Innate Immunity: Nonspecific Defenses of the Host

Innate immunity		adaptive immunity
First line of defense	Second line of defense	Third line of defense
1- Intact skin. 2-Mucous membranes and their secretions. 3- Normal microbiota.	1-Phagocytes, such as neutrophils, dendritic cells and macrophages. 2- Inflammation. 3- Fever. 4-Antimicrobial substances	1-Specialized lymphocytes T cells and B cells. 2- Antibodies.

- Innate immunity involves defenses against any pathogen. regardless of species.
- adaptive immunity involves defenses against a specific pathogen.

The Concept of Immunity

Innate immunity refers to defenses that are present at birth. They are always present and available to provide rapid responses to protect us against disease. Innate immunity does not involve specific recognition of a microbe. Further, innate immunity does not have a memory response, that is, a more rapid and stronger immune reaction to the same microbe at a later date.

Adaptive immunity is based on a specific response to a specific microbe once a microbe has breached the innate immunity defenses. It adapts or adjusts to handle a particular microbe.

Unlike innate immunity, adaptive immunity is slower to respond, but it does have a memory component.

First line of defense

Physical Factors

1- The intact skin

is the human body's largest organ in terms of surface area and weight and is an extremely important component of the first line of defense. It consists of two distinct portions: the **dermis** and the **epidermis**. The top layer of epidermal cells is dead and contains a protective protein called **keratin**. The periodic shedding of the top layer helps remove microbes at the surface. In addition, the dryness of the skin is a major factor in inhibiting microbial growth on the skin.

2- Mucous membranes

line the entire gastrointestinal, respiratory, and genitourinary tracts. The epithelial layer of a mucous membrane secretes a fluid called mucus, a slightly viscous (thick) glycoprotein produced by **goblet cells** of a mucous membrane. Among other functions, mucus prevents the tracts from drying out.

One such mechanism that protects the eyes is the **lacrimal apparatus**, a group of structures that manufactures and drains away tears. The **lacrimal glands**, produce the tears and pass them under the upper eyelid.

Saliva: produced by the **salivary glands**, helps dilute the numbers of microorganisms and wash them from both the surface of the teeth and the mucous membrane of the mouth.

The mucous membrane of the nose also has mucus-coated hairs that filter inhaled air and trap microorganisms, dust, and pollutants. The cells of the mucous membrane of the lower respiratory tract are covered with **cilia**.

The cleansing of the **urethra** by the flow of urine is another physical factor that prevents microbial colonization in the genitourinary tract.

Vaginal secretions likewise move microorganisms out of the female body.

Peristalsis, defecation, and vomiting also expel microbes.

Peristalsis is a series of coordinated contractions that propel food along the gastrointestinal tract . Mass peristalsis of large intestinal contents into the rectum results in defecation. In response to microbial toxins, the muscles of the gastrointestinal tract contract vigorously, resulting in vomiting and/or diarrhea, which may also rid the body of microbes.

Chemical Factors

1- **Sebaceous** (oil) glands of the skin produce an oily substance called **sebum** that prevents hair from drying and becoming brittle.

One of the components of sebum is unsaturated fatty acids, which inhibit the growth of certain pathogenic bacteria and fungi. The low pH of the skin, between pH 3 and 5, is caused in part by the secretion of fatty acids and lactic acid. The skin's acidity probably discourages the growth of many other microorganisms.

2- **Sweat glands** of the skin produce **perspiration**, which helps maintain body temperature, eliminate certain wastes, and flush microorganisms from the surface of the skin. Perspiration also contains **lysozyme**, an enzyme capable of breaking down cell walls of gram-positive bacteria and, to a lesser extent, gram negative bacteria. Specifically, lysozyme breaks chemical bonds on peptidoglycan, which destroys the cell walls. Lysozyme is also found in **tears**, **saliva**, **nasal secretions, tissue fluids, and urine,** where it exhibits its antimicrobial activity.

Saliva also contains an antibody (immunoglobulin A) that prevents attachment of microbes so that they cannot penetrate mucous membranes.

3-Gastric juice is produced by the glands of the stomach. It is a mixture of hydrochloric acid, enzymes, and mucus. The very high acidity of gastric juice (pH 1.2-3.0) is sufficient to destroy bacteria and most bacterial toxins, except those of *Clostridium botulinum* and *Staphylococcus aureus*. However, many enteric pathogens are protected by food particles and can enter the intestines via the gastrointestinal tract. In contrast, the bacterium *Helicobacter pylori* neutralizes stomach acid, thereby allowing the bacterium to grow in the stomach.

4- **Vaginal secretions** play a role in antibacterial activity in two ways. Glycogen produced by vaginal epithelial cells is broken down into lactic acid by *Lactobacillus acidophilils.* This creates an acid pH (3-5) that inhibits microbes. **Urine**, in addition to containing lysozyme, has an acid pH (average 6) that inhibits microbes. Also, urine contains urea and other metabolic by-products, such as uric acid, hippuric acid, which inhibit microbes.

Normal Microbiota

several relationships between normal microbiota and host cells. Some of these relationships help prevent the overgrowth of pathogens and thus may be considered components of innate immunity.

- **antagonism**, the normal microbiota prevent pathogens from colonizing the host by competing with them for nutrients, by producing substances that are harmful to the pathogens, and by altering conditions that affect the survival of the pathogens, such as pH and oxygen availability. The presence of normal

microbiota in the vagina, for example, alters pH, thus preventing overpopulation by *Candida albicans*, a pathogenic yeast that causes vaginitis. In the large intestine, *E. coli* bacteria produce **bacteriocins** that inhibit the growth of *Salmonella* and *Shigella*.

- **commensalism**, one organism uses the body of a larger organism as its physical environment and may make use of the body to obtain nutrients. Thus in commensalism, one organism benefits while the other is unaffected. Most microbes that are part of the commensal microbiota are found on the skin and in the gastrointestinal tract. The majority of such microbes are bacteria that have highly specialized attachment mechanisms and precise environmental requirements for survival. Normally, such microbes are harmless, but they may cause disease if their environmental conditions change. These opportunistic pathogens include *E. coli, Staphylococcus aureus S. epidermids, Enterococcus faecalis,* and oral streptococci.

Question

- Describe the role of the skin and mucous membranes in innate immunity.
- Differentiate physical from chemical factors. and list five examples of each.
- Describe the role of normal microbiota in innate Immunity.
- Identify one physical factor and one chemical factor that prevent microbes from entering the body through skin and mucous membranes.
- Identify one physical factor and one chemical factor that prevent microbes from entering or colonizing the body through the eyes, digestive tract. and respiratory tract.
- Distinguish microbial antagonism from commensalism.