Microbiology

Lecture 5

Host-parasite Relationship

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The relation of bacteria to disease

When microorganism first **associated with a host**, the host is said to be "**contaminated**". If the microorganisms establish them selves and **grow and multiply for period time**, the host is said to be "**infected**".

If **infection causes damage**, the host is said to have an" **infectious disease**".

Ecological Interactions between Organisms in a Community: Dynamic interrelationships based on nutrition and shared habitat

SYMBIOSIS: neutral, antagonistic or synergistic relationship between two dissimilar organisms living in close association with each other. It include :

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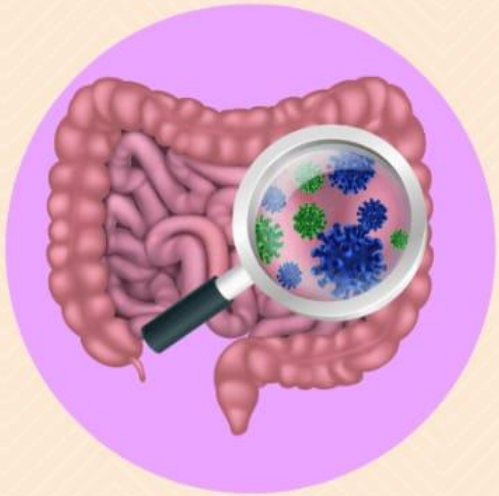
Symbiosis

Symbiosis is an ecological relationship between organisms of different species.



Mutualism
both species benefit

humans and gut bacteria

Commensalism
one benefits, other is unaffected

cattle egret and cattle

Parasitism
one benefits, other is harmed

ticks and dogs

A. **MUTUALISM** (+/+): mutually beneficial relationship between two species.e.g.

i. certain indigenous enteric microorganisms produce large amount of the B & K vitamins which absorbed through the intestine wall of the human body and used in metabolism. In the same time the intestine provides the microorganisms with favorable Temp., moisture and nutrients for growth.

ii. growth of Lactobacillus Arabinoses and Streptococcus faecalis. Lactobacillus produce folic acid and the Streptococcus produce phenylanine, each organism produce a sufficient amount of the factor require by other organism.

B. COMMENSALISM (+/0): relationship between two species in which one is benefited and the other is not affected, neither negatively or positively. e.g.

i. Veillonella in the dental plaque require lactate for growth which provided by other dental plaque bacteria by fermenting glucose to produce lactic acid (such as lactobacilli & Streptococi) the lactic acid used for growth of Veillonella while lactobacilli & Streptococci still unaffected.

- syntrophism : metabolic products of one are useful nutrients for another
- Amphibiosis (opportunistic pathogens) : Commensal microorganism of the human body that possess the potential for causing infection when conditions becomes favor for their invasion of tissue.

C. PARASITISM (+/-): relationship between two species in which one benefits (parasite) from the other (host); usually involves detriment to the host.

- ✓ Antagonism : among microorganisms is important to the host **because it helps control the microbial population and thus helps prevent the over growth of certain microorganism.(e.g. **some bacteria produce lethal substances called colicins or bacteriocins which inhibit the growth of other bacteria, also production of antibiotics is an example of antagonism relationship)

- ✓ Synergism : two usually independent organisms cooperate to break down a nutrient neither one could have metabolized alone (**This is relationship in which different organisms produce a reaction that non can produce by individual growth.). (e.g. the relationship of Proteus vulgaris and Staphylococcus aureus when growing separately both organisms ferment glucose resulting in the production acid only. When the species are grown together they produce acid and gas).

Entry of a Microbe

- Need to adhere, penetrate, and then cause damage
- Gain access via portal of entry and may have preferred portal of entry

Portals of Entry

st 1 Entry Portal . Mucous membranes :

- Mucous membranes: G.I. Tract :

✓Salmonellosis (Salmonella sp.)
✓Shigellosis (Shigella sp.)
✓Cholera (Vibrio cholorea)

- Mucous Membranes Respiratory
  - ✓Common cold
  - ✓Whooping cough
  - ✓Measles
  - ✓Diphtheria

- Fecal - Oral Diseases
  - ✓Coxsackie virus
  - ✓giardia

- Mucous Membranes of the Genitourinary System:

✓Gonorrhea(Neisseria gonorrhoeae),
✓HIV
✓Herpes Simplex II

- Mucous Membranes: Conjunctiva

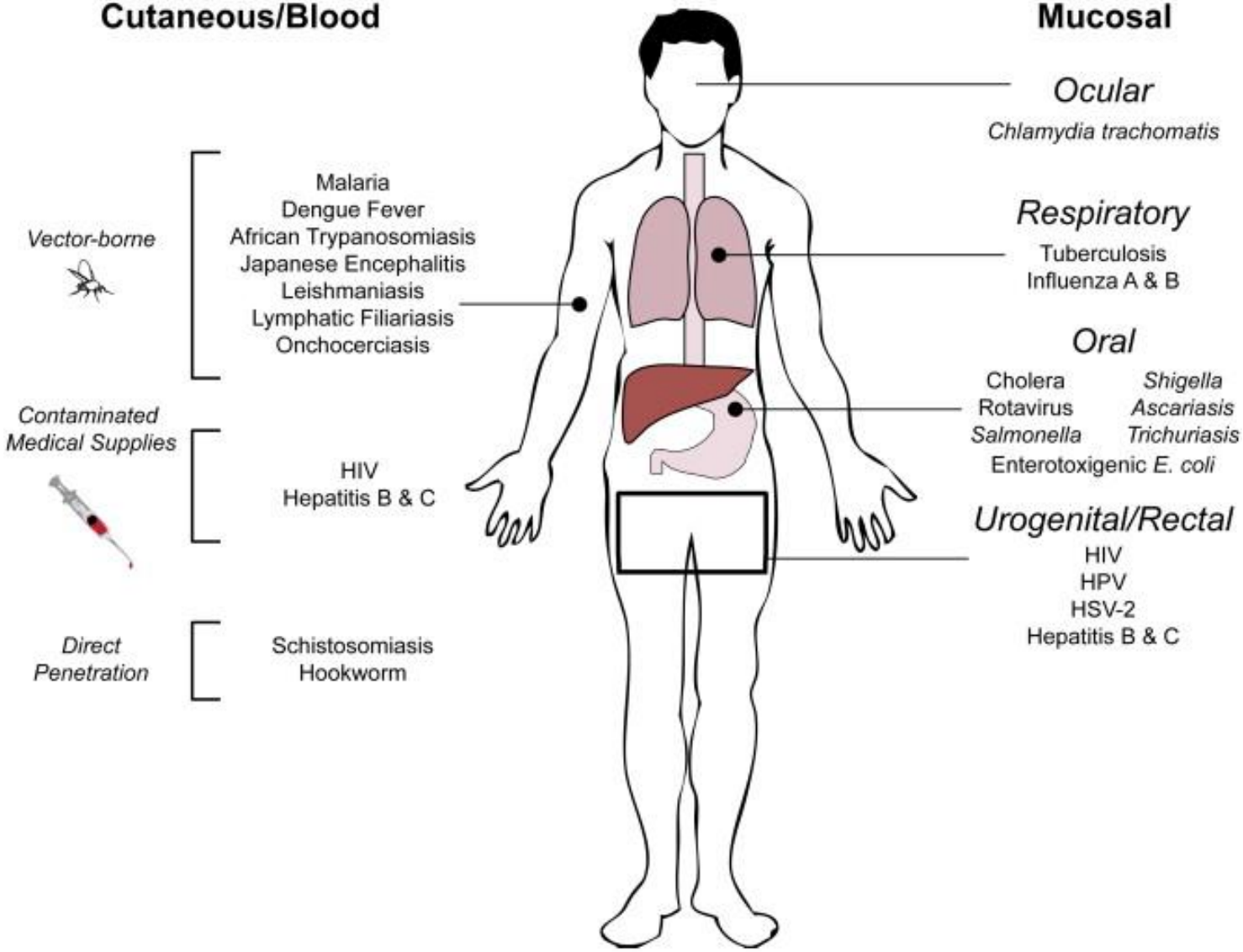
✓Trachoma(Chlamydia trachomatis)

2nd. Portal of Entry: Skin

- Skin - the largest organ of the body.
- When unbroken is an effective barrier for most microorganisms.
- Some microbes can gain entrance through openings in the skin: hair follicles and sweat glands.

3rd. Portal of Entry: Parenteral

Microorganisms are deposited into the tissues below the skin or mucous membranes Punctures, injections, bites, scratches, surgery, splitting of skin due to swelling or dryness


Cutaneous/Blood
Mucosal
Vector-borne
Malaria
Dengue Fever
African Trypanosomiasis
Japanese Encephalitis
Leishmaniasis
Lymphatic Filiariasis
Onchocerciasis
Contaminated Medical Supplies
HIV
Hepatitis B & C
Direct Penetration
Schistosomiasis
Hookworm
Ocular
Chlamydia trachomatis
Respiratory
Tuberculosis
Influenza A & B
Oral
Cholera
Rotavirus
Salmonella
Shigella
Ascariasis
Trichuriasis
Enterotoxigenic E. coli
Urogenital/Rectal
HIV
HPV
HSV-2
Hepatitis B & C

Preferred Portal of Entry:

• Just because a pathogen enters your body it does not mean it's going to cause disease?

• **pathogens have preferred portal of entry

⎩ Streptococcus pneumoniae (if inhaled can cause pneumonia, if enters the G.I. Tract, no disease)

⎩ Salmonella typhi (if enters the G.I. Tract can cause Typhoid Fever, if on skin, no disease)

In general the source of infection includes:

A. Exogenous infection:

i. ill persons :

Infections due to some microbial species are acquired from ill persons with active infection (Whooping cough)

ii. Healthy carrier:

- ❖Convalescent carrier : are localized infection continues for a period of week or months after clinical recovering from infection.
- ❖Contact carrier: those who acquire the pathogen from patient.
- ❖Paradoxical carrier: those who acquire the pathogen from other carriers.

iii. Infected animals: some pathogens that are primarily parasites of different animal species spread from the infected animal to man and cause human disease such infection are called zoonoses (e.g. anthrax, Brucellosis)

iv. Soil: a few infection disease of man are caused by microbes derived from soil (e.g. tetanus, gas-gangrene).

B. Endogenous infections:

the source of endogenous infection are microorganisms grow as a commensal in the certain site of patient's body and under abnormal condition, these

microorganisms cause disease in the other site of the body, e.g. E.coli have a commensalisms relationship and grow in the intestine as a normal flora but can cause urinary tract infection when invade the urinary tract.

**Types of bacterial pathogens:

1-Oppertunistic pathogens: these rarely cause disease in individual with intact immunological and anatomical defenses. Only when such defenses are impaired or compromised, as a result of congenital or acquired disease or by the use of immune-suppressive therapy or surgical techniques, are these bacteria able to cause disease.

However, introduction of these organisms into anatomical sites in which they are not normally found, or removal of competing bacteria by the use of broad-spectrum antibiotics, may allow their localized multiplication and development of disease.

2 –primary pathogens: these are capable of establishing infection and causing disease in previously healthy individuals with intact immunological defenses.

Microbial Pathogenicity:

The structural and biochemical mechanisms where by microorganisms cause disease.

❖ Numbers of Invading Microbes:

Virulence: The degree of the pathogenicity can be measured by:

- **ID50**: Infectious dose for 50% of the test population
- **LD50**: Lethal dose for 50% of the test population
- **ID50 and LD50** : are the quantity of organism that will infect or kill 50% of inoculated animals.

***Mechanisms of Bacterial pathogenicity:

a. Colonization of surface(adherence)
b. Invasion of tissue(invassivenss)
c. Production of toxin(Toxigenicity)

a. Colonization (Adherence Factors):

Adherence alone does not mean that an organism is pathogenic, so **the pathogenicity of most microorganisms is related to the sequence of their ability to (adhere, penetrate& multiplication, bring about pathogenic changes that resulting disease) Once bacteria enter the body of the host, they must adhere to cells of a tissue surface. **If they did not adhere, they would be swept away by mucus and other fluids that bathe the tissue surface.

**Adherence, which is only one step in the infectious process, is followed by development of microcolonies and subsequent steps in the pathogenesis of infection. The interactions between bacteria and tissue cell surfaces in the adhesion process are complex. **Several factors play important roles:

- surface hydrophobicity and net surface charge,
- binding molecules on bacteria (ligands),
- host cell receptor interactions.

In general, the more hydrophobic the bacterial cell surface, the greater the adherence to the host cell.

Bacteria also have specific surface molecules that interact with host cells like pili, hair-like appendages that extend from the bacterial cell surface and help mediate adherence of the bacteria to host cell surfaces. The E coli that cause diarrheal diseases have pilus-mediated adherence to intestinal epithelial cells.

b. Invasion of tissue (invassivenss)

The ability of organisms to penetrate tissues. May be aided by the production of bacterial extracellular substance which acts against the host by breaking down primary or secondary defenses of the body.

**Examples:

- Lecithinase…. produce by Clostridium
- Hyaluronidase(spreading factor)….. produce by Clostridium.
- Collagenase…… produce by Bacteroides
- Catalase…. Produce by T.B
- Hemolysins…. Produce by Staphylococcus

c. TOXIGENICITY:

The ability of a microorganism to cause disease is determined by the toxin.

1. ENDOTOXIN: a complex bacterial toxin that is composed of protein, lipid, and polysaccharide (LPS) which is **released only upon lysis of the cell. Endotoxins - part of the Gram (-) Bacterial cell wall.

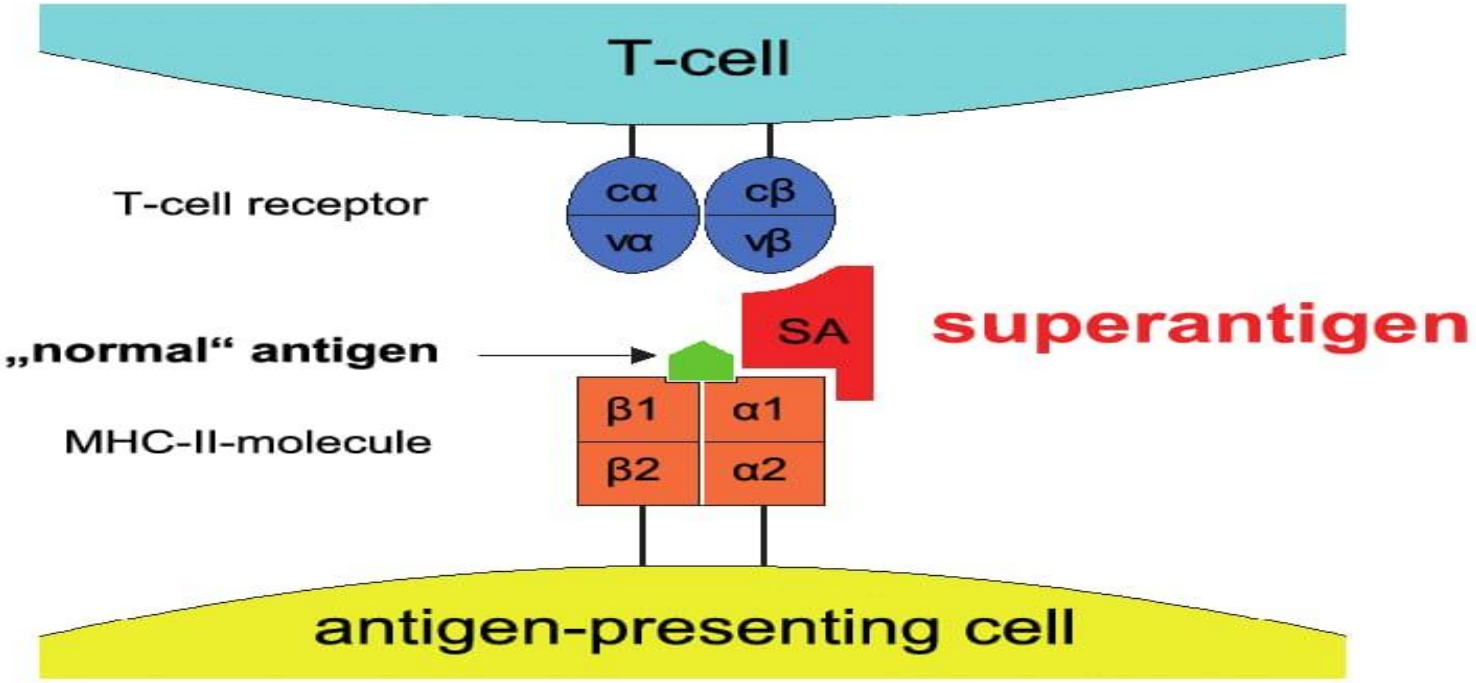
2. EXOTOXINS: a potent toxic substance **formed and secreted by species of certain bacteria. Mostly seen in Gram (+) Bacteria.

****Exotoxins - three types???**

1. Superantigens or type I toxins \ Enterotoxins (effect cells lining the G.I. Tract)

   ⎩ Cause an intense immune response due to release of cytokines from host cells

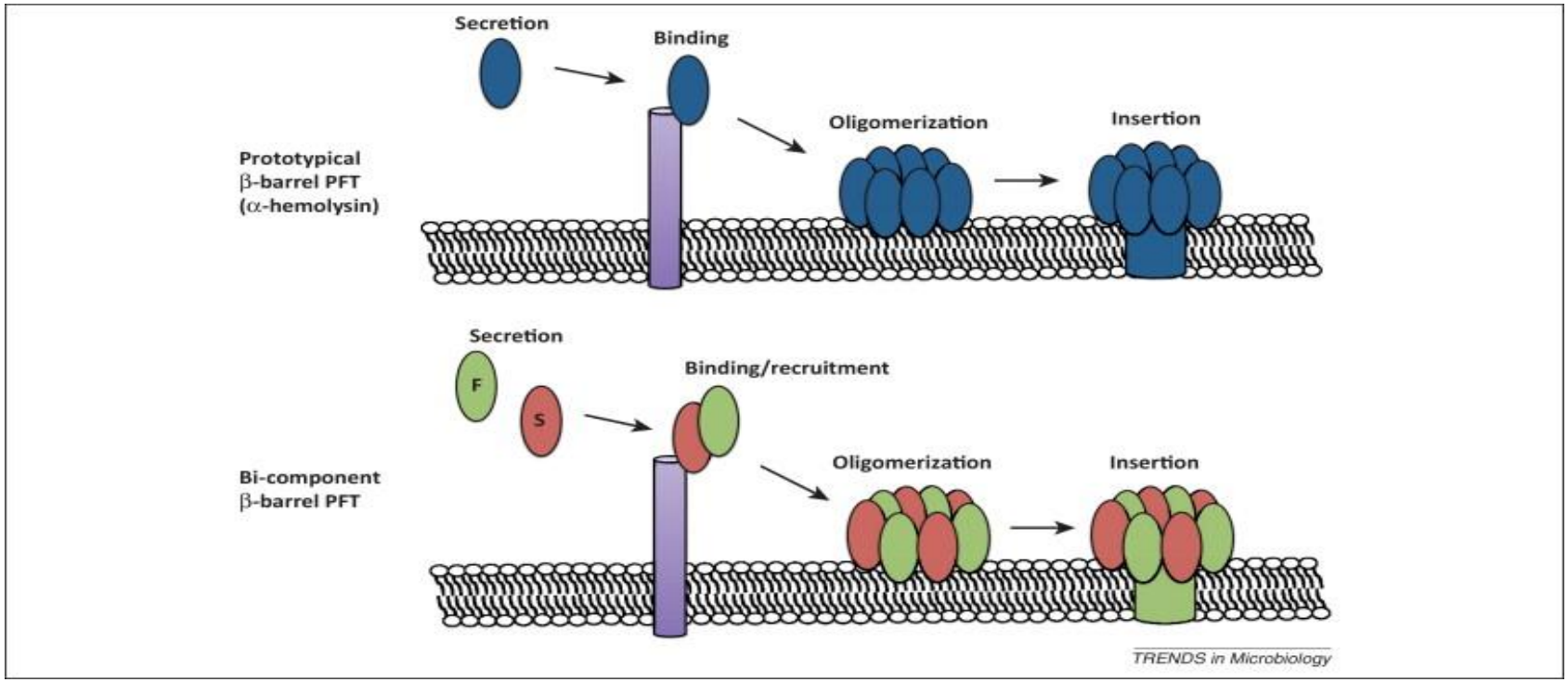
   ⎩ Fever, nausea, vomiting, diarrhea, shock, death



2. Membrane-disrupting toxins or type II toxins \ Cytotoxins (kill cells)

Lyses host's cells by:

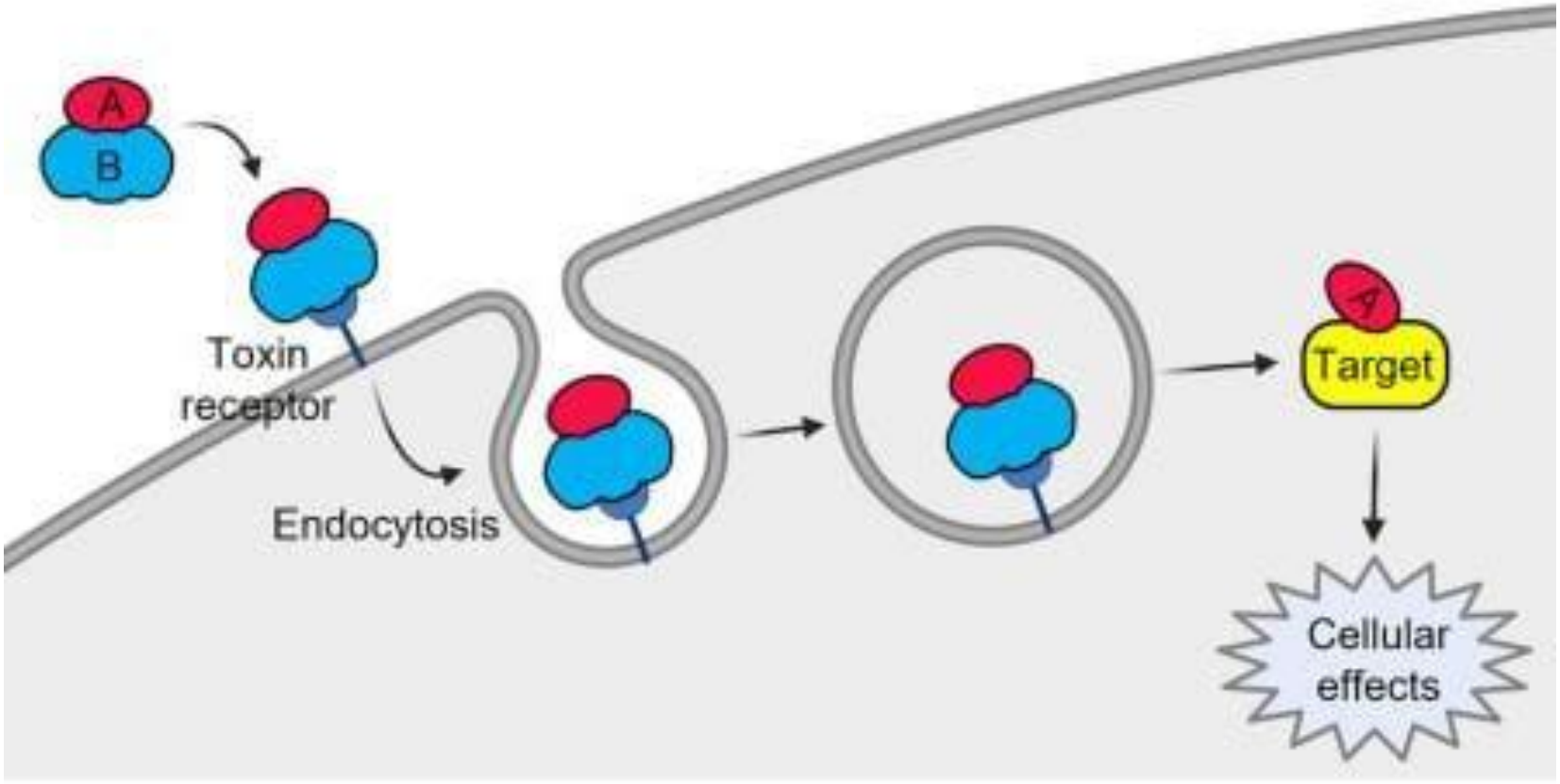
- Making protein channels in the plasma membrane (leucocidin , hemolysin)
- Disrupting phospholipid bilayer



3. Type III toxins (A-B) toxin \ Neurotoxins (interfere with normal nerve impulses)

A - Active Causes change in host

B - Binding



ENDOTOXINS	EXOTOXINS
1. Integral part of cell wall	1. Released from the cell before or after lysis
2. Endotoxin is LPS; lipid A is toxic	2. Protein
3. Heat stable	3. Heat labile
4. Antigenic; questionable immunogenicity	4. Antigenic and immunogenic
5. Toxoids not be produced	5. Toxoids can be produced
6. Many effects on host	6. Specific in effect on host
7. Produced only by gram-negative organisms	7. Produced by gram-positive & gram-negative organisms

Other factors that enhance the pathogenicity of bacteria are

**AVOIDING THE HOST DEFENSE

- Capsules Allow some organisms to avoid phagocytosis and digestion
- Changing the antigenic determinants Some organisms can avoid the immune system
- Similar protiens Others avoid the host defense by coating themselves with proteins similar to that coating red blood cells
- Special proteins M protein or protein A of some organisms prevent opsonization

IRON

Most bacteria require iron for certain enzymes to function . In humans Iron forms a complex with **iron-binding proteins that are bacteriostatic :

- ✓ transferrin in blood
- ✓ lactoferrin in milk and saliva

This bacteriostatic effect is lost when these molecules are saturated with iron some bacteria secrete **Siderophores remove iron from the host for their growth and enhance their virulence **Examples of siderophores are:

- ✓ Aerobactin
- ✓ Enterobactin

**The properties which are essential for pathogenicity:

- Transmisibility
- Infectivity
- Virulence

****The pathogens can transmit by:**

- Direct transmission of the disease(syphilis)
- From carrier(Salmonella typhi)
- Transmission by droplets(whooping cough)
- By toxin (Food born infection)(neurotoxin of Clostridium botulinum)
- By vector insect (mosquito/ malaria)
- Water born infection(cholera)