

# Microbial Infectious Disease: A Mini Review

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## Abstract

In the 21<sup>st</sup> century where science and its technology have revolutionized the world, there has been also a remarkable increase in the infectious diseases which have disastrously affected mankind. From the past when millions of people die due to chickenpox and measles in America till today when a virus like the SARS, Coronavirus (COVID 19) has challenged the world, which is a highly infectious disease. Infectious disease reports the main cause of death in this global world. Despite high equipment facilities and technology, this type of disease has regularly challenged the global scenario. Infectious diseases are particularly important causes of death among the people who are elderly, immunocompromised, already having a chronic disease and also to whom who are suffering from malnutrition. The article focuses on the mechanisms by which the infectious agents cause pathology, various routes of infection and also throws light on the different microbial agents which are causing various infectious diseases.

**Keywords:** *Infectious Disease, Pathology, Microbial Agents, Infection.*

## Introduction

Infectious disease has always a adverse effect to human beings as it is a pathological condition which is caused specific infectious agents which can be virus, bacterium, fungi or protozoan that affects the body parts or tissues, characterized by a group of signs and symptoms. As we all know bacteria were discovered by A.V. Leeuwenhoek in the year 1675 but the German

physician named Robert Koch discovered that specific organisms are associated with a particular disease, after which the physician-developed four criteria to demonstrate that specific agents caused a particular, which he called Koch's Postulates that takes medical diagnosis to another level as it becomes accurate to find out the proper medication of different disease.<sup>1</sup> Infectious disease is always associated with infection, host, pathogen and virulence. There are different routes of transmission of infectious disease and different phases involving in this disease. Modern microbiology which is based on molecular genetics is the key to defeating this infectious disease. When it was discovered that DNA was the responsible material for the transmission of genetic traits which was the turning point in the medical research history that has continued to this day. In today scenario modern and improved techniques lead the advancement in controlling and detecting the various disease.<sup>2</sup>

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### Classification of Infectious Disease<sup>3</sup>:

The classification is based on a different basis, which includes:

**By location:** It is divided into 2 types – Local: The disease is curbed to a specific area of the body.

**Systemic:** It is a generalized disease that affects most of the body parts and its pathogenesis distributed thoroughly in the tissues.

**By Duration:** It is divided into 3 types- Acute: It develops quickly and fastly spreads.

**Chronic:** Chronic disease develops very slowly and it mild but it may last for a long time, it has an indefinite period.

**Latent:** This type of disease is characterized by periods of no symptoms in the outbreak of illness.

**By timing:** It is divided into 2 types – Primary: It is an initial infection which has affects previously healthy person.

**Secondary:** This infection occurs in a person who has weakened by a primary infection.

### Types of Infectious Agents

These are different agents which are very small in size and thus can be noticed in a microscope that includes:

**Bacteria:** These are the most common cause of diseases. They are generally 0.8-1.5 $\mu$ m in size. The bacteria cells are prokaryotes in nature and have cell membranes but lack membrane-bound nuclei. Their cell wall consists of peptidoglycan and most of the bacteria synthesize their RNA, proteins & DNA, but depends upon the host for their nutrition. The bacteria which retain crystal violet stains are Gram-positive & those do not retain are Gram-ve Bacteria. Most of the bacteria are extracellular but few survive within host cells like as obligate intracellular bacteria.

**Prions:** These are found in neurons and they are abnormal forms of a normal host prion protein (PRP). The accumulation of abnormal PRP will lead to distinctive spongiform changes in the brain and also can cause neuronal damage. They are intracellular. These are associated with diseases like Creutzfeldt-Jakob disease.

**Chlamydiae:** These organisms divide by binary

fission like bacteria and they are sensitive in binary fission but the feature that distinguishes it with the bacteria is that they cannot synthesize ATP (Adenosine triphosphate). They are obligate intracellular microorganisms. Chlamydia trachomatis is the common cause for the female sterility and blindness. They are normally 200-1000nm in size.

**Viruses:** These are obligate intracellular organisms having size 20-30nm. They consist of a capsid which is a protein coating that surrounds the nucleic acid genome. Viruses are classified under the basis of their nucleic acid genome combination i.e. DNA or RNA, but not the both. They contribute to the huge allocation of human infections.

**Fungi:** These are eukaryotes having 2-100 $\mu$ m in size. Their cell wall contains thick chitin and their cell membrane containing ergosterol and these constituents are the most targeted area for the different anti-fungal agents. A fungus grows by hyphae or like budding yeasts forms. Their site of propagation includes cutaneous, mucosal, extracellular and facultative intracellular. They can cause superficial or deep infections.

**Protozoa:** These are single-cell eukaryotes which are the most common cause of infectious disease in developing countries. They are 1-50 $\mu$ m in size and can replicate intracellularly in many types of cells like parasitic protozoa which includes microorganism likes malaria in erythrocytes and leishmania in macrophages.

**Helminths:** These are highly differentiated parasitic worms having complex life cycles varying 3mm-10m in size. They consist of 3 classes which include Roundworms, Flatworms & Flukes.

**Different Routes of Infection<sup>3-5</sup>:** Microbes can enter the host in many ways which includes through the air, through the body fluids, by the animal vectors such as insects, birds, bats,etc, by the direct contact, or through the contaminated food. To enter in the host and to infect an individual, microbe's virulence factors are responsible which can break the host barriers and colonize the host. The barriers in host includes:-

- **Skin and oral mucous membrane:** The outer layer of the skin is dense and keratinized and its low pH 5.5 with its fatty acids content helps to inhibit the growth of microbes. Although skin and oral mucous membranes are very effective barrier but some microbes penetrate through due to cuts

or abrasions. Some of the examples of microbes include Staphylococci in wounds, Pseudomonas aeruginosa in burns and multibacterial infections in diabetic ulcers.

- **Respiratory Tract:** Many microorganisms are inhaled by human beings causing pathological condition, which includes different forms of viruses, bacteria or fungi. The size of microbes is inversely proportional to its traveling distance in the host. Large microbes are been trapped in the nose with the help of goblet cells by the action of respiratory epithelium goes back of the throat where they are swallowed and cleared and the alveolar macrophages or neutrophils phagocytes the smaller microbes less than 5µm in size, but some of the microbes like M. Tuberculosis can escape the phagocytic killing by alveolar macrophages and can cause severe respiratory infections.
- **Intestinal Tract:** Some of the pathogens which are transmitted by contaminated food or drink breaks the barrier of the intestinal tract, but there are some normal defenses against these pathogens which includes acidic gastric pH, immunoglobulin's like IgA which is secreted by B cells located in the mucosa-associated lymphoid tissue, viscous mucus secretions, the bile detergents or lytic pancreatic enzymes and the normal gut flora. These barriers also weaken in some cases due to the loss of gastric acidity or the antibiotics which unbalance the normal bacterial flora like in Pseudomembranous colitis or syndrome like blind loop syndrome. Most types of viruses are killed by bile and digestive enzymes that are mostly enveloped but few which are nonenveloped like Hepatitis A or rotaviruses, etc are resistant towards these barriers.
- **Urogenital Tract:** Many pathogens cause urinary tract infection but as the urinary tract is sterile as it is flushed many times per day but few like E.coli pathogen adhere to the epithelium successfully causing UTI. Women are more prone to UTI as compared to men as the urinary bladder and bacteria-laden skin which is length of urethra is less as compared to men. The distance in the women is 5cm and in men it is 20 cm. Obstruction in the bladder and excessive bleeding in menstrual leads to infection of the genital tract.

### **Mechanisms Associated with Infectious Disease<sup>6,7</sup>:**

**There are 3 general mechanisms by which viral, fungal and bacteria attacks host; which include:**

- The Pathogens enter to host cells or bind them and directly cause cell death.
- The endotoxins or exotoxins which are released by infectious agents kill cells and damage blood vessels leading to ischemic injury.
- The pathogen induces the host immune and inflammatory responses causing additional tissue damage.

**Viral injury mechanisms:** When the viruses enter inside the host cells then they can damage or kill in many ways:

**Lysis of host cells:** The replication of the viruses which interferes with the host cells because cell death-like as influenza virus kills the respiratory epithelium.

**Alteration in apoptosis Pathways:** Apoptosis is a common process by which the host inhibits the pathogen route and eliminates the virus but some viruses inhibit apoptosis by encoding some genes like BCL-2 gene and damage the cell in the cases like virus-induced cancers.

Viruses induce the cytotoxic T lymphocytes attack and cause damage to host like in liver cell injury during HBV infection.

Viruses like HBV, EBV induces the proliferation of cells and transformation that leads to cancer.

### **Mechanism of bacterial injury<sup>8,9</sup>:**

**The mechanism includes a simple process by which bacteria causes diseases includes:**

- **Adherence to Host cells:** It includes the invasiveness which is the ability to invade tissues and encompasses the mechanisms for colonization with the production of the extracellular substances that facilitate the invasion.
- **Toxigenesis:** Bacteria can produce toxins which include exotoxins & endotoxins. The bacterial endotoxins which are a lipopolysaccharide present in the cell wall of gram-negative bacteria which contain

long-chain fatty acids. This LPS is both harmful and beneficial to the host. However high levels of LPS induces cytokines such as tumor necrosis factor, IL-1, and IL-2, etc and will cause septic shock, acute respiratory syndrome, disseminated intravascular coagulation, etc.

The exotoxins are released from the bacterial cells which are bacterial enzymes like coagulase, protease hyaluronidases, etc that targets the substrates and damage the host cells. Some of the neurotoxins which are released by pathogens like *C. botulinum* or *C. tetani* inhibit the release of neurotransmitters leading to paralysis.

Cytokine storm can be appreciated which is caused by superantigens that are bacterial toxins that have the potential to stimulate the large population of T lymphocytes.

**Table 1. Examples of some recently introduced important infectious Disease**

Agents	Disease
Corona Virus	COVID-19
Staphylococcus Aureus	Toxic shock syndrome
Hepatitis E virus	Enterically transmitted hepatitis
HIV	AIDS
Hepatitis C virus	Chronic hepatitis
Hantavirus	Hemorrhagic fever with renal disease, Hanta virus pulmonary syndrome
Vibrio cholerae O139	New epidemic cholera

**Different phases of infectious disease<sup>9</sup>:** The stages involved are: Incubation period – It is the time from the occurrence of pathogens in the body to the appearance of first symptoms. In this phase the microbes grow and rapidly multiply.

**Prodrome Period:** In this phase nonspecific symptoms like fever, fatigue and malaise can be noticed with the starting of specific symptoms.

**Illness Period:** It is time in which symptoms of specific infection occurs. In this phase pathogen is at peak level.

**Convalescence:** In this phase acute symptoms disappear and returning of the immune system occurs.

**Some techniques for diagnosing infectious disease<sup>11,12</sup>:**

There are some method to detect this infectious pathogen which includes histopathological process, PCR test which is useful in the amplification of nucleic acids. Different staining process which diagnosed infectious pathogens includes:

Gram staining process which reacts to most of bacteria, Acid-fast stain for Mycobacteria and Nocardia, silver stains and periodic acid -Schiff for the fungi, Giemsa for campylobacteria and malarial parasites, DNA probes for viruses, bacteria and protozoa & Mucicarmine process for cryptococci. These staining processes have played a crucial role in detecting these pathogens as well as controlling infectious diseases.

## Conclusion

According to WHO the 10 most disease which cause maximum death in the world population includes 5 infectious diseases like Influenza, chickenpox, tuberculosis and new coronavirus which is giving disastrous impact to the global world causing COVID-19 disease and declared as a pandemic. Various advance technology and medical research have to control the infectious disease with a proper medication of it but in today world also there is an infectious disease like COVID-19 which is highly transferable and yet its proper medication is not discovered or made, different infectious pathogens like coronavirus or hantavirus can be used for bioterrorism which is very dangerous to mankind as it can be used as a biological weapon. Infectious diseases are challenging the world from long back history to present scenario and preventive care and social measures are highly impactful to controlling these severe diseases.

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