Introduction to Basic Concepts of the Immune System-1

What is immunology?
Immunology is the study of immune system.
• The immune system is a versatile defence system that has evolved to protect animals from invading pathogenic microbes and cancer.
• Immune system protects the animal by recognizing diverse pathogenic conditions and eliminating the causative agents.
• Immune system is made up of many cells and molecules that act in a dynamic network which rivals nervous system in complexity.

Edward Jenner : He was an English physician. He observed that milk maids who suffered from cowpox became immune to later infection of smallpox.
• He reasoned that if fluid from cowpox pustle is transferred into other people i.e., inoculate them, these inoculated people shall be protected from smallpox.
• He inoculated an 8 years old boy with fluid from cowpox pustule and later infected him with smallpox. The child did not develop smallpox.
• Thus, Edward Jenner had made the child immune to smallpox.
• Edward Jenner is called Father of immunology.

Louis Pasteur : He was a French scientist.
• He coined the term vaccine.
• He developed the concept and method of attenuating a pathogen.
• He developed vaccines against cholera in chicken, anthrax in sheep and rabies in humans.

Immunity: When an organism is fully protected against invading pathogen and internal abnormalities of body by various effects of immune system, the state is called immunity.

This state of immunity is reached and maintained by two aspects of immune system. These are called types of immunity. These are

I. Innate immunity
II. Adaptive immunity

I. Innate immunity: Its features are :
• It makes up the first line of defence.
• It can differentiate between self (host) and non-self (pathogen). Thus, responds against foreign or non-self.
• It is quick in response and there is no lag phase between entry of pathogen and mounting an immune response against it.
• It is less specific and is not specific for a particular pathogen.
• By less specific we mean It is specific for a class of pathogen i.e. for bacteria, virus, protozoa etc. But not for specific pathogen in each class.
• It recognizes the pathogen by recognizing the molecules peculiar to frequently encountered pathogens.

Innate immunity acts as first line of defence by various barriers presented to the pathogen. These are elaborated below.

1. Anatomic barriers: It includes skin and mucous membranes.
Skin
• Epithelium cells of skin are very tightly packed. This blocks pathogen entry via loose intercellular spaces.

• Epidermis being dead layer acts as mechanical blockade to retard pathogen entry.
• Acidic environment (pH 3-5) retards growth of microbes.

Mucous membranes
• Normal microbial flora competes with pathogens for attachment sites and nutrients.
• Mucous entraps foreign microbes and cilia propel microbes out of body. This process is also done by peristalsis in the gut.

2. Physiologic barriers: It includes temperature, low pH and chemical mediators.
Temperature: Normal body temperature inhibits growth of many microbes. Fever inhibits growth of many pathogens.
Low pH: Acidity of stomach contents kills most ingested microbes.
Chemical mediators:
• Lysozyme cleaves bacterial cell wall.
• Interferons induce antiviral state in uninfected cells.
• Complement system lyses microbes or facilitates their phagocytic elimination.
• Collectin proteins disrupt cell wall of pathogen.

3. Phagocytic barriers: It is also called endocytic barrier. Specilized cells i.e., monocytes, neutrophils and macrophages internalize (phagocyte), kill and digest pathogens.

4. Inflammatory barriers: Tissue damage due to wound or infection initiates inflammatory response that acts to contain the infection and eliminate the pathogen. Inflammation is discussed later in this chapter.

II. Adaptive immunity: Its features are:
It is specific for a particular pathogen. The degree of specificity is very high.

E.g.
(a) It can distinguish between bacteria for typhoid and bacteria for dysentry.
(b) It can also differentiate among different strains of each bacteria.

• It is slow in response and there is a lag phase (delay) between entry of pathogen and mounting an immune response specific to the pathogen.

• It is specific because it generates immunological memory against each pathogen it encounters. Thus, it can specifically recognize the same pathogen on next infection and mount an immune response specific for pathogen alone.

It identifies the pathogen by a complex process of antigen presentation by specialized molecules.

• It can differentiate self (host) from non self (foreign particle or pathogen).

Thus, we can identify four features of adaptive immunity.
1. Antigen specificity
2. Diversity
3. Immunologic memory
4. Self/non-self-recognition

Types of adaptive immunity: Adaptive immunity has two basic types:
1. **Natural:** It is when natural events lead to development of adaptive immunity. It has two types:

• **Passive:** In this, preformed antibodies pass from mother to foetus. They provide protection to foetus

against a specific pathogen though foetus has not been infected by pathogen.
E.g. Pregnant mother vaccinated for tetanus. Antibodies pass into foetus and protect it against tetnaus at birth.

• **Active:** In this, an individual infected with a particular pathogen develops an immunological memory. This activates immune system when same pathogen again attacks the body and thus, protects it.
E.g. A person infected with smallpox once remains immune to smallpox in future.

2. Artificial: In this, medical intervention utilizes adaptive immune system to provide protection. It has two types:
• **Passive:** In this, preformed antibodies against a particular pathogen are injected to provide protection.
E.g. Anti-tetanus is antibody against inactivated tetanus toxin.

• **Active:** In this, weakened or dead pathogen is injected into body. They activate the adaptive immune system and cause the formation of memory against them but cannot cause disease. When actual pathogen attacks the body it is detected due to presence of memory and then eliminated.
E.g.
Injectable polio vaccine contains dead polio virus.
This is the strategy behind most vaccinations.

Cells involved in immune response: Cells that activate and achieve the tasks of immune system are many.

1. Innate immunity: The cells involved are neutrophils, monocytes, macrophages, eosinophils and basophils, NK (Natural killer) cells.
2. Adaptive immunity: The cells involved are B-cells, T-cells and antigen presenting cells (APCs) and target cells. B-cells and T-cells.