



Introduction to immunity & innate immunity

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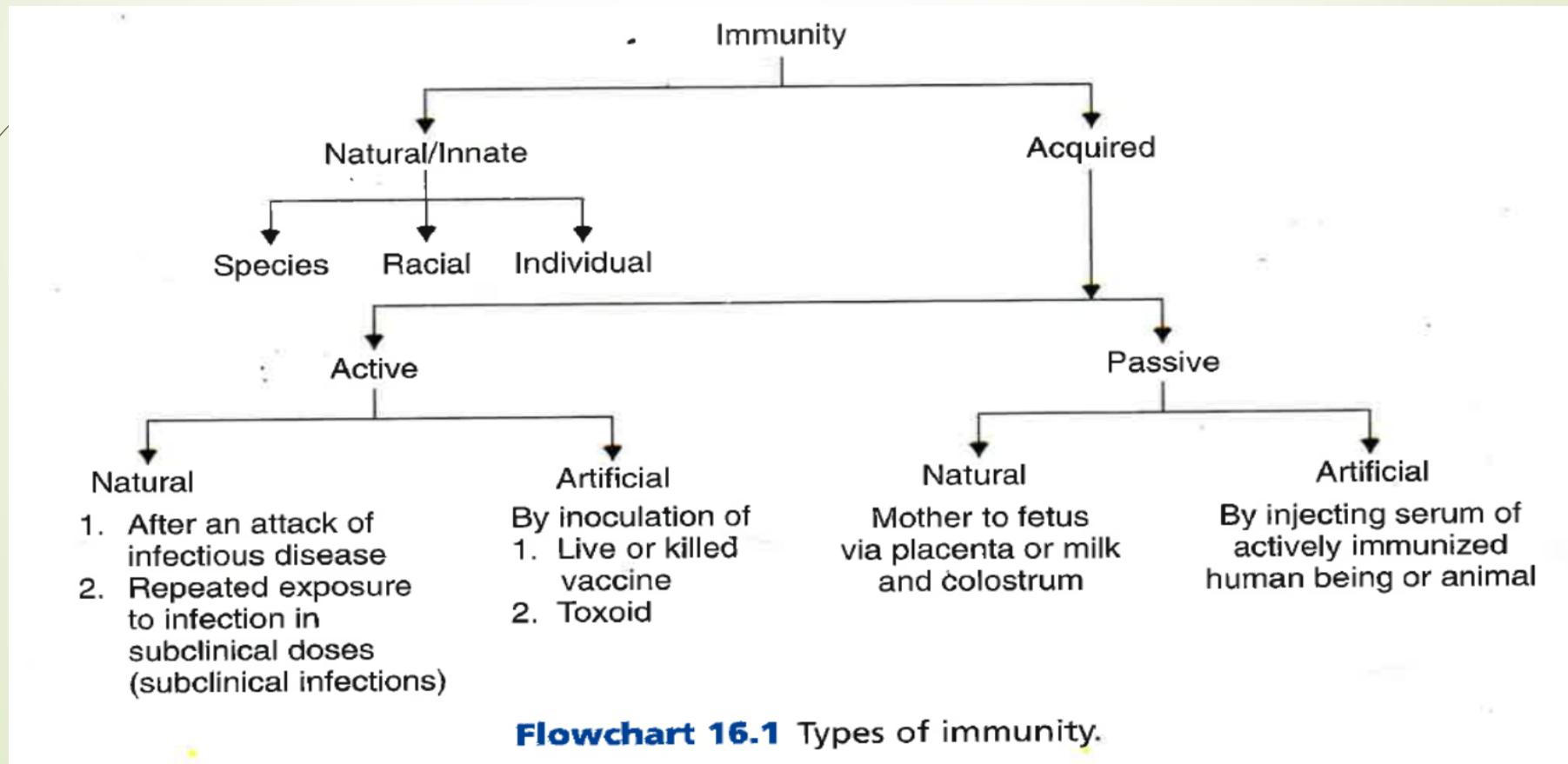
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What is the immunity

- **Immunity** is defined as the resistance exhibited by the host towards injury caused by the microorganisms or their products.
- Or; the capability of organisms (human) to resist harmful microorganisms.
- Or; the capacity of immune system to recognize and tolerate the self cells, and reject foreign non-self cells.

Types of immunity

- Immunity to infectious agents can result from **innate immunity** (nonspecific) or **acquired immunity** (specific) or both.



The innate immunity

- Innate immunity may be considered at the level of **species, race and individual**.
- In **species immunity**, all individuals of a species are born with resistance to an infectious agent that causes disease in another species. **For example**, humans are immune to most infectious agents that causes disease in pets and other domesticated animals.
- In **racial immunity**, different races show difference in susceptibility to infections. **For example**, the resistance of Algerian sheep to anthrax while the sheep in general are susceptible to anthrax. Also, the Negroes (black) in the USA are more susceptible to tuberculosis than the whites.
- In **individual immunity**, resistance to disease also depends on age, nutritional status, stress, hormone influence and general health in addition to genetic factor. **For example**, in outbreak of infections Some individuals would entirely escape from it, Some individuals will develop subclinical infections, Some individuals might develop the disease



Mechanism of Innate Immunity

- **1- Anatomic or physical** (skin, mucous membranes)
- **2- Physiologic or chemical** (temperature, pH, lysozyme, complement, and some interferons)
- **3- Phagocytic** (monocytes, neutrophils, macrophages)
- **4- Inflammatory and fever action**

1- Anatomical or Physical barriers

- **Skin and mucous membrane** form an important **first line of defense**.
- **The skin** consists of keratin, which is indigestible by most of the microbes.
- The intact skin is impermeable to most of the microbes
- Most bacteria fail to survive on skin for a long time because of the inhibitory effect of saturated and unsaturated fatty acids in sweat and sebum
- Sweat also contains high concentration of salts, which are inhibitory to bacteria and fungi
- Acidic pH (5.2-5.9) of the skin prevents growth of bacteria
- The continual shedding of the squamous epithelium also reduces bacterial load.
- If the skin is compromised, it may be infected as in burn patients

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- **The mucous membranes** form a less formidable barrier.
- Mucous membrane secretes mucus, which is a protective barrier with entrapped bacteria
- The flushing effect of the body secretions in urination reduces the microbial flora.
- Saliva teeming with oral bacteria flows to the back of throat and is swallowed then gastric acidity destroys most swallowed bacteria.
- Commensal flora in the intestine prevents the colonization by pathogenic bacteria.
- Ciliary movements, remove microbes trapped within the adhesive mucus of the ciliated respiratory tract and coughed out by cough reflex and sneezing.
- Mucous secretions of the respiratory, alimentary and genitourinary tract contains a bactericidal substance known as **lysozyme**, which kills bacteria by acting on cell wall mucopeptide

The Role of Body Secretions in innate immunity

- **Sweat and sebum:** secreted by skin contain bactericidal substances
- **Tears:** contain lysozyme, which is bactericidal, also the flushing action of tears makes conjunctiva free from microbes and dust particles
- **Saliva:** consist of Mucopolysaccharides which inactivate bacteria and viruses
- **Gastric juice:** in stomach contains hydrochloric acid (HCl), which destroys bacteria and keeps stomach free from microbes
- **Urine:** the urination by flushing action eliminates bacteria from urethra
- **Semen:** is believed to contain antibacterial substances, e.g. spermine

2- Physiologic or chemical barriers

- ▶ **Lysozyme**, a hydrolytic enzyme, found in tears and most of the tissue fluids except urine and cerebrospinal fluid, is able to cleave the peptidoglycan of the bacterial cell wall.
- ▶ **hydrogen peroxide (H₂O₂)** antibacterial substance in saliva .
- ▶ **The low pH** of stomach and vagina is inimical to most bacteria. Cholera infection occurs more rapidly in association with achlorhydria.
- ▶ **Complement:** a group of serum proteins that circulate in an inactive state. active form of complement proteins leading to lysis of bacteria, cells and viruses; promotion of phagocytosis (opsonization)
- ▶ **Properdin:** It is a complement-like substance normally present in serum. With the help of complement components and Mg²⁺ ions, it exerts.
- ▶ **Interferon IFN:** It is a nonspecific antiviral agent that interferes with intracellular viral replication. It also increases the activity of nonspecific killer cells Interferons
- ▶ **Immunoglobulin:** All classes of immunoglobulins (Ig) have been detected on mucous membranes, but **IgA** is the most important, because it is present in the greatest amount.
- ▶ **Phagocytin:** It is a heat stable protein derived from polymorphs. It is bactericidal in nature

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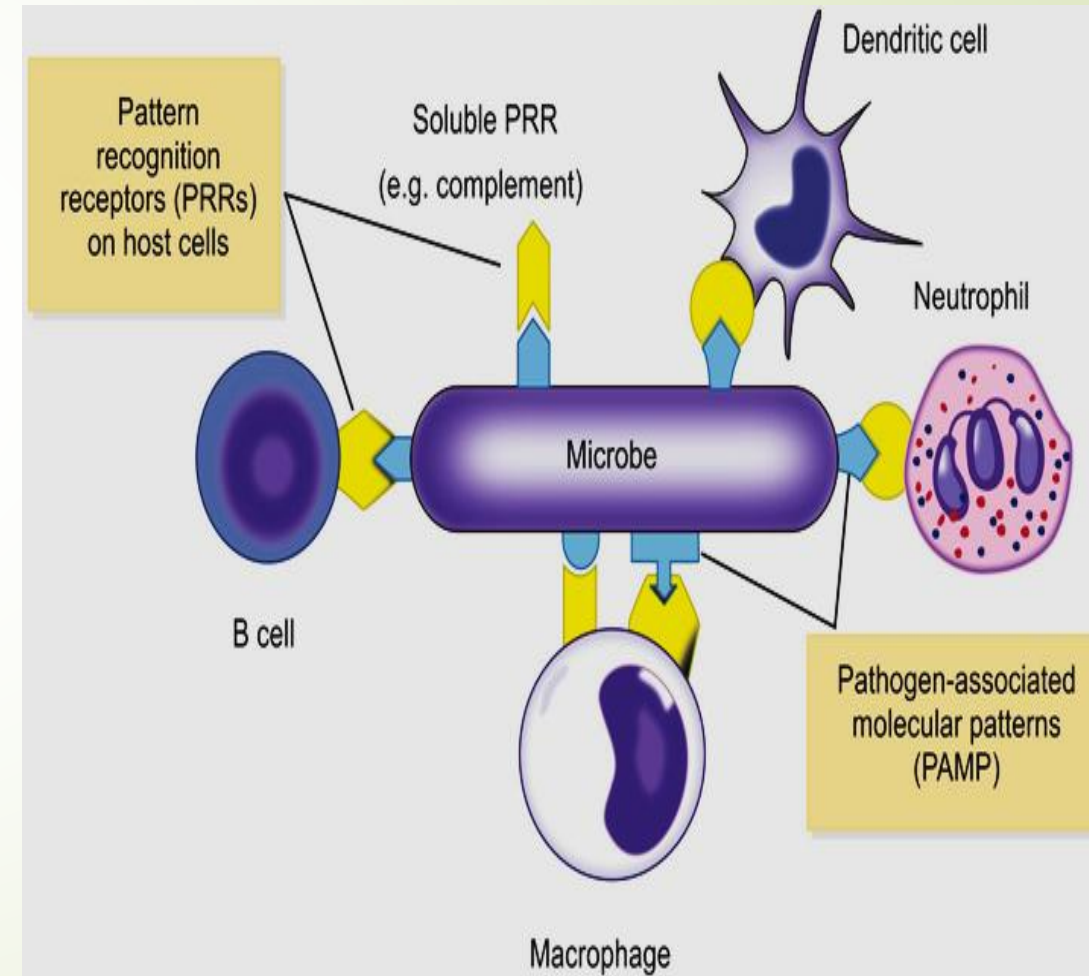
- **Cytokines** The cytokines are secreted by leukocytes act in an antigen non-specific manner, triggering a wide range of biological activities from chemotaxis to activation of specific cells.
- **Chemokines** are subgroups of cytokines of low molecular weight involved in chemotaxis (chemical-induced migration).
- Several substances, possessing antimicrobial property, have been described in blood and tissue. These include:
 - 1. **Beta-lysine** active against anthrax and related bacilli.
 - 2. **leukin** from leukocytes and **plakin** from platelets.
 - 3. **Lactic acid** found in the muscle tissue and in the inflammatory zone.
 - 4. **Lactoperoxidase** in the milk.
 - 5. Virus inhibiting substances (antiviral substances) inhibit viral hemagglutinin.
 - 6. **Defensins** secreted by (epithelial cells, neutrophils, macrophages) in the skin and mucous membrane.
 - 7. **Cathelicidin**, deoxyribonuclease (**DNases**) and ribonuclease (**RNases**).
 - 8. **Acute phase proteins**

3- Phagocytic barriers or Cellular factors in innate immunity

- Natural defense against microbes invading blood and tissues is mediated by phagocytic cells that engulf and digest them. Phagocytosis is the most important means of defense against microbes. There are two types of phagocytic cells:
 - **1 . Microphages:** These are polymorphonuclear leucocytes or granulocytes in the blood. These
 - include neutrophils mainly and eosinophils to a lesser extent
 - **2. Macrophages:** These are mononuclear cells-monocytes in blood and tissues
 - Their function is to recognize microbes and to initiate engulfment and activate the lytic enzymatic action to kill the ingested microbes.
- In addition to phagocytic cells **natural killer cells (NK)** that act on intracellular microbes by killing viral infected cell and tumor cell.

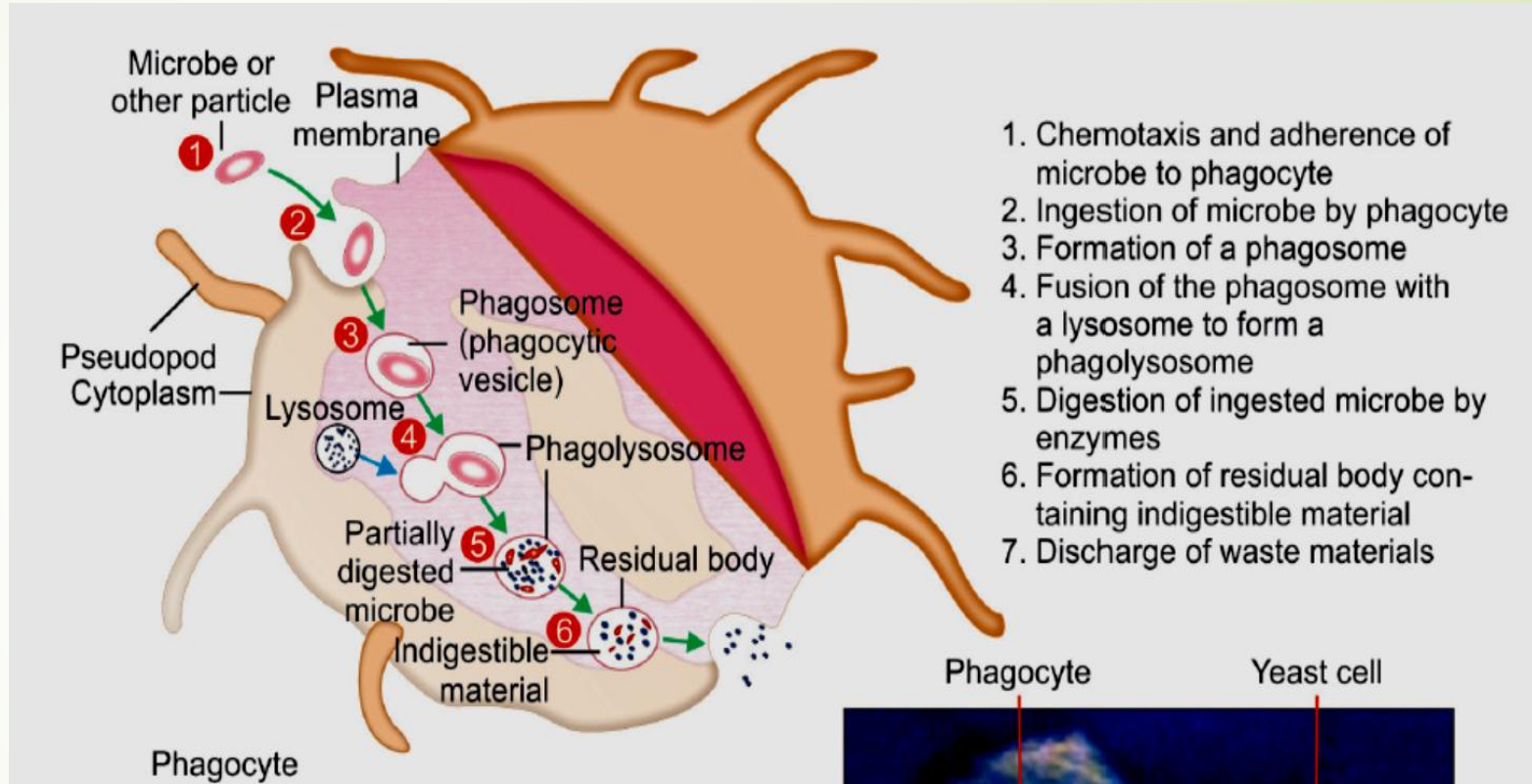
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- The innate immune system provides receptors that recognize structures of microbes that are not found in the host.
- Such receptors are known as **pattern recognition receptors (PRRs)**, which are found on or in phagocytic cells, which bind to **pathogen-associated molecular patterns (PAMPs)**.
- **PRRs binding to PAMPs result in phagocytosis** and enzymatic degradation of the infectious organisms
- PRRs include:
 - 1. **Toll-like receptors (TLRs)**, which signals the synthesis and secretion of cytokines to promote inflammation by recruiting cells.
 - 2. **Scavenger receptors** that are involved in internalization of bacteria and phagocytosis of host cells that are undergoing apoptosis.
 - 3. **Opsonins**, the molecules (C3a, IgM), which bind to microbes to facilitate their phagocytosis.

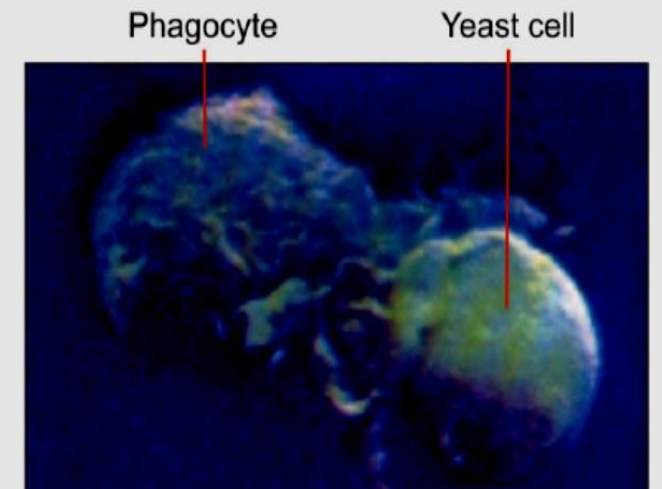


phagocytosis

- **Phagocytosis** is the process by which the invading organisms are ingested by phagocytic cells, ingestion being followed by intracellular killing.
- Three cells are professional in phagocytosis; **neutrophils**, **macrophages** and to a much lesser degree **eosinophils**.



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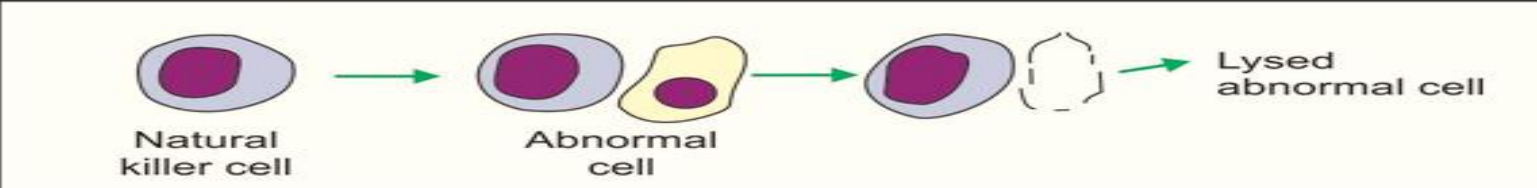



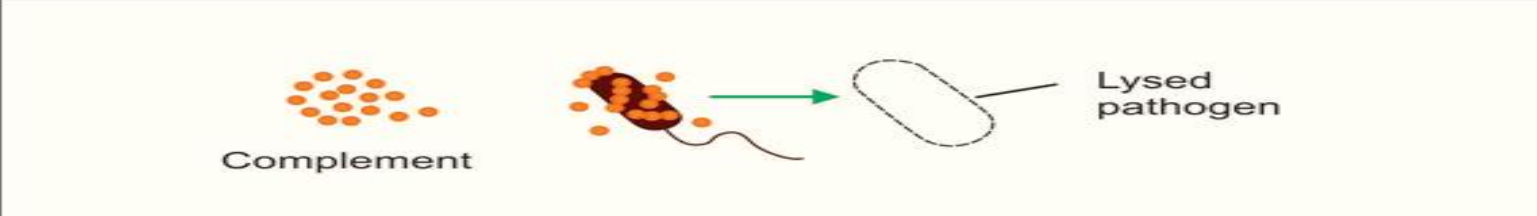
4- Inflammatory and fever action

- **Inflammation:** is the response of immune system to tissue injury initiated by the entry of pathogens leads to population of mast cells at injury site and degranulation to release various mediators that are responsible for an acute inflammatory response, which have five classical signs are heat, pain, redness, swelling, and loss of function, it have the following role:
 - Increased blood flow will allow easier access for neutrophils and monocytes.
 - Aggregation of macrophages and microphages by chemotactic mechanism
 - The outpouring of plasma helps to dilute the dilutes the toxins and enzymes
 - restrict infection
 - limit tissue damage
 - initiate tissue repair



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- **Fever** is a protective defense mechanism of the body. Increase in body temperature helps in the following ways:
- It increases circulation of blood and flushing of tissue that help to eliminate toxin through urine and sweat
- Increased body temperature may be harmful to invading microbes and in some instances may destroy the pathogens
- It stimulates the production of interferon that helps in recovery of viral infections

<p>Physical barriers</p> <p>Prevent approach and deny access to pathogens</p>	 <p>Hair Secretions Epithelium</p>
<p>Phagocytes</p> <p>Remove debris and pathogens</p>	 <p>Fixed macrophage Neutrophil Free macrophage Eosinophil Monocyte</p>
<p>Extracellular killing</p> <p>Destroys abnormal cells</p>	 <p>Natural killer cell Abnormal cell Lysed abnormal cell</p>
<p>Inflammatory response</p> <p>Multiple effects</p>	 <ol style="list-style-type: none"> 1. Blood flow increased 2. Phagocytes activated 3. Capillary permeability increased 4. Complement activated 5. Clotting reaction walls off region 6. Regional temperature increased 7. Specific defenses activated
<p>Fever</p> <p>Mobilizes defenses, accelerates repairs, inhibits pathogens</p>	 <p>Body temperature rises above 37°C in response to pyrogens</p>
<p>Interferons</p> <p>Increase resistance of cells to infection, slow the spread of disease</p>	 <p>Released by activated lymphocytes and macrophages and by virus-infected cells</p>
<p>Complement system</p> <p>Attacks and breaks down cell wall, attracts phagocytes, stimulates inflammation</p>	 <p>Complement Lysed pathogen</p>



Questions

- Q1 \ define the immunity and numerate the mechanisms of innate immunity.
- Q 2 \ what is the role of skin and mucus membrane in innate immunity.
- Q 3\ numerate the humeral or chemical factors in innate immunity.
- Q 4\ explain with steps the phagocytosis and mention the phagocytic cells