Infection

Infection: The invasion and multiplication of microorganisms such as bacteria, viruses, and parasites that are not normally present within the body.

Infections are caused by infectious agents (pathogens) including:

1- **Bacteria** 2- **Viruses** 3- **Fungi** 4- **Parasites**

The term pathogen: refers to those microbes capable of causing disease, especially if they cause disease in immunocompetent people.

The term opportunistic pathogen: refers to microbes that are capable of causing disease only in immunocompromised people.

- **Virulence:** is a measure of a microbe's ability to cause disease (i.e., a highly virulent microbe requires fewer organisms to cause disease than a less virulent one).
- The virulence of a microbe is determined by **virulence factors,** such as capsules, exotoxins, or endotoxins.
- Whether a person gets an infectious disease or not is determined by the balance between the number and virulence of the microbes and the competency of that person 's host defenses.
- Many infections are **asymptomatic** or **inapparent** because our host defenses have eliminated the microorganism before it could multiply to sufficient numbers to cause the symptoms of disease.
- **The term infection has two meanings:** (1) the **presence of microbes** in the body and (2) the **symptoms of disease**. The presence of microbes in the body does not always result in symptoms of disease .
- **Bacteria cause the symptoms of disease by two main mechanisms:**

1- production of toxins (both exotoxins and endotoxins).
2-induction of inflammation.

- Most bacterial infections are **communicable** (i.e., capable of spreading from person to person), but some are not (e.g., ***botulism*** **and** ***Legionella pneumonia***).

Three epidemiologic terms are often used to describe infections:

1- Endemic: infections are those that occur in a certain geographic area.
2- Epidemics: are those infections that occur at a much higher rate than usual.
3-pandemics are those infections that spread rapidly over large areas of the globe.

Determinants of Bacterial Pathogenesis

1- Transmission

- The modes of transmission of microbes include both **human-tohuman** and **nonhuman-to-human** processes. Nonhuman sources include animals, soil, water, and food.

- Human-to-human transmission can occur either by **direct contact** or indirectly via a **vector** such as an insect, notably ticks or mosquitoes. Animal-to-human transmission can also occur either by direct contact with the animal or indirectly via a vector.

- The main "portals of entry" into the body are the **respiratory tract, gastrointestinal tract, skin,** and **genital tract**.

- Human diseases for which animals are the reservoir are called **zoonoses**.

***2*- Adherence to Cell Surfaces**

- **Pili** are the main mechanism by which bacteria adhere to human cells. They are fibers that extend from the surface of bacteria that **mediate attachment** to specific receptors on cells.

- **Glycocalyx** is a polysaccharide "slime layer" secreted by some strains of bacteria that **mediates strong adherence** to certain structures such as heart valves, prosthetic implants, and catheters.

3- Invasion, Inflammation, & Intracellular Survival

- Invasion of tissue is enhanced by enzymes secreted by bacteria. For example, **hyaluronidase** produced by *Streptococcus pyogenes* degrades hyaluronic acid in the subcutaneous tissue, allowing the organism to spread rapidly.

IgA protease degrades secretory IgA, allowing bacteria to attach to mucous membranes.

- The **capsule** surrounding bacteria is **antiphagocytic** (i.e., it retards the phagocyte from ingesting the organism). Mutant strains of many pathogens that do not produce capsules are nonpathogenic.

- **Inflammation** is an important host defense induced by the presence of bacteria in the body. There are two types of inflammation, **pyogenic and granulomatous,** and bacteria typically elicit one type or the other. **Pyogenic inflammation,** the host defense against pyogenic (pus-producing) bacteria such as *S. pyogenes*, consists of neutrophils (and antibody and complement). **Granulomatous inflammation,** the host defense against intracellular, granuloma-producing bacteria, such as *Mycobacterium tuberculosis*, consists of macrophages and CD4- positive T cells. The type of inflammatory lesion is an important diagnostic criterion.

- Bacteria can evade our host defenses by a process called **intracellular survival** (i.e., bacteria that can live within cells are protected from attack by macrophages and neutrophils). Note that many of these bacteria (e.g., *M. tuberculosis*) are not obligate

intracellular parasites (which can grow only within cells), but rather have the ability to enter and survive inside cells.

4- Toxin producton:

Exotoxins: are **polypeptides secreted** by certain bacteria that alter specific cell functions resulting in the symptoms of disease. They are produced by both grampositive and gram-negative bacteria, whereas endotoxin is found only in gramnegative bacteria.

- Exotoxins are **antigenic** and induce antibodies called **antitoxins**. Exotoxins can be modified to form **toxoids,** which are antigenic but not toxic. Toxoids, such as tetanus toxoid, are used to immunize against disease.

- Many exotoxins have an **A–B subunit** structure in which the A subunit is the **active** (toxic) one and the B subunit is the one that **binds** to the cell membrane and mediates the entry of the A subunit into the cell.

Exotoxins have different mechanisms of action and different targets within the cell and therefore cause a variety of diseases with characteristic symptoms. (See Tables 7–9 and 7–10.) Several exotoxins are enzymes that attach ADP-ribose to a cell component (**ADP-ribosylation**). Some exotoxins act by **proteolytic cleavage** of a cell component, whereas others act as **superantigens,** causing the overproduction of cytokines.

Endotoxins: are **lipopolysaccharides (LPS)** located in the outer membrane only of gram-negative bacteria. They are not secreted by bacteria.

- **Lipid A** is the toxic component of LPS.

The biologic effects of endotoxin include the following:

(1) **Fever** due to the release by macrophages of interleukin-1 (endogenous pyrogen) and interleukin-6, which act on the hypothalamic temperature-regulatory center.

(2) **Hypotension,** shock, and impaired perfusion of essential organs owing to nitric oxide–induced vasodilation, TNF-induced increased capillary permeability, bradykinin-induced vasodilation, and increased capillary permeability.

(3) **DIC** due to activation of the coagulation cascade, resulting in thrombosis, a petechial or purpuric rash, and tissue ischemia, leading to failure of vital organs.

(4) Activation of the alternative pathway of the complement cascade, resulting in inflammation and tissue damage. C5a is potent chemokine that attracts neutrophils to the site of infection.

(5) Activation of macrophages, increasing their phagocytic ability, and activation of many clones of B lymphocytes, increasing antibody production. (Endotoxin is a polyclonal activator of B cells, but not T cells.)

Typical Stages of an Infectious Disease:

There are often four stages:

1- **The incubation period:** is the time between the moment the person is exposed to the microbe (or toxin) and the appearance of symptoms.

2- The prodrome period: is the time during which nonspecific symptoms occur.

3- The specific-illness period: is the time during which the characteristic features of the disease occur.

4- The recovery period: is the time during which symptoms resolve and health is restored.

- After the recovery period, some people become **chronic carriers** of the organism and in others **latent** infections develop.
- Some people have **subclinical** infections during which they remain asymptomatic.

Q1- Define of the following?

Infection , The term pathogen , opportunistic pathogen , Virulence

Q2- Choose the correct answer ?

1- The microbes that are capable of causing disease only in immunocompromised people.

A- Infection

B- opportunistic pathogen

C- Virulence

2- The virulence of a microbe is determined by virulence factors, such as

A- capsules

B- exotoxinsor endotoxins.

C- All above

3- The infections that spread rapidly over large areas of the globe:

A-Endemic

B- Epidemics

C- pandemics

4- The polypeptides secreted by certain bacteria that alter specific cell functions resulting in the symptoms of disease is called.

A- Endotoxin

B- Exotoxins

C- lipopolysaccharides (LPS)

Q3- There are three epidemiologic terms are often used to describe infections explain them?

Q4- What is the biologic effects of endotoxin ?