

Significance of Microbiome: Normal Microflora, True Pathogen and Opportunistic Pathogens

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The normal flora influences the anatomy, physiology, susceptibility to pathogens, and morbidity of the host

- **Skin Flora**

- Gram-positive organisms (e.g., staphylococci, micrococci, diphtheroids) usually predominating.
- A different bacterial flora characterizes each of three regions of skin:
 - (1) axilla, perineum, and toe webs;
 - (2) hand, face and trunk; and
 - (3) upper arms and legs.
- Skin sites with partial occlusion (axilla, perineum, and toe webs) harbor more microorganisms than do less occluded areas (legs, arms, and trunk).
- These quantitative differences may relate to increased amount of moisture, higher body temperature, and greater concentrations of skin surface lipids. The axilla, perineum, and toe webs are more frequently colonized by Gram-negative bacilli than are drier areas of the skin.
- *S. epidermidis* is a major inhabitant of the skin, and in some areas it makes up more than 90 percent of the resident aerobic flora.
- The nose and perineum are the most common sites for *S. aureus* colonization, which is present in 10 percent to more than 40 percent of normal adults.
- Micrococci are not as common as staphylococci and diphtheroids; however, they are frequently present on normal skin.
- The term diphtheroid denotes a wide range of bacteria belonging to the genus *Corynebacterium*. Anaerobic diphtheroids are most common in areas rich in sebaceous glands.
- Gram-negative bacteria make up a small proportion of the skin flora. Desiccation is the major factor preventing the multiplication of Gram-negative bacteria on intact skin. *Enterobacter*, *Klebsiella*, *Escherichia coli*, and *Proteus* spp. are the predominant Gram-negative organisms found on the skin.
- Dust particles and other extraneous materials may get trapped under the nail, depending on what the nail contacts. In addition to resident skin flora, these dust particles may carry fungi and bacilli. *Aspergillus*, *Penicillium*, *Cladosporium*, and *Mucor* are the major types of fungi found under the nails.

Oral and Upper Respiratory Tract Flora

- A varied microbial flora is found in the oral cavity, and streptococcal anaerobes inhabit the gingival crevice.
- The pharynx can be a point of entry and initial colonization for *Neisseria*, *Bordetella*, *Corynebacterium*, and *Streptococcus* spp.
- The pharynx and trachea contain primarily those bacterial genera found in the normal oral cavity (for example, α - and β -hemolytic streptococci); however, anaerobes, staphylococci, neisseriae, diphtheroids, and others are also present.

Gastrointestinal Tract Flora

- Organisms in the stomach are usually transient, and their populations are kept low (10^3 to 10^6 /g of contents) by acidity.
- *Helicobacter pylori* is a potential stomach pathogen that apparently plays a role in the formation of certain ulcer types. In normal hosts the duodenal flora is sparse (0 to 10^3 /g of contents).
- The ileum contains a moderately mixed flora (10^6 to 10^8 /g of contents).
- Concentrations of 10^9 to 10^{11} bacteria/g of contents are frequently found in human colon and feces.
- This flora includes a bewildering array of bacteria (more than 400 species have been identified); nonetheless, 95 to 99 percent belong to anaerobic genera such as *Bacteroides*, *Bifidobacterium*, *Eubacterium*, *Peptostreptococcus*, and *Clostridium*.
- The flora of the large bowel is dense (10^9 to 10^{11} /g of contents) and is composed predominantly of anaerobes.
- The strict anaerobic conditions, physical exclusion (as is shown in many animal studies), and bacterial waste products (acetic, butyric, and lactic acids) are factors that inhibit the growth of other bacteria in the large bowel.
- These organisms participate in bile acid conversion and in vitamin K and ammonia production in the large bowel. They can also cause intestinal abscesses and peritonitis.

- **Urogenital Flora**

- The vaginal flora changes with the age of the individual, the vaginal pH, and hormone levels.
- Transient organisms (e.g., *Candida* spp.) frequently cause vaginitis.
- *Lactobacillus* spp. predominate in female infants (vaginal pH, approximately 5) during the first month of life.
- Glycogen secretion seems to cease from about 1 month of age to puberty.
- During this time, diphtheroids, *S. epidermidis*, streptococci, and *E. coli* predominate at a higher pH (approximately pH 7).
- At puberty, glycogen secretion resumes, the pH drops, and women acquire an adult flora in which *L. acidophilus*, corynebacteria, peptostreptococci, staphylococci, streptococci, and Bacteroides predominate.
- The distal urethra contains a sparse mixed flora; these organisms are present in urine specimens (10^4 /ml) unless a clean-catch, midstream specimen is obtained.

- **Conjunctival Flora**

- The conjunctiva harbors few or no organisms.
- *Haemophilus* and *Staphylococcus* are among the genera most often detected.

- **Host Infection**

- Many elements of the normal flora may act as opportunistic pathogens, especially in hosts rendered susceptible by rheumatic heart disease, immunosuppression, radiation therapy, chemotherapy, perforated mucous membranes, etc.
- The flora of the gingival crevice causes dental caries in about 80 percent of the population.

True Pathogens

- Microorganisms that are capable of causing disease are called **pathogens**.
- A simple definition of a pathogen is an organism that can overcome the defence mechanisms of the body and induce deleterious changes in the host.
- A true pathogen is an infectious agent that causes disease in virtually any susceptible host.
- Another name for a pathogen is an infectious agent such as a virus, bacterium, protozoan, prion, viroid, or fungus, as they cause infections.

Opportunistic pathogens

- Opportunistic pathogens are potentially infectious agents that rarely cause disease in individuals with healthy immune systems.
- The opportunistic pathogen is an infectious pathogen that is normally commensal in the body but can cause disease when the host's resistance is altered.
- They can be some viruses (referred to as “opportunistic viruses”), fungi (referred to as “opportunistic fungi”), parasites (“opportunistic parasites”), and bacteria (“opportunistic bacteria”).
- They are normally present in the body without causing disease but cause an infectious disease in certain conditions, such as when the immunological response of the host is low.
- The low resistance of the body to opportunistic pathogens may occur due to many factors such as malnutrition, HIV, genetic factors, leukopenia (low WBC count), and aging.

... Opportunistic pathogens

- Opportunistic pathogens are usually present in healthcare settings as hospitals.
- Such pathogens cause opportunistic diseases that they do not usually cause under normal conditions.
- Opportunistic pathogens cause infections by taking advantage of the weakened immunity of the host, disturbance in the normal microbiota, or penetrating barriers as in case of traumas.
- Moreover, opportunistic pathogens may cause mild infections in healthy individuals.
- However, the infection may lead to serious complications if the individual's immunity was disturbed.

Factors that induce a commensal organism to become pathogenic

- Disturbance of the host immunity may occur due to the following:
 - Administration of immunosuppressants
 - Advanced HIV
 - Chemotherapy
 - Damage of the skin, as in surgeries
 - [Antibiotic](#) intake resulting in the disruption of the normal flora in the body
- Opportunistic pathogens are also a major cause of infections and deaths in cancer patients as well as patients receiving organ transplantation.
- Severe immunocompromised drugs may lead to simultaneous infections with different opportunistic pathogens.

What are the main characters of opportunistic pathogens?

- Normally, they are organisms that are less likely to cause infections and do not act as a true pathogen
- Infections caused by opportunistic pathogens are serious infections and occur due to impaired immunity of the host.
- Opportunistic infections may be clinically different from normal infections of the same pathogen.
- **Examples of *opportunistic microorganisms***
 - *Candida albicans*
 - *Staphylococcus aureus*
 - *Pseudomonas aeruginosa*
 - *Staphylococcus epidermidis*
 - *Haemophilus influenzae*
 - *Streptococcus pyogenes*
 - *Neisseria meningitidis*

How to avoid infections of opportunistic pathogens during periods of low immunity?

- ***A boost in the immune system.*** The immunity is restored as soon as possible to *reduce* the incidence of infections caused by opportunistic pathogens
- ***Healthy lifestyle and habits.*** The individual should avoid infectious agents by cooking eggs and meat well, drink pasteurized dairy products, avoid potential sources of infections as infected individuals and hospitals, avoid any contact with feces, dust, or farm animals as they represent a major source of infection.
- ***Using prophylactic antibiotics.*** The risk of acquiring opportunistic infections may be reduced by the administration of antibiotic prophylaxis, which is given before surgical incisions.

Common examples of opportunistic infections

- **Candidiasis** – the infection caused by a fungus, [Candida albicans](#), which is normal flora in the oral cavity as well as genital organs in humans. However, it may cause infections if the host immunity is low.
- **Staph infections** – by *Staphylococcus aureus*. This bacterial agent covers the skin of humans but may cause opportunistic staph infections when present in internal devices such as prosthetic joints and intravenous lines. Staph infection may lead to severe *sepsis*.
- **Pseudomonas aeruginosa infections** – usually, this bacterial species colonizes medical devices such as catheters. It is the most common cause of external ear infections, burn infections, and respiratory infections. It is usually associated with hospital infections and [cystic fibrosis](#).
- **Clostridium difficile opportunistic infections** –in gastrointestinal tract, especially in the form of nosocomial infection.
- **Legionnaire's disease** – by *Legionella pneumophila*, a bacterium that may cause respiratory infection.
- The normal flora in the pharynx and nose in the upper respiratory tract may carry pathogenic microorganisms without the appearance of symptoms. These opportunistic infections usually occur after the damage of the [epithelium](#) following a viral infection in the [respiratory tract](#).