The immune responses:

As multicellular organisms such as plants, invertebrates, and vertebrates arose during evolution, they had to develop mechanisms for defending themselves against

- microbial infections
- Eliminating damaged and necrotic cells.

The defense against microbes is mediated by the early reactions of **innate immunity** and the later responses of **adaptive immunity**.

	Innate Immune	Adaptive immunity
Components		
Cellular and chemical barriers	Skin, mucosal epithelia; antimicrobial molecules	Lymphocytes in epithelia; antibodies secreted at epithelial surfaces
Blood proteins	Complement, others	Antibodies
Cells	Phagocytes (macrophages, neutrophils), natural killer cells, innate lymphoid cells	Lymphocytes

Early Innate Immune Response :

COMPONENTS OF INNATE IMMUNITY:

1- The main **physical barriers & Chemical barriers** —the body's first line of defense—are epithelial layers barriers

The common portals of entry of microbes:

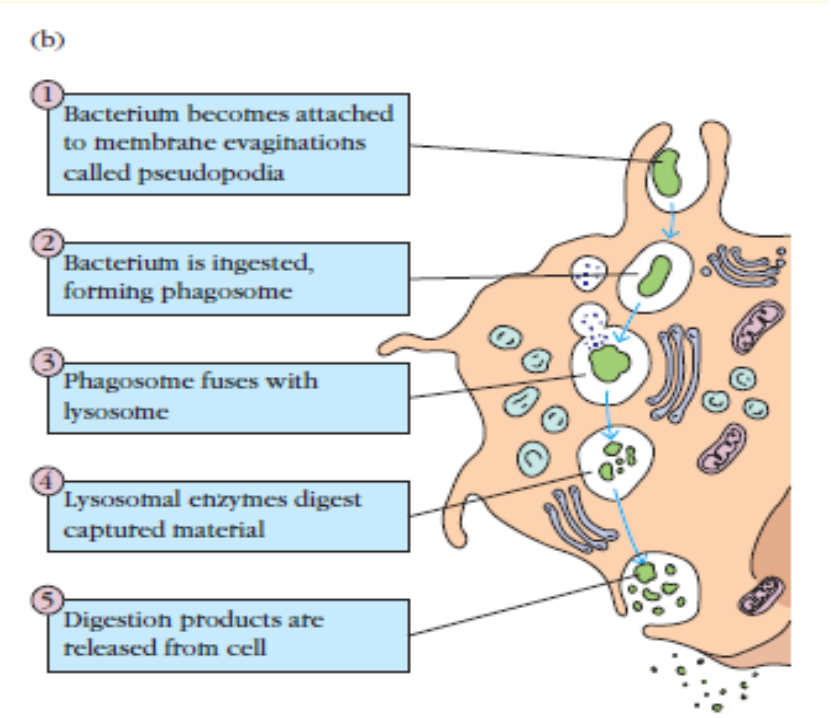
- the skin
- the mucosal and glandular tissue
- gastrointestinal tract
- respiratory Tract

These epithelial barriers prevent infection by blocking pathogens from entering the body, where provide physical barrier against infection, and so **Chemical barriers** at these surfaces include specialized soluble substances that possess antimicrobial activity as well as acid pH.

If microbes are able to enter tissues and the circulation, they encounter the defense mechanisms of innate immunity by Phagocytes (including neutrophils and macrophages) where they:

1. Ingest microbes and destroy them by producing microbicidal substances.
2. Macrophages and dendritic cells that encounter microbes also secrete cytokines, which serve numerous functions.

Phagocytosis is one type of endocytosis, the general term for the uptake by a cell of material from its environment. In phagocytosis, a cell's plasma membrane expands around the particulate material, which may include whole pathogenic microorganisms, to form large vesicles called phagosomes . Most phagocytosis is conducted by specialized cells, such as blood monocytes, neutrophils, and tissue macrophages .



The steps in phagocytosis of a bacterium

And so, induce the production of proteins and other substances that have a variety of beneficial effects, including:

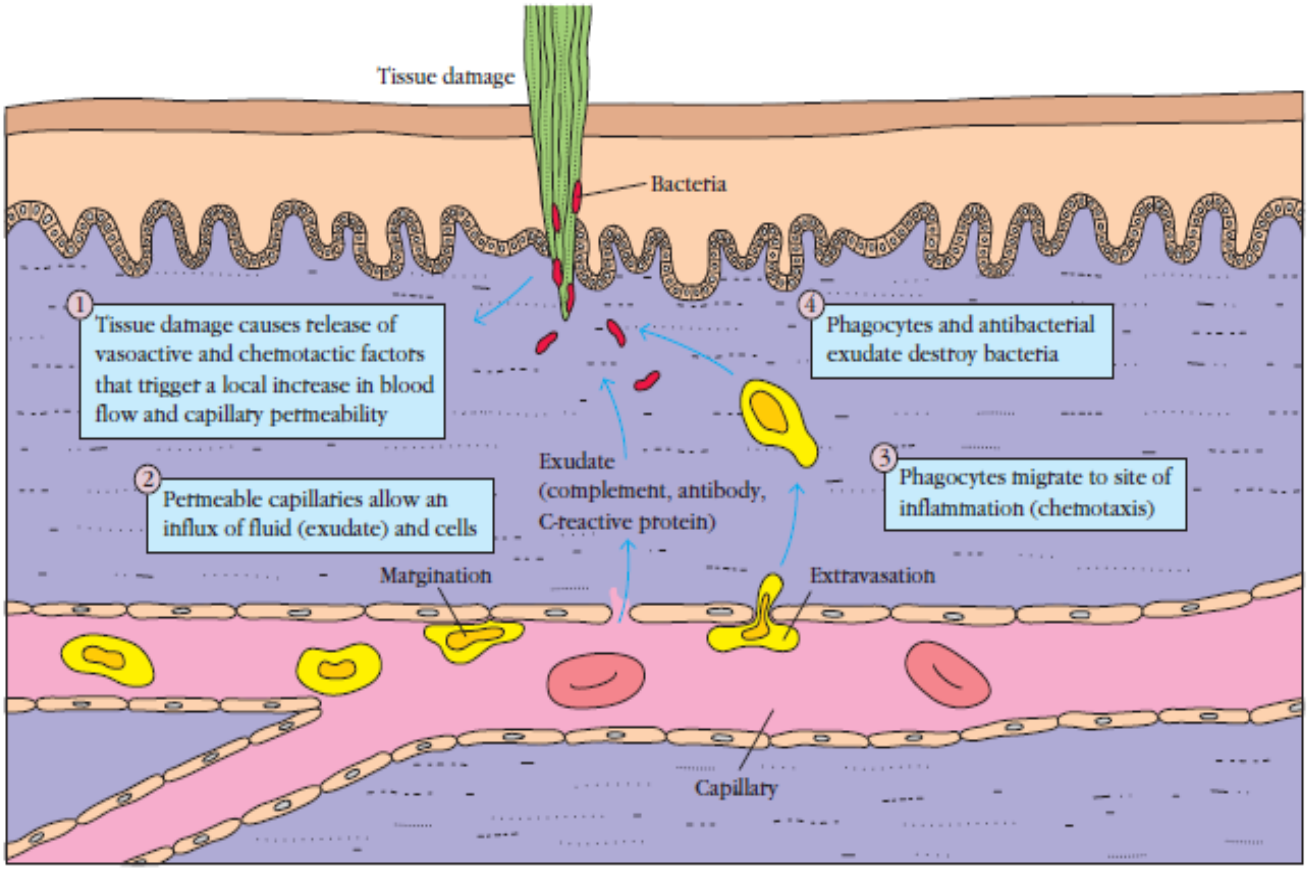
1. Direct antimicrobial activity
2. The recruitment of fluid, cells, and molecules to sites of infection.

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

Inflammation Represents a Complex Sequence of Events That Stimulates Immune Responses;

Tissue damage caused by a wound or by an invading pathogenic microorganism induces a complex sequence of events collectively known as the inflammatory response.



Major events in the inflammatory response. A bacterial infection causes tissue damage with release of various vasoactive and chemotactic factors. These factors induce increased blood flow to the area, increased capillary permeability, and an influx of white blood cells, including phagocytes and lymphocytes, from the blood into the tissues. The serum proteins contained in the exudate have antibacterial properties, and the phagocytes begin to engulf the bacteria,

a molecular component of a microbe, such as LPS, may trigger an inflammatory response via interaction with cell surface receptors. The end result of inflammation may be the marshaling of a specific immune response to the invasion or clearance of the invader by components of the innate immune system.

The inflammatory signs:

1. redness
2. swelling
3. heat
4. pain

In the second century AD, another physician, Galen, added a fifth sign: (loss of function).
The cardinal signs of inflammation reflect the

Three major events of an inflammatory response:

1. Vasodilation—an increase in the diameter of blood vessels—of nearby capillaries occurs as the vessels that carry blood away from the affected area constrict, resulting in engorgement of the capillary network. The enlarged capillaries are responsible for tissue **redness (erythema)** and **an increase in tissue temperature.**
2. An increase in capillary permeability facilitates an influx of fluid and cells from the engorged capillaries into the tissue. The fluid that accumulates (exudate) has a much higher protein content than fluid normally released from the vasculature. Accumulation of exudate contributes to tissue **swelling (edema**).
3. Influx of phagocytes from the capillaries into the tissues is facilitated by the increased permeability of the capillaries. The emigration of phagocytes is a multistep process that includes **adherence of the cells to the endothelial wall** of the blood vessels (margination), followed by their emigration between the capillary endothelial cells into the tissue (diapedesis or extravasation), and, finally, their migration through the tissue to the site of the invasion (chemotaxis).

As phagocytic cells accumulate at the site and begin to phagocytose bacteria, they release lytic enzymes, which can damage nearby healthy cells. The accumulation of dead cells, digested material, and fluid forms a substance called pus. Among the chemical mediators released in response to tissue damage are various serum proteins called:

Acute-phase proteins they include the following:

1. **C-reactive protein** is a major acute-phase protein produced by the liver in response to tissue damage.
2. One of the principal mediators of the inflammatory response is **histamine**, a chemical released by a variety of cells in response to tissue injury.
3. Another important group of inflammatory mediators**, small peptides** called **kinins**, are normally present in blood plasma in an inactive form.
4. Vasodilation and the increase in capillary permeability in an injured tissue also enable enzymes of the blood-clotting system to enter the tissue. These enzymes activate an enzyme cascade that results in the deposition of insoluble strands of **fibrin**, which is the main component of a blood clot. The fibrin strands wall off the injured area from the rest of the body and serve to prevent the spread of infection.