

Immunology

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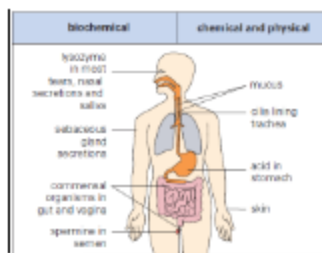
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The levels of host defense

The innate immune system includes anatomical barriers against infection both physical and chemical as well as cellular responses.

- The first line of defense consists of nonspecific physical and chemical barriers that prevent the entrance of infectious agents into the tissue.
- The second line of defense consists of white blood cells (phagocytes) and chemical defenses (inflammation) that remove and destroy infectious agents that have entered the tissues.
- The third line of defense is based on white blood cells that show extreme specificity for their target microbes.

This defense must be brought into play for each different microbe that is encountered, and it accounts for the immunities of diseases that develop following infection.



In addition to serving as physical barriers, the skin and mucosal and glandular epithelial layers are defended against microbial colonization by a variety of mechanisms: mechanical (cilia, fluid flow, smooth muscle contraction), chemical (pH, enzymes, antimicrobial peptides) and cellular (resident macrophages and dendritic cells).

The Immune Response

- As the immune system defends the host against pathogens, it uses different recognition systems to effectively eliminate the invading pathogen or its products. A response generated against a potential pathogen is called an immune response.
- The first defense system, which is **nonspecific** to the invading pathogen, is rapidly mobilized at the initial site of infection but lacks immunologic memory and is **called innate immunity**.
- The second defense system is called **adaptive** immunity. It is **specific** for the pathogen and confers protective immunity to reinfection with that pathogen.

Adaptive immunity can specifically recognize and destroy the pathogen because lymphocytes carry specialized cellular receptors and produce specific antibodies. A protein that is produced in response to a particular pathogen is called the antibody, and the substance that induces the production of antibodies is called the antigen.

- In summary, the innate immune response is effective and critical in eliminating most pathogens. However, if this initial mechanism fails, the adaptive immune response is induced that specifically confronts the pathogen and establishes immunity to that invading pathogen. Hence, both systems interact and collaborate to achieve the final goal of destroying the pathogen.

Innate	Adaptive
Characteristics	
Rapid immune response	Slow response
Antigen-nonspecific	Highly antigen-specific
No memory, not long-lasting protection	Induces memory response, rapidly and vigorously to second antigen exposure
Immunologic Components	
Natural barriers to infection: skin, mucous membranes	
Cells: Phagocytes, NK cells, mast cells, eosinophils	T lymphocytes (effector and memory), B lymphocytes (antibody-secreting, APCs)
Molecules: Complement, defensins, cytokines, various TLRs, NOD-like receptors, TLRs	Secreted molecules (antibodies, chemokines, complement)



- The main physical barriers to the body's first line of defense are the epithelial layers of the skin and the mucosal and glandular tissue surfaces connected to the body's openings; these barriers prevent infection by blocking pathogens from entering the body. Chemical barriers at these surfaces include specialized soluble substances that possess antimicrobial activity and acid pH.
- Some white blood cell types (macrophages and neutrophils) are activated to rapidly engulf and destroy extracellular microbes through the process of phagocytosis. Other receptors induce the production of proteins and other substances that have a variety of beneficial effects, including direct antimicrobial activity and the recruitment of fluid, cells, and molecules to sites of infection.

This influx causes swelling and other physiological changes that collectively are called inflammation. Such local innate and inflammatory responses usually are beneficial for eliminating pathogens and damaged or dead cells and promoting healing.

- Increased levels of antimicrobial substances and phagocytic cells help to eliminate pathogens, and dendritic cells take up pathogens for presentation to lymphocytes, activating adaptive immune responses.
- Despite the multiple layers of the innate immune system, some pathogens may evade the innate defenses leading to the activation of adaptive immune responses (B and T lymphocytes), which generate antibodies, and effector T cells that specifically recognize and neutralize or eliminate the invaders.