Lecture -1-

Introduction to Immunity

LEARNING OBJECTIVES

After reading and studying this lecture, you shouldbe able to:

- Describe innate immunity, artificial active immunity, natural passive immunity, herd immunity

DEFINITION

Immunology is an emerging branch of medical science that deals with the studies of **immune system** like the organs, cells, structure, function, response against antigens, and disorders.

The immune system is a collection of organs, cells, chemicals, processes, and mechanisms that function to protect the body (give **immunity**) from foreign antigens, such as microbes, cancer cells, and toxins.

Immunity [Latin *immunis*] refers to the resistance exhibited by the host towards injurycaused by microorganisms and their products.

Introduction:

The main function of the immune system is to **prevent or limit infections** by microorganisms such as bacteria, viruses, fungi, and parasites, such as protozoa and worms.

The first line of defense against microorganisms is the **intact skin and mucous membranes.** If microorganisms breach this line and enter the body, there was the second line **innate arm** of the immune system is available to destroy the invaders. They can function immediately upon entry of the microorganism but it is not specific if fail in protection the third line highly specific protection is provided by the **adaptive (acquired)** arm of the immune system, but it takes several days for this arm to become fully functional. The two components of the adaptive arm are **cell mediated immunity** and **antibody-mediated (humoral) immunity.**

CLASSIFICATION

Immunity against infectious diseases is of differenttypes:

1. **Innate (or natural) immunity**
2. **Acquired (or adaptive) immunity**

1. Innate or Natural Immunity

It is the resistance to infections which an individual possesses by virtue of his genetic or constitutional make up. Repeated exposure to a pathogen does not enhance the innate immune system.

Innate immunity may be considered at the level of
species, race or individual.

a. Species Immunity

Resistance or susceptibility (lack of resistance) to infections can vary from one species of animal to other. It refers to the total or relative refractoriness to a pathogen, shown by all members of a species.

Example

All human beings are totally unsusceptible to plant pathogens and to many animal pathogens, such as rinderplast or distemper.

b. Racial Immunity

Within a species, different races may show differences in susceptibility to infections. This is known as *racial immunity*. Such racial differences are known to be *genetic in origin*, and by selection and inbreeding.

Examples

a. *High resistance of Algerian sheep to anthrax* is the classic example.
b. *Susceptibility to tuberculosis:* The people of Negroid origin in the USA are more susceptible than the Caucasians to tuberculosis.
c. *Genetic resistance to* ***Plasmodium falciparum*** *malaria:* It is seen in some parts of Africa and the Mediterranean coast and is attributed to the hereditary abnormality of the red blood cells (sickling) prevalent in the area.

c. Individual Immunity

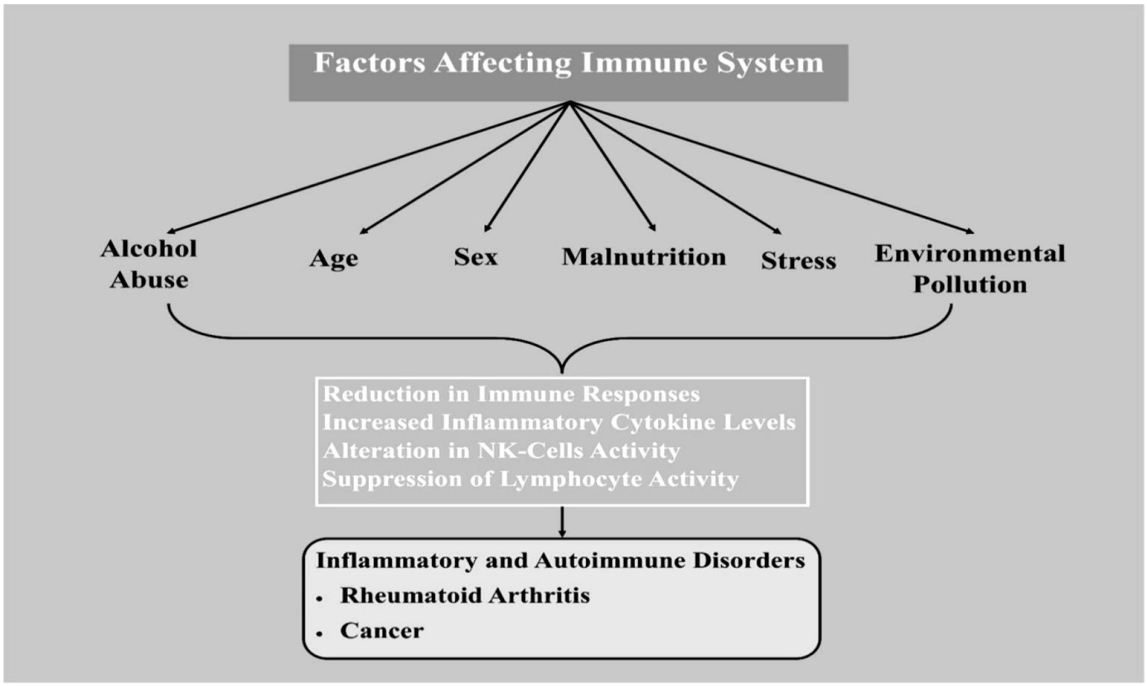
The difference in innate immunity exhibited by different individuals in a race is known as **individual immunity** Individual immunity is determined by various factors such as health status, nutritional status, previous illness, personal hygiene, and genetic differences.

Example

Individuals with a genetic deficiency of glucose-6 phosphate dehydrogenase are resistant to Malaria.

Factors influencing the level of immunity

1. **Age**
   - Fetus in utero: The two extremes of life carry higher susceptibility to infectious diseases as compared with adults. The higher susceptibility of the young appears to associate with immaturity of immune system.
   - In the elderly, besides a general waning of the activities of the immune system, physical abnormalities (e.g. prostatic enlargement leading to stasis of urine) or long-term exposure to environmental factors (e.g. smoking) are common causes of increased susceptibility to infection.
2. **Hormonal Influences and Sex**
   - Endocrine disorders: There is an increased susceptibility to infection in endocrine disorders, such as diabetes mellitus, hypothyroidism and adrenal dysfunction (increased corticoids secretion).
   - Sex: In general, incidence and death rate from infectious diseases are greater in males than in females. On the other hand, autoimmune diseases are more common in females.
3. **Nutrition:** In general, both humoral and cell mediated immune processes are reduced in **malnutrition**. Experimental evidence in animals has shown that inadequate diet may be correlated with increased susceptibility of a variety of bacterial diseases, associated with decreased phagocytic activity and leukopenia.
4. **Stress:** A growing body of evidence has demonstrated an inverse relation between stress and immune function. The end result is an increased susceptibility to infection.



MECHANISMS OF INNATE IMMUNITY

Mechanisms of innate immunity work collectively to inhibit the entry of a pathogen or eliminate it, preventing infection. Alternatively, innate immunity holds an infection in check until the slower adaptive immune response can be mounted. There were msany barriors hold the pathogen include:

1. Mechanical Barriers and Surface Secretions

Also called **physical or anatomical barriers**

A. Skin

B. Mucous membranes.

A. Skin

The intact skin and the mucous membranes provide mechanical barriers that prevent the entrance of most microbial species. Even though the structure of the skin itself gives a great deal of protection, considerably more important are **the fatty acids** secreted by the sebaceous glands and the **propionic acid** by the normal flora of the skin. Secretions from the sebaceous glands contain both saturated and unsaturated fatty acids that kill many bacteria and fungi.

B. Mucous Membrane

A major protective component of mucous membranes is the *mucus* itself in addition, other characteristics specific to each anatomic site.

a. Mouth or Oral Cavity

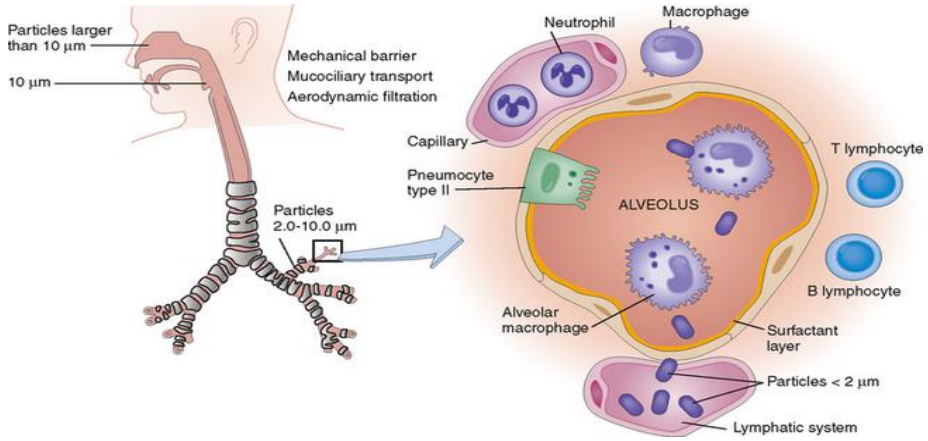
The mouth or oral cavity is protected by the **flow of saliva** that physically carries microorganisms away from the cell surfaces and also contains the **lysozyme**, which destroys bacterial cell walls and antibodies.

b. Gastrointestinal Tract

1. ***Stomach:*** **The low pH** and **proteolytic enzymes** of the stomach help keep the number of micro-organisms low. The pH becomes progressively alkaline from the duodenum to the ileum.
2. ***Small intestine:*** In the *small intestine*, protection is provided by the presence of **bile salts.**
3. ***Ileum:*** *The ileum* contains a **rich and varied flora** and in the large intestine, the bulk of the contents is composed of bacteria.

c. Upper Respiratory Tract

1. **Architecture of the nose:** In the upper respiratory tract, **nasal hairs** keep out large airborne particles that may contain microorganisms.
2. **Sticky mucus***:* The sticky mucus covering the respiratory tract acts as a **trapping mechanism** for inhaled particles.
3. **Ciliary motion***:* Ciliary motion **transports the trapped organisms back** up the respiratory tract to the external openings.
4. **Cough reflex***:* Cough reflex is an important defense mechanism of the respiratory tract.
5. **Mucopolysaccharides***:* capable of combining with influenza and certain other viruses.



d. Genitourinary Tract

1. **Normal flow of urine***: The normal flow of urine* flushes the urinary system, carrying microorganisms away from the body.
2. **Sperms: Spermine** and **zinc** present in the semen carry out antibacterial activity.
3. **Acidity of the adult vagina:** The **low pH (acidity)** of the adult vagina, due to fermentation of glycogen in the epithelial cells by the resident aciduric bacilli, provides an inhospitable environment for colonization by pathogens. A thick mucus plug in the cervical opening is a substantial barrier.

e. Conjunctiva

Lachrymal fluid: Conjunctiva is kept moist by the continuous flushing action of **tears** (lachrymal fluid). Tears contain large amounts of **lysozyme**, **lactoferrin**, and **sIgA** and thus provide protection.

2. Antibacterial Substances in Blood and Tissues

Also called **physiological or chemical barriers**

Many microbial substances are present in the tissue and body fluids. These are non-specific. The **complement system** possesses bactericidal activity and plays an important role in the destruction of pathogenic bacteria that invade the blood and tissues.

Other Substances

(i) *beta lysin*;

(ii) *basic polypeptides*, such as **leukins** extracted from leucocytes and **plakins** from platelets;

(iii) *acidic substances*, such as **lactic acid** found in muscle tissue and in the inflammatory zones; and *lactoperoxidase in milk.*

The production of **interferon** is a method of defense against viral infections.

3. Microbial Antagonisms

The skin and mucous surfaces have resident **bacterial flora** which **prevents colonization** by pathogens. Invasion by extraneous microbes may be due to alteration of normal resident flora, causing serious diseases, such as staphylococcal or **clostridial enterocolitis** or **candidiasis** following oral antibiotics.

4. Cellular Factors in Innate Immunity

Also called: **phagocytic barriers**

Natural defense against the invasion of blood and tissues by microorganisms and other foreign particles is mediated to a large extent by **phagocytic cells** which **ingest** and **destroy** them. **Phagocytic cells**, originally discovered by Metchnikoff (1883), were classified by him into **microphages** (polymorphonuclear leucocytes) and **macrophages**.

Macrophages: *Macrophages* consist of histiocytes which are the wandering **ameboid cells** seen in tissues, fixed reticuloendothelial cells and monocytes of blood.

5. Inflammation

If the surface defenses, physiologic defenses and phagocytic defenses of the body are breached by a pathogen, **inflammation** can result, which is an important, nonspecific defense mechanism. Sequences of events in acute inflammation in response to an injury will be:

1. vasodilation,
2. increased vascular permeability;
3. emigration of leucocytes;
4. chemotaxis;
5. phagocytosis.

6. Fever

Following infection, **a rise in temperature** is a natural defense mechanism. It not merely helps to accelerate the physiological processes, but may, in some cases, actually destroy the infecting pathogens. Fever aids recovery from viral infections by stimulating the production of interferon.

7. Acute Phase Proteins

A sudden increase in the plasma concentration of certain proteins collectively termed '***acute phase proteins'*** occurs as a result of infection or tissue injury. These include:

1. *C-reactive protein (CRP),*
2. *mannose-binding protein,*
3. *alpha-I-acid glycoprotein,*
4. *serum amyloid P component,*

The alternative pathway of complement is activated by CRP and some other acute phase proteins. They are believed to enhance host resistance, prevent tissue injury and promote repair of inflammatory lesions.