

**COLLEGE NAME & CODE : Periyar Arts College, Cuddalore-01 & 105**  
**COURSE NAME & CODE : III B.Sc., Microbiology & U26**  
**SEMESTER : V**  
**SUBJECT TITLE & CODE : MEDICAL BACTERIOLOGY & BMB52**

## **UNIT-I**

- Normal microbial flora of human body;
- General attributes and virulence factors of bacteria causing infections.
- Host Parasite relationships

## NORMAL HUMAN MICROBIAL FLORA (MICROBIOTA)

- Through normal everyday activities, the human body is exposed to microorganisms in the environment.
- Hundreds of species and countless individual microbial cells, collectively called the **normal microflora**, grow on or in the human body. This is the **human microbiome**, the sum total of all microorganisms that live on or in the human body.
- The normal microflora are first introduced at birth.

### Normal Microbiota of the Skin

- The skin is the human body's largest organ, colonized by a diverse array of microorganisms, most of which are harmless or even beneficial to the host.
- The predominant resident microorganisms of the skin are:
  - *Staphylococcus epidermidis*
  - *Staphylococcus aureus* (in small numbers)
  - *Micrococcus* species
  - $\alpha$ -Hemolytic and nonhemolytic streptococci (eg, *Str mitis*)
  - *Corynebacterium* species

### Normal Microbiota of the Conjunctiva

- The predominant organisms of the conjunctiva are diphtheroids, *S epidermidis*, and nonhemolytic streptococci.
- Neisseriae and gram-negative bacilli resembling haemophili (*Moraxella* species) are also frequently present.
- The conjunctival flora is normally held in check by the flow of tears, which contain antibacterial lysozyme.

### Normal Microbiota of Mouth and Upper Respiratory Tract

- The flora of the nose consists of prominent corynebacteria, staphylococci (*S epidermidis*, *S aureus*), and streptococci.
- Infants delivered via C-section harbor bacterial communities (across all body habitats) that are most similar to the skin communities of the mothers (eg, *Staphylococcus*, *Corynebacterium*, or *Propionibacterium* spp.).

- Early in life, aerobic and anaerobic staphylococci, gram-negative diplococci (Neisseriae, *Moraxella catarrhalis*), diphtheroids, and occasional lactobacilli are added.
- When teeth begin to erupt, the anaerobic spirochetes, *Prevotella* species (especially *Prevotella melaninogenica*), *Fusobacterium* species, *Rothia* species, and *Capnocytophaga* species establish themselves along with some anaerobic vibrios and lactobacilli.

### **Normal Microbiota of the Intestinal Tract**

- The human gastrointestinal tract is divided into sections, allowing digestion and nutrient absorption in the proximal region to be separate from the vast microbial populations in the large intestine.
- At birth, the intestine is sterile, but organisms are soon introduced with food.
- The environment (eg, maternal vaginal, fecal, or skin microbiota) is a major factor in determining the early microbial profile.
- Diet has a marked influence on the relative composition of the intestinal and fecal flora.
  - For example, individuals on an animal-based diet have been shown to have an increased abundance of bile-tolerant microorganisms (*Alistipes*, *Bilophila*, and *Bacteroides*) and decreased levels of Firmicutes that metabolize dietary plant polysaccharides (*Roseburia*, *Eubacterium rectale*, and *Ruminococcus bromii*).
- Six major phyla predominate; these are *Bacteroidetes*, *Firmicutes*, *Actinobacteria*, *Verrucomicrobiota*, *Fusobacteria*, and *Proteobacteria*.

### **Normal Microbiota of the Urethra**

- The anterior urethras of both sexes contain small numbers of the same types of organisms found on the skin and perineum.
- In the anterior urethra of humans, *S. epidermidis*, enterococci, and diphtheroids are found frequently; *E. coli*, *Proteus*, and *Neisseria* (nonpathogenic species) are reported occasionally (10 to 30 percent).

### **Normal Microbiota of the Vagina**

- Soon after birth, aerobic lactobacilli appear in the vagina and persist as long as the pH remains acidic (several weeks).
- When the pH becomes neutral (remaining so until puberty), a mixed flora of cocci and bacilli is present.
- The normal vaginal flora often also includes  $\alpha$ -hemolytic streptococci, anaerobic streptococci
  - (peptostreptococci), *Prevotella* species, clostridia, *Gardnerella vaginalis*, *Ureaplasma urealyticum*, and sometimes *Listeria* or *Mobiluncus* species.
- The cervical mucus has antibacterial activity and contains lysozyme.
- Vaginal organisms present at time of delivery may infect the newborn (eg, group B streptococci).

<https://microbenotes.com/normal-human-microbiota/>

## **GENERAL ATTRIBUTES AND VIRULENCE FACTORS OF BACTERIA CAUSING INFECTIONS**

### **VIRULENCE FACTORS OF *VIBRIO CHOLERAE***

- *V. cholerae* possess following virulence factors:
  - i. Cholera toxin (CT):
  - ii. Toxin coagulated pillin (TCP):
  - iii. Accessory colonization factor:
  - iv. Hemagglutination protease (mucinase):
  - v. Neuraminidase:
  - vi. Sidephores:

### **VIRULENCE FACTORS OF *YERSINIA***

- Capsule
- Endotoxin
- Exotoxin-v & w protein
- Yersinia outer protein (YOPS)

### **VIRULENCE FACTORS OF *PASTEURELLA***

- Capsule: Some strains of *Pasteurella multocida* capsulated
- Dermonecrotic toxin: Essential virulence factor for development of progressive respiratory tract infection,also activates several cellular signal transduction pathways
- 'tox A' gene is responsible for production of toxin which is present in conserved region of *Pasteurella multocida* chromosome.
- Produce lipases
- Broad host range

### **VIRULENCE FACTORS OF *NEISSERIA MENINGITIDIS***

#### **a) Capsular Polysaccharide**

- 13 serogroups (A, B,C, D, W135, X, Y, Z, H, K &L)
- Used in vaccine
- Antiphagocytic in nature

#### **b) Outer membrane proteins**

- 5 classes
- Serogroups further subdivided into 20 serotypes

#### **c) Pili**

- Helps in meningeal invasion

**d) Toxin**

- Endotoxin – Lipid A, part of lipopolysaccharide
- Induces septicemic shock

**e) Enzymes**

IgA protease – cleaves the IgA antibodies present in the respiratory mucosa.

**VIRULENCE FACTORS OF *NEISSERIA GONORRHOEAE***

- Pili: Piliated Gonococci – Virulent; Non-piliated Gonococci – Avirulent
- Endotoxin – Lipooligosaccharide (LOS) but weaker
- Outer membrane proteins (OMP)
- IgA protease

**VIRULENCE FACTORS OF *HAEMOPHILUS***

1. Capsular polysaccharide: It resists phagocytosis. Loss of capsule leads to loss of virulence.
2. Pili (Fimbriae): They help in attachment of organisms to epithelial cells.
3. Outer membrane proteins: They contribute in adhesion and invasion of host tissues.
4. IgA1 protease: *H. influenzae* produces a protease that specifically cleaves the heavy chain of IgA1.

## **HOST-PARASITE RELATIONSHIPS**

Based on the relationship between the hosts & microorganisms, the microorganisms are classified as SAPROPHYTES and PARASITES.

### **SAPROPHYTES**

- Saprophytes are free-living microbes that depend on dead & decaying organic matter. They play an important role in the degradation of organic matter in nature.

### **PARASITES**

- Parasites are microbes that can establish themselves & multiply in host. Parasites may either be PATHOGENS or COMMENSALS.
  - a) **PATHOGENS** are microorganisms that are capable of producing disease in the host.
  - b) **COMMENSALS** are microbes that live in complete harmony with the host without causing any damage to it.

### **PATHOGENECITY:**

- It is the capability of a microbial species to cause disease.
- The degree of pathogenicity is termed as **VIRULENCE**. The virulence of a pathogen is usually measured by determining its LD<sub>50</sub> dose. The LD<sub>50</sub> dose is defined as the number of microorganisms which, when administered to a number of lab animals, will kill 50 percent of them.
- LD<sub>100</sub> dose or minimum lethal dose (MLD) is defined as the dose that kills 100 % of the animals.

## **MICROBIAL INFECTIONS**

The term infection is termed as the lodgment & multiplication of a parasite in or on the host tissues. Not all the infections leads to disease. To cause an infectious disease, a pathogen must accomplish the following steps.

- i. It must enter the host.
- ii. It must metabolize & multiply in or on the host tissue.
- iii. It must resist host defenses.
- iv. It must damage the host.

### **TYPES OF INFECTIONS**

- 1) **ACUTE:** Has a short & relatively severe course  
e.g., *Streptococcus pyogenes* – Cause Sore throat

- 2) **CHRONIC:** Has a long duration  
e.g., Tuberculosis caused by *Mycobacterium tuberculosis*.
- 3) **FULMINATING:** Occurs suddenly with severe intensity  
e.g., Meningitis caused by *Neisseria meningitidis*.
- 4) **MIXED / POLYMICROBIAL:** More than one kind of microorganism contributes to the infection.  
e.g., Gangerene caused by *Clostridium* spp.
- 5) **LOCALISED:** Restricted to a limited area of the body.  
e.g., UTI caused by *E. coli*.
- 6) **GENERALISED:** Affects many parts of the body.  
e.g., Typhoid fever.
- 7) **PRIMARY:** Initial infection with a parasite in a host.
- 8) **REINFECTION:** Subsequent infection by the same parasite or pathogen in the host.
- 9) **SECONDARY:** a new parasite infects a host whose resistance is lowered by a preexisting infection
- 10) **NOSOCOMIAL:** Cross infection occurring in hospitals.

Depending on the source of infection, the infections are classified into

Exogenous	-	External sources
Endogenous	-	Host's own body.

### **SOURCES OF INFECTION:**

The following things are the sources of infection viz.,

- i. Human beings
- ii. Animals
- iii. Insects
- iv. Soil & Water
- v. Contaminated food.

#### **i. Human beings**

The common source of infection for human beings are human being themselves.

- A **Carrier** is a person, who harbors the pathogen without suffering any illness because of it.



- A **Healthy Carrier** is one, who harbors the pathogen but has never suffered from the disease caused by the pathogen.
- A **Convalescent Carrier** is one, who has recovered from the disease & continues to harbor the pathogen in his body.

Depending on the duration of carriage, the carriers are classified into two types.

- a) **Temporary** - For less than 6 months
- b) **Chronic** - For several years

## ii. Animals

- Many animals maintain the parasite in nature & act as the reservoir host.
- Disease transmitted from animals to human beings are called **Zoonoses**.  
e.g.,
 

Bacterial	- Plague from rats
Viral	- Rabies from dogs
Protozoal	- Leishmaniasis from dogs
Fungal	- Dermatophytes from cats & dogs.

## iii. Insects

- Diseases transmitted through blood sucking insects are called **Arthropod borne diseases** & the insects are called **Vectors**.  
e.g., Mosquitoes, Ticks, Mites, etc.
- The vectors may be of two types
  - a) **Mechanical Vectors:** In which, the transmission may be mechanical.
  - b) **Biological Vectors:** In which, the pathogens is undergoing part of a developmental cycle in the vectors.  
e.g., Anopheles mosquito in Malaria.

## iv. Soil & Water

- Spores of Tetanus bacilli (*Clostridium tetani*), fungi like *Histoplasma* & *Nocardia* and parasites like Hookworm & Roundworm can remain in the soil for a longer time & serves as the source of infection.
- Water contaminated with pathogen may also serve as a source of infection.  
e.g., Cholera, Hepatitis virus

## v. Contaminated food.

- These materials also act as the source of infection. The infection may be either due to the presence of pathogens or due to the presence of microbial products.  
e.g., Food poisoning by *Staphylococcus* spp.