

# Infection and Infectious Diseases

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# **Chapter Outline**

**Introduction**

**Definitions**

**Mode of transmission of infectious diseases**

Prenatal infections

Postnatal infections

Endogenous infections

Exogenous infections

**Classification of infectious agents**

**AIDS**

## Learning Objectives

After studying this chapter the student should be able to:

1. Define the following terms: infection, contagion, nosocomial, reservoir, carrier, pathogen, host, vector
2. Describe and classify the microorganisms that may be pathogenic to humans
3. Briefly describe how pathogens spread from one person to the other
4. Briefly describe how organisms spread in tissue
5. Name the crucial differences between viruses and bacteria
6. Describe the cellular inflammatory reaction to bacteria, viruses, mycobacteria and fungi
7. Name the two types of Gram-positive cocci that cause most pyogenic infections

# Chapter Outline



## Introduction

Infections are the diseases that are caused by living organisms – these organisms are commonly termed “pathogens”

# Definitions

**Infection** Is the state of **colonization** by a pathogen

**Infectious disease** Is the disease caused by microorganisms. The microorganisms in this case are referred to as pathogens. Infectious diseases are also termed **contagious diseases**

**Contagion** Is the spread of infection from one person (host) to another.

**Host** Is the infected person or animal

**Vector** A vector is organism which itself does not cause disease but allows the transmission of disease causing microbes. The typical example is the fleas which transmitted the black death plague organism (*Y.pestis*).

**Reservoir** A place where the pathogen exists and from which it spreads to new hosts. The reservoir may be food, water, soil, equipment, animals or animal products, or humans.

**Pathogenesis** Is the mechanism by which the disease occurs

**Pathogenicity** is the ability to cause the disease

**Pathogen** A microorganism capable of causing disease

**Pathology** Is the study of the structural and functional manifestations of the disease

**Incubation Period** Is the time that elapses between invasion by a microorganism and the onset of symptoms. This period depends on: 1) Virulence of the pathogen and 2) Immunity of the host

**Prodromal Period** Time during which the patient starts to feel something wrong but does not yet experience the actual symptoms of the disease

**Period of illness** Time when the person experience the typical symptoms of the disease

**Convalescent Period** Also termed convalescence is the time when the person recovers from the disease

**Primary Infection** Is the fist infection

**Secondary Infection** Is the second infection that usually follows the first infection

**Mixed infection** Some diseases are caused by the infection by more than one type of organism simultaneously. Such infections are called mixed infections

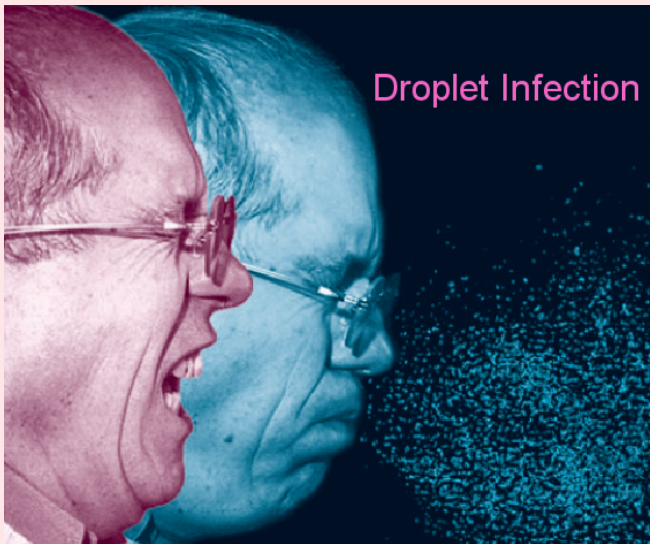
**Latent infection** A latent infection is inactive though remains capable of producing symptoms at periods of decreased immunity. Herpes viruses are examples of pathogens which readily enter a latent stage



during which symptoms disappear, only to reappear at a later time upon the reactivation of the latent infection.

**Localized Infection** Is the infection that is localized to one site, it may spread later to other sites

**Systemic Infection** An infection that has spread through out the body, also called **generalized infection**



## Mode of transmission of infectious diseases

### Prenatal infections

- Prenatal infections occurs from a mother to the fetus through the placental and hence termed transplacental spread
- Examples are syphilis, German measles (rubella), toxoplasmosis and cytomegalovirus
- Fetal infections may results in developmental abnormalities, mental defects and blindness

### Postnatal infections

#### Endogenous infections

- The skin and mucous membrane of many organs harbors beneficial microorganisms known as flora
- If one member of this flora gains access to other sites that should be normally devoid of them, serious infection can result
- Examples are bronchopneumonia, when organisms of the oral and pharyngeal mucosa reach the lungs in debilitated subject. Also, the intestinal organisms are the common cause of peritonitis

### Exogenous infections

- In exogenous infections, organisms from the external environment may reach the tissues of the host causing serious infections
- The following modes of transmission are important:
  1. Ingestion of contaminated food  
As in food poisoning, typhoid fever and bacillary dysentery
  2. Direct skin contact  
As in wound infection and sexually transmitted diseases
  3. Spread by droplet and dust  
Respiratory droplets from coughing or sneezing are the mode of transmission for most upper respiratory infections (“colds”), influenza, mumps, and other diseases

### 4. Vectors

Malaria and other parasitic diseases are often transmitted by insect vectors, intermediate carriers such as mosquitoes

### 5. Hospital (nosocomial) infection

The hospital staff acquire pathogenic organisms from their patients, become carriers and further disseminate these organisms

# Classification of infectious agents

### 1. Metazoa

- Multicellular organisms, complex life cycle, multiple hosts.
- Classified initially according to external morphology e.g.:
  - a) Tapeworms (Cestodes) (platyhelminths)
  - b) Roundworms (nematodes)
  - c) Flatworms (trematodes) (Flukes): e.g. Schistosoma (the agent of bilharziasis) and Fasciola hepatica (the agent of liver fluke).

### 2. Protozoa

- Single cell eukaryotes (i.e. nuclear is enclosed within a nuclear membrane)

## Classification of infectious agents

- Classification according to methods of locomotion and reproduction:
  - a) Flagellates: Trichomonas, Gardia, Leishmania, Trepan-soma.
  - b) Amoeba: e.g. Entamoeba.
  - c) Sporozoa: (have cycles of sexual and asexual reproduction): e.g. Plasmodium malaria, Toxoplasma, Cryptospora, Isospora, Coccidia and Babesia.
  - d) Unclassified: e.g. Pneumocystis (the agent causing pneumocystis carinii pneumonia), sometimes classified as fungus.



### 3. Fungi

- Eukaryotes, rigid continuous cell walls.
- Classified morphologically into:
  - a) **Moulds:** Multicellular, filamentous, spore forming, grow in the form of branching tubules called hyphae (mycelia). Hyphae are further classified into septate and non-septate and branch under varying angles. These morphologic features are essential for the microscopic diagnosis of fungal organisms.
  - b) **Yeasts:** Unicellular, rounded or oval, reproduce by binary fission or budding. Budding in candida albicans can form chains termed as pseudohyphae. Pseudohyphae are yeast cells with a bud that remain attached to the parent cell,

then elongate and bud again. Pseudohyphae which are a hallmark of *C. albicans*, resemble true hyphae, but a slight constriction remains where each bud begins.

- c) **Dimorphic:** Unicellular or multicellular, grow as moulds or yeasts, depending upon the cultural condition. In tissues, in exudates and in medium incubated at 37 °C, dimorphic fungi are yeasts. In culture media incubated at 25 °C, dimorphic fungi are moulds. Conversion to the yeast form appears to be essential for the pathogenicity of dimorphic fungi. Table (??) summarizes the morphologic classification of medically important fungi.

### 4. Bacteria

- Bacteria are commonly identified according to their shape and color when stained by dyes. The most common stain is the Gram stain, which is performed using a deep purple dye followed by decolorization with an acid wash then retaining with a red dye. thick-walled organisms remain purple and are called Gram positive. Thin-walled organisms lose their initial purple in the acid wash and are then stained red by the second stain. They are called Gram negative.
- Unicellular prokaryotes (have no nuclear membrane). They lack mitochondria. Bacteria reproduce by binary fission.
- Classification:
  - a) Filamentous bacteria (higher bacteria): e.g. Actinomyces,

## Classification of infectious agents

Mycobacteria, Corynebacteria and streptomyces.

- b) True bacteria (Eubacteria): Are classified into:
  - i. Cocci: e.g. Streptococcus, Staphylococcus, Neisseria and Veillonella; see classification of streptococci (table??).
  - ii. Bacilli: Which is further classified into:
    - A. Gram-positive spore forming bacilli e.g. Clostridia.
    - B. Gram-positive non-spore forming bacilli e.g. Lactobacilli and Listeria.
    - C. Gram-negative bacilli e.g. Pseudomonas, Coliform bacilli (E. coli), Hemophilus, Brucella and bacteroids.
- c) Vibrios and spirilla: e.g. Vibrio cholerae.

- d) Spirochaetes: Are classified into:
  - i. Borrelia
  - ii. Treponema
  - iii. Leptospira
- e) Mycoplasma: Which lack rigid cell wall.
- f) Rickettsiae and Chlamydia: Which are strict intra-cellular parasites.

### 5. Viruses

- Consist of DNA or RNA (never both) and enclosed in a protein shell known as capsid. Sometimes the nucleocapsid may be enclosed in a lipoprotein envelope largely derived from the host.
- A simple classification of important viruses that are involved in human disease is shown in Table Principle-types-of-viruses.

### 6. Prions

- A tiny proteinaceous particle, having no genetic component, thought to be an infectious agent in bovine spongiform encephalopathy (BSE“mad cow syndrome”).
- The human equivalent disease is Creutzfeldt-Jakob disease, and similar encephalopathies.

## AIDS

**Definition** AIDS is the acquired immunodeficiency syndrome.

In AIDS, there is severe CD4<sup>+</sup> lymphocyte depletion (less than 200 CD4<sup>+</sup> lymphocytes per  $\mu$ l of blood). The normal CD4<sup>+</sup> lymphocyte count is between about 550 and 1000 lymphocytes/ $\mu$ l blood.



## Etiology

- The disease is caused by the retrovirus known as human immunodeficiency virus (HIV), which belong to the family of lentiviruses.
- HIV is a retrovirus that primarily infects components of the human immune system such as CD4<sup>+</sup> T cells, macrophages and dendritic cells. It directly and indirectly destroys CD4<sup>+</sup> T cells.
- Two types of HIV have been characterized: HIV-1 and HIV-2. HIV-1 is the virus that was originally discovered. It is more virulent, more infective, and is the cause of the majority of HIV infections globally.
- HIV-2 is of lower infectivity as compared to HIV-1. Being less prevalent than HIV-1 and is largely confined to West Africa.

**Pathogenesis** The virus binds to the CD4<sup>+</sup> receptor on T lymphocytes and thus produces elimination of the entire population of T4<sup>+</sup> cells (helper T lymphocytes).

## Transmission

1. Sexual
2. Parenteral
  - a) Blood transfusion
  - b) Shared needles in drug addicts
  - c) Accidental needle stick
3. From mother to fetus (vertical transmission)

**Incubation Period** 3 – 7 years

## Clinically

1. An acute viral like illness in 50% of patients
2. Persistent generalized lymphadenopathy with mild illness
3. AIDS related complex consists of: Persistent fever, Weight loss, Diarrhea
4. Full blown AIDS: Appear after 5-7 years and consists of:
  - Opportunistic infections e.g. pneumocystis carinii pneumonia
  - Multiple malignancies
  - Neurologic involvement:
    - Encephalopathy
    - Dementia

## Diagnosis

- Most people infected with HIV develop specific antibodies (i.e. sero-convert) within three to twelve weeks of the initial infection.
- Detection of antibodies can be done by the routine test known as enzyme-linked immunosorbent assay (ELISA) or by Western blot test which is more accurate.
- Confirmation is done by detecting the virus particles by PCR.

- Diagnosis of primary HIV before seroconversion is done by PCR.
- Detection of the antibodies in the oral fluids is possible. The oral test uses a collector specially designed to obtain a sample of transudate through the oral mucosa. Oral fluid testing has been approved as a test that can be done by people at home. A positive oral test is confirmed by a blood test.
- HIV testing is an important means of controlling HIV infection by allowing infected individuals to be treated and as a result, their viral load and potential infectivity are decreased.

## Prevention

### Pre-exposure

- Routine HIV screening is an important mean for controlling HIV Infection by allowing infected individuals to be identified and treated.
- Treating people with HIV whose CD4<sup>+</sup> count  $\geq 350$  cells/ $\mu$ L with antiretrovirals protects 96% of their partners from infection.
- Pre-exposure prophylaxis (PrEP) with a daily dose of the medications tenofovir, with or without emtricitabine, is effective in a number of groups including men who have sex with men, couples where one is HIV positive, and young heterosexuals in Africa.



## Post-exposure

- A course of antiretrovirals administered within 48 to 72 hours after exposure to HIV-positive blood or genital secretions is referred to as post-exposure prophylaxis (PEP).
- The duration of treatment is usually four weeks and is frequently associated with adverse effects such as nausea, fatigue, emotional distress and headaches.
- The use of the single agent zidovudine reduces the risk of a HIV infection five-fold following a needle-stick injury.
- As of 2013, the prevention regimen recommended in the United States consists of three medications – tenofovir, emtricitabine and raltegravir – as this may reduce the risk further.

**Vaccination** There is currently no effective HIV vaccine.

**Prognosis** With full blown AIDS, the 5 year survival is 85%.

## Oral Manifestation

- Moniliasis: in 70% of cases.
- Viral infections: Herpes simplex, Herpes zoster.
- Bacterial infections: gingivitis and periodontitis.
- Deep mycosis: Histoplasmosis, Cryptococcosis.
- Tumors: Kaposi's sarcoma, Non-Hodgkin's lymphoma.
- Hairy leukoplakia: Is a type of leukoplakia occurring in AIDS patients characterized by presence of a keratinous hair like projections from its surface and occurring at the lateral border of tongue.
- Miscellaneous: Multiple aphthous ulceration.

## Medically Important Fungi

Filamentous fungi  
(moulds)

Zygomycetes

Dermatophytes (caustive of all types of tinea except tinea versicolor)

Malassezia furfur (caustive of tinea versicolor)

Aspergillus species

Yeasts

Candida species

Cryptococcus neoformans

## Classification of Streptococci

1. Classification according to culture characteristics
  - a)  $\alpha$  hemolytic: Produces a narrow zone of partial hemolysis and green discoloration around the colony e.g. streptococcus viridans associated with dental caries and endocarditis
  - b)  $\beta$  hemolytic: Produces a wide clear translucent zone of complete hemolysis around the colony e.g. streptococcus pyogenes
  - c)  $\gamma$  hemolytic (non-hemolytic): are usually not pathogenic
2. Classification according to serology (Lancefield classification):

A serologic classification dividing hemolytic streptococci into



**Questions?**