Lac. : 6 **General Microbiology** **Dr. Selda S. Yaseen**

The Normal Flora and Bacterial Virulence

*- Normal flora are the microorganisms that live on another living organism (human or animal) or inanimate object without causing disease. The human body is not sterile ; we become colonized by bacteria from the moment we are born.
*- Normal flora covered skin, and within intestines, approximately one hundred trillion bacteria that form the normal flora of bodies.
*- This normal flora helps to prevent becoming colonized with more dangerous bacteria, which might lead to infection.
*- Many circumstances can change normal flora, e.g. normal flora of the human body begins to change after admission to a hospital or long-term care facility.
*- These process usually begins around day 4 of admission; this is why after 4 days of admission the antibiotics for hospital acquired infections changed .

Knowledge of the normal flora of the body allows :-

- Prediction of the pathogens causing infection as bacteria tend to grow in specific body sites e.g. *Streptococcus pneumoniae* from the upper respiratory tract causing pneumonia or *Staphylococcus aureus* from the skin causing intravenous cannula infections .
- Investigation for underlying abnormalities in specific areas of the body when bacteria are isolated from normally sterile sites e.g. *Escherichia coli* isolation from blood cultures indicates probable intra-abdominal pathology because *Escherichia coli* is part of the normal gastrointestinal flora .
- Microbes, like bacteria and fungi (which includes yeast), are spread on and in particular regions of the body and are considered the **Normal Flora (or Microflora)** .
- Many of these microbes serve beneficial roles by preventing pathogens from growing or by producing products that the human body needs. An example of a beneficial product is the production of (vitamin K) in the intestinal tract by *Escherichia coli* .

The Normal Flora in the body .

Skin .

The human skin is home to about 1012 microbes ! There are four main groups of bacteria that predominate almost everywhere on the skin , are :-
1- Corynebacteria like *Corynebacterium diphtheria* and *Propionibacterium acnes* was once classified as a *Corynebacterium* is considered part of this group .
2- Staphylococci such as *Staphylococcus epidermidis* .
3- Streptococci (either alpha (α) or gamma (γ) hemolytic).
4- Enterococci .

Besides bacteria the skin also is the place to yeast (like *Candida*) and fungi. The populations of microbes vary over the body's skin due to differences in pH, oxygen, water, and secretions. Certain groups, such as the diphtheroids, are found mainly in the groin and armpits. The armpit is home to about 500,000 bacteria per square inch; the forearm - about 12,000 bacteria per square inch.

Eye .

Microbes normally found directly on or on the conjunctiva of the eye are usually transitory and include Staphylococci , Streptococci , *Diphtheroid bacilli*, *Haemophilus* , and *Neisseria* .

Upper Respiratory Tract (Pharynx and Trachea) .

Microbes normally found in upper respiratory tract include Staphylococci, Streptococci (*Streptococcus agalactiae*), diphtheroid bacilli (such as *Corynebacterium diphtheria*) , *Spirochetes* , *Neisseria* , *Haemophilus* .

Oral Cavity (Mouth And Teeth) .

Microbes normally found on the mouth and teeth include Staphylococci , Streptococci (*Streptococcus mutans*), *Lactobacillus acidophilus* , *Actinomyces odontolyticus* .

Intestinal Tract (Gastro-intestinal tract) .

Microbes normally found in the **upper intestine** include lactobacilli and enterococci (such as *Enterococcus faecalis*) .
Microbes of the **lower intestine and colon** include mostly >90% anaerobes such as *Bacteroides* and *Clostridium*. Enterics (*Escherichia coli* and relatives) *Pseudomonas,* and *Candida* (a yeast) .

Genitourinary Tract (genital region and urethra) .

Microbes normally found in the genitourinary include a balanced population of yeast (such as *Candida*) and *Lactobacilli* found in the vaginal tract of a healthy woman.

- *Mycobacterium smegmatis* can be found on the penis. The urine of a healthy individual is sterile but can become contaminated due to transfer of microbes from the GI or genital tract.

The Normal flora exhibit certain characteristics. These are :-

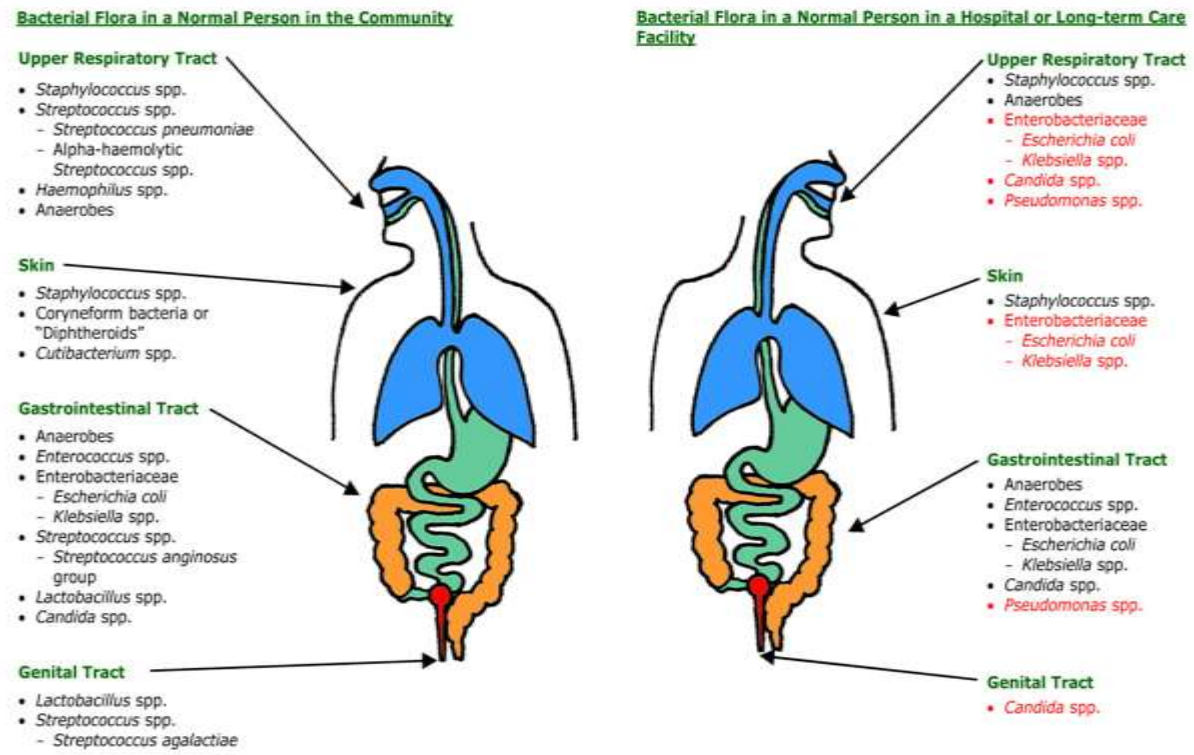
1 - Not disease-inducing : - They normal flora are also known as Microbiota and are not typical disease causing micro-organisms found in and on healthy individuals .

2 - Very abundant :- The normal flora are extremely abundant in terms of sheer numbers . For instance, an ordinary human has approximately 1012 body cells .

3 - All found externally and internally :- Normal flora are found more often on the skin , eyes, nose, oral fissure as well as on the throat and lower parts of the urethra and the large intestine.

4 - Benefits of the Normal Flora :- There is an increased ability of the host to nourish itself from the bacteria that Produce vitamins like vitamin B12 and vitamin K .

5 - They help digest food as they breakdown foods that are normally indigestible by the host into forms that are easily digestible by the host .



Virulence Factors Bacteria .

Introduction .

• Bacterial virulence factors enable a host to replicate and disseminate within a host in part by subverting or eluding host defenses .

• The use of genomic techniques has led to the identification of new virulence factors that may serve as targets for new therapies .

• Virulence is the ability of a microorganism to produce disease. Virulence depends on the number of infecting bacteria, their route of entry into the body, the response of the host immune system and any characteristics specific to that bacteria .

• Bacterial virulence factors are typically proteins or molecules synthesized by protein enzymes .

• Genes that encode virulence factors may be carried on mobile genetic elements such as plasmids or bacteriophages .

• Pili and fimbriae are rodlike or hairlike structures, that facilitate attachment to host cells.

• Invasion of host cells is a complex mechanism that involves elaboration of proteins that facilitate entry.

• Bacterial toxins may be extracellular (exotoxins) or are a component of the bacterial cell membrane (endotoxin, LPS) and are among the most powerful toxins in nature (eg, botulinum toxin).

• Other mechanisms important to bacterial survival and virulence include tissue -degrading enzymes, antiphagocytic factors, IgA proteases, antigenic heterogeneity, and the ability to chelate iron.

Virulence Factors , include :-

1- Enzymes .

Numerous enzymes have been implicated in microbial virulence. Although the number of enzymes in this category is vast. Enzymes that are considered virulence factors are generally active against host components and contribute to virulence by damaging host tissue .

Damage makes the host permissive for microbial infection. Enzyme virulence factors that damage tissue include proteases, neurominidases and phospholipases.

2 - Motility .

Motility is a complex trait that has been associated with virulence in both bacteria and parasites. Bacterial cells can move by the action of specialized organelles called flagella .
For movement in intracellular spaces, many microbes exploit host actin to propel themselves forward . Actin-based motility is used by several intracellular pathogens including *Shigella spp*., *Listeria monocytogenes* and *Rickettsiae* for cell-to-cell spread Like bacteria .

3- Capsules .

Many pathogenic bacteria possess polysaccharide capsules, which are required for virulence in mammalian hosts . Encapsulated bacteria with polysaccharide capsules include *Streptococcus pneumonia* , *Neisseria meningitides* and *Haemophilus influenza* .
Most capsules function in microbial pathogenesis by protecting the microbe against host immune mechanisms , although for some the capsular structures can serve as adhesions .

4- Pigments .

Pigment production, and specifically melanin-like pigments, have been associated with virulence in several microbes .
Melanin in melanotic organisms can protect against a variety of host defense mechanisms that include free radical fluxes .

5-Toxins .

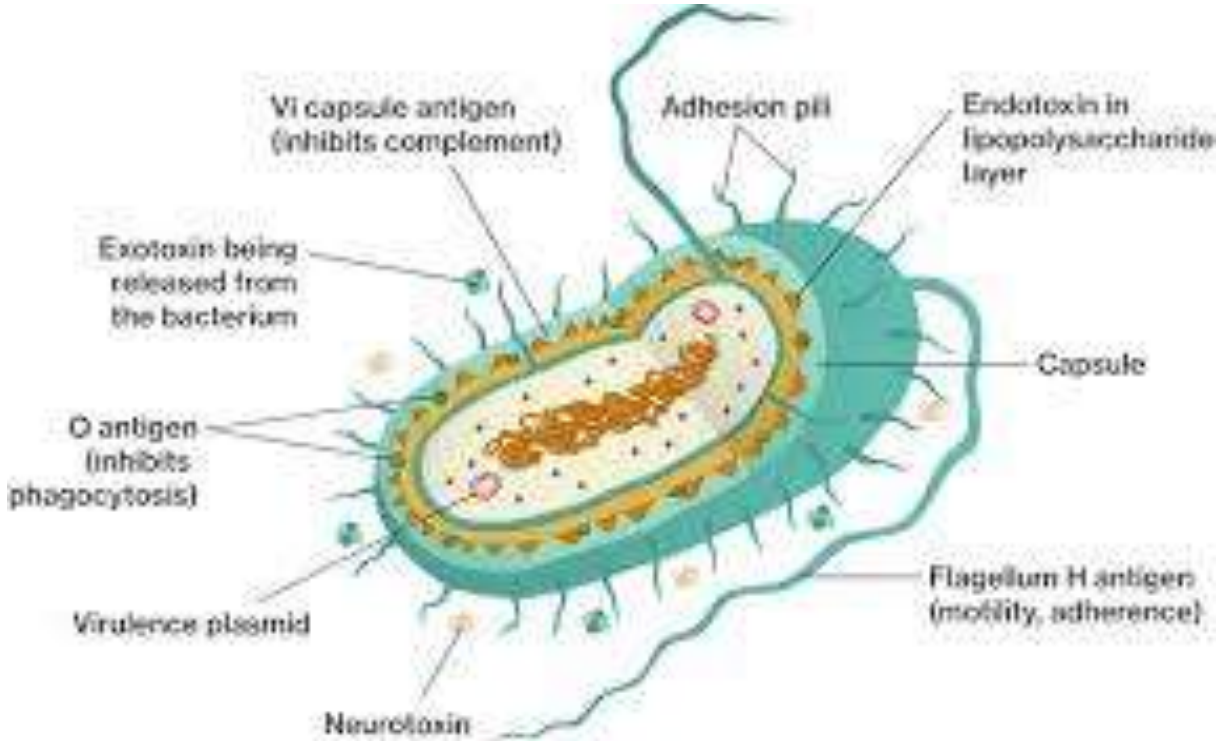
A large proportion of virulence factors are proteins produced by bacteria which are toxic to the host, these toxins cause damage to hosts cells and tissues .
Toxins produced by bacteria are generally classified into two groups : Exotoxins and Endotoxins .

6 - Adherence Factors .

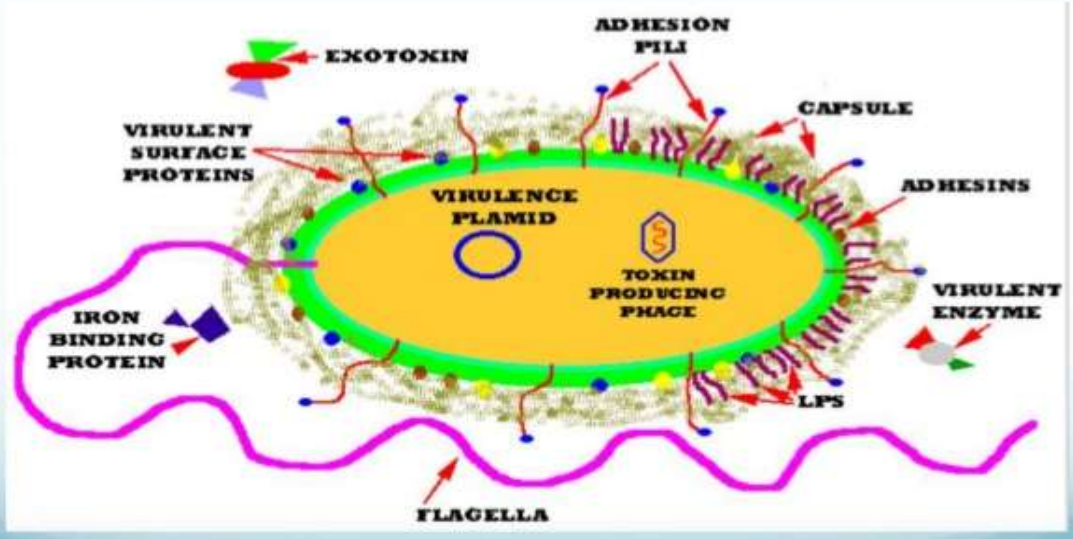
When bacteria enter the body of the host, they must adhere to cells of a tissue surface. If they did not adhere, they would be swept away by mucus and other fluids . Adherence, which is only one step in the infectious process. Bacteria also have specific surface molecules that interact with host cells. Many bacteria have **pili**, thick rodlike appendages or **fimbriae**, shorter “hairlike” structures that extend from the bacterial cell surface and help mediate adherence of the bacteria to host cell surfaces .

- Other specific receptor mechanisms have evolved to promote bacterial adherence to host cells, the diverse mechanisms used by bacteria, include :-

- **Lipoteichoic acid**, protein F, and M protein are found on the fimbriae . The lipoteichoic acid and protein F cause adherence of the streptococci to epithelial cells; this adherence is mediated by fibronectin, which acts as the host cell receptor molecule. M protein acts as an antiphagocytic molecule and is a major virulence factor.



Virulence factor



The Role of Bacterial Biofilms .

- A Biofilm is an aggregate of interactive bacteria attached to a solid surface or to each other and encased in an Exopolysaccharide matrix.

- Biofilms form a slimy coat on solid surfaces and occur throughout nature. A single species of bacteria may be involved or more than one species may form a biofilm.
Fungi, including yeasts, are involved in biofilm . After a biofilm is formed, sensing molecules produced by the bacteria in the biofilm accumulate, resulting in a modification of the metabolic activity of the bacteria .

- The bacteria in the Exopolysaccharide matrix may be protected from the host's immune mechanisms. This matrix also functions as a diffusion barrier for some antimicrobials, but other antimicrobials may bind to it.

- Some of the bacteria within the biofilm show marked resistance to antimicrobials compared with the same strain of bacteria grown free living in broth, which helps to explain why it is so difficult to treat infections associated with biofilms.

- Biofilms are important in human infections that are persistent and difficult to treat. A few examples include *Staphylococcus epidermidis* and *S. aureus* infections of central venous catheters, eye infections such as that occur with contact lenses and intraocular lenses, in dental plaque, and in prosthetic joint infections. Perhaps the most profound example of a biofilm in human infection is in *P. aeruginosa* airway infections in cystic fibrosis patients.