Introduction:

Immunology: is the study of all biological, chemical, and physical events surrounding the function of the immune system (to react) against infectious microbes (bacteria- viruses- fungi- parasites) and non-infectious foreign substances to eliminate them to protect the body. The term **immunity** means the state of protection from infectious disease involving specific and non-specific elements. **The immune system** is a complex collection of fluids and cells that penetrate every organ, tissue space, fluid compartment, and vascular network of the body.

Our environment contains a great variety of infections microbes. These can cause disease, and if they multiply unchecked, they will eventually kill their host. So, the primary function of the immune system is to eliminate infectious agents and to minimize the damage they cause.

The protection of our organism against infectious agents involves many different mechanisms: some nonspecific (i.e., generically applicable to many different pathogenic organisms) and others specific (i.e., their protective effect is directed to one single organism).

Immune response:

Any immune response involves, firstly, recognition of the pathogen or other foreign material, and secondly a reaction to eliminate it. The different types of the immune response fall into two categories:

Innate (non-specific) immune response which is the first line of defense against infection and it does not alter on repeated exposure to a given infectious agent and it react in the same manner with each pathogen.

Adaptive (specific) immune response: it is a highly specific for a particular pathogen and the immune response improves with each successive encounter with the same antigen. Thus, the two-key feature of the adaptive immune response are the specificity and the memory.

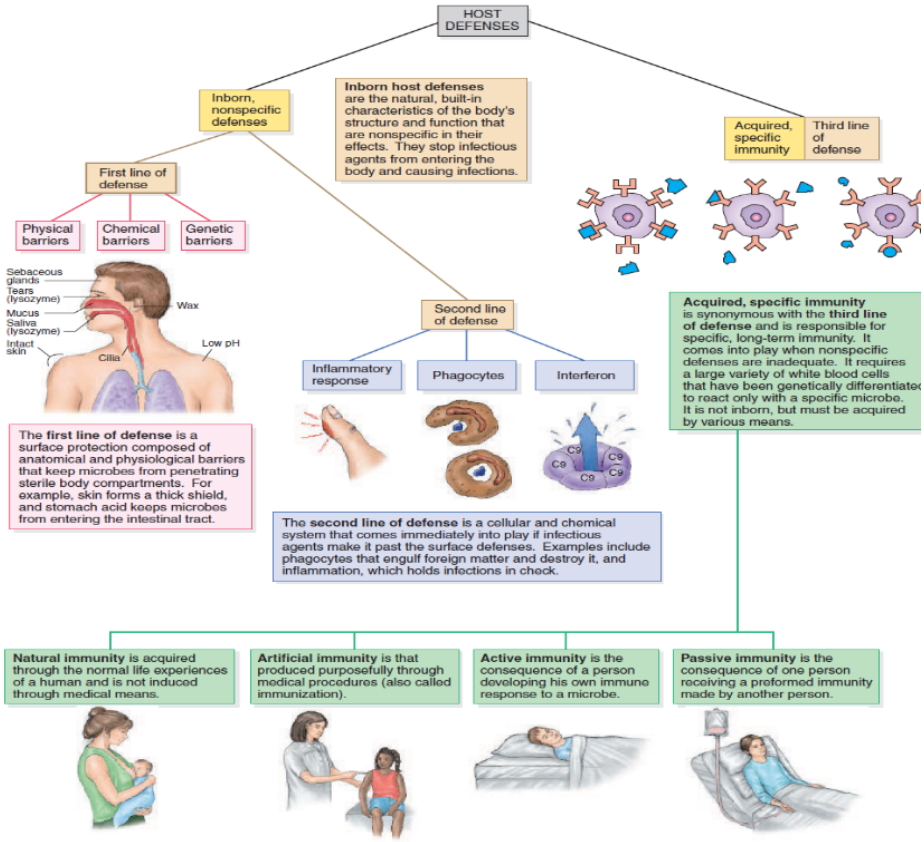
The table below shows the main differences between innate and adaptive immune responses.

N0.	Characteristics	Innate Immunity	Adaptive immunity
1	Presence	Innate immunity is something already present in the body.	Adaptive immunity is created in response to exposure to a foreign substance.
2	Specificity	Non-Specific	Specific
3	Response	Fights any foreign invader.	Fight only specific infection.
4	Response	Rapid	Slow (1-2 weeks)
5	Potency	Limited and Lower potency.	High potency
6	Time span	Once activated against a specific type of antigen, the immunity remains throughout the life.	The span of developed immunity can be lifelong or short.
7	Inheritance	Innate type of immunity is generally inherited from parents and passed to offspring.	Adaptive immunity is not passed from the parents to offspring; hence it cannot be inherited.
8	Memory	Cannot react with equal potency upon repeated exposure to the same pathogen.	Adaptive system can remember the specific pathogens which have encountered before.
9	Presence	Present at birth	Develops during a person's lifetime and can be short-lived.
10	Used Against	For microbes	Microbes and non-microbial substances called antigens
11	Memory	No memory	Long term memory
12	Complement system activation	Alternative and lectin pathways	Classical pathway
13	Anatomic and physiological barriers	Skin, Mucous membranes, Temp, pH, chemicals, etc.	Lymph nodes, spleen, mucosal associated lymphoid tissue.
14	Composition	The innate immune system is composed of physical and chemical barriers, phagocytic leukocytes,	Adaptive immune system is composed of B cells and T cells.

		dendritic cells, natural killer cells, and plasma proteins.	
15	Example	White blood cells fighting bacteria, causing redness and swelling, when you have a cut.	Chickenpox vaccination so that we don't get chickenpox because adaptive immunity system has remembered the foreign body.

Defenses development and specificity

There are three lines of defenses against any foreign bodies: **1st line** such as chemical, physical and genetic barriers, **second line** defenses include phagocytosis, inflammation, complement system, and interferon and **third line** defenses: acquired immunity.



First line defense:

The natural, inborn, nonspecific defenses that can be divided into physical, chemical, and genetic barriers that impede the entry of microbes at the site of first contact.

Barriers at the Body's Surface

In the skin

- (stratum corneum) of the skin is composed of epithelial cells that have become compacted, cemented together, and impregnated with an insoluble protein, **keratin**.
- Sebaceous secretions exert an antimicrobial effect
- The high lactic acid and electrolyte concentrations of sweat and the skin's acidic pH and fatty acid content

Eye

- Blinking and (*lacrimation)* flush the eye's surface with tears and rid it of irritants.
- Specialized glands such as the **meibomian** glands of the eyelids lubricate the **conjunctiva** with an antimicrobial secretion (**lysozyme)**
- **Lysozyme:** *an enzyme that hydrolyzes the peptidoglycan in the cell wall of bacteria*.

The digestive tract

- The mucocutaneous membranes of the free surface of digestive tract, in addition to saliva secretion (lysozyme) impedes the entry of bacteria
- The constant flow of saliva helps carry microbes into the harsh conditions of the stomach.
- The HCl in the stomach renders protection against many pathogens that are swallowed.
- the intestine's digestive juices and bile are potentially destructive to microbes.
- Vomiting and defecation also evacuate noxious substances or microorganisms from the body.

Respiratory tract effective adaptations

- Nasal hair traps larger particles.
- Flushing action and copious flow of mucus and fluids that occurs in allergy and colds.
- The ciliated epithelium (called the ciliary escalator) in the respiratory tree a conveys foreign particles entrapped in mucus toward the pharynx to be removed
- Irritation of the nasal passage reflexly initiates a sneeze, which expels a large volume of air at high velocity.
- Similarly, the acute sensitivity of the bronchi, trachea, and larynx to foreign matter triggers coughing, which ejects irritants.

The genitourinary tract

- The mucocutaneous membranes of the free surface of genitourinary tract
- periodic bladder emptying and continuous trickle of urine through the ureters that flushes the urethra.
- Semen contains an antimicrobial chemical that inhibits bacteria, and the vagina has a protective acidic pH maintained by normal flora.

Non-anatomical barriers like resident flora by creating an unfavorable environment for pathogens like pH in intestine and vagina.

Genetic Defenses

Some pathogens have great specificity to infect one host species that they are incapable of infecting other species (e.g. Humans can't acquire distemper from cats, and cats can't get mumps from humans). Genetic differences insusceptibility can also exist within members of one species. Humans carrying a gene or genes for sickle-cell anemia are resistant to malaria. why?

Q) Why the first line does not consider a true immune response?

because it does not involve recognition of a specific foreign substance but is very general in action.

The importance of first line of defenses is manifested by examples:

1- Patients with severe skin damage due to burns are extremely susceptible to infections

2- With blockages in the salivary glands, tear ducts, intestine, and urinary tract are also at greater risk for infection.

Q) Why the first line of defense alone is not sufficient to protect against infection?

Because many pathogens find a way to circumvent the barriers by using their virulence factors.

Immune terminology

pathogen: an infectious agent that causes disease

Infectious disease: occurs when microorganism succeeds in evading host defenses to establish a local site of infection and replication.

Foreign material: Is something that can be recognized or distinguished as not being a natural part of an organism's body

Surveillance: Is the process of scouting the tissues for foreign molecules and other possibly threatening particles

Recognition: Is the process of evaluating and differentiating of the molecules that detect by white blood cells surveillance.

Markers: Are molecules that protrude from the cell surface like minuscule signposts announcing that cell or molecule's identity.

Specificity: A unique configuration that dictates the kinds of immune responses it can elicit.

Receptors: Molecules that bind specifically with complementary molecules in ways that signal, communicate, and trigger reactions inside the cell.

Antigen: A foreign, non-self-molecule, often a surface marker, that evokes a specific immune response.