**Lec. 2**

**IMMUNOLOGY**

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**Applications of Immunology:**

At present the application of immunology is widespread. Following are some of the examples of its application.

**1. Diagnosis of diseases**- by detecting antibody or antigen, it helps in diagnosis of many diseases, which includes infectious diseases, autoimmune disease and neoplasms. Some common tests are ASO, WIDAL, CA 15-3, and VDRL.

**2. Prevention and treatment of diseases**- active and passive immunization against many diseases by vaccines and immunoglobulins.

**3. Blood transfusion serology** – grouping, typing and cross matching in transfusion.

**Branches of immunology**

1. **Serology**- Study of immune reactions mediated by antibodies of immunoglobulin's present in the serum (*in vitro*) or reaction between antigen and antibody outside the body (in the lab) *in vitro*. The term serology usually refers to the diagnostic identification of antibodies in the serum. Serological tests may be performed for diagnostic purpose not protection or treatment when an infection is suspected. There are several serological techniques including: -

**a- Agglutination test - b- Precipitation test - c- Complement fixation test - d- Immunofluorescence test - e- Radio immunoassay test.**

Serum contains proteins known as antibodies. (For every antigen there exists a specific antibody). A serum that contains antibodies is known as an antiserum. (It reacts against antigens- only the specific one it is named for).

**2- Immunobiology** - Related to biological functions of the cells and tissue component of the immune system. Immune components are divided into: -

**a- Humoral factor** (Immunoglobulins. Complement system, cytokine)

**b- Cellular factor** (Phagocytes and Lymphocytes).

**3- Immunochemistry**-Deals with the chemical nature or structure of antigen and antibody and their interactions.

**4- Immunogenetics** - Study of immunoglobulin genes and the genetic basis of immune response.

**Host defense mechanisms -** Ways in which the body protects itself from pathogen - can be thought of as an army consisting of three lines of defense. If the enemy (the pathogen) breaks through the first line of defense, it will encounter and, it is hoped, be stopped by the second line of defense. If the enemy manages to break through and escape the first two lines of defense, there is a third line of defense ready to attack it.

The first two lines of defense are **nonspecific**; these are ways in which the body attempts to destroy all types of substances that are foreign to it, including pathogens. The third line of defense, the **immune response**, is very specific. In the third line of defense (or **specific host defense mechanisms**), special proteins called **antibodies** are usually produced in the body in response to the presence of foreign substances. These foreign substances are called **antigens** because they stimulate the production of specific antibodies; they are” antibody generation “substances. The antibodies that are produced are very specific, in that they can only recognize and attach to the antigen that stimulated their production.

**Antigen** means any substance that can evoke an immune response (production of antibody). Vaccines must be antigen to be effective).

The reaction of the cells and molecules of the immune system to infectious microbes is the **immune response**. The usual outcome of immune response is beneficial, but it may cause harmful effects such as autoimmunity.

The human **immune system** includes cells (Neutrophil, Macrophage, Lymphocyte), tissue and molecules (antibody and complement), organs (Thymus gland, Bone marrow, Spleen, Lymph node) and mediators which are inactivating the microorganisms and neutralizing the toxins., also the immune system is capable of remembering previous encounters with antigen.

**Host defense mechanisms** consist of **innate immunity** which mediates the initial protection against infections and adaptive **immunity** which develops more slowly and mediates the later, even more effective, defense against infection.

**A -Innate immunity (also called natural or non-specific or native immunity)** refers to the fact that: -

1- this type of host defense is always present in healthy individuals,

2- act from the start of an infection and

3- present from birth, and

4- prepared to block the entry of microbes and to

5- Rapidly eliminated microbes that do succeed in entering host tissues.

6- Innate immunity protect against microorganisms in general (without memory),

7- Found in all multicellular organisms.

8- Defect in this type of immunity is very rare and almost lethal if occur.

This kind of defense can be classified into two major categories: -

1- The first line of defense includes -

a- any barrier (mechanical or physical barriers) that block invasion at the portal of entry - or – block the entry of microorganisms such as skin.

b- Bactericidal substances of the tissues and body fluids such as lysozyme, complement system or proteins.

2- The second line of defense includes protective cells and fluids that include phagocytosis and inflammation such as neutrophil, macrophage. It acts rapidly at both the local and systemic levels when the first line of defense failed.

**B- Adaptive immunity (also called specific or acquired immunity)** is the type of host defense that is stimulated by microbes that invade tissue, it adapts to the presence of microbial invaders.

1- The acquired immunity is induced by exposure to foreign substance,

2- And is absent at the time of first exposure to a pathogen, but develops after being exposed to the pathogen.

3- It is present only in vertebrate

4- And the resistance increases during subsequent exposure to the same pathogen.

5- It is specific to a particular microbe (e.g the acquired immune responses induced against the bacteria Staphylococcus aureus will act against Staph. aureus only, but not against any other microbe), while the innate immunity responses are not specific and these responses act against any microbe entering into the host.

6- The induction of acquired immune responses against a microbe takes 5 to 6 days after the first entry of the microbe into the host.

**Properties of acquired Immunity**

* **Specificity** – T & B cells have specific receptors that will allow them to only recognize & target a specific Ag; this process is known as “antigen recognition”
* **Memory** – after initial exposure, long term acquired immunity occurs through the production of memory cells; secondary exposure results in stronger faster response to previously recognized Ag
* **Tolerance** – immune cells recognize self-antigens & “tolerate” them, only going after foreign (non-self) Ag’s.

The acquired immune responses are executed by two pathways based on the components of the immune system involved: -

1. **Humoral immunity-** It is mediated by molecules produced by B- lymphocytes called antibodies that are responsible for specific recognition and elimination of foreign substances called antigen. Humoral immunity is effective against extracellular pathogens and their products. Antibodies are secreted into circulation and mucosal fluids, and they neutralize and eliminate microbes and microbial toxins that are present in the blood and in the lumens of mucosal organs such as in the gastrointestinal and respiratory tracts. Antibodies are able to recognize many different types of microbial molecules, including proteins, carbohydrates and lipids.
2. **Cellular immunity –**It is mediated by T- lymphocytes. Cellular immunity plays a major role in the elimination of intracellular pathogens like virus, intracellular bacteria by causing lysis of the infected cells or intracellular destruction of the microorganism. T-cells recognize only microbial protein antigens.



Acquired immunity is classified on the basis of how it is acquired: -

1. **Active acquired immunity**
2. **Passive acquired immunity**

**Active immunity** – Is the resistance induced after contact with foreign antigens, e.g., bacteria. When this contact occurs by clinical infections, it is called active natural immunity and when it is induced by immunization through live or killed infectious agents or their products e.g., toxoids, it is called active artificial immunity. In both types, the host actively produces antibodies and /or T-cell mediated response to confer immunity.

**Passive immunity**– development of immunity due to transfer of “pre-made” antibodies performed in another host.

* naturally acquired passive immunity – Ab’s transferred from mom à baby across placenta or in breast-milk
* induced (artificial) passive immunity – administration of Ab’s to fight disease after exposure to pathogen.

