
Receptor
Interaction
Host Cell



Tissue destruction by:

a) **Toxin** production ,either:
   - **Exotoxin**: produced outside the gram positive and gram negative bacteria eg. cholera toxin, or
   - **Endotoxin**: only found in gram negative bacteria

b) **Invasion** by:
   - Capsulated ,or
   - Non-capsulated organisms

Capsulated organisms : bacteria that have capsule.

Bacterial capsules are polysaccharide except the capsule of *Bacillus anthracis* (is polypeptide).

Capsule prevents phagocytosis and capture by immune system.

The organisms are readily killed once phagocytosed. So called extracellular (EC) organisms

eg. *S. pneumoniae (Pneumococcus)*

Haemophilus influenzae

- **Non capsulated organisms** resist intracellular killing so called intracellular (IC) organisms.

  e.g. ***Mycobacterium tuberculosis, Salmonella typhi,*** ***Brucella*** **species, etc.**

- **Exotoxin** can be:

  a) **A – B type exotoxins eg.** Cholera toxins

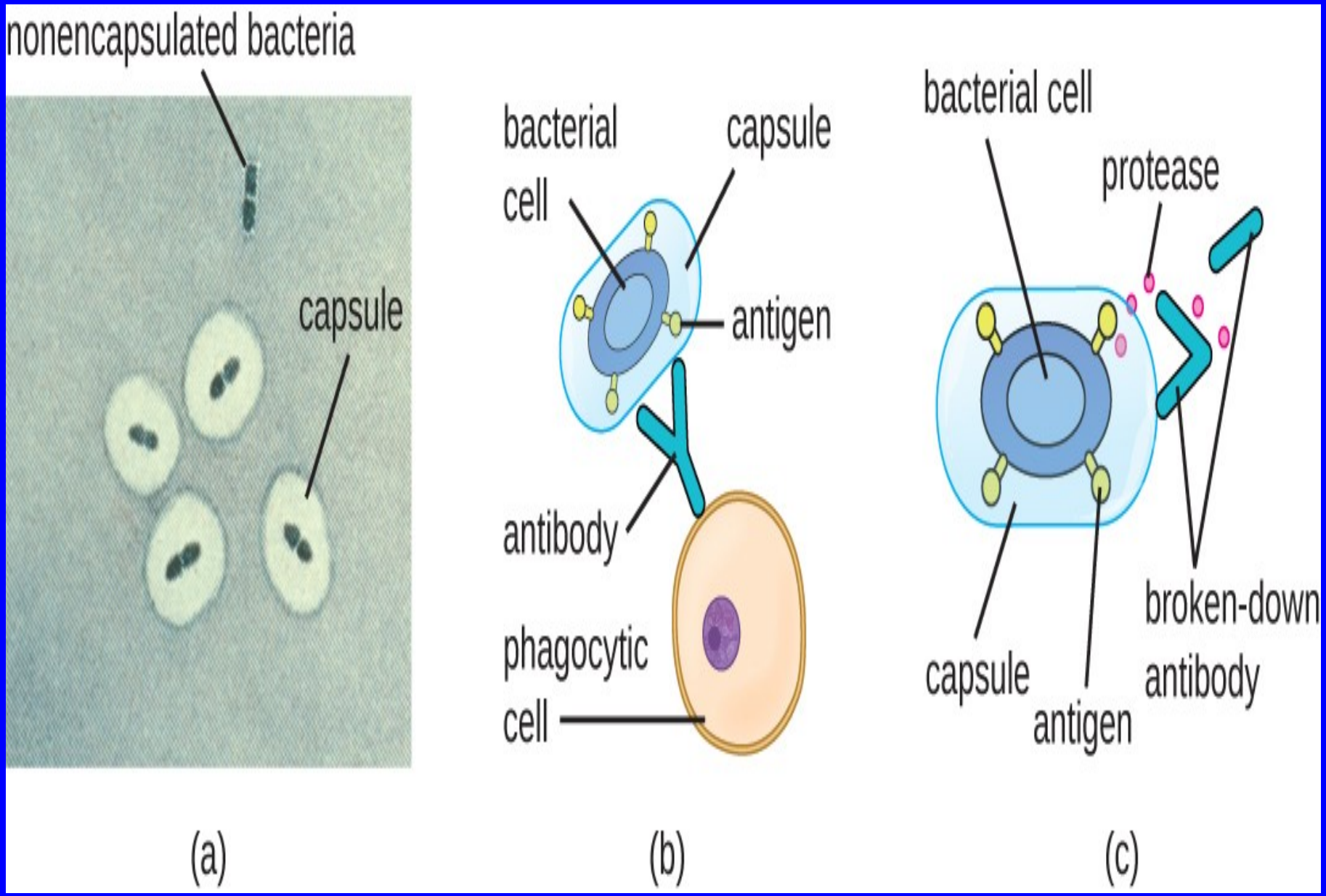
  A : Active unit

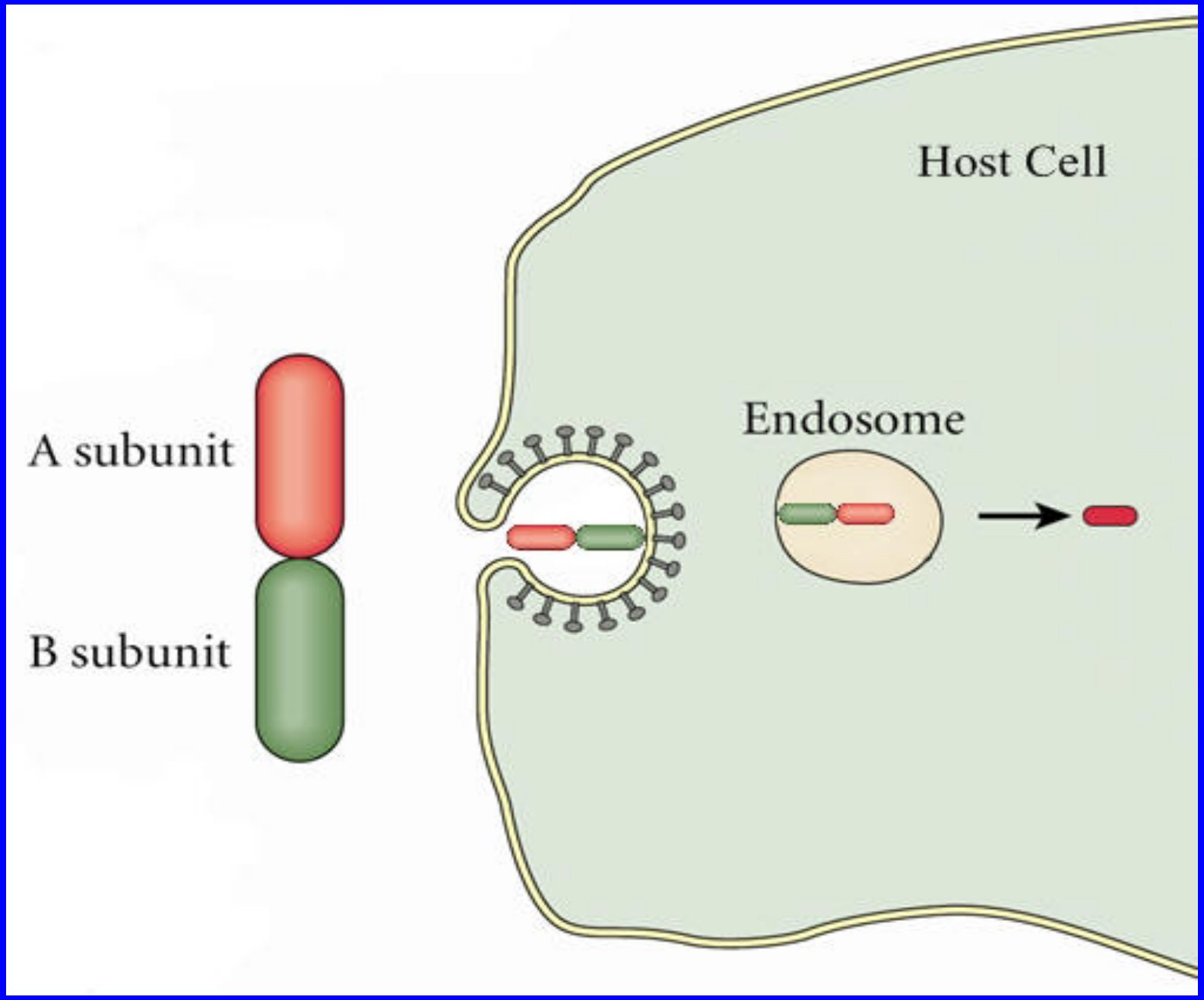
  B : Binding unit for attachment

Or:

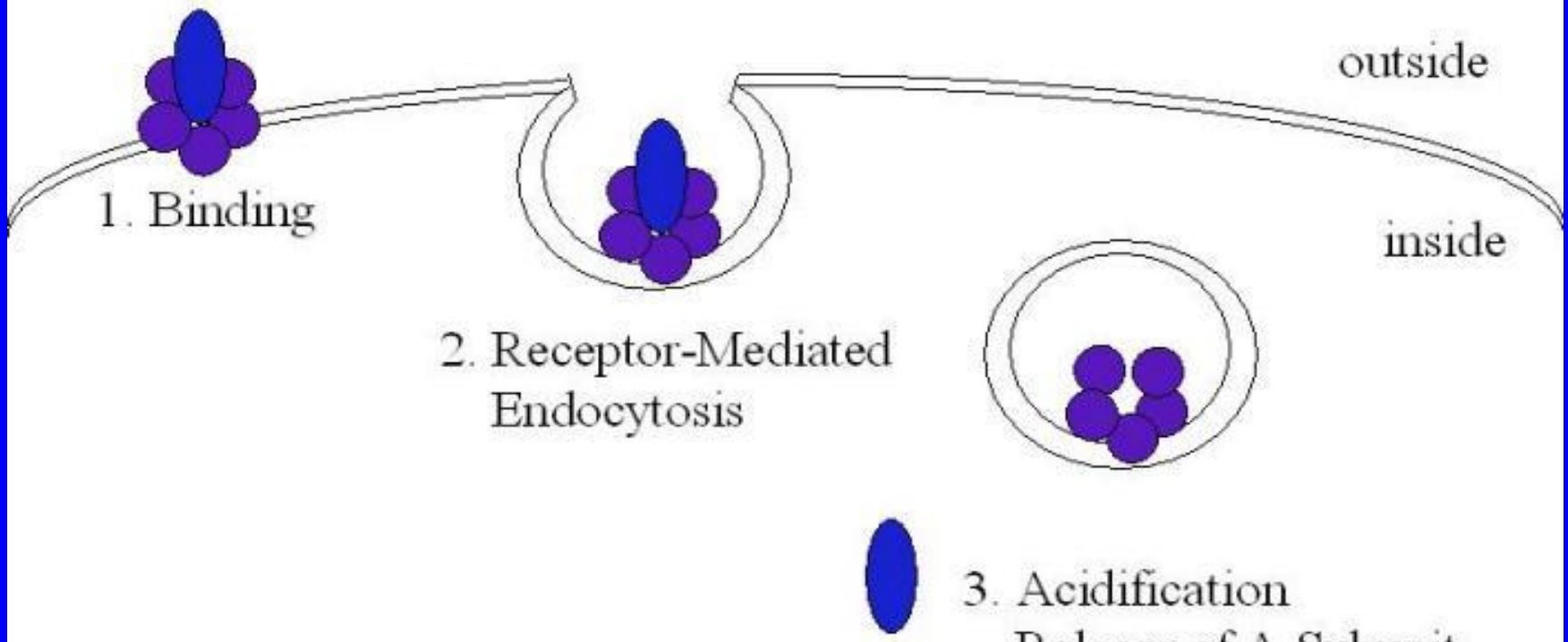
  b) **Membrane active exotoxin**

  eg. Haemolysin of group A Streptococci


nonencapsulated bacteria
capsule
bacterial cell
capsule
antigen
antibody
phagocytic cell
bacterial cell
protease
capsule
antigen
broken-down antibody
(a)
(b)
(c)


Host Cell
A subunit
B subunit
Endosome

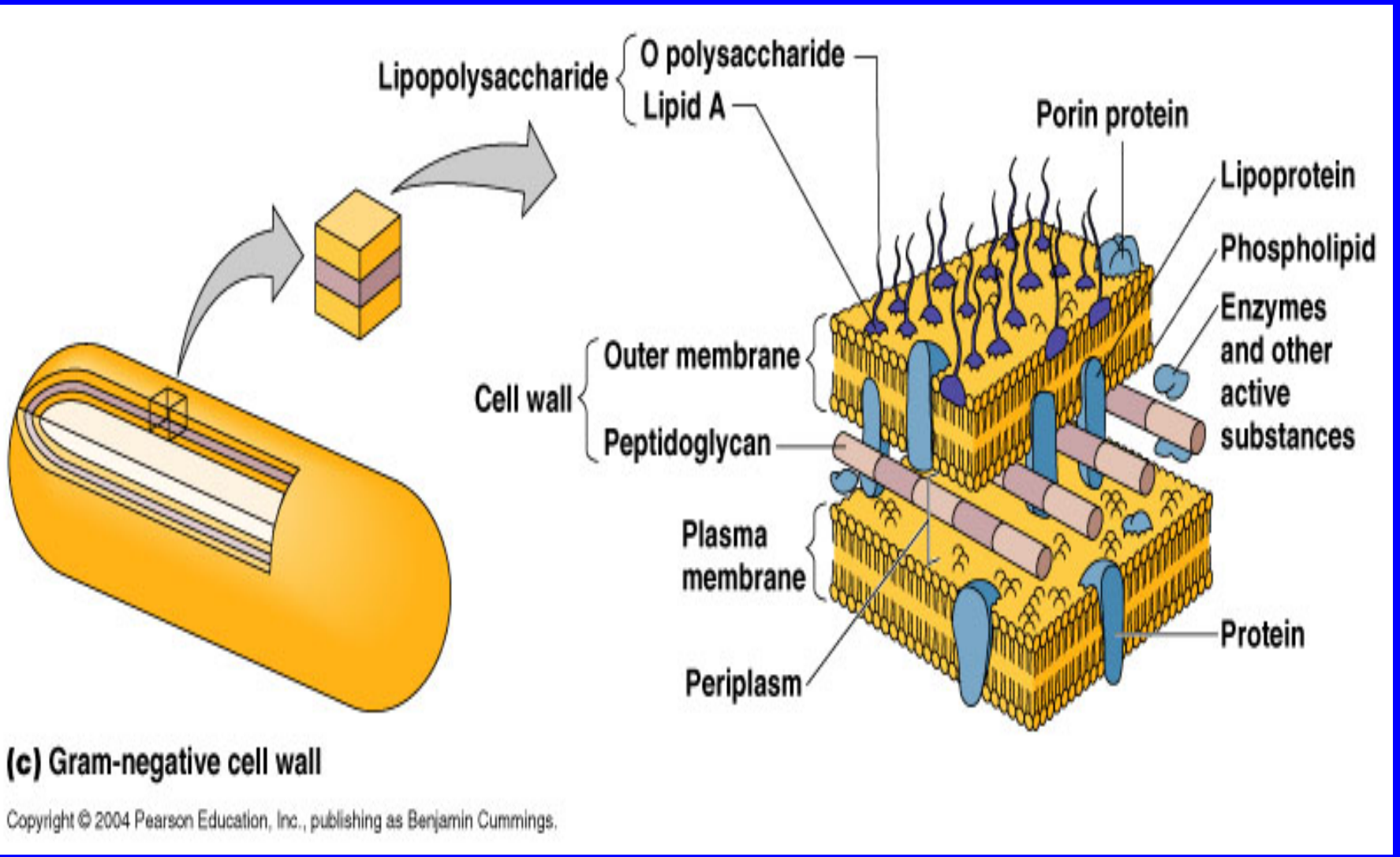
A-B Toxin Entry



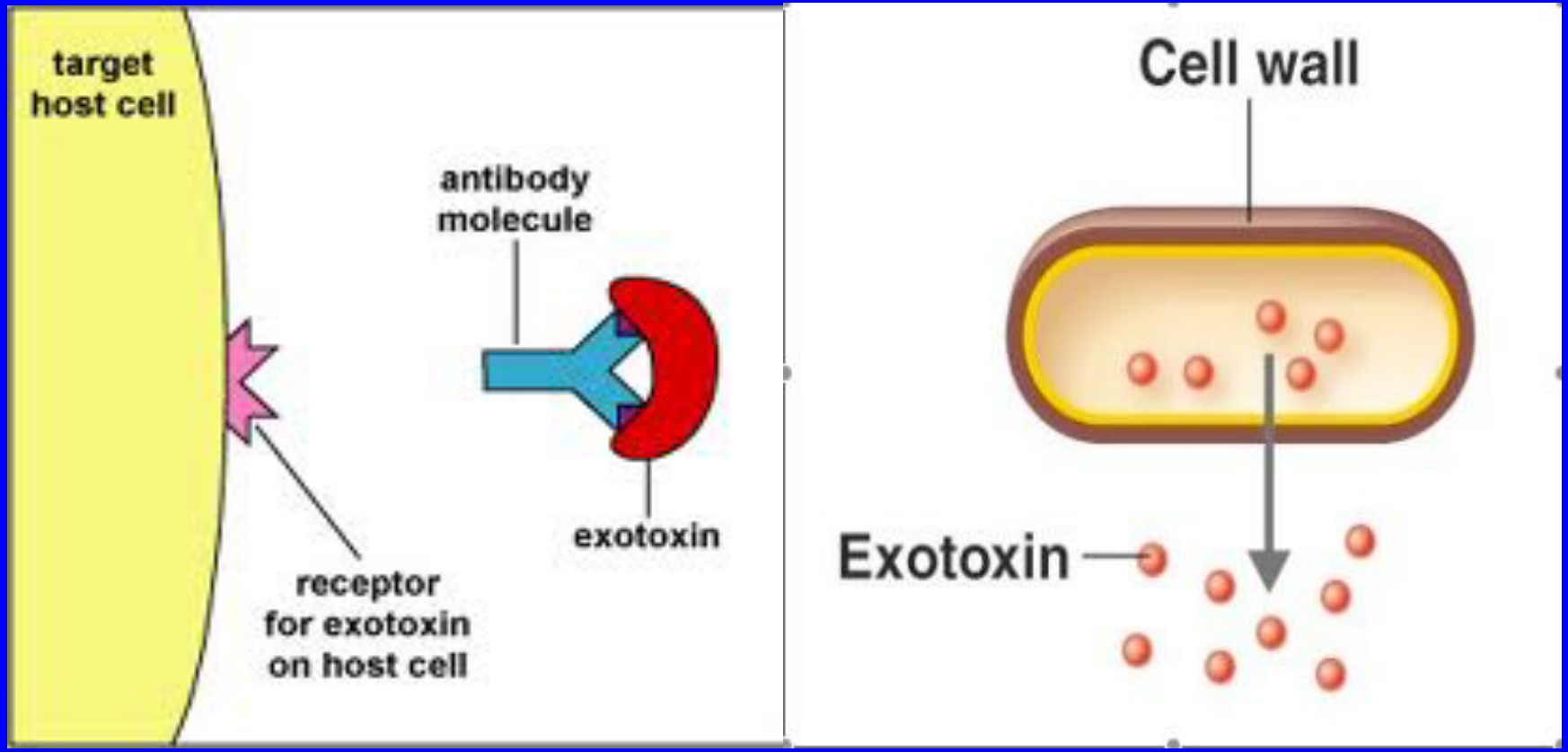
Exotoxin *vs* Endotoxin

Exotoxin	Endotoxin
1- Protein	Lipopolysaccharide
2- Soluble & Diffusible	Part of cell wall
3- Heat Labile	Heat stable
4- Pharmacologically specific action	Non-Specific
5- High Immunogenicity	Low Immunognicity
6- Inactivated by chemicals to toxoids	Do not form toxoids
7- No Fever	Induce Fever

Endotoxin



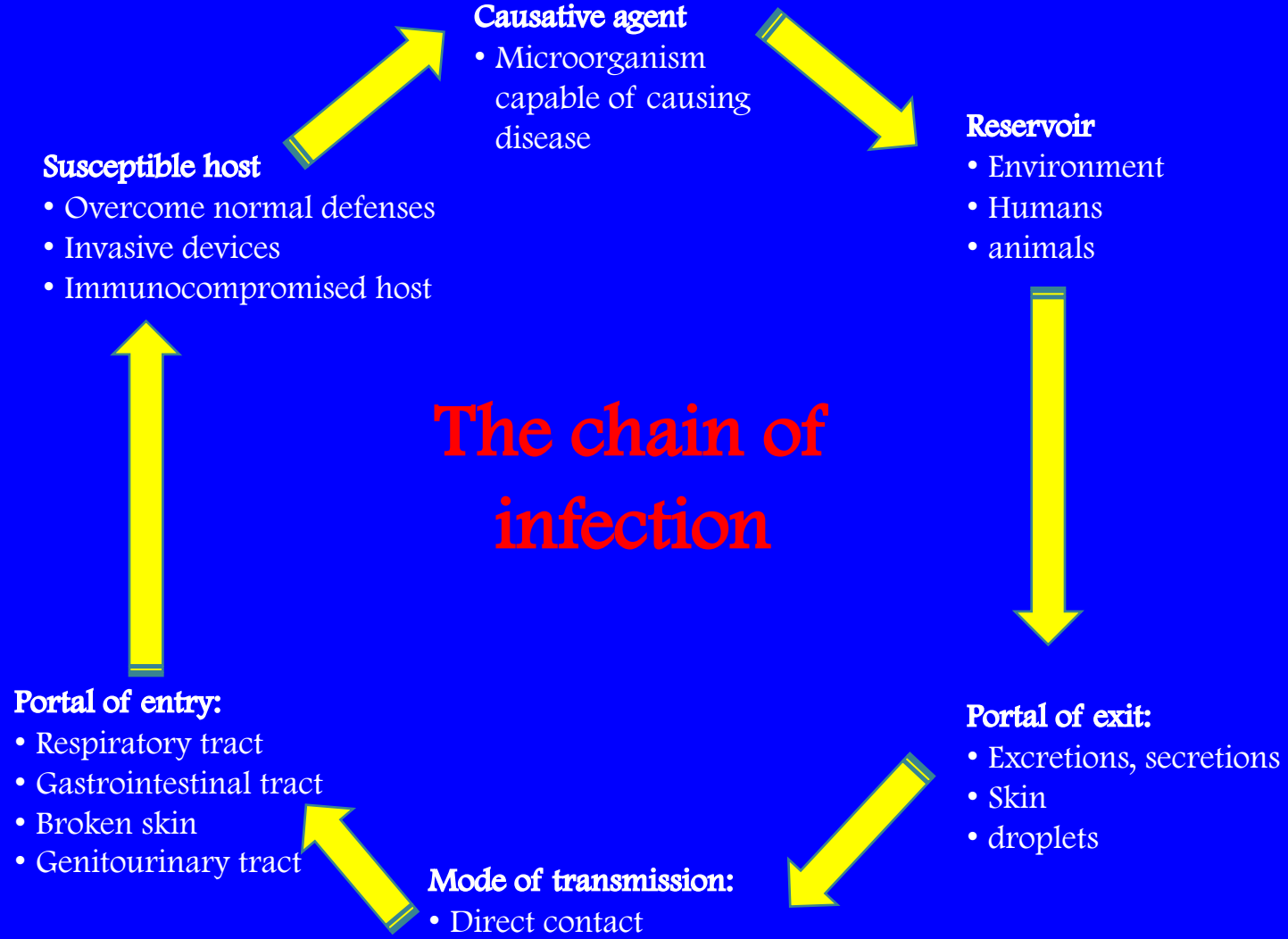
Exotoxin

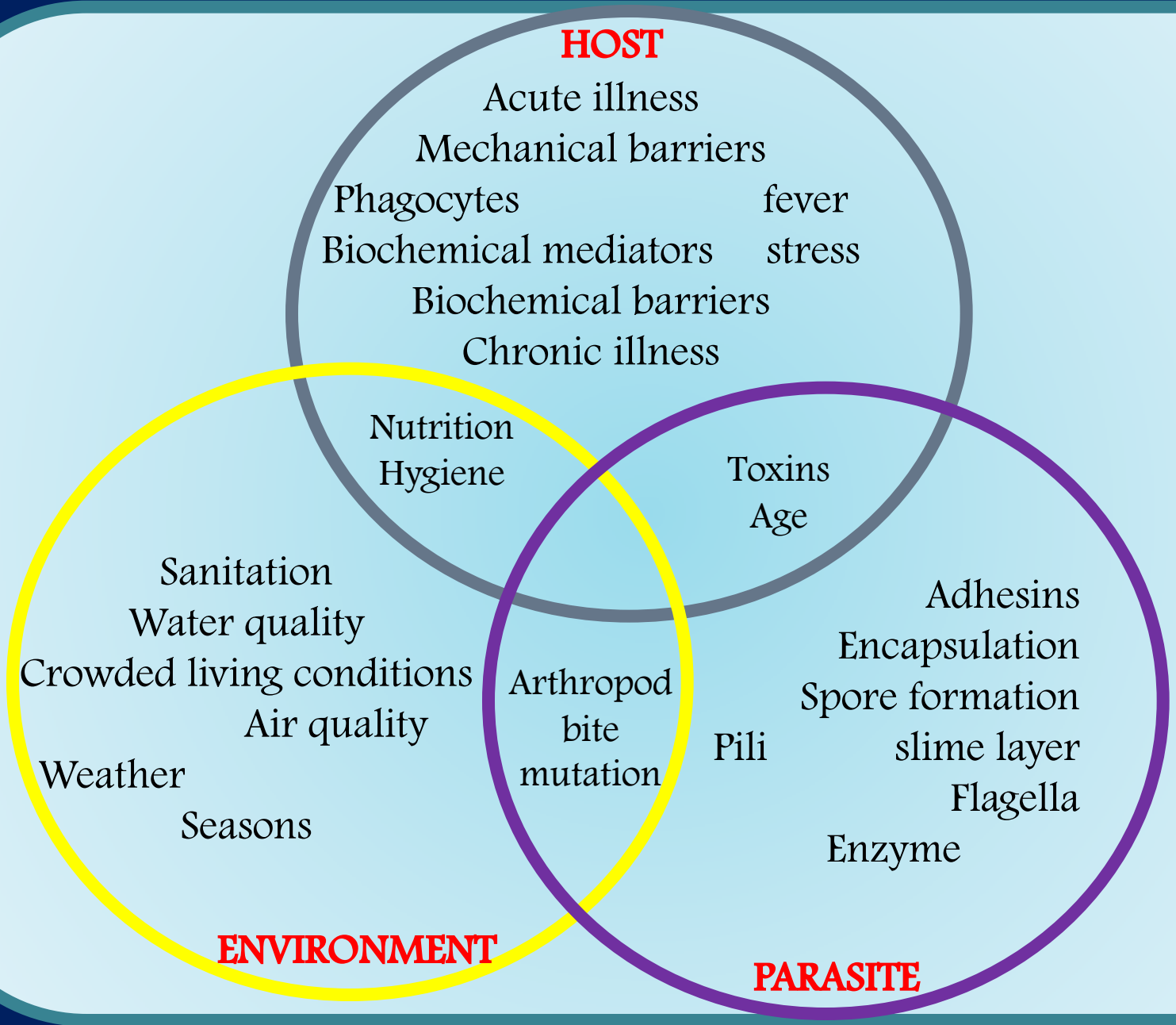

target
host cell
antibody
molecule
exotoxin
receptor
for exotoxin
on host cell
Cell wall
Exotoxin

The chain of infection

1. **Pathogen source/reservoir** (animate or inanimate)
2. **Transmission modes** (airborne, contact, vehicle, vector)
3. **Host susceptibility** (immune status, host nutrition, virulence of pathogens, genetic predisposition, etc,)
4. **Exiting the host** (excretion in faeces, urine, droplets, blood, saliva, or shed from the body).

The chain of infection




HOST
Acute illness
Mechanical barriers
Phagocytes
fever
Biochemical mediators
stress
Biochemical barriers
Chronic illness
Nutrition
Hygiene
Toxins
Age
Sanitation
Water quality
Crowded living conditions
Air quality
Weather
Seasons
Arthropod
bite
mutation
Adhesins
Encapsulation
Spore formation
Pili
slime layer
Flagella
Enzyme
ENVIRONMENT
PARASITE

Infectious diseases process

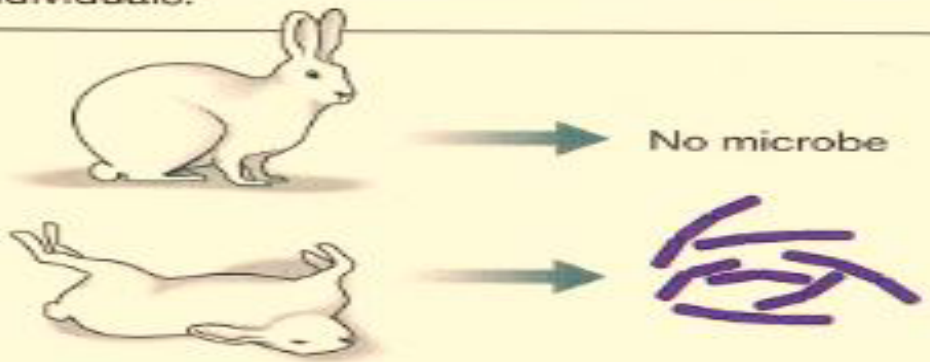
Once organism inside the host ,it passes into several phases before initiating infectious disease :

1. **Incubation period** (from entry to sigs /symptoms)
2. **Prodromal stage** (clinical signs not sufficient)
3. **Illness** (severe disease, immune system triggered)
4. **Convalescent period** (recovery)

Koch's postulates

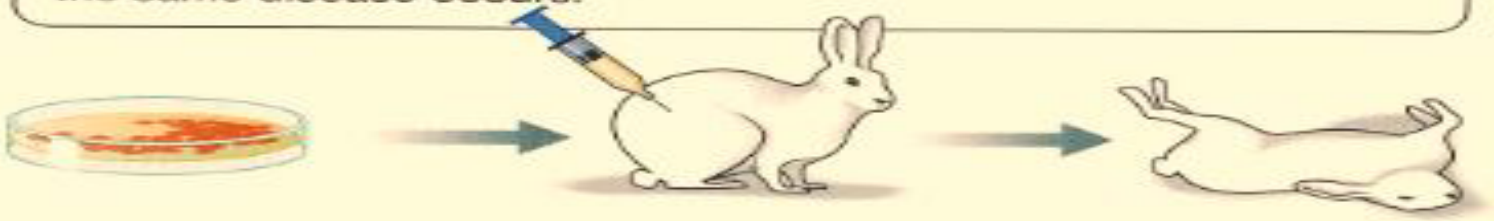
- In order to identify what organism causes a specific disease, certain rules are followed.
- Koch's postulates
  1. Pathogen must be found in subject with disease but never in a healthy subject
  2. Pathogen can be isolated from sick person and grown in the lab
  3. Pathogens injected into healthy person will cause the individual to become infected with the same disease
  4. Injected pathogens can be isolated from newly infected individual and are identical to original pathogens

1. The microbe is found in all cases of the disease but is absent from healthy individuals.



2. The microbe is isolated from the diseased host and grown in pure culture.

3. When the microbe is introduced into a healthy, susceptible host, the same disease occurs.



4. The same strain of microbe is obtained from the newly diseased host.