

11.2B: Physical and Chemical Barriers

The innate immune response has physical and chemical barriers that exist as the first line of defense against infectious pathogens.

Learning Objectives

- Describe physical and chemical barriers in the innate immune response

Key Points

- The skin, or epithelial surface, serves as the primary barrier to microbial entry into the body; skin peeling, drying out, and the skin's acidity all serve to dislodge or kill foreign pathogens.
- Orifices such as the eyes and mouth, which are not covered by skin, have other mechanisms by which they prevent entry; tears wash away microbes, while cilia in the nasal passages and respiratory tract push mucus (which traps pathogens) out of the body.
- Many chemical barriers also exist once pathogens make it past the outer physical barriers; the acidity of the stomach ensures that few organisms arriving with food survive the digestive system.

Key Terms

- cilium:** a hairlike organelle projecting from a eukaryotic cell (such as unicellular organism or one cell of a multicelled organism), which serves either for locomotion by moving or as sensors
- microbicidal:** functioning to reduce the infectivity of microbes

Physical and chemical barriers

The immune system comprises both innate and adaptive immune responses. Innate immunity occurs naturally due to genetic factors or physiology. It is not induced by infection or vaccination, but is constantly available to reduce the workload for the adaptive immune response. The adaptive immune response expands over time, storing information about past infections and mounting pathogen-specific defenses. Both the innate and adaptive levels of the immune response involve secreted proteins, receptor-mediated signaling, and intricate cell-to-cell communication. From an historical perspective, the innate immune system developed early in animal evolution, roughly a billion years ago, as an essential response to infection. In the innate immune response, any pathogenic threat triggers a consistent sequence of events that can identify the type of pathogen and either clear the infection independently or mobilize a highly-specialized adaptive immune response.

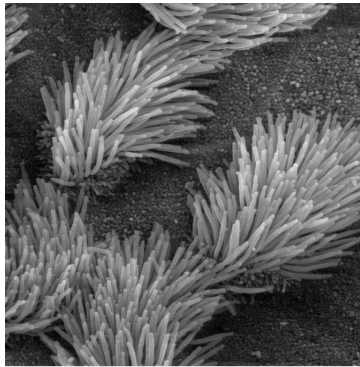


Figure: **Cilia up close:** Cilia are a type of organelle found in eukaryotic cells. In the innate immune system, they serve to move pathogens out of the respiratory system via a concerted sweeping motion.

Before any immune factors are triggered, the skin (also known as the epithelial surface) functions as a continuous, impassable barrier to potentially-infectious pathogens. The skin is considered the first defense of the innate immune system; it is the first of the nonspecific barrier defenses. Pathogens are killed or inactivated on the skin by desiccation (drying out) and by the skin's acidity. In addition, beneficial microorganisms that coexist on the skin compete with invading pathogens, preventing infection. Desquamation, or peeling skin, also serves to dislodge organisms that have adhered to the surface of the body and are awaiting entry. Regions of the body that are not protected by skin (such as the eyes and mucous membranes) have alternative methods of defense. These include tears in the eyes; mucous membranes that provide partial protection despite having to allow absorption and secretion; mucus secretions that trap and rinse away pathogens; and cilia (singular cilium) in the nasal passages and respiratory tract that push

the mucus with the pathogens out of the body. Furthermore, tears and mucus secretions contain microbicidal factors that prevent many infections from entering via these routes.

Despite these barriers, pathogens may enter the body through skin abrasions or punctures, or by collecting on mucosal surfaces in large numbers that overcome the mucus or cilia. Some pathogens have evolved specific mechanisms that allow them to overcome physical and chemical barriers.

Once inside, the body still has many other defenses, including chemical barriers. Some of these include the low pH of the stomach, which inhibits the growth of pathogens; blood proteins that bind and disrupt bacterial cell membranes; and the process of urination, which flushes pathogens from the urinary tract. The blood-brain barrier also protects the nervous system from pathogens that have already entered the blood stream, but would do significantly more damage if they entered the central nervous system.

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