

LEC. 4: BACTERIAL PATHOGENICITY

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Bacterial Pathogenicity

Infection: is the invasion of the human body tissue by disease causing agents, their multiplication, and the reaction of host tissues to the infectious agents and the toxin they produce.

According to its way of living bacteria can be classified to:

1. **Nonpathogenic:** A microorganism that does not cause disease.
2. **Opportunistic pathogen:** An agent capable of causing disease only when the host's resistance is impaired (e.g. when the patient is "immunocompromised").
3. **Pathogenic bacteria:** is parasitic bacteria that are the causative agents of bacterial infections.
4. **Saprophytic bacteria:** which live freely in the soil and feed on decaying organic matters.
5. **Commensals:** Are parasitic bacteria live on external or internal surfaces of the body without causing disease, these bacteria may even be beneficial to the host e.g. commensals of the gut digest polysaccharides and are source of certain vitamins, these bacterial flora also compete with pathogenic bacteria for nutrition thus inhibiting their growth.

Bacterial Pathogenesis: refers to the ability of an organism to cause disease, using its virulence factors. Virulence usually refers to the degree of pathogenicity within a group or species of microorganisms. Virulence of a microorganism is not generally attributable to a single factor, but depends on several parameters that are related to the organism, the host, and the dynamic interaction between them. Bacterial virulence can be measured by bacterial infectivity (their ability to initiate an infection) and the severity of the condition produced. In the lab, virulence can be quantified by how many organisms are required to cause disease in 50% of those exposed to the pathogen (ID₅₀, where I = Infectious and D = Dose) or to kill 50% of test animals (LD₅₀, where L = Lethal). The number of organisms required to cause disease varies greatly among pathogenic bacteria.

Pathogenicity depends on:

- 1- Virulence factors (Adherence factors, Invasiveness, Toxin production).
- 2- Number of initial organisms.
- 3- Immune status.

A. Virulence factors

Virulence factors are those characteristics of a bacterium that enhance its pathogenicity, that is, properties that enable a microorganism to establish itself and replicate on or within a specific host. Some of the more important steps in the infectious process are reviewed below.

1. Entry into the host: The first step of the infectious process is the entry of the microorganism into the host by one of several ports: via the respiratory, GI, or urogenital tract or through the skin that has been cut, punctured, or burned. Once entry is achieved, the pathogen must overcome diverse host defenses before it can establish itself. These include phagocytosis, the acidic environments of the stomach and urogenital tract, and various hydrolytic and proteolytic enzymes found in the saliva, stomach, and small intestine. Bacteria that have an outer polysaccharide capsule (eg, *Streptococcus pneumoniae* and *Neisseria meningitidis*) have a better chance of surviving these primary host defenses.

2. Adherence to host cells: Some bacteria (eg, *Escherichia coli*; use pili (also known as finbriae) to adhere to the surface of host cells. The Neisseriae have similar structures .Other bacteria have cell surface adhesion molecules or particularly hydrophobic cell walls that allow them to adhere to the host cell membrane. In each case, adherence enhances virulence by preventing the bacteria from being carried away by mucus or washed from organs with significant fluid flow, such as the urinary and the GI tracts. Adherence also allows each attached bacterial cell to form a micro colony. A striking example of the importance of adhesion is that of *Neisseria gonorrhoeae*, in which strains lacking pili are not pathogenic

3. Invasiveness: Invasive bacteria are those that can enter host cells or penetrate mucosal surfaces, spreading from the initial site of infection. Invasion is facilitated by bacterial enzymes, including collagenase and hyaluronidase. These enzymes degrade components of the extracellular matrix, providing the bacteria with easier access to host cell surfaces. Many bacterial pathogens express membrane proteins known as "invasins" that interact with host cell receptors, thereby eliciting signaling cascades that result in bacterial uptake by induced phagocytosis. Invasion is often followed by inflammation, which can be either pyogenic (involving pus formation) or granulomatous (having nodular inflammatory lesions), depending on the organism. The pus of pyogenic inflammations contains mostly neutrophils, whereas granulomatous lesions contain fibroblasts, lymphocytes, and macrophages.

4-Virulence factors that inhibit phagocytosis:

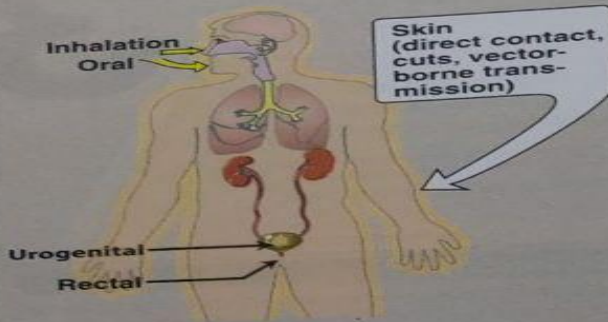
The most important antiphagocytic structure is the capsule external to the cell wall, such as in *S. pneumoniae* and *N. meningitidis*. A second group of antiphagocytic factors are the cell wall proteins of gram-positive cocci, such as protein A of *Staphylococcus* and **M** protein of group **A** streptococci .

6. Bacterial toxins:

Some bacteria cause disease by producing toxic substances, of which there are two general types: **exotoxins and endotoxin**. Exotoxins are proteins secreted by both gram-positive and gram-negative bacteria. In contrast, endotoxin, which is synonymous with lipopolysaccharide (LPS), is not secreted but is an integral component of the cell walls of gram-negative bacteria.

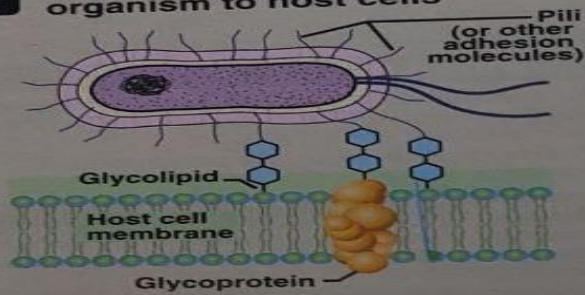
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Entry into the host, with evasion of host primary defenses



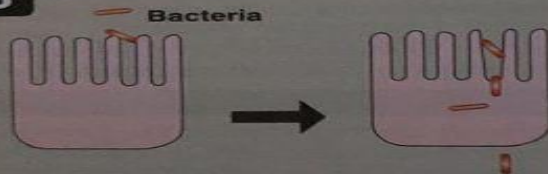
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Adhesion of the micro-organism to host cells



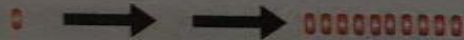
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Invasion of the host



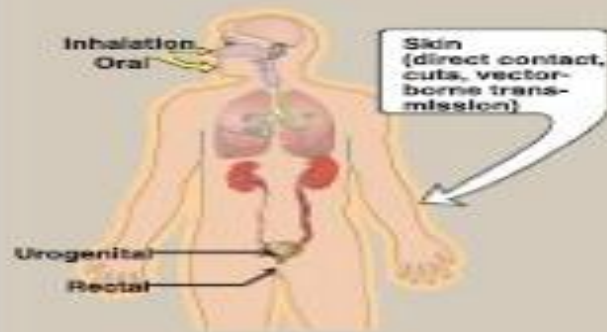
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Propagation of the organism



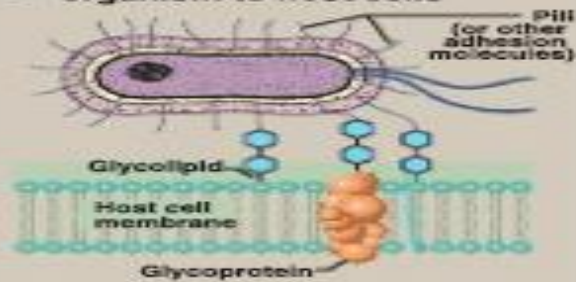
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Propagation of the organism

