Department of biology

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((MICROBIOLOGY))

Stage (2)

LEC- ((9))

Immunology

By

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Immunology

Microorganisms that cause pathology in humans and animals enter the body at different sites and produce disease by a variety of mechanisms. Many different infectious agents can cause pathology, and those that do are referred to as pathogenic microorganisms or pathogens.

Invasions by microorganisms are initially countered, in all vertebrates, by **innate defense mechanisms** that preexist in all individuals and act within minutes of infection. Only when the innate host defenses are bypassed, adaptive immune response is required.

- Our bodies are constantly exposed to microorganisms present in the environment, including infectious agents that have been shed from infected individuals.
- Contact with these microorganisms may occur through external or internal epithelial surfaces: the respiratory tract mucosa provides a route of entry for airborne microorganisms, the gastrointestinal mucosa for microorganisms in food and water; insect bites and wounds allow micro-organisms to penetrate the skin; and direct contact between individuals offers opportunities for infection of the skin and reproductive mucosa.

The normal flora can also produce antimicrobial substances, such as the colicins (anti-bacterial proteins made by Escherichia coli) that prevent colonization by other bacteria.

Routes of infection for pathogens			
Route of entry	**Mode of transmission**	**Pathogen**	**Disease**
Mucosal surfaces			
Airway	Inhaled droplets	Influenza virus *Neisseria meningitidis*	Influenza Meningococcal meningitis
Gastrointestinal tract	Contaminated water or food	*Salmonella typhi* Rotavirus	Typhoid fever Diarrhea
Reproductive tract	Physical contact	*Treponema pallidum*	Syphilis

Infectious disease occurs when a microorganism succeeds in evading or overwhelming innate host defenses to establish a local site of infection and replication that allows its further transmission.

In some cases, the initial infection remains local and does not cause significant pathology.

In other cases, the infectious agent causes significant pathology as it spreads through the lymphatics or the bloodstream, or as a result of secreting toxins.

Our surface epithelia are more than physical barriers to infection; they also produce chemical substances that are microbicidal or inhibit microbial growth.

For example, the antibacterial enzyme lysozyme is secreted in tears and saliva. The acid pH of the stomach and the digestive enzymes of the upper gastrointestinal tract create a substantial chemical barrier to infection.

Intrinsic epithelial barriers to infection	
Mechanical	Epithelial cells joined by tight junctions Longitudinal flow of air or fluid across epithelium Movement of mucus by cilia
Chemical	Fatty acids (skin) Enzymes: lysozyme (saliva, sweat, tears), pepsin (gut) Low pH (stomach) Antibacterial peptides: defensins (skin, gut), cryptidins (intestine)
Microbiological	Normal flora compete for nutrients and attachment to epithelium and can produce antibacterial substances

Surface epithelia provide mechanical, chemical, and microbiological barriers to infection

The immune system can be divided into three basic lines of defense against pathogenic infection:

The first line of defense against infection is the surface barriers that prevent the entry of pathogens into the body

The second line of defense is the non-specific phagocytes and other internal mechanisms that comprise innate immunity

The third line of defense is the specific lymphocytes that produce antibodies as part of the adaptive immune response

The Immune System: Three Lines of Defense

NON-SPECIFIC DEFENCES (INNATE IMMUNITY)		SPECIFIC DEFENCES (ADAPTIVE IMMUNITY)
First line of defense	Second line of defense	Third line of defense
• Skin • Mucous membranes • Secretions of skin and mucous membranes	• Phagocytic leukocytes • Antimicrobial proteins • Inflammatory response • Fever	• Lymphocytes • Antibodies • Memory cells

First Line of Defense

1. The primary defence against infectious disease are the **surface barriers** that prevent pathogens from entering the body

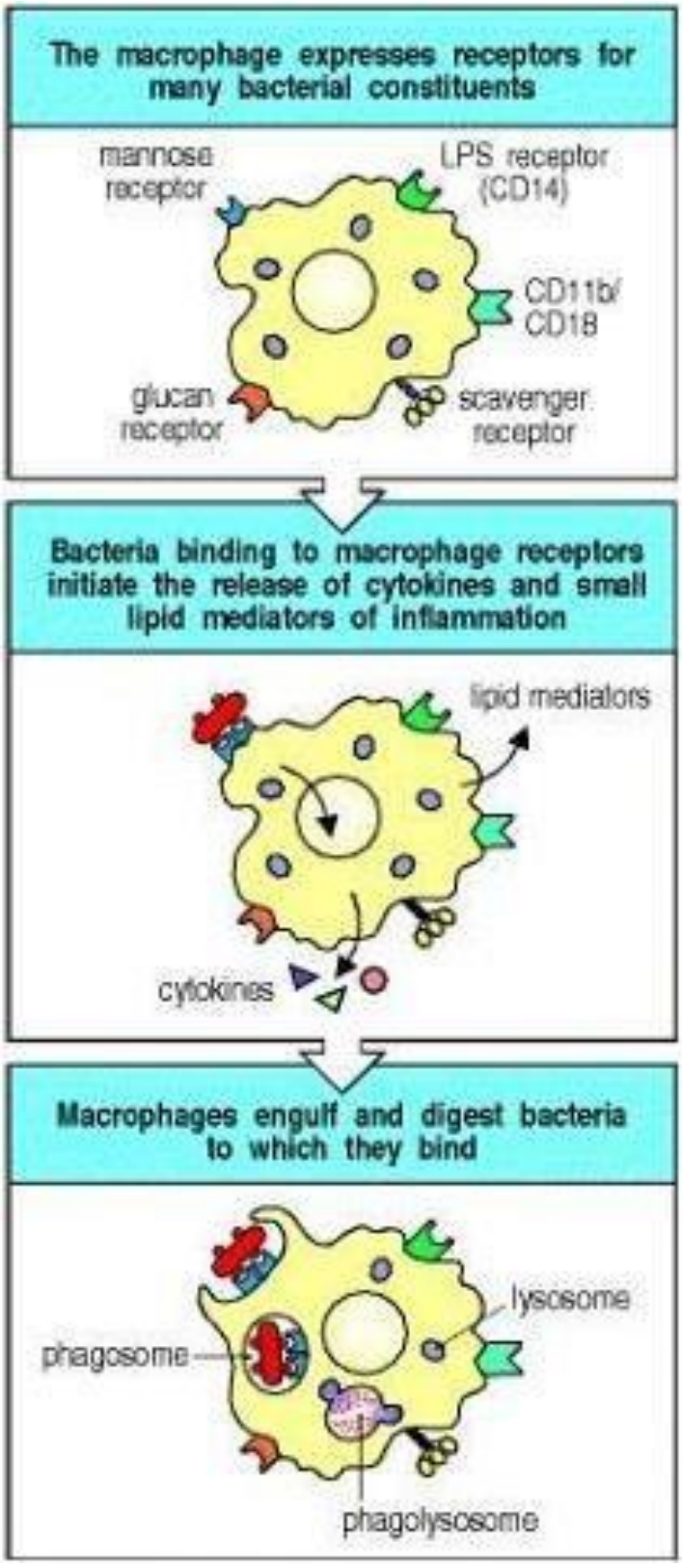
- These surface barriers include intact **skin** (protect external boundaries) and **mucous membranes.**
- Both the skin and mucous membranes release chemical secretions which restrict the growth of microbes on their surfaces

- If pathogens cannot enter the host body, they cannot disrupt normal physiological functions and cause disease

Second Line of Defense

The second line of defence against infection are the **nonspecific** cellular and molecular responses of the **innate immune system**

- These defences do not differentiate between different types of pathogen and respond the same way upon every infection
- **Phagocytic leukocytes** migrate to infection sites and engulf foreign bodies (dendritic cells then present antigens to lymphocytes)
- Inflammatory responses increase capillary permeability at infected sites, recruiting leukocytes but leading to localised swelling
- Antimicrobial proteins (such as **cytokines** and **complement proteins**) regulate immune activity within the body
- Fever increases body temperatures to activate heat-shock proteins and suppress microbial growth and propagation Phagocytes bear several different receptors that recognize microbial components and induce **phagocytosis**.


The macrophage expresses receptors for many bacterial constituents
mannose receptor
LPS receptor (CD14)
CD11b/ CD18
glucan receptor
scavenger receptor
Bacteria binding to macrophage receptors initiate the release of cytokines and small lipid mediators of inflammation
lipid mediators
cytokines
Macrophages engulf and digest bacteria to which they bind
lysosome
phagosome
phagolysosome

Third Line of Defense

- The final line of defence against infection are the lymphocytes that produce antibodies to specific antigenic fragments.
- Each B cell produces a specific antibody, and the body has millions of different B cells capable of detecting distinct antigens.
- Helper T cells regulate B cell activation, ensuring that antibodies are only mass produced at the appropriate times.
- Both B and T cells will differentiate to form memory cells after activation, conferring long-term immunity to a particular pathogen.