# 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 *(including: adherence, survival, multiplication ,invasion &tissue destruction*) and recall examples.
- 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.
- Host-parasite relationship is discussed under :

  pathogenicity & normal flora

# 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.
- **Pathogenicity** : the ability of the microorganism to cause diseases
- **A Pathogen** :a microorganism having the capacity to cause disease in a particular host.

A pathogen may infect one body organ or multiple organs.

# Definitions, cont.

~Some pathogens enter into latent state ( infection but no symptoms) eg. *Mycobacterium tuberculosis* .

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

- **Disease** : is the end product of an infectious process (signs & symptoms of infection)

# Definitions, cont.

- **Resistance:** The ability of the host to prevent establishment of infection by using its defense mechanisms.

- **Susceptibility:** Lack of resistance to an 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.

# Pathogens

Can be divided according to the degree of pathogenicity 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 infects people with low immunity. eg. *Pseudomonas & S. epidermidis*

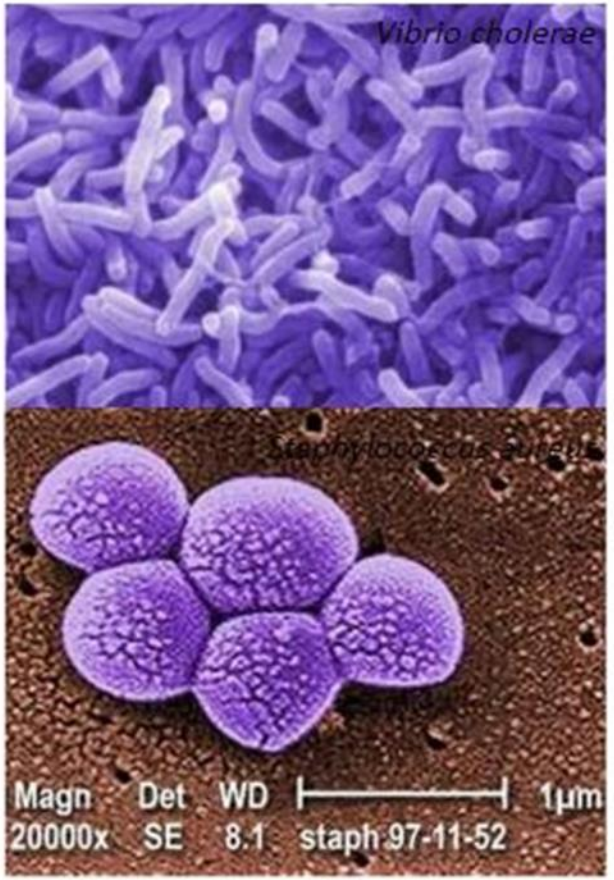
# True vs. Opportunistic Pathogen

## 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) to 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 an 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 & Colonization

- By means of **adhesins** (adherence factors) found on bacterial surfaces.

a) Pili

b) Other protein surface structures

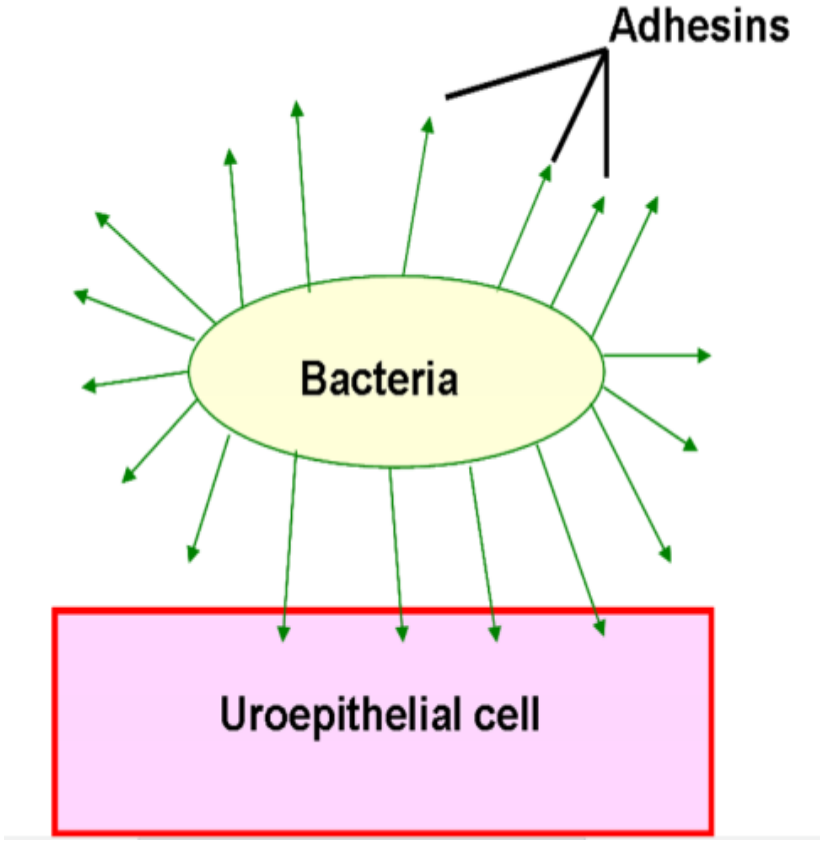
c) Capsid spikes (of viruses)

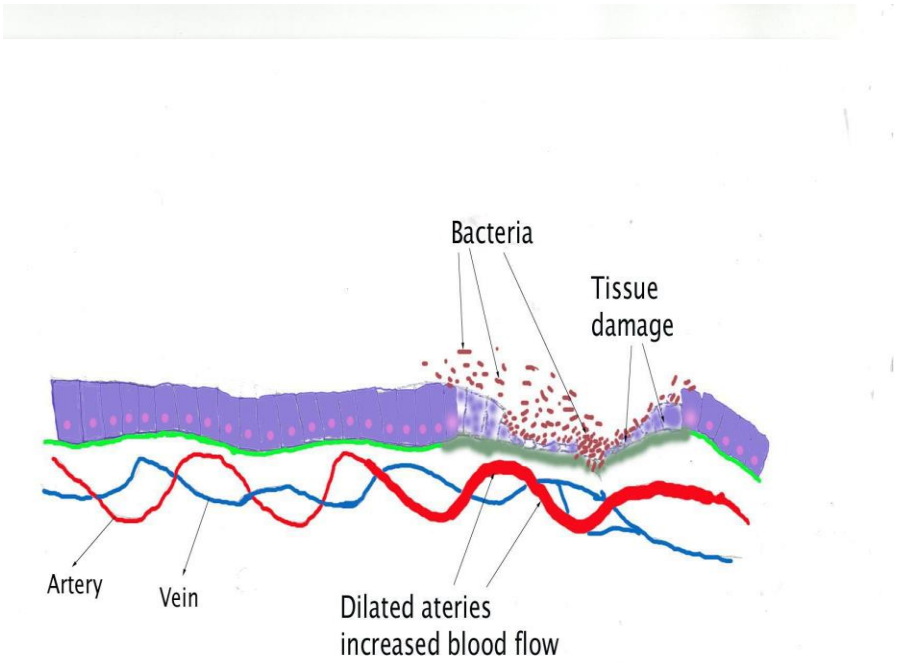
- Structures **on host cells** involved in adhesion include:

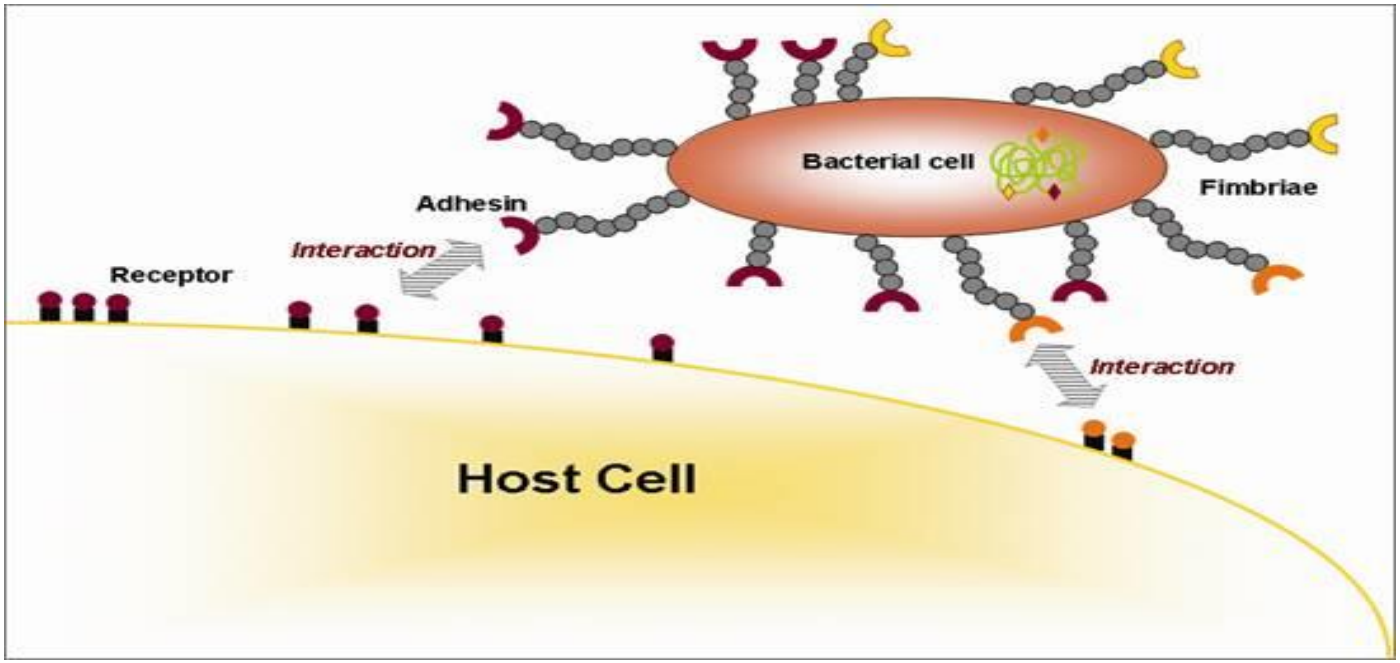
**a**) Fibronectin

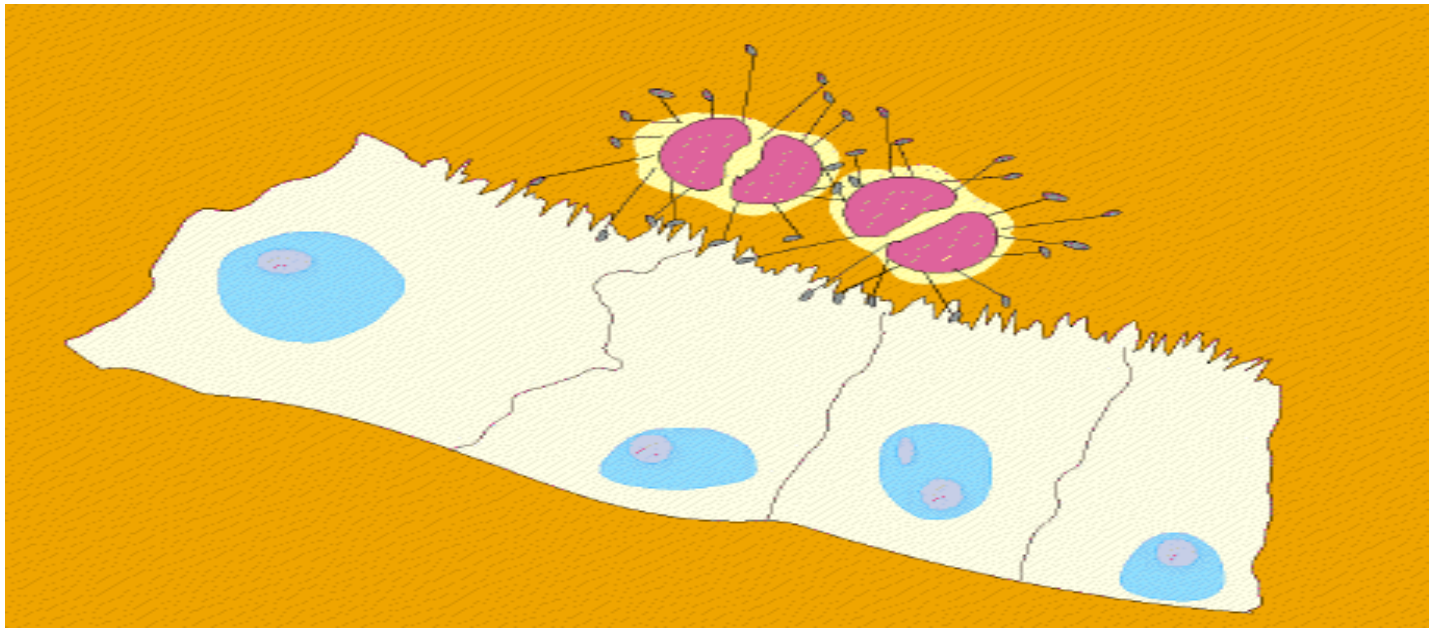
b) Proteins and glycopeptide

# 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

**Exotoxin** can be:

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

**A** :Active unit

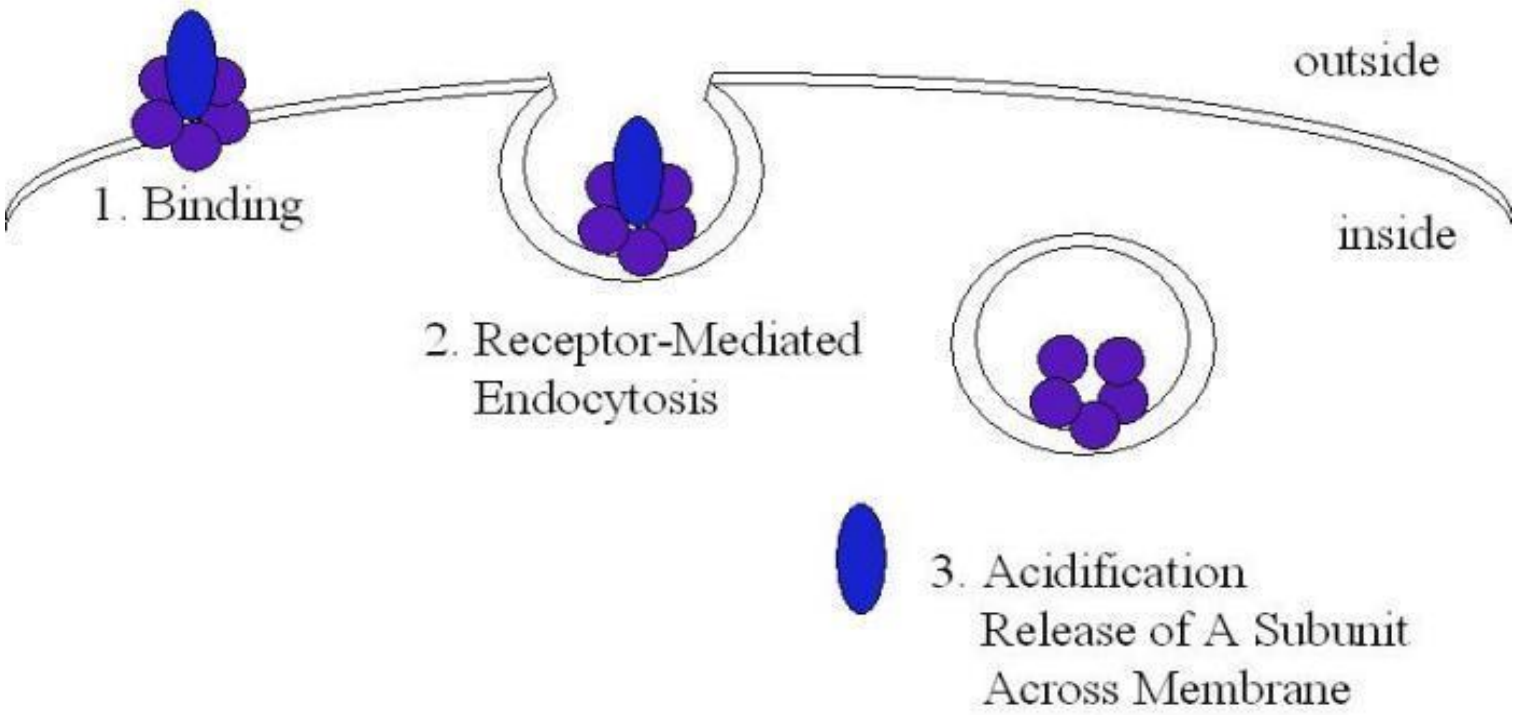
**B** :Binding unit for attachment

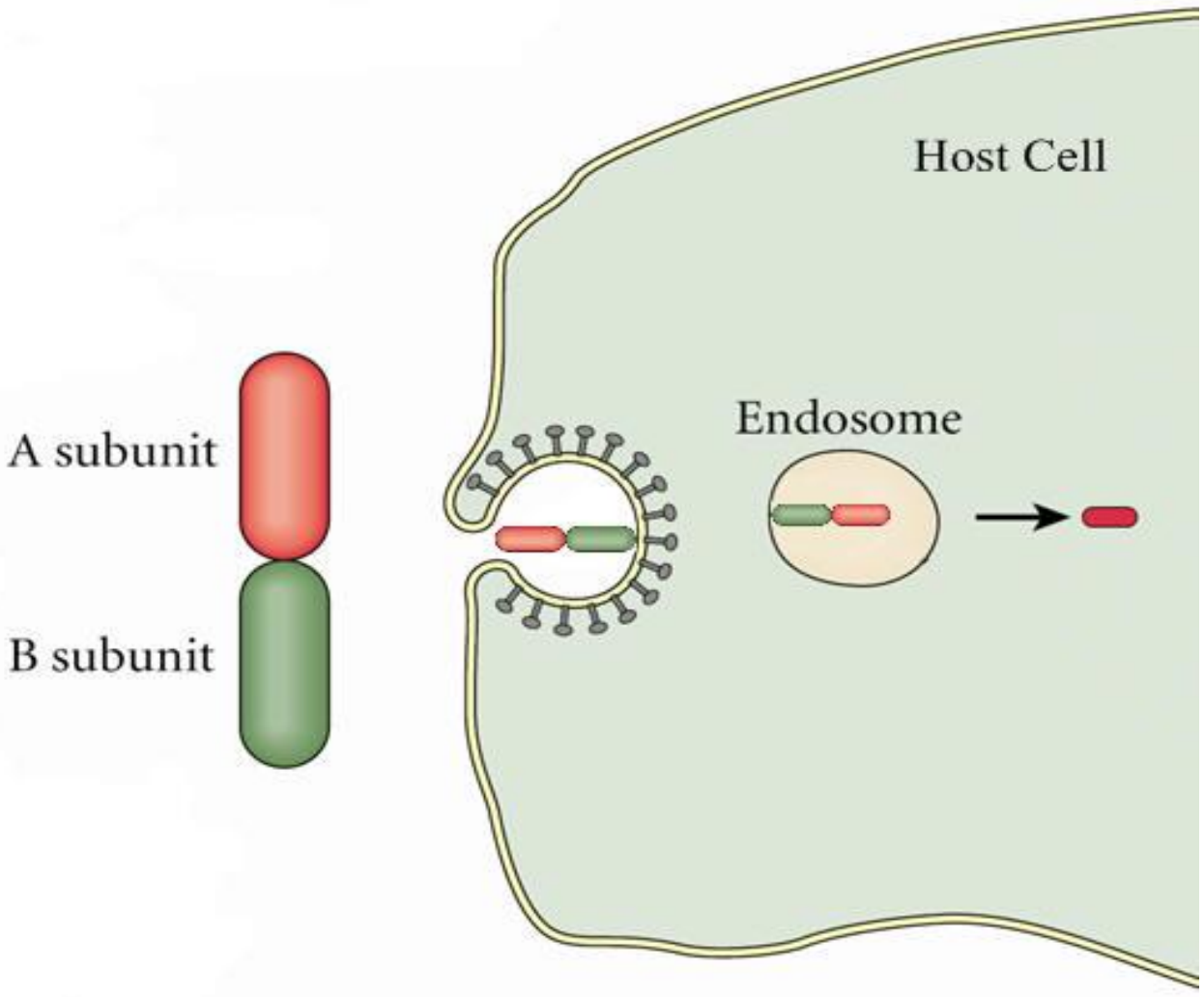
Or:

b) **Membrane active exotoxin**

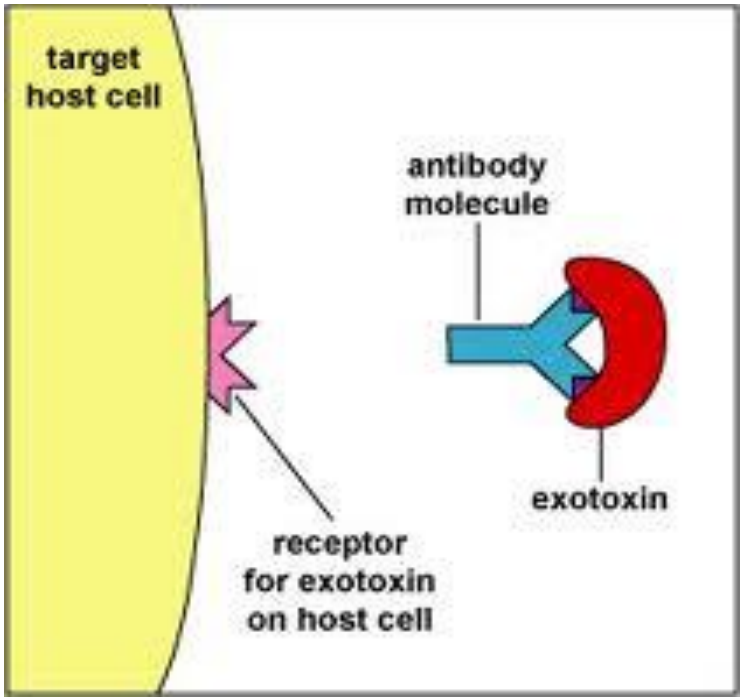
**eg.** Haemolysin of group *A Streptococcus*

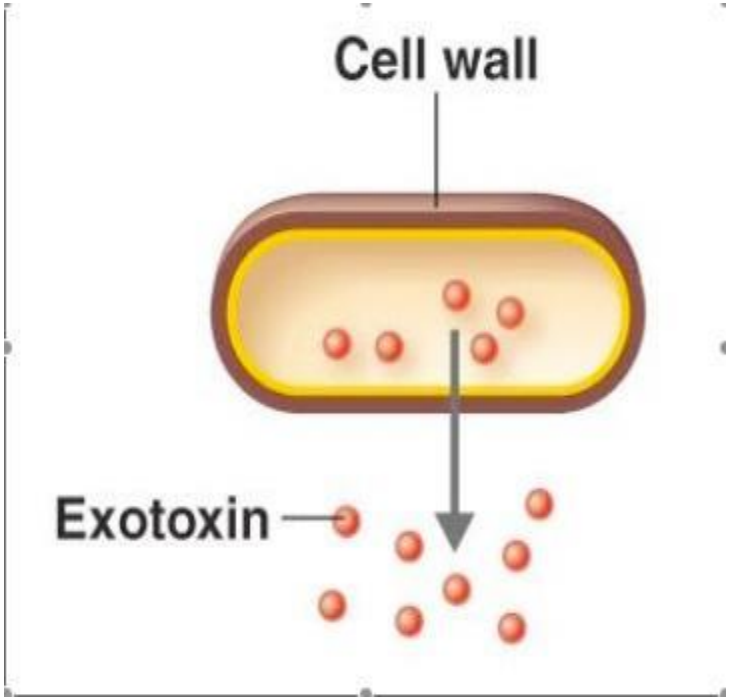
# A-B Toxin Entry



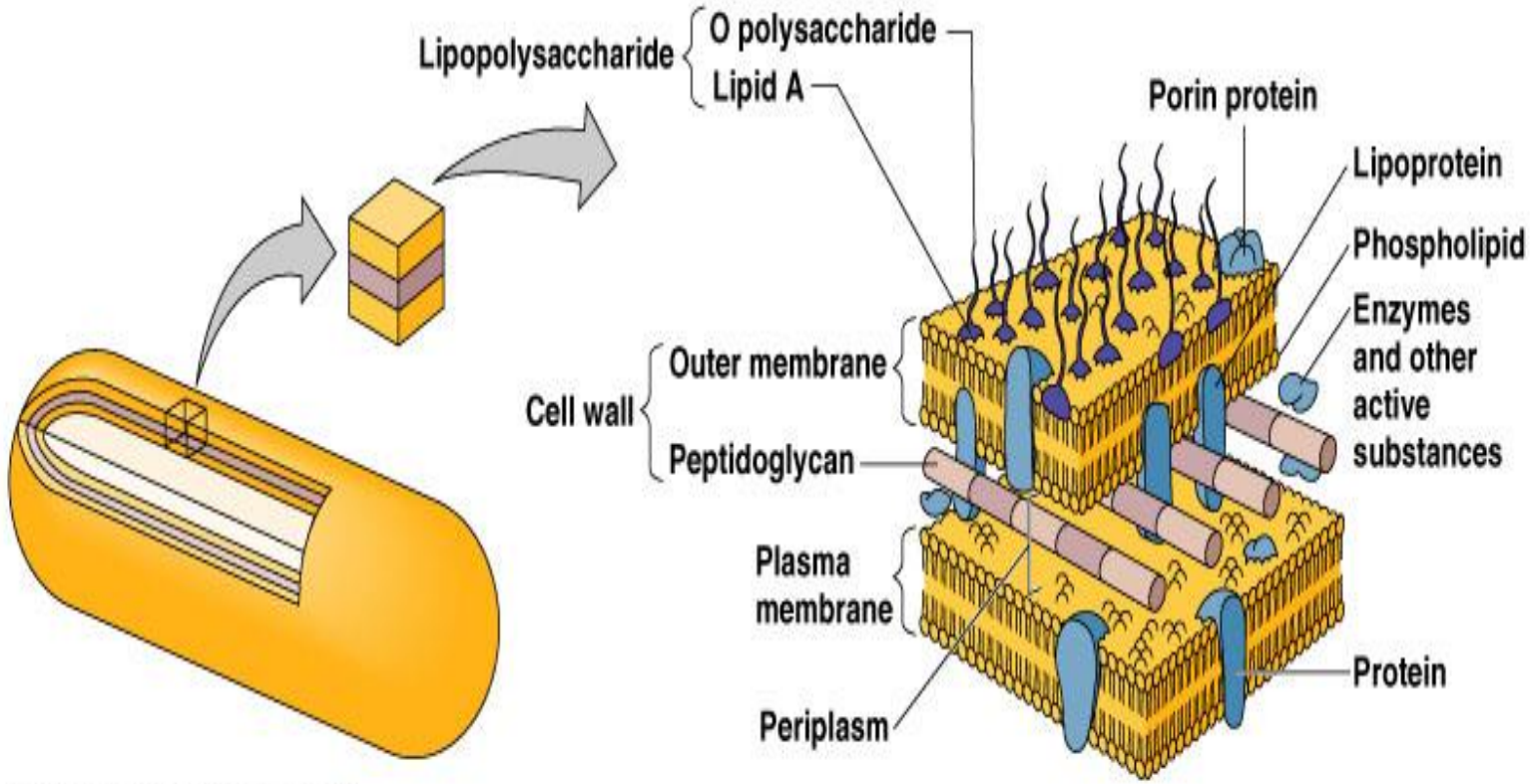

Host Cell
A subunit
B subunit
Endosome

# Exotoxin


target
host cell
antibody
molecule
exotoxin
receptor
for exotoxin
on host cell

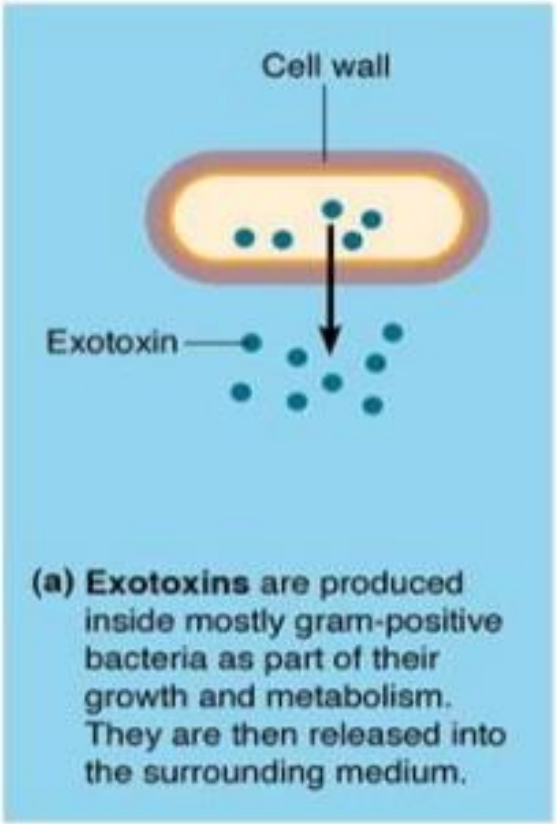

Cell wall
Exotoxin

# Endotoxin

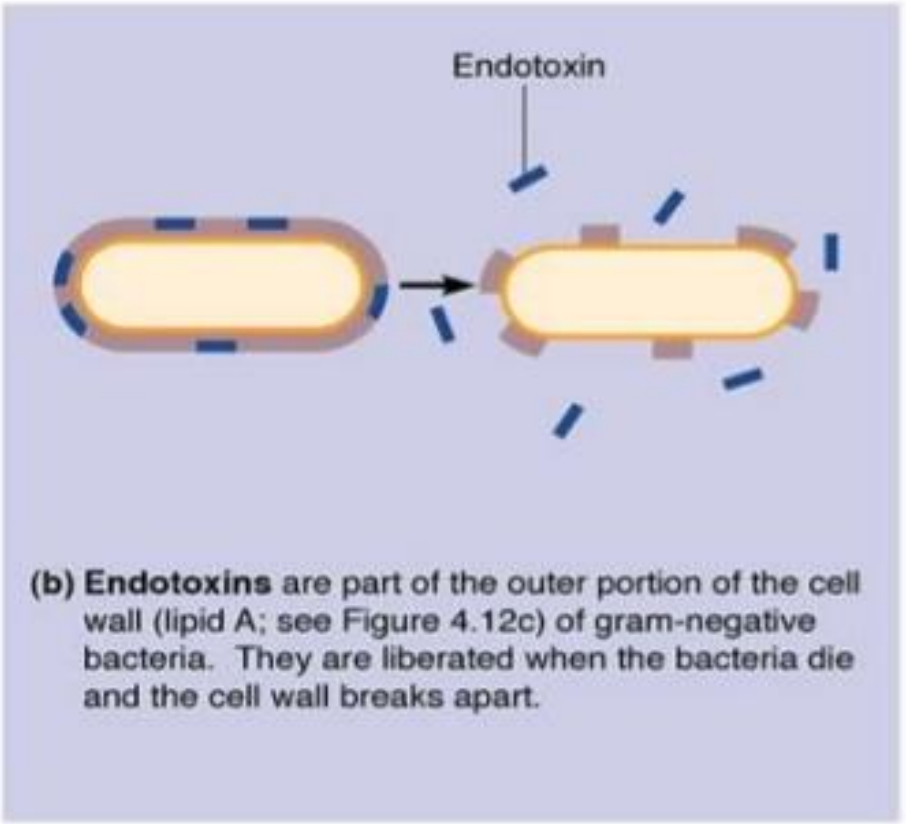



**(c) Gram-negative cell wall**

# EXOTOXINS VERSUS ENDOTOXINS



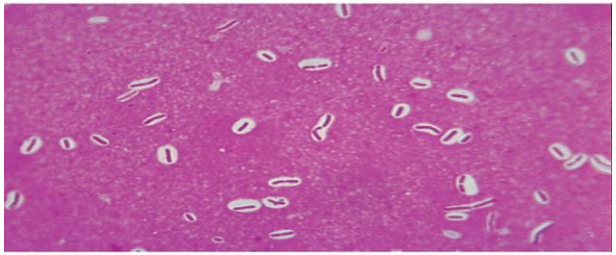

(a) **Exotoxins** are produced inside mostly gram-positive bacteria as part of their growth and metabolism. They are then released into the surrounding medium.




(b) **Endotoxins** are part of the outer portion of the cell wall (lipid A; see Figure 4.12c) of gram-negative bacteria. They are liberated when the bacteria die and the cell wall breaks apart.

# Exotoxin *vs* Endotoxin

| Exotoxin | Endotoxin |
| --- | --- |
| 1- Protein | Lipopolysaccharide |
| 2- Soluble | 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 |



- **Capsulated organisms** :

Bacteria that have capsule.

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. Therefore called extracellular (EC) organisms

eg. *S.pneumoniae (Pneumococcus)*

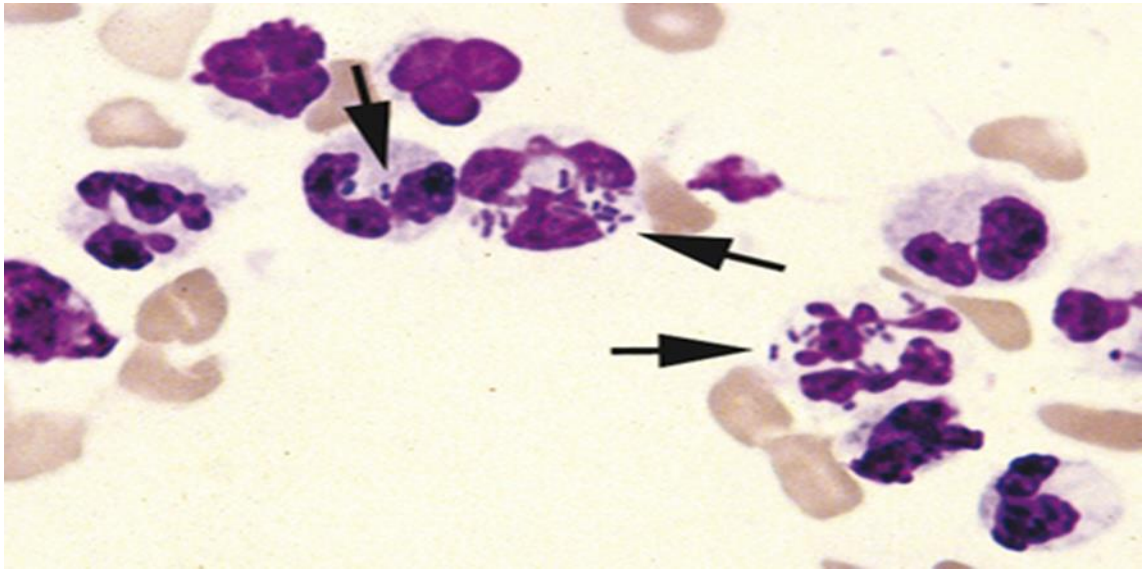
*Haemophilus influenza*

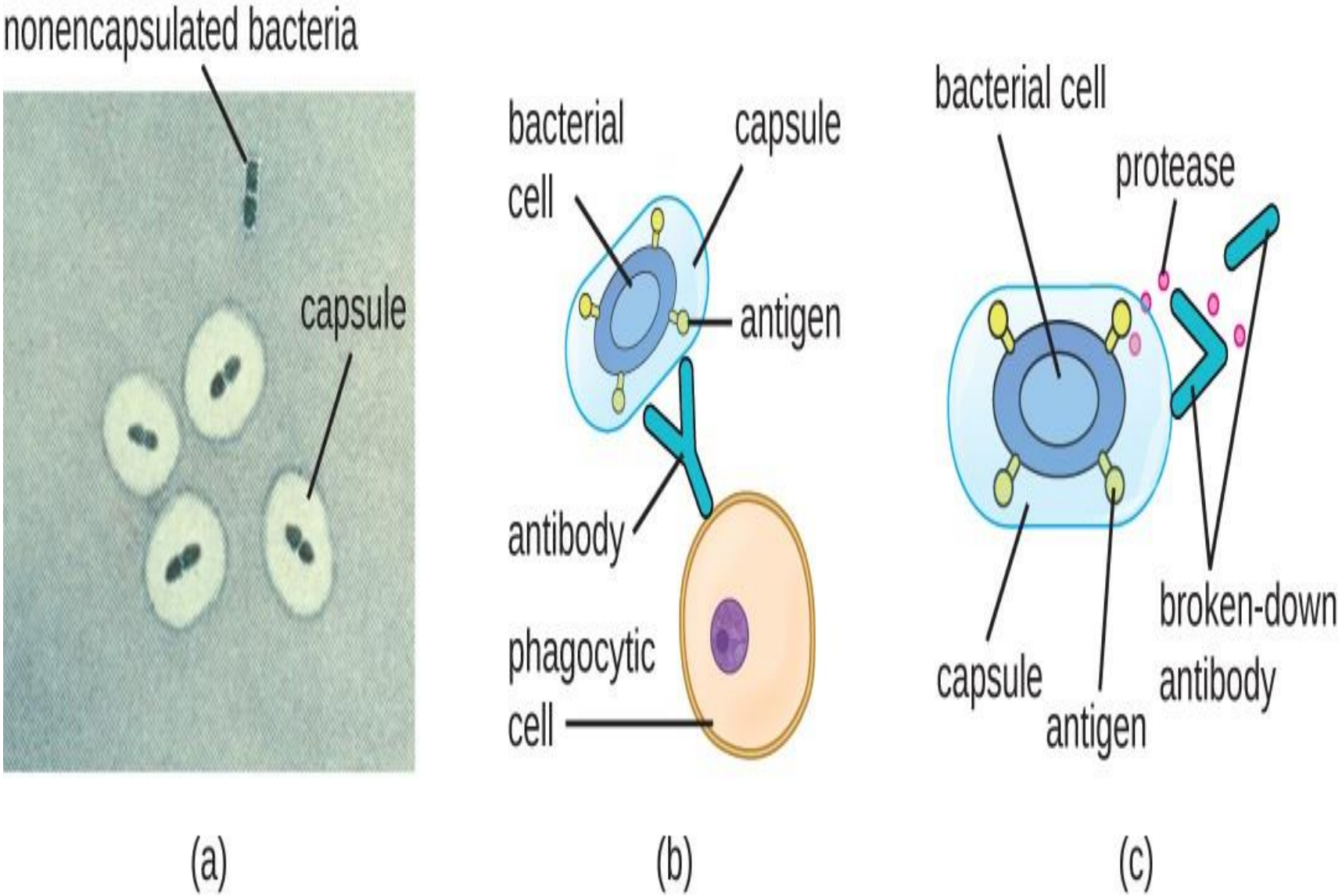
- **Non capsulated organisms** resist intracellular killing therefore called intracellular ( IC) organisms.eg.

*Mycobacterium tuberculosis*,

*Salmonella typhi*,

*Brucella* species.




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

# Koch's Postulates

- In order to identify what organism causes a specific disease, certain rules are followed.
- Koch 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 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

# Koch's Postulates

- For a microorganism to be accepted as the cause of an infectious disease it must satisfy all or most of these criteria:

  1) The organism must be found in all cases of the disease and its distribution in the body must correspond to that of the lesions observed in the host.

# Koch's Postulates (continued)

2) The organism should be cultured in pure culture from all cases of the disease.

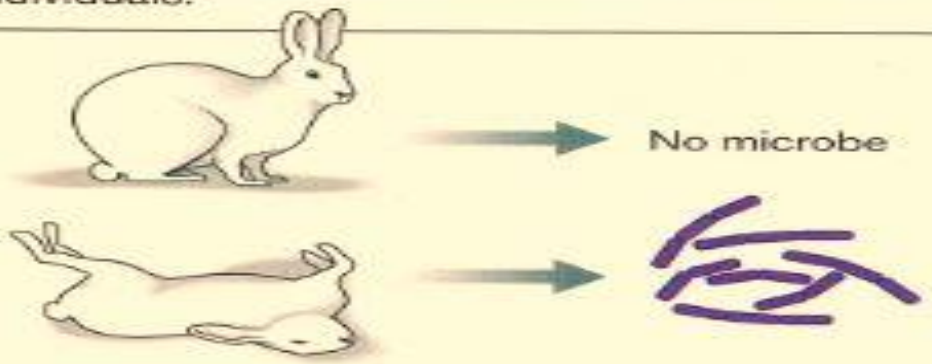
**N.B.** Some organisms are yet to be cultured in the lab.

**e.g.**. ***Treponema pallidum, M. leprae.***

3) The organisms should reproduce the disease in other susceptible animal hosts.

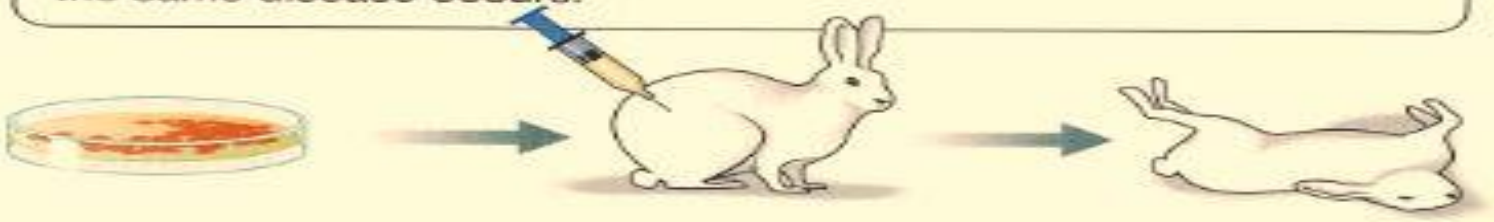
4) The organism should be cultured and antibodies to the disease usually develop in the course of the disease.

**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.

# Reference book

***Sherris* Medical Microbiology, an Introduction to Infectious Diseases.**

Latest edition, Kenneth Ryan and George Ray.
Publisher : McGraw Hill .