Innate Immunity

Innate immunity: is the resistance that an individual possesses by birth.

Innate immunity may be classified as

(*a*) individual immunity (*b*) racial immunity (*c*) species immunity**.**

Factors influencing innate immunity

The factors that may influence innate immunity of the host include age and nutritional status of the host.

1- Age: Extremes of age make an individual highly susceptible to various infections. This is explained in part by the immature immune system in very young children and waning immunity in older individuals. The fetus-in-utero is usually protected from maternal infections by the placental barrier. However, human immunodeficiency virus (HIV), rubella virus, cytomegalovirus, and *Toxoplasma gondii* cross the placental barrier and cause congenital infections.

Nutritional status: Nutritional status of the host plays an important role in innate immunity. Both humoral and cell mediated immunities are lowered in malnutrition. Examples are:

■ Neutrophil activity is reduced, interferon response is decreased, and C3 and factor B of the complement are decreased in protein–calorie malnutrition.

■ Deficiency of vitamin A, vitamin C, and folic acid makes an individual highly susceptible to infection by many microbial pathogens.

Hormonal levels: Individuals with certain hormonal disorders become increasingly susceptible to infection.

Mechanisms of innate immunity

Innate immunity of the host performs two most important functions: it kills invading microbes and it activates acquired (adaptive) immune processes.

Innate immunity unlike adaptive immunity, however, does not have any memory and does not improve after re-exposure to the same microorganism.

The innate immunity is primarily dependent on four types of defensive barriers:

(*a*) anatomic barriers (*b*) physiologic barriers

(*c*) phagocytosis (*d*) inflammatory responses.

A- Anatomic barriers: Anatomic barriers include skin and mucous membrane.

They are the most important components of innate immunity. They act as mechanical barriers and prevent entry of microorganisms into the body.

1-Skin: The intact skin prevents entry of microorganisms. For example, breaks in the skin due to scratches, wounds, or abrasion cause infection. Bites of insects harboring pathogenic organisms (e.g., mosquitoes, mites, ticks, fleas, and sandflies), introduce the pathogens into the body and transmit the infection.

Skin secretes sebum, which prevents growth of many microorganisms. The sebum consists of lactic acid and fatty acids that maintain the pH of skin between 3 and 5, and this pH inhibits the growth of most microorganisms.

2-Mucous membranes: mucous membrane form a large part of outer covering of gastrointestinal, respiratory, genitourinary, and many other tracts of human host.

A number of nonspecific defense mechanisms act to prevent entry of microorganisms through mucous membrane.

■ Saliva, tears, and mucous secretions tend to wash away potential invading microorganisms, thereby preventing their attachment to the initial site of infections. These secretions also contain antibacterial or antiviral substances that kill these pathogens.

■ Mucus is a viscous fluid secreted by the epithelial cells of mucous membranes that entraps invading microorganisms.

■ In lower respiratory tract, mucous membrane is covered by cilia, the hair-like protrusions of the epithelial cell membranes.

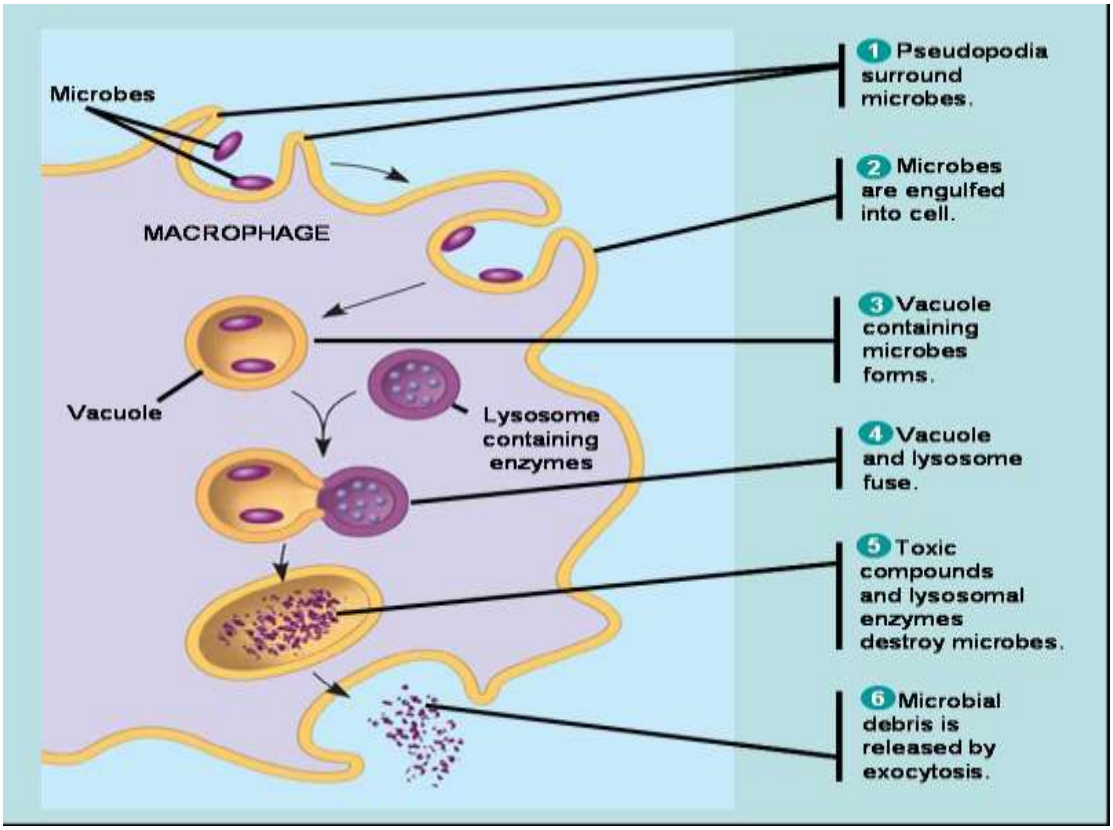
■ In addition, nonpathogenic organisms tend to colonize the epithelial cells of mucosal surfaces. These normal flora generally compete with pathogens for attachment sites on the epithelial cell surface and for necessary nutrients.

B- Physiologic barriers: The physiologic barriers that contribute to innate immunity include the following:

■ Gastric acidity is an innate physiologic barrier to infection because very few ingested microorganisms can survive the low pH of stomach contents.

■ Lysozyme, interferon, and complement are some of the soluble mediators of innate immunity. Lysozyme has antibacterial effect due to its action on the bacterial cell wall. Interferons are secreted by cells in response to products of viral infected cells. These substances have a general antiviral effect by preventing the synthesis of viral structural proteins. Complement is a group of serum-soluble substances that when activated damage the cell membrane.

C- Phagocytosis: Phagocytosis is another important defense mechanism of the innate immunity. Phagocytosis is a process of ingestion of extracellular particulate material by certain specialized cells, such as blood monocytes, neutrophils, and tissue macrophages. It is a type of endocytosis in which invading microorganisms present in the environment are ingested by the phagocytic cells. In this process, plasma membrane of the cell expands around the particulate material, which may include whole pathogenic microorganisms to form large vesicles called phagosomes.



D- Inflammatory responses: Tissue damage caused by a wound or by an invading pathogenic microorganism induces a complex sequence of events, collectively known as the inflammatory responses. The end result of inflammation may be the activation of a specific immune response to the invasion or clearance of the invader by components of the innate immune system.

The four cardinal features of inflammatory responses are *rubor* (redness), *calor* (rise in temperature), *dolor* (pain), and *tumor* (swelling).

Mediators of inflammatory reactions: Histamine, kinins, acute phase proteins, and defensin are the important mediators of inflammatory reactions.

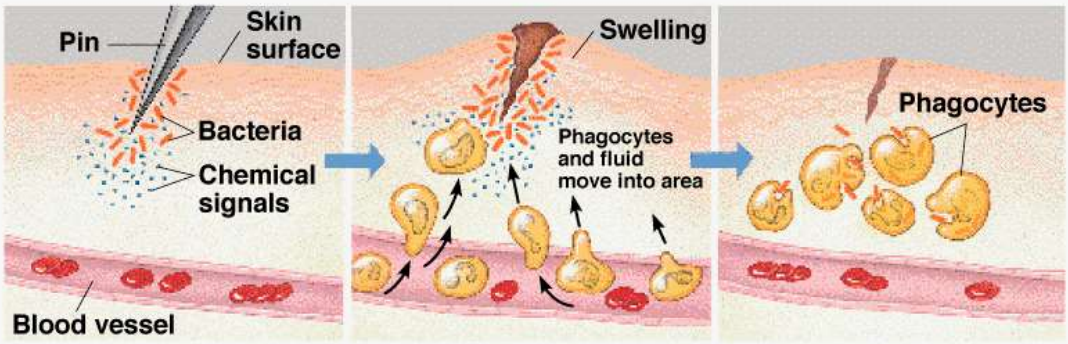
■ **Histamine:** It is a chemical substance produced by a variety of cells in response to tissue injury. It is one of the principal mediators of the inflammatory response. It binds to receptors on nearby capillaries and venules, causing vasodilatation and increased permeability.

■ **Kinins:** These are other important mediators of inflammatory response. They are normally present in blood plasma in an inactive form. Tissue injury activates these small peptides, which then cause vasodilatation and increased permeability of capillaries. Bradykinin also stimulates pain receptors in the skin. This effect probably serves a protective role because pain normally causes an individual to protect the injured area.

■ **Acute-phase proteins:** These include C-reactive proteins and mannose-binding proteins that form part of the innate immunity. These proteins are produced at an increased concentration in plasma during acute-phase reaction, as a nonspecific response to microorganisms and other forms of tissue injury. They are synthesized in the liver in response to cytokines called ***proinflammatory cytokines***, namely, interleukin-1 (IL-1), interleukin-6 (IL-6), and tumer necrosis factor (TNF). They are called proinflammatory cytokines because they enhance the inflammatory responses.

■ **Defensins:** They are another important component of the innate immunity. They are cationic peptides that produce pores in membrane of the bacteria and thereby kill them.

These are present mainly in the lower respiratory tract and gastrointestinal tract. The respiratory tract contains ß_-defensins, whereas the gastrointestinal tract contains α_-defensins. The α_-defensins also exhibit antiviral activity.



1. Tissue injury; release of chemical signals such as histamine
2. Dilation and increased leakiness of local blood vessels; migration of phagocytes to the area
3. Phagocytes (macrophages and neutrophils) consume bacteria and cell debris; tissue heals