Immunology

Lecture 2 **Dr. Basim Mohammed Hanon**

Types of Immunity

Innate and Acquired Immunity

Innate Immunity: It is nonspecific and includes host defenses such as **barriers** to infectious agents (eg. Skin and mucous membranes), **certain cells** (eg. Natural killer cells), **certain proteins** (eg. The complement and interferon) and **other processes** such as phagocytosis and inflammation. Is resistance not acquired through contact with an antigen?

Note/ Innate immunity does not improve after exposure to the organism, in addition it have no memory.

Acquired Immunity: occurs after exposure to an agent, improves upon repeated exposure, and **it is specific**. It is mediated by **antibody and by T-lymphocytes** named helper T cells and cytotoxic T cells. The cells responsible for acquired immunity **have long term memory** for a specific antigen.

Mechanisms of Innate Immunity:-

The Skin:-

- Few microorganisms are capable of penetrating intact skin, but many can enter sweat or sebaceous glands and hair follicles and establish themselves.

1. **Sweat and sebaceous secretions** are the **acid pH** and certain **chemical substances (especially fatty acids**) —have antimicrobial properties that tend to eliminate pathogenic organisms and **keratine layer of intact skin**

- **Lysozyme,** an enzyme that dissolves some bacterial cell walls, is present on the **skin, tears** and in **respiratory and cervical secretions** can help provide protection against some microorganisms.
- The skin produces a variety of antimicrobial agents including **a protein with antibacterial properties** known as **psoriasin.**

Mucous Membranes and The mucociliary apparatus:-

- In the respiratory tract, a film of mucus covers the surface and is constantly being **driven upward by ciliated cells toward the natural orifices.**
- In addition, **mucus and tears contain lysozyme** and other **substances with antimicrobial properties.**
- For removal of bacteria in the respiratory tract is **aided by pulmonary macrophages.**
- Special protective mechanisms in the respiratory tract include the **cough reflex, which prevents aspiration.**

In the gastrointestinal tract: -

- Saliva contains numerous **hydrolytic enzymes.**
- **The acidity of the stomach** kills many ingested bacteria (eg, *V cholerae*).
- The small intestine contains many **proteolytic enzymes and active macrophages**.

Phagocytic Cells

- Mononuclear phagocytic cells are present in blood, lymphoid tissue, liver, spleen, lung, and other tissues that are **efficient in uptake and removal of particulate matter** from lymph vessels and the blood stream.
- They include cells lining blood and lymph sinuses macrophages (Kupffer cells in the liver)
- An important function of the **spleen is filtering microorganisms** from the bloodstream.
- Phagocytosis is **greatly enhanced by opsonins**. When macrophages recognize microbial constituents, they are **stimulated to release cytokines** that cause the **recruitment of more phagocytic cells** to the site of infection.

Phagocytosis

Is mediated by macropgages and polymorphnuclear leucocytes. **There are several stages of phagocytosis:**

1. Chemotaxis:-

- ❒ This is the movement of cells up a gradient of **chemotactic factors such as C5a**, produced as a result of complement activation.
- ❒ Indirectly release of **preformed mediators** within **mast cells** by the action of C3a or C5a e.g. eosinophil chemotactic factor, or neutrophil chemotactic factor.
- ❒ The metabolism of mast cell produced **Leukotrienes and arachidonic acid**, are also chemotactic.

2. Adherence

- ❒ This works **reasonably well for whole bacteria or viruses**, but **less so for proteins or capsulated bacteria,** more effectively with **encapsulated bacteria,**
- ❒ A second effect of the mediators is to **induce changes in expression of various adhesion molecules on endothelial cells and on leukocytes.**
- ❒ Adhesion molecules such as **the selectins and integrins** cause leukocytes to attach to the endothelial cells of the blood vessels and thereby promote their movement across the vessel wall.

3. Pseudopodium formation

- ☐ This is the protrusion of membranes to **flow round the microorganism.**

4. Phagosome formation

- ☐ **Fusion of the** pseudopodium **with a membrane** enclosing the microorganism leads to the **formation of a structure termed a phagosome**.

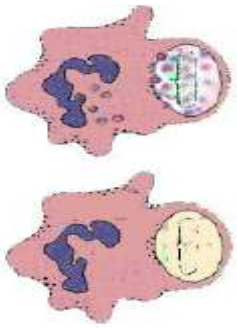
5. Phago-lysosome formation

- ❒ The phagosome moves deeper into the cell and **fuses with a lysosome**, forming **a phago-lysosome**.
- ❒ These contain **hydrogen peroxide**, active oxygen species (free radicals), **peroxidase**, **lysozyme and hydrolytic enzymes** known as the oxidative burst.
- ❒ **Digestion of the phagolysosomal contents**, after which they are eliminated by **exocytosis.**

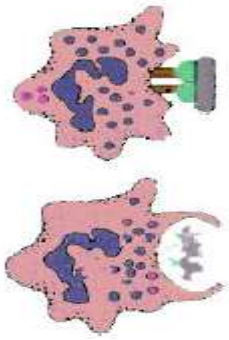
Factors affecting phagocytosis—Phagocytosis is made more efficient by the presence of antibodies (opsonins) that coat the surface of bacteria and facilitate their ingestion by phagocytes. Opsonization can occur by three mechanisms:

1. Antibody alone can act as opsonin;
2. Antibody plus antigen can activate complement via the classic pathway to yield opsonin.
3. opsonin may be produced by C3 via the alternative pathway.

Chemotaxis



Phagosome formation



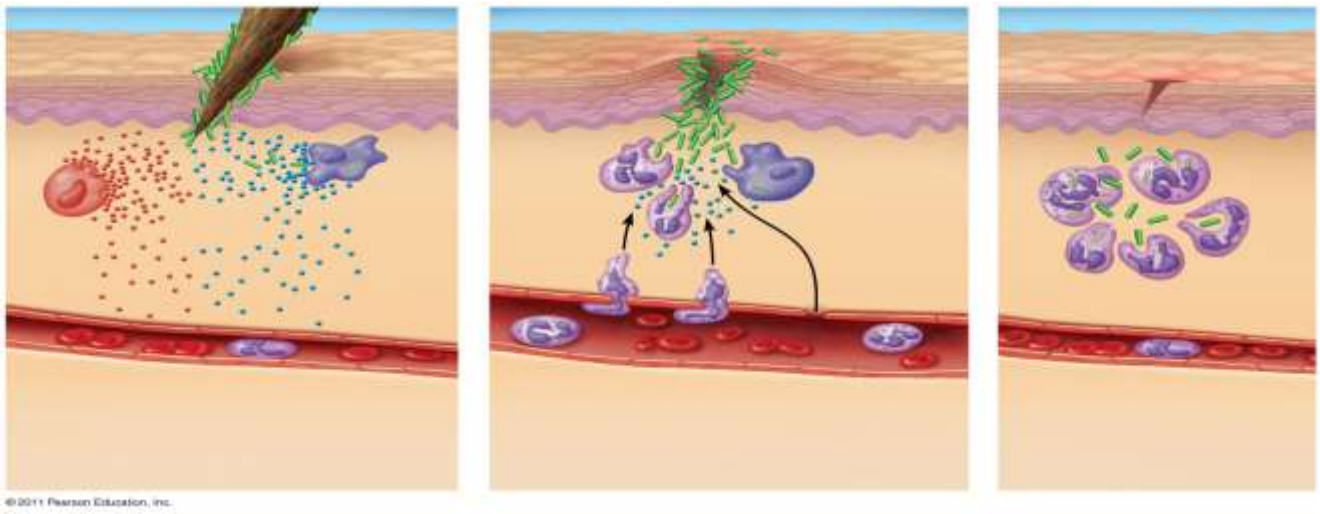
Adherence & Pseudopodium formation

Alternative Pathway of Complement Activation

- The complement system, a **set of proteins** that **enhance the function of both the adaptive and innate** responses to infection.
- Activated by microbial surfaces and proceeds in the absence of antibody.
- There are several antimicrobial properties including **opsonization, lysis of bacteria, and amplification of inflammatory responses**

Inflammatory Response

- **Pain and swelling** is brought about by molecules released upon injury of infection
- Mast cells, release **histamine**, **which triggers blood vessels to dilate and become more permeable**
- Activated macrophages and neutrophils **release cytokines,** signaling molecules that enhance the immune response
- Pus, a fluid rich in **white blood cells, dead pathogens, and cell debris from damaged tissues.**



Fever

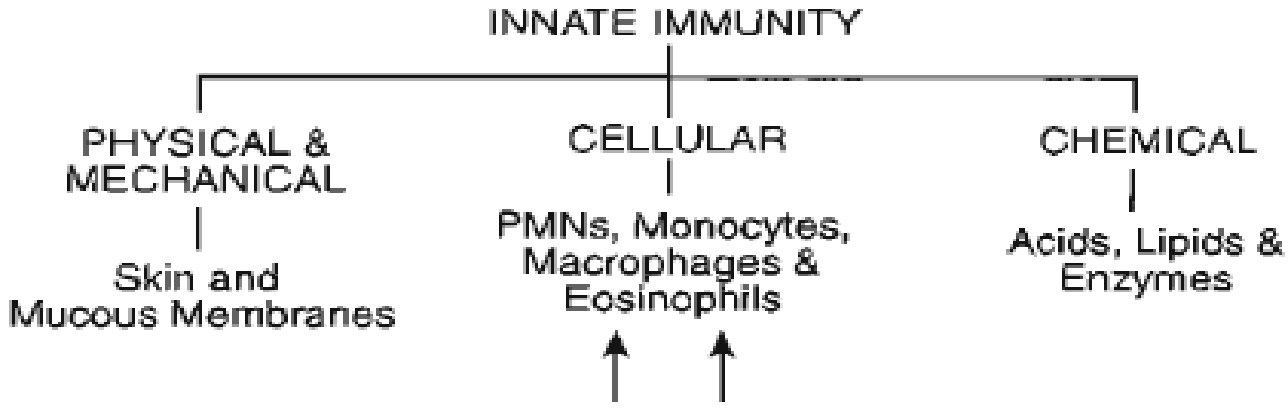
- Fever is the most common systemic manifestation of the inflammatory response and a **cardinal symptom of infectious disease.**
- The ultimate regulator of body temperature is the **thermoregulatory center in the hypothalamus.**
- Inducing fever (pyrogens) are **endotoxins of gram-negative** bacteria and **cytokines released from lymphoid cells, such as IL-1**.

Interferons

- Viral infection induces the expression of **antiviral proteins** known as **interferons.**

Natural Killer (NK) Cells:-

- Natural killer cells represent a distinct functional population of **lymphocytes.**
- Have a role in the early phases of infection with certain **viruses** such as herpesviruses and some **intracellular bacteria and tumors.**



Mechanisms of innate immunity:

2. Keratine layer of intact skin
3. Lysozyme in tears and other secretions degrade peptidoglycan in bacterial cell wall.
4. Fatty acids of skin inhibit growth of microorganisms.
5. Respiratory cilia elevate mucus containing trapped organisms.
6. Normal flora of throat, colon and vagina inhibit colonization by pathogens.
7. Low PH of vagina and stomach inhibit or kill certain pathogens.
8. Surface phagocytes eg. Aleveolar macrophage.
9. Natural killer cells kill virus-infected cells.
10. Interferons inhibit virus replication.
11. Complement (C3b is an opsonin, membrane attack complex kill bacteria.
12. Inflammatory response limit spread of organisms.