

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ
(وَفَوْقَ كُلِّ ذِي عِلْمٍ عَلِيمٌ)



HLS Physiology | MID 5

Leukocytes pt.2



Written by : Rayyan Theeb
Jamila Bouka

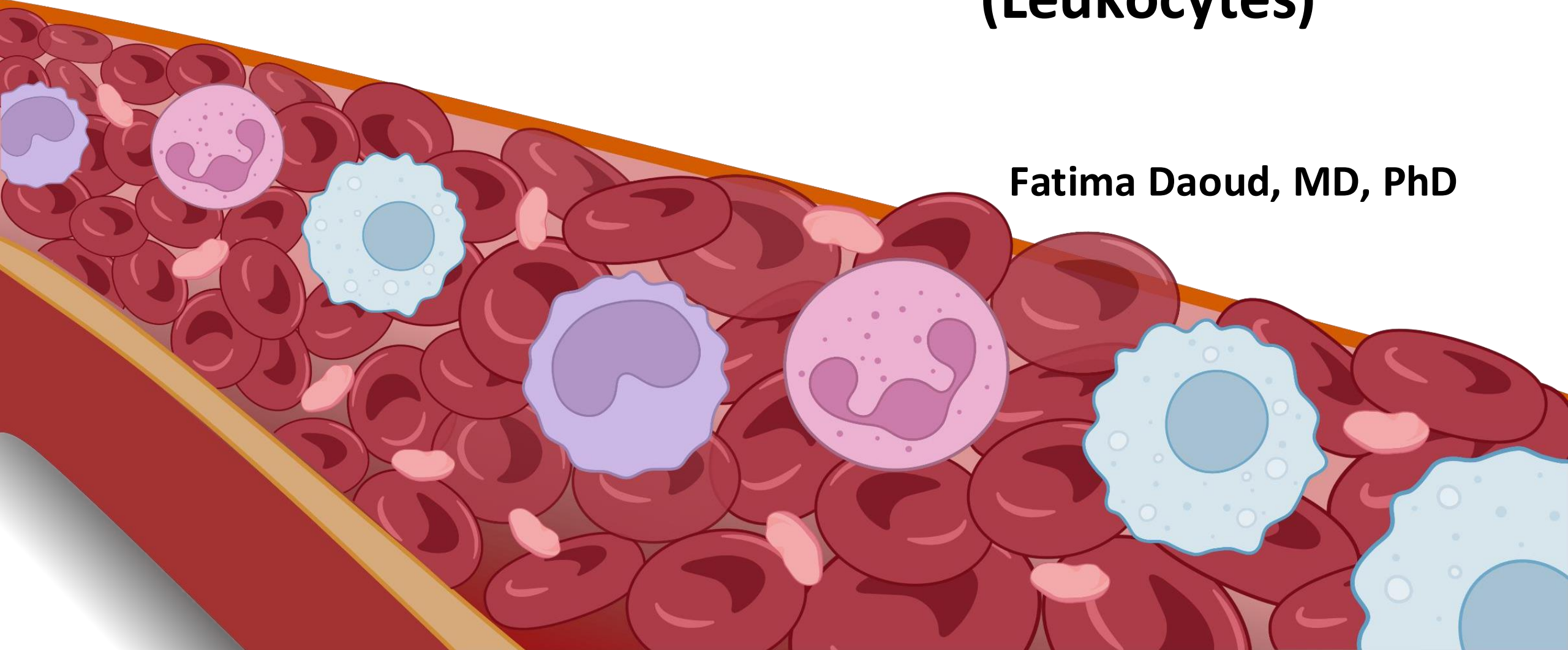
Reviewed by : Jannat Nasri

Hematology

Lymphocytes

White Blood Cells (Leukocytes)

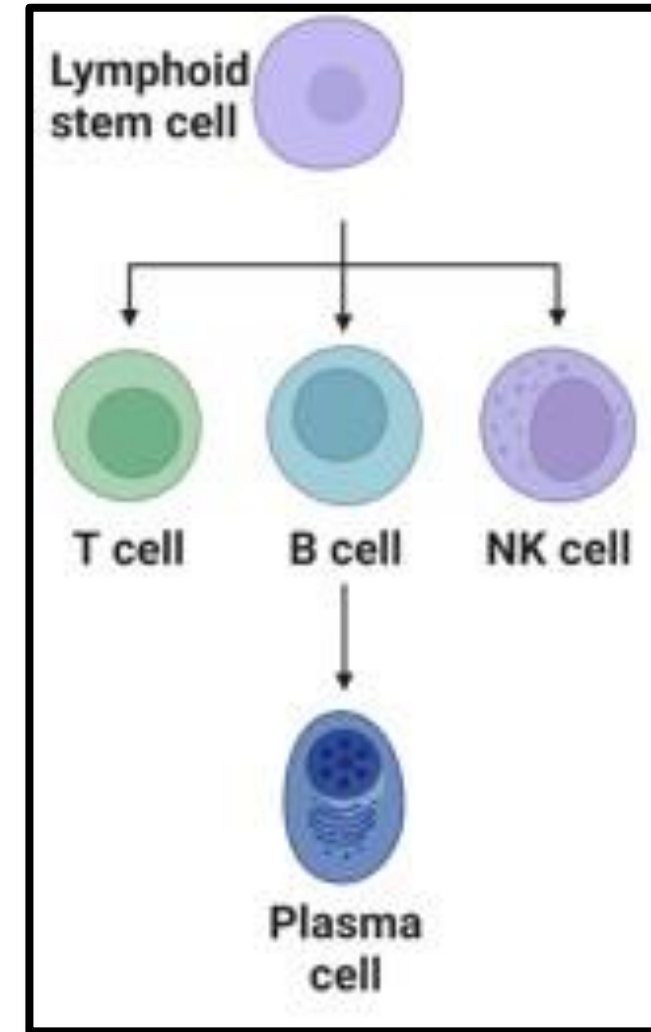
Fatima Daoud, MD, PhD



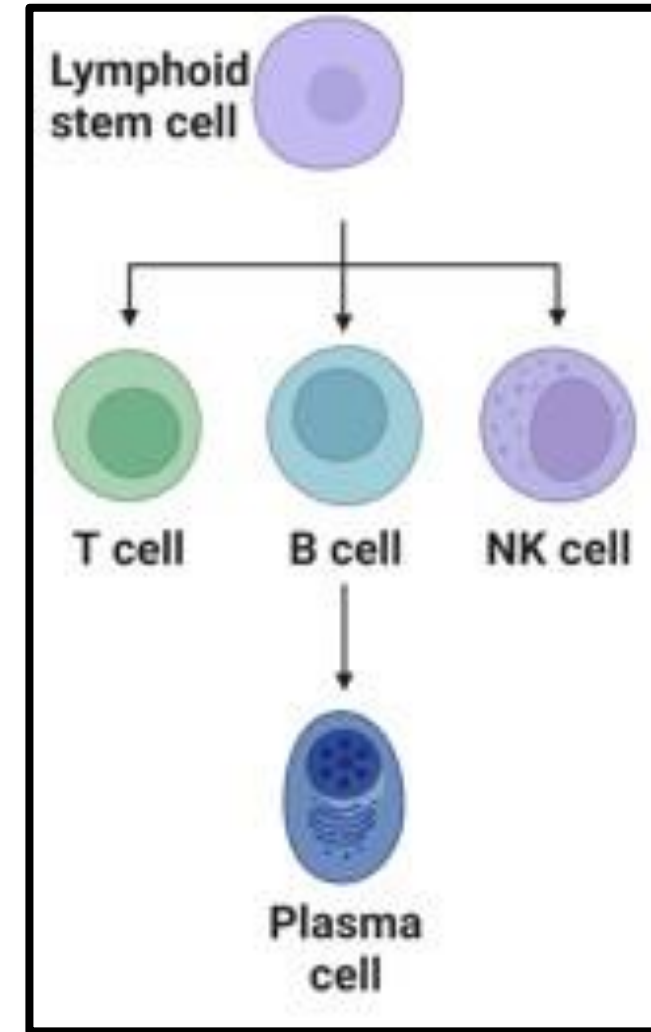
Hematology

Lymphocytes

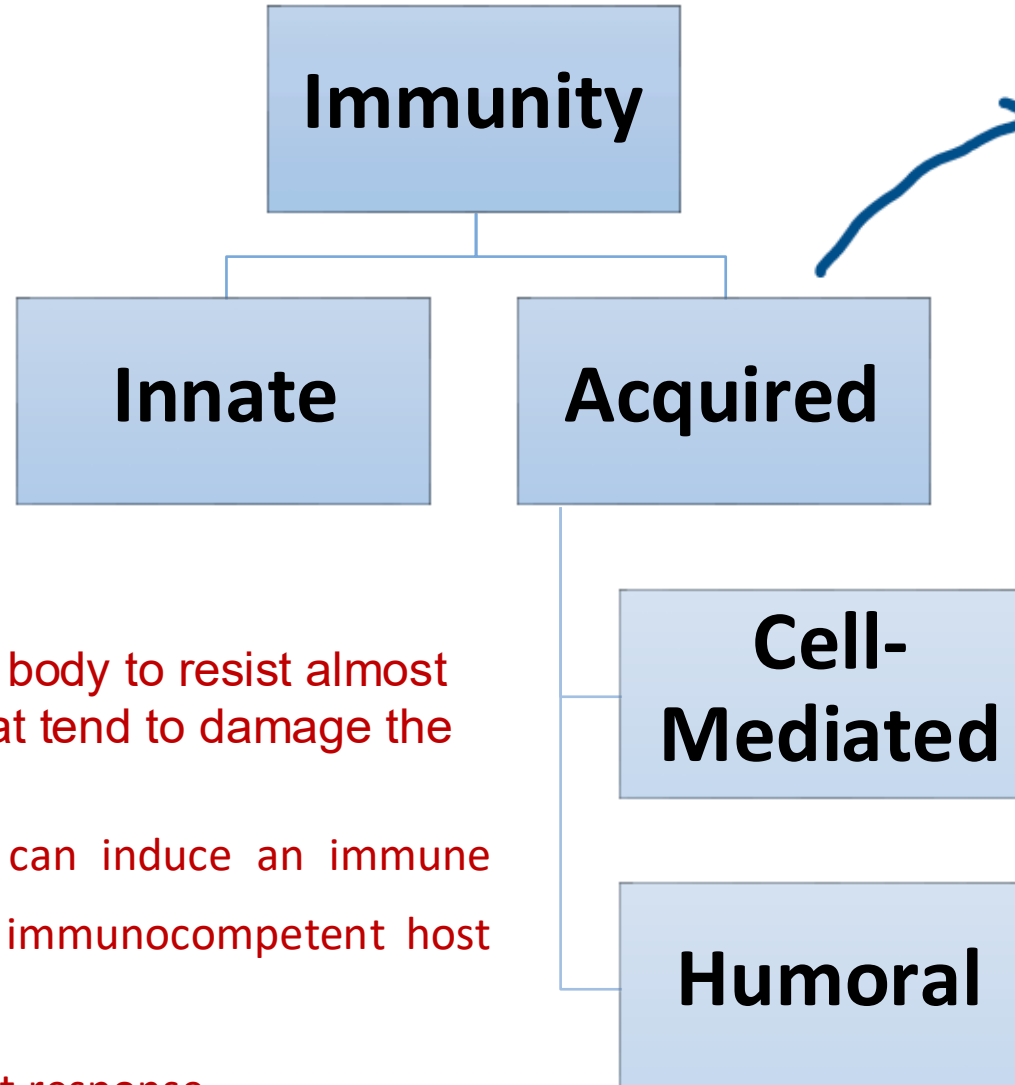
- Lymphocytes are produced mainly in the various lymphogenous tissues including the lymph glands, spleen, thymus, tonsils, and other pockets of lymphoid tissue throughout the body such as bone marrow except for a small number that are temporarily transported through the blood.



- Some of the lymphocytes enter the circulatory system continually.
- They leave the blood and return to the tissues after a few hours. The lymphocytes then re-enter the lymph and return to the blood resulting in a continuous circulation of lymphocytes throughout the body.
- Lymphocytes have life spans of weeks or months, depending on the body's need for these cells.



Immunity is described as the human body's ability to resist all forms of pathogens or toxins that cause tissue and organ damage.



Acquired Immunity is the function of lymphocytes

** Immunity is capability of human body to resist almost all types of organisms or toxins that tend to damage the tissues and organs.

** An antigen is a substance that can induce an immune response when introduced into an immunocompetent host and that can react with the antibody produced from that response

Innate Vs. Acquired (Adaptive)

- Results from general processes.
(Non specific)

- Results from processes directed towards specific disease organisms.
- Does not develop until the body is first attacked by a bacterium, virus, or toxin, often requiring weeks or months to develop the immunity.

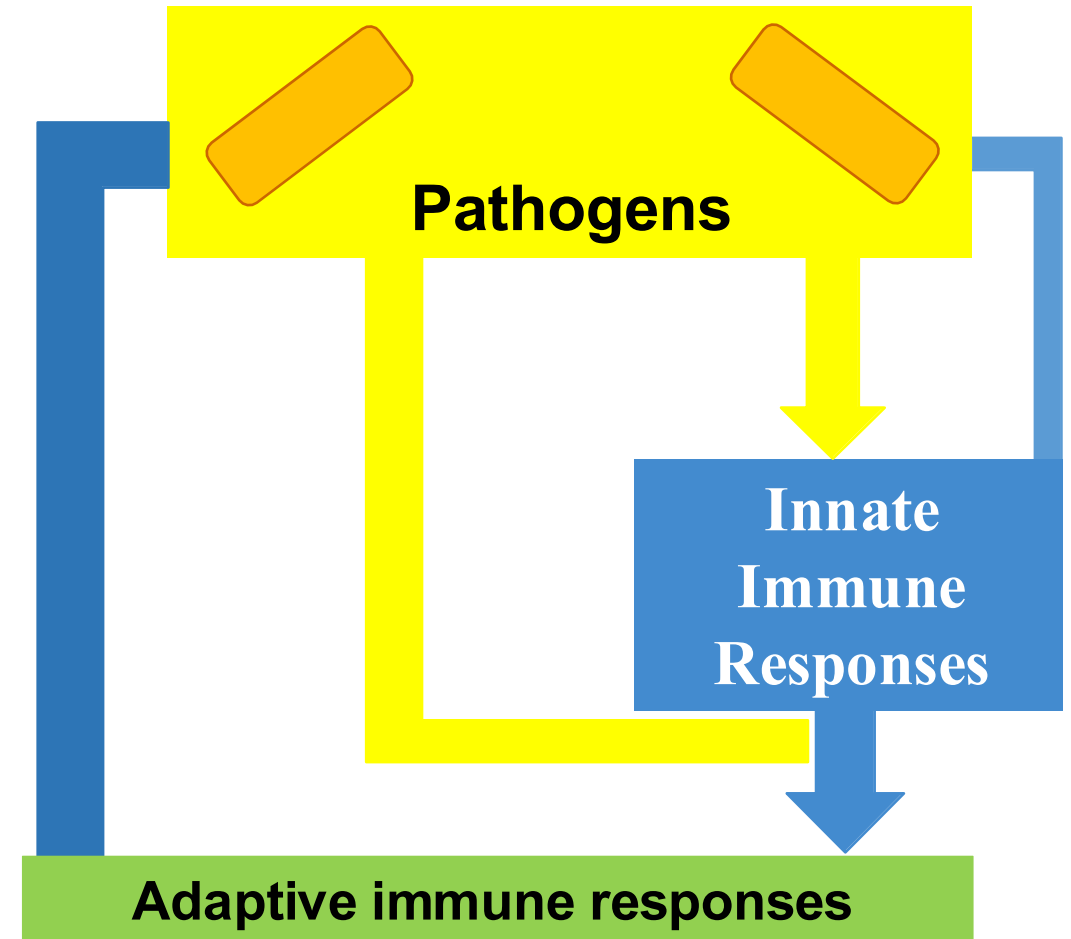
Innate Vs. Acquired (Adaptive)

- Phagocytosis
- Acid secretions of the stomach and the digestive enzymes.
- Skin (tight junctions).
- lysozyme
- Basic polypeptides
- Complement system
- Natural killer lymphocytes

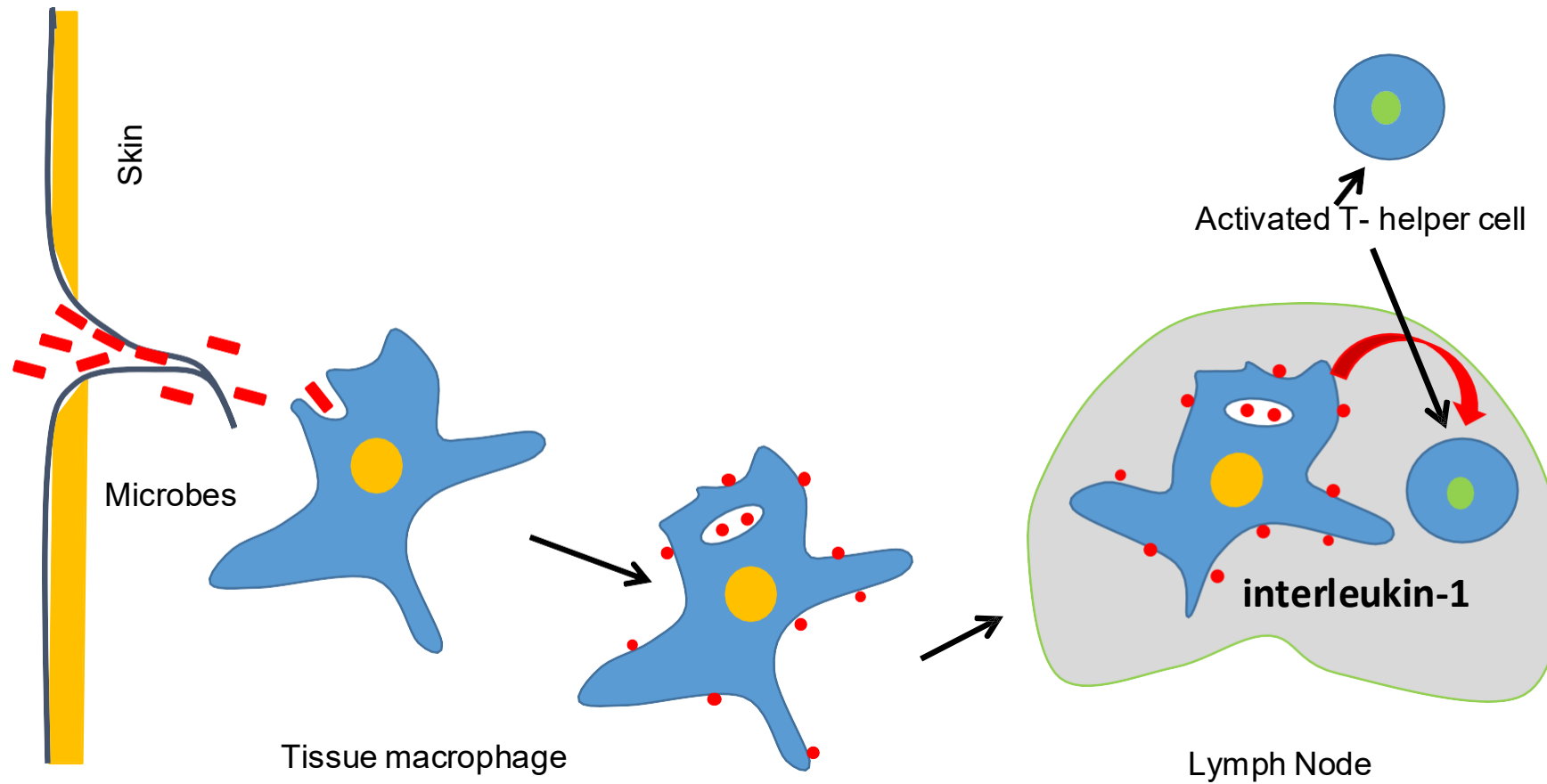
- Antibodies
- Activated lymphocytes

The innate immune system aims to :

- Prevent infection.
- Eliminate invader pathogens.
- Stimulate the acquired immune response.



Macrophage- activation of lymphocyte



Innate Immune Response

Adaptive Immune Response

- The innate immune system and the adaptive immune system interact and macrophages play a key role in this communication.
- The macrophages phagocytize and partially digest most invading microorganisms releasing antigenic components into the macrophage cytoplasm.
- The macrophages then transmit these antigens directly to the lymphocytes via cell to cell contact thus leading to activation of specific lymphocytic clones.
- Interleukin-1 is secreted by macrophages and supports the growth and reproduction of particular lymphocytes known as T-helper cells.

Basic Types of Acquired Immunity—Humoral and Cell-Mediated

- **Humoral (B-cell immunity)**
- Circulating antibodies, which are γ -globulin molecules in the plasma that are capable of attacking the invading agent.
- **The five classes of antibodies are: IgG, IgA, IgM, IgE, IgD**

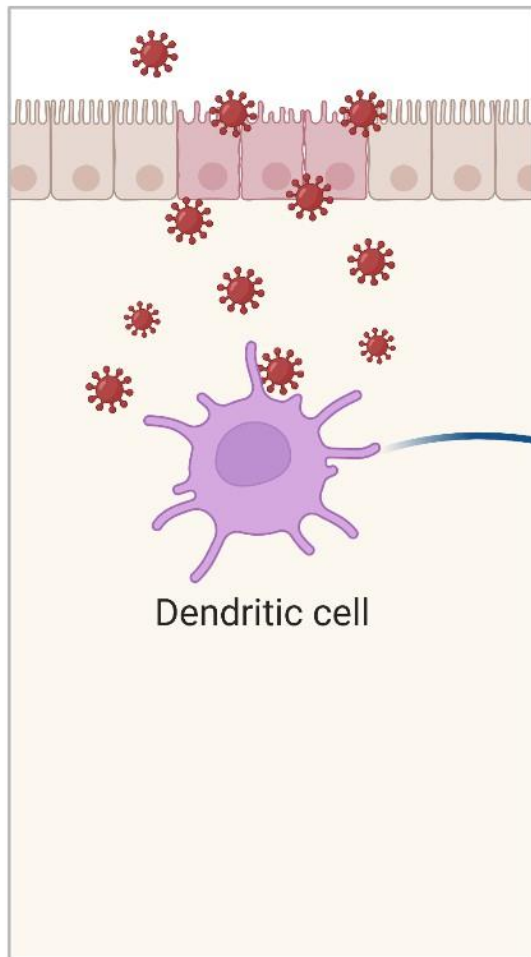
Most antigens stimulate both
B & T cells simultaneously

- **Cell-Mediated (T-cell immunity)**
- Achieved through the formation of large numbers of activated T lymphocytes that are specifically crafted in the lymph nodes to destroy the foreign agent.
- (1) *helper T cells*
(2) *cytotoxic T cells*
(3) *suppressor T cells*

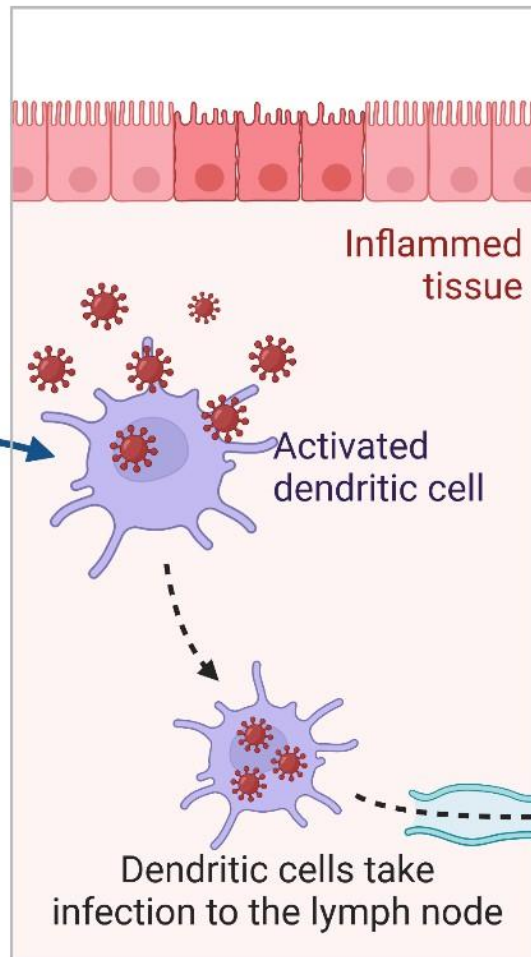
Image explanation->Next slide

Adaptive Immunity

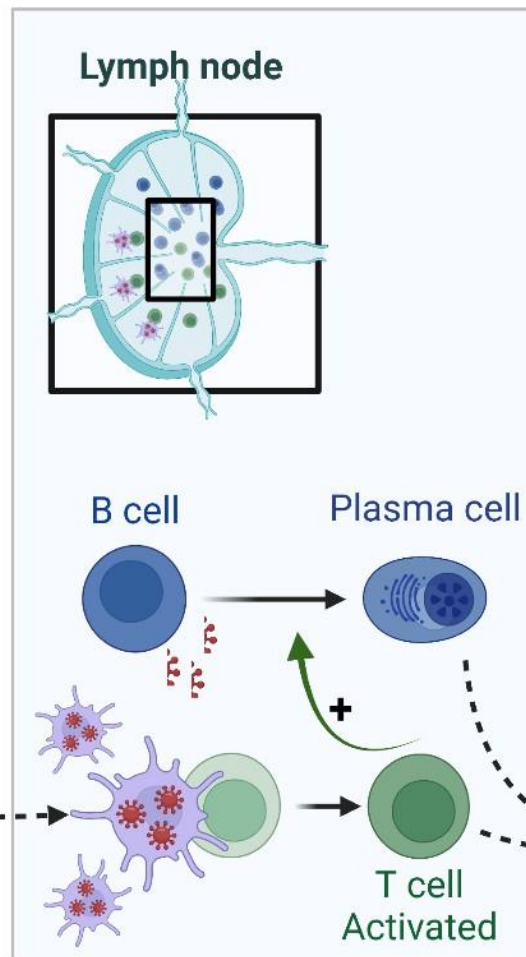
① Virus infects and replicates within the epithelium



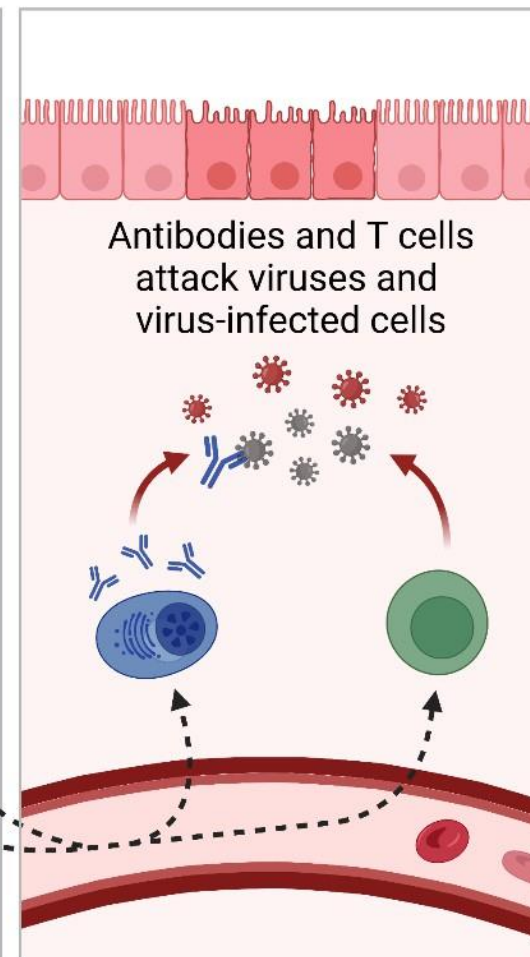
② Dendritic cell activation



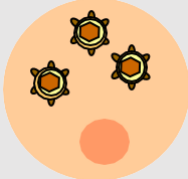
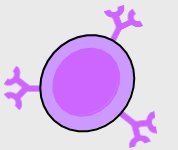
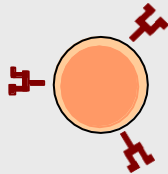
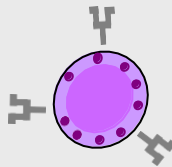
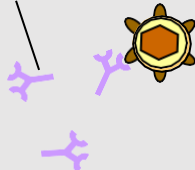
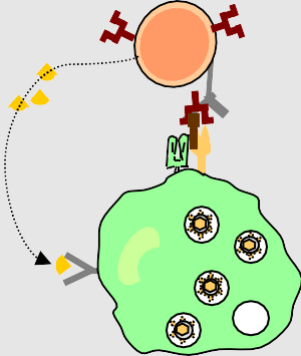
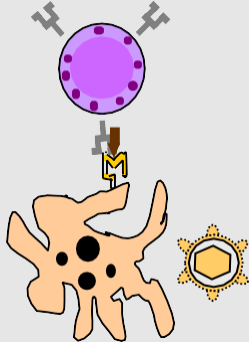
③ T and B cell priming in the lymph node



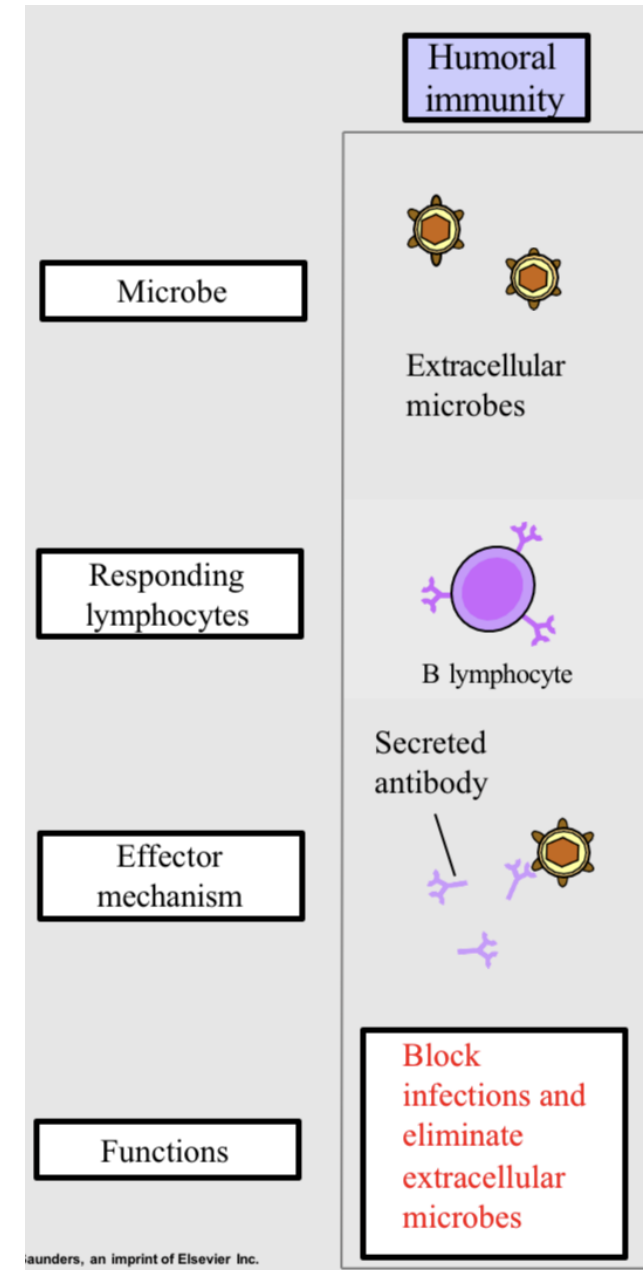
④ Adaptive immunity



- Before becoming exposed to a specific antigen, B lymphocytes clones lie latent in lymphoid tissue. When a foreign antigen enters the lymphoid tissue, macrophages phagocytize it and present it to T cells resulting in the formation of activated helper T cells.
- These helper cells release chemicals known as lymphokines that activate the specific B lymphocytes. Indeed, without the assistance of these helper T cells, the amount of antibodies produced by B lymphocytes is usually minimal.
- The plasma cells then divide, yielding a total population of around 500 cells for each original plasma cell in 4 days.
- The mature plasma cell then generates gamma globulin antibodies at an extremely rapid rate.
- The antibodies are released into the lymph and then circulated through the blood.

	Humoral immunity	Cell-mediated immunity	
Microbe	 <p>Extracellular microbes</p>	 <p>Phagocytosed Microbes in macrophage</p>	 <p>Intracellular Microbes (e.g., viruses) Replicating within Infected cell</p>
Responding lymphocytes	 <p>B lymphocyte</p>	 <p>Helper T lymphocyte</p>	 <p>Cytolytic T lymphocyte</p>
Effector mechanism	 <p>Secreted antibody</p>		
Functions	<p>Block infections and eliminate extracellular microbes</p>	<p>Activate macrophages to kill phagocytosed microbes</p>	<p>Kill infected cells and eliminate reservoirs of infection</p>

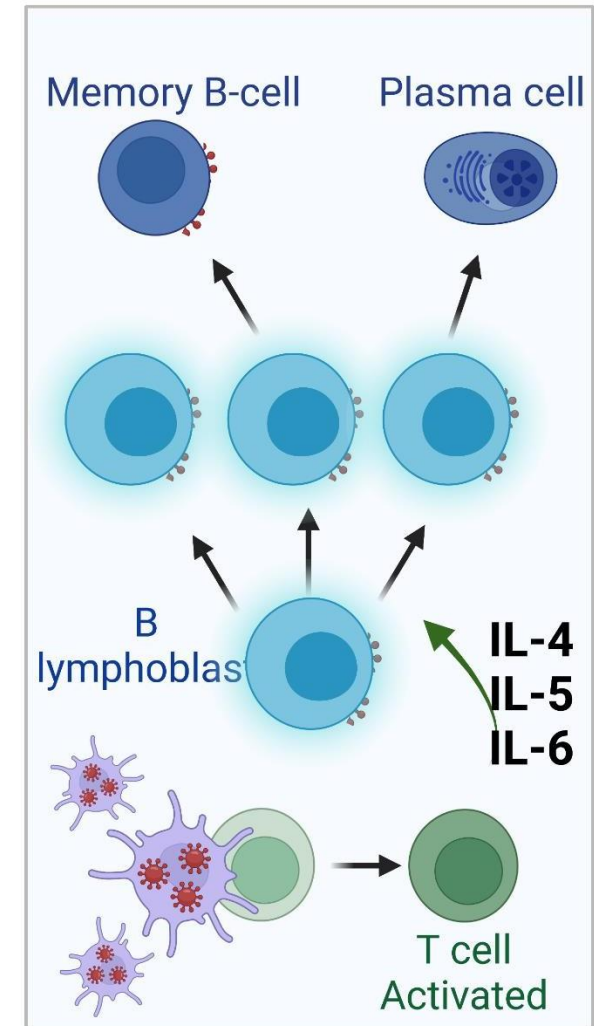
- As previously noted, humoral immunity occurs through the activation of B lymphocytes, transforming them into plasma cells capable of producing antibodies to eradicate extracellular microorganisms.
- The presence of T-helper cells, which are activated first by macrophages significantly increases plasma cells ability to make antibodies. T-helper cells are part of cell mediated immunity.



- The last subtype of lymphocytes to be discussed is cytotoxic T cells which are also a component of cell mediated immunity.
- Cytotoxic T cells are trained to attack cells infected with intracellular pathogens such viruses that replicate within the cells.
- They also target cancer cells and other foreign cells. When certain antigens interact with T & B lymphocytes in lymphoid tissue, some T lymphocytes become activated T cells and some plasma cells start forming antibodies.
- Activated T cells and antibodies in turn react very specifically against the antigens that triggered their formation.
- Each lymphocyte clone responds to only one type of antigen.

Formation of Memory cells (B-lymphocyte)

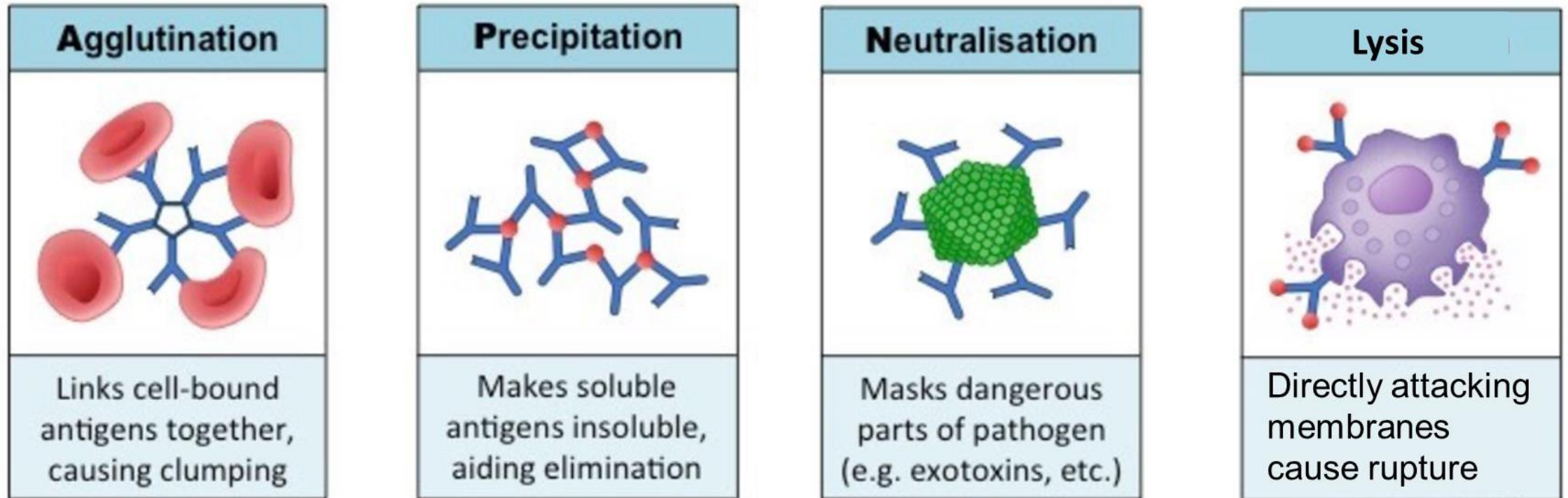
- Moderate numbers of new B lymphocytes similar to those of the original clone.
- They also circulate throughout the body to populate all the lymphoid tissue; immunologically, however, they remain dormant until activated once again by a new quantity of the same antigen



****A few of the lymphoblasts formed by activation of a clone of B lymphocytes do not go on to form plasma cells but instead form moderate numbers of new B lymphocytes similar to those of the original clone.**

****They also circulate throughout the body to populate all the lymphoid tissue; immunologically, however, they remain dormant until activated once again by a new quantity of the same antigen**

Mechanisms of Action of Antibodies



Agglutination examples: bacteria and RBCs

Precipitation examples: tetanus toxin

Neutralization covers the harmful sites

Hematology

Inflammation

Inflammation



Inflammation

- The complex of changes that accompany tissue damage including vascular and cellular events that aim to clean up any cellular debris or pathogen and initiate repair.

Damaged tissues themselves release various compounds that produce secondary changes

Autoimmune inflammation: the body mistakes its own/self antigens for foreign antigens and attacks them.

Types/causes of Inflammation:

Infectious



Autoimmune inflammation



Heat



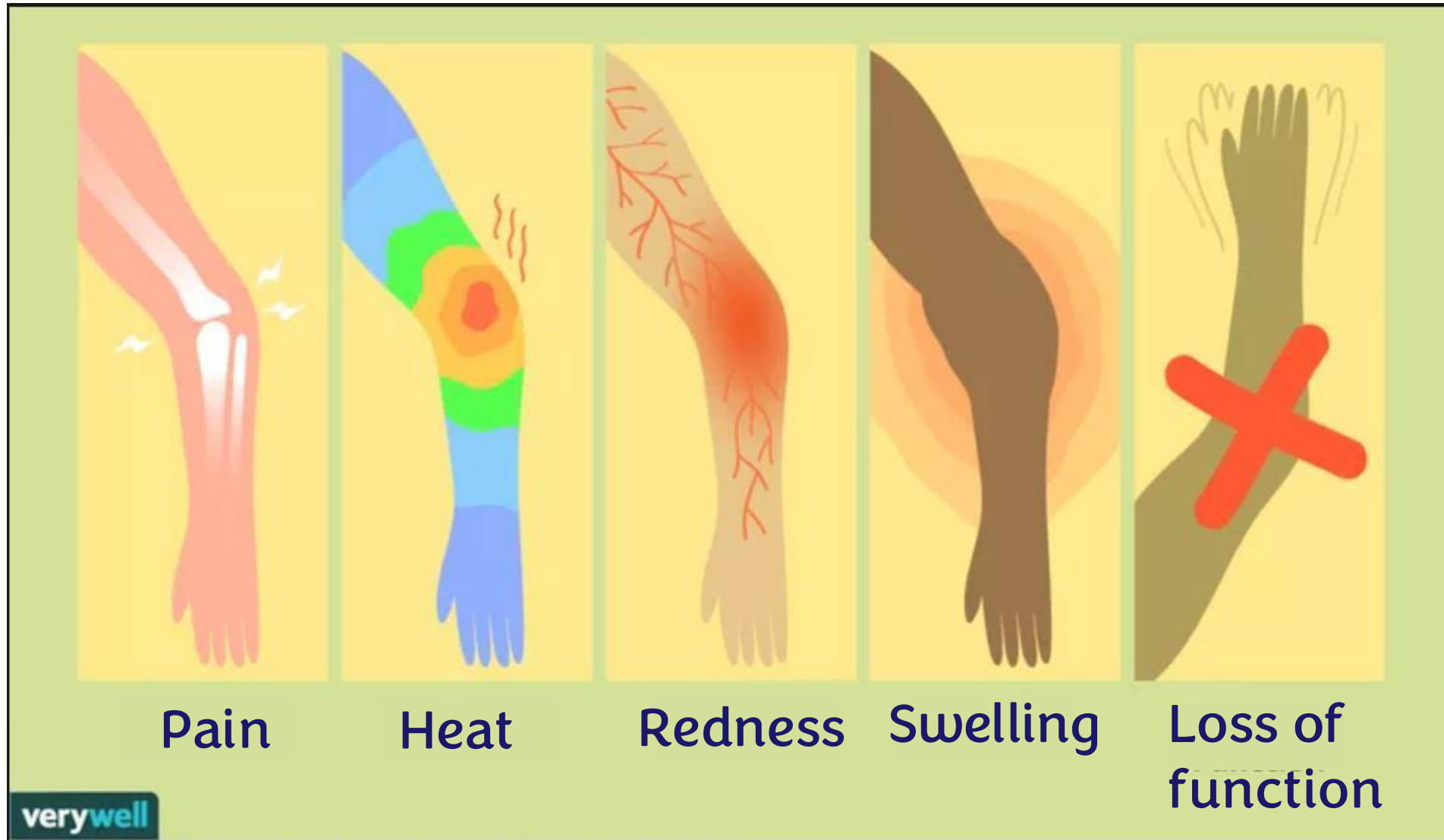
Infectious



metabolic inflammation



Signs of Inflammation



Signs of inflammation

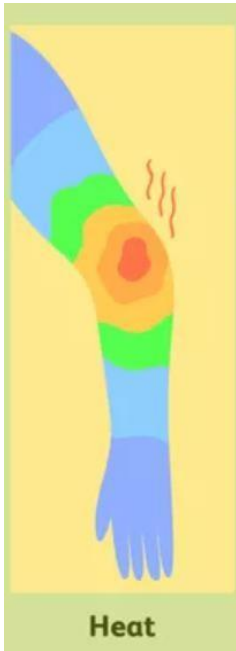
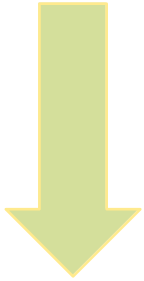
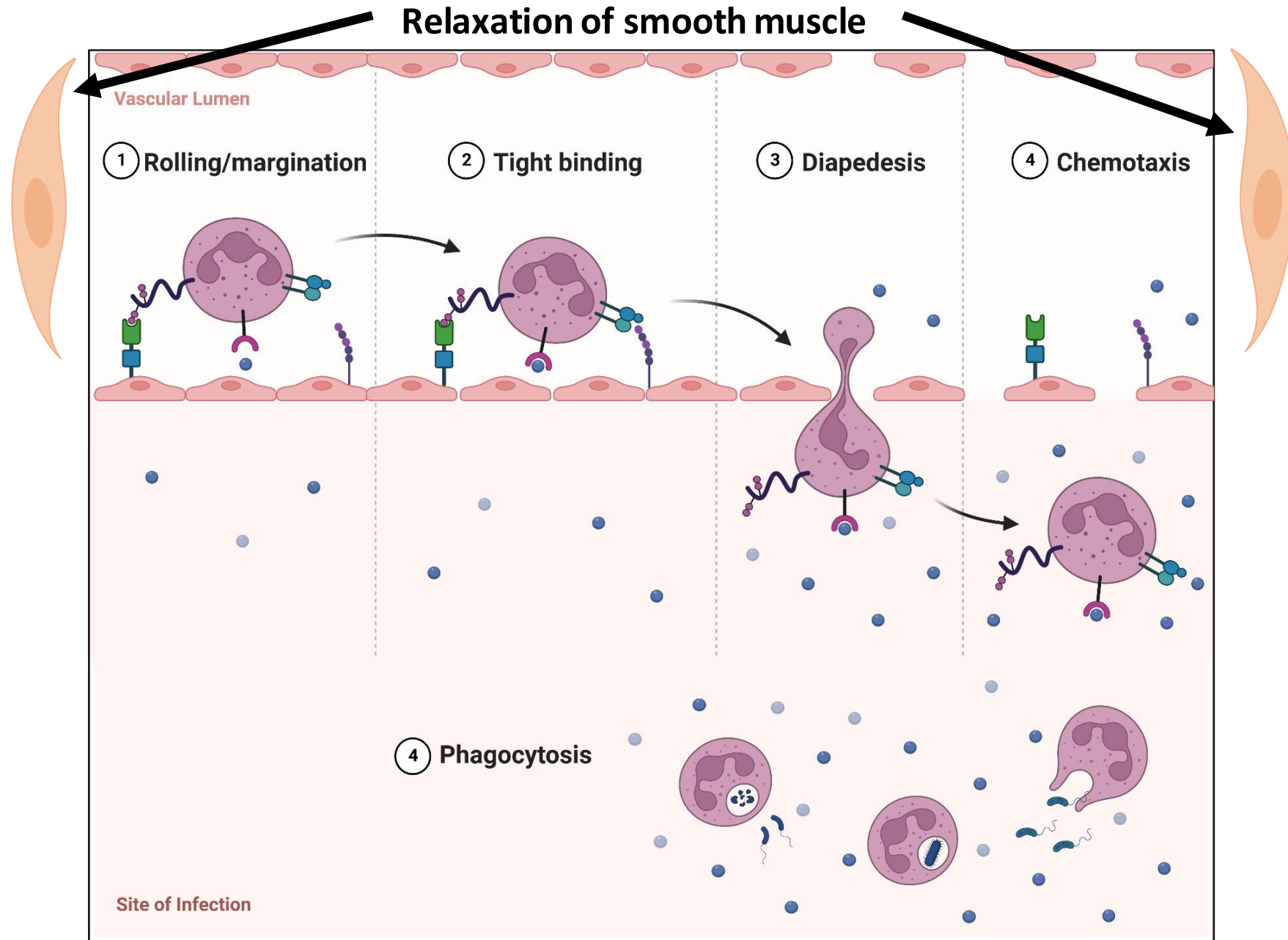
1. Loss of function: specifically around a joint, where swelling can reduce movement
2. Vasodilation: This increases local blood flow which leads to redness (erythema) and heat. The vasodilation is a result of smooth muscle contraction.
3. Heat: the slight increase in local temperature speeds metabolic reactions, which can generate more heat
4. Increased permeability: fluid leaks into the interstitial spaces, producing swelling/edema
5. Swelling: if the edema is around a joint, it can lead to decreased movement/ loss of function.
6. Pain: direct nerve injury, toxic chemicals released by microbes, and increased tissue pressure from swelling.

Pain mediators

1. Bradykinin acts on nerve endings and causes a considerable amount of inflammatory pain
2. Prostaglandins: aggravate and prolong pain

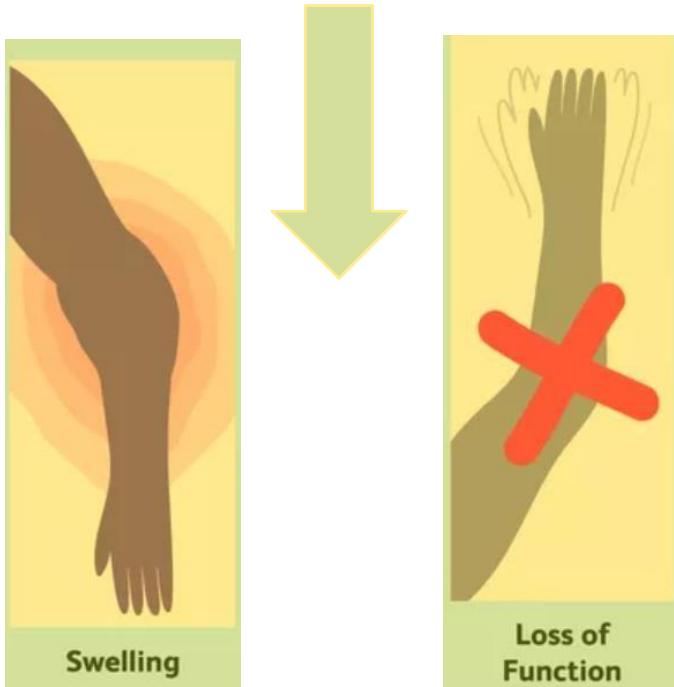
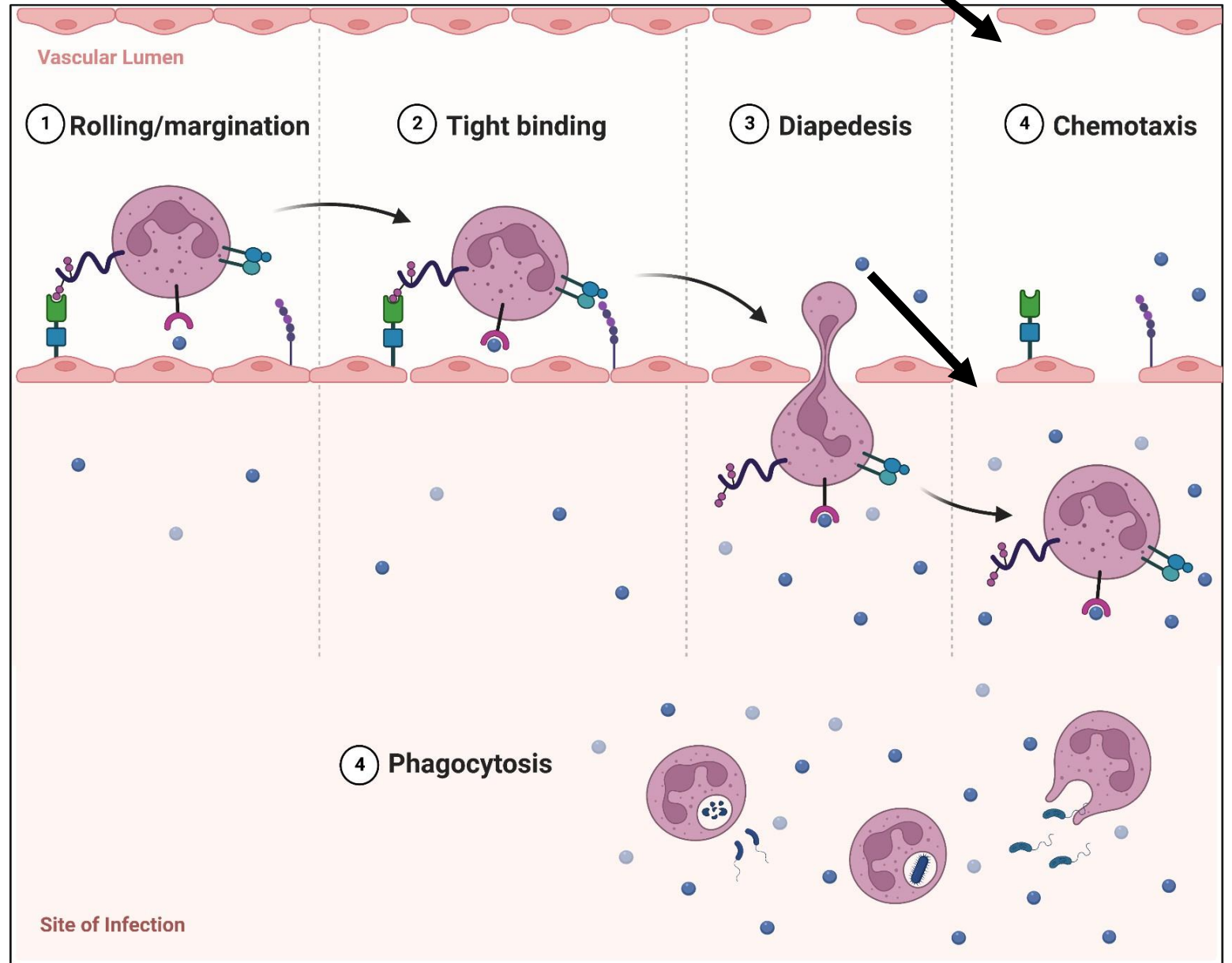
Inflammation is characterized by:

1. Vasodilation of the local blood vessels.



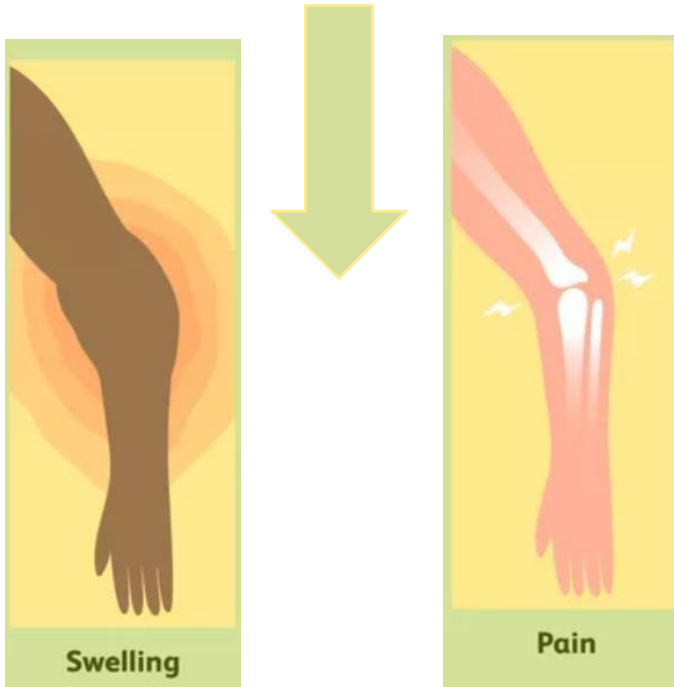
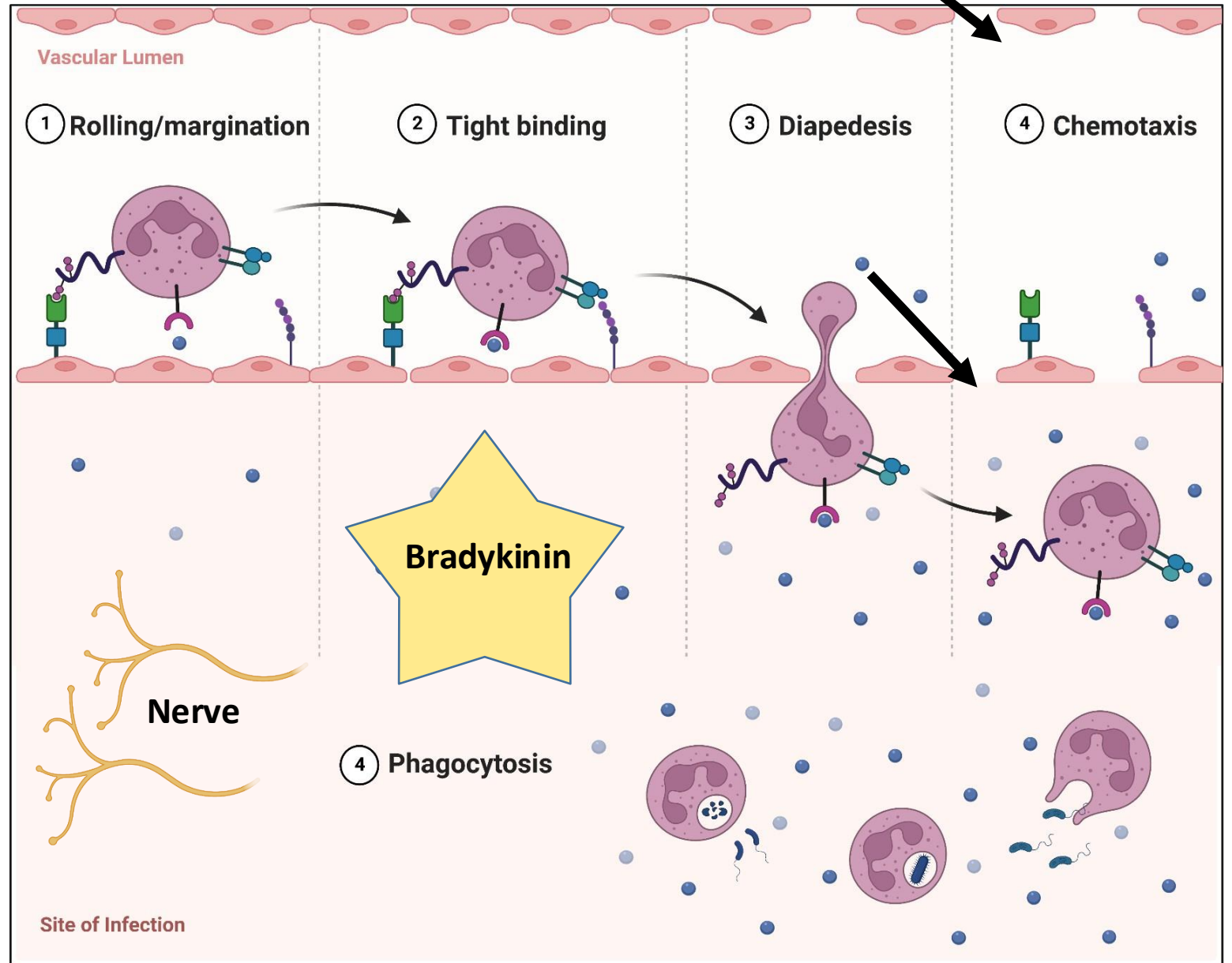
Inflammation is characterized by:

2. Increased permeability of the capillaries.



Inflammation is characterized by:

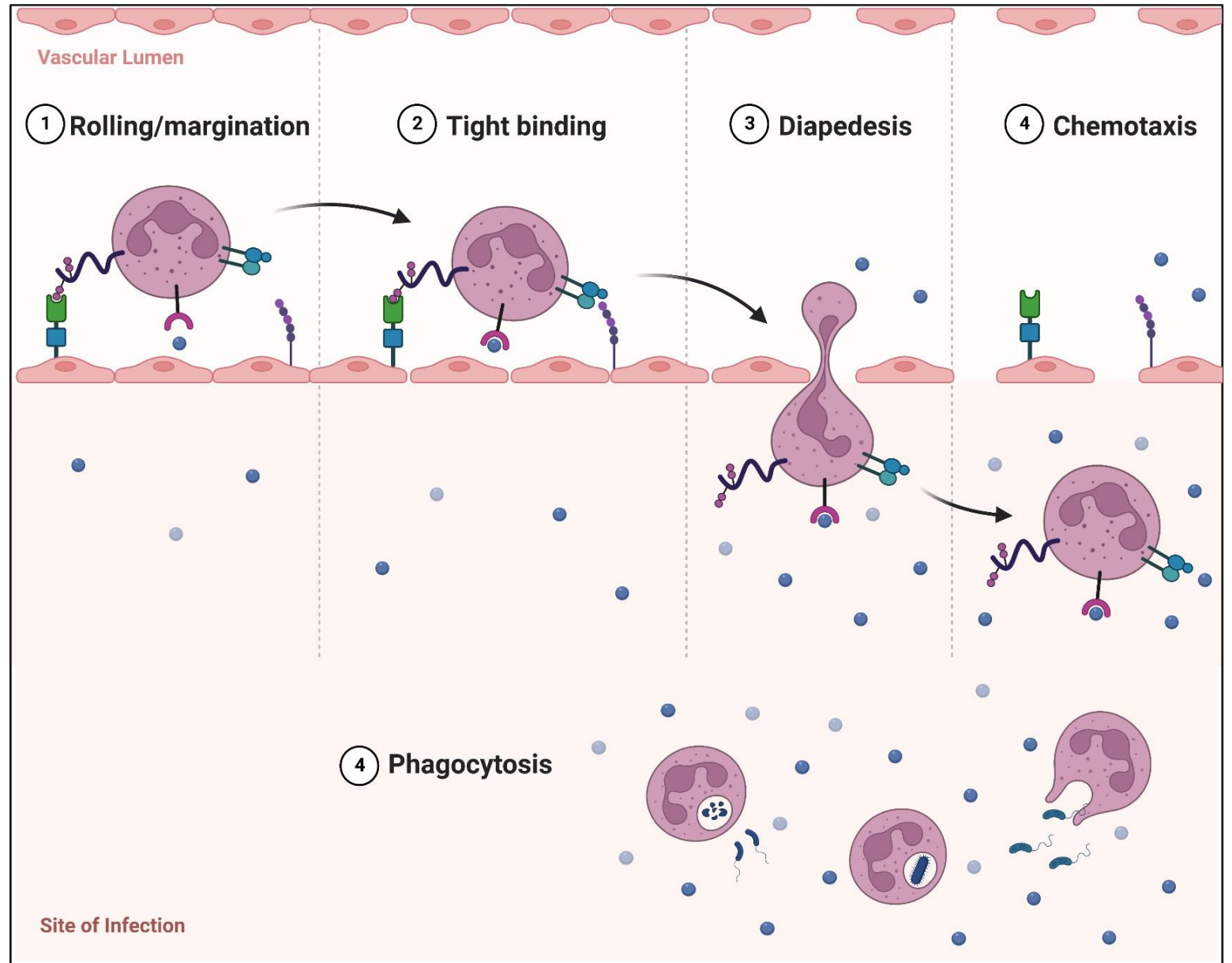
2. Increased permeability of the capillaries.



Inflammation is characterized by:

3. Migration of large numbers of granulocytes and monocytes into the tissue. Due to locally produced inflammatory chemicals that activate the macrophage system.

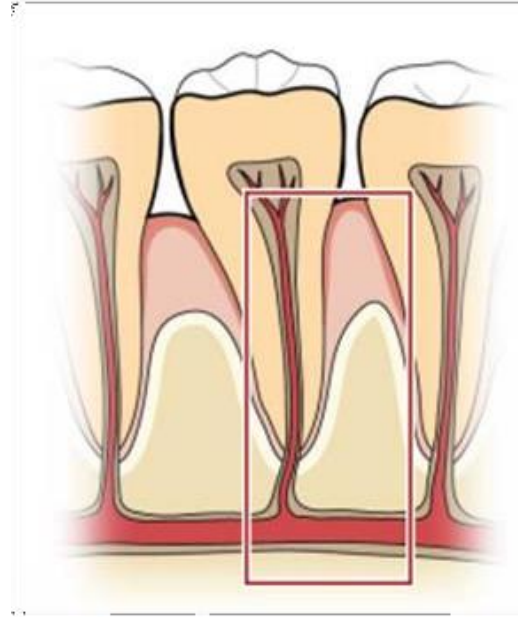
Leukocytosis



Inflammation is characterized by:

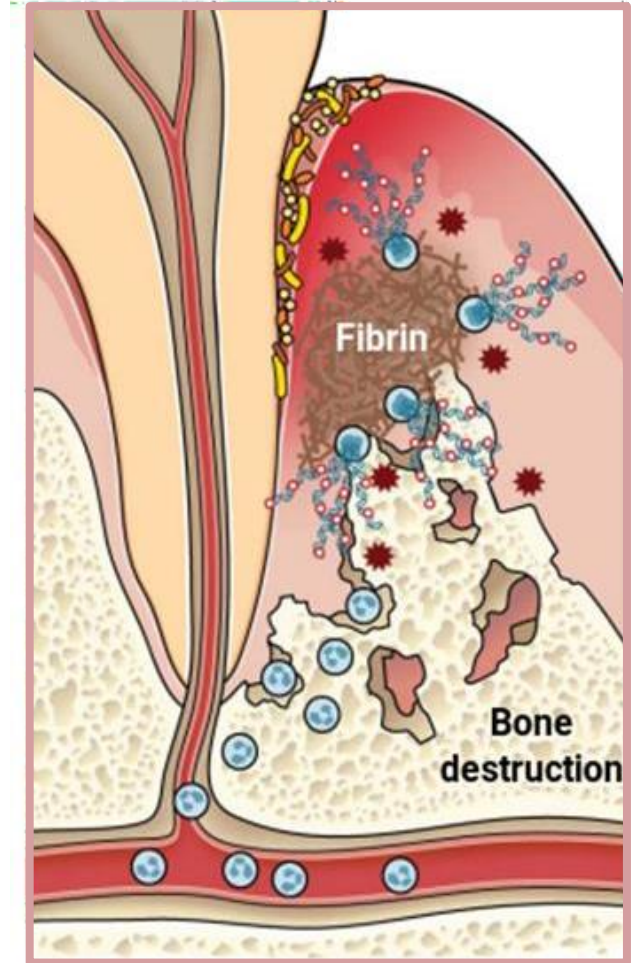
4. Increased amounts of fibrinogen and other proteins leaking from the capillaries.

The leaked fibrinogen causes clotting of fluid within the interstitial spaces, causing 'walling-off' which is the separation of inflamed area from the surrounding tissues.



Walling-Off

Pathogenic (periodontitis)



Walling-off

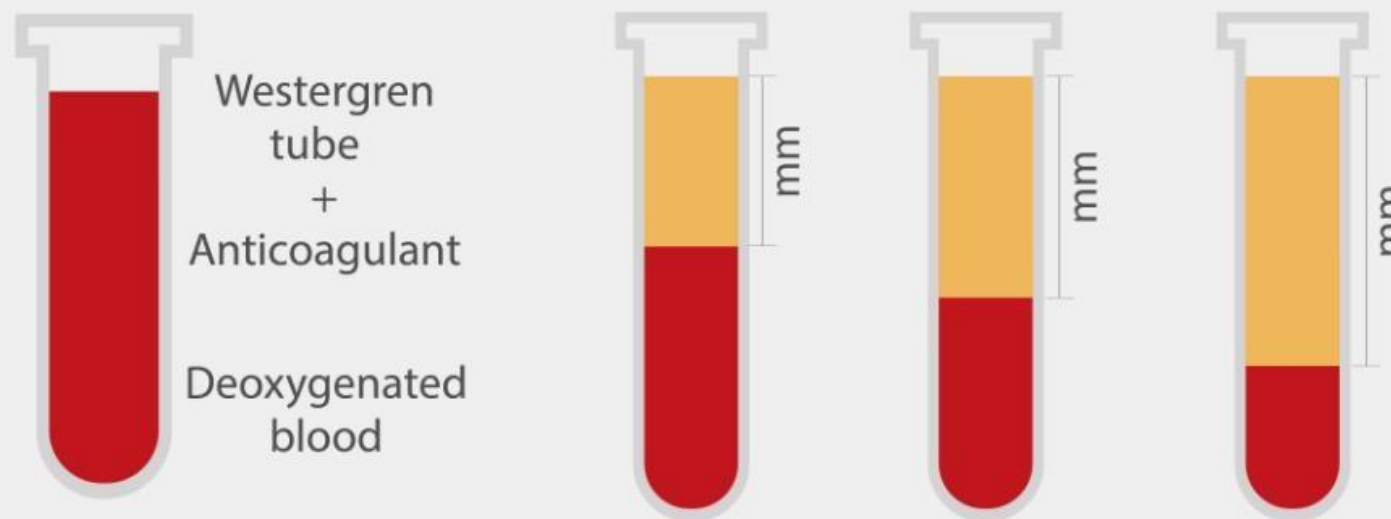
The fibrin clots can block tissue spaces and lymphatic vessels, greatly reducing fluid movement through the area. This helps slow the spread of bacteria and harmful compounds.

Erythrocyte sedimentation rate (ESR)

ESR: how quickly RBCs settle to the bottom of a blood sample tube over time, measured in mm.



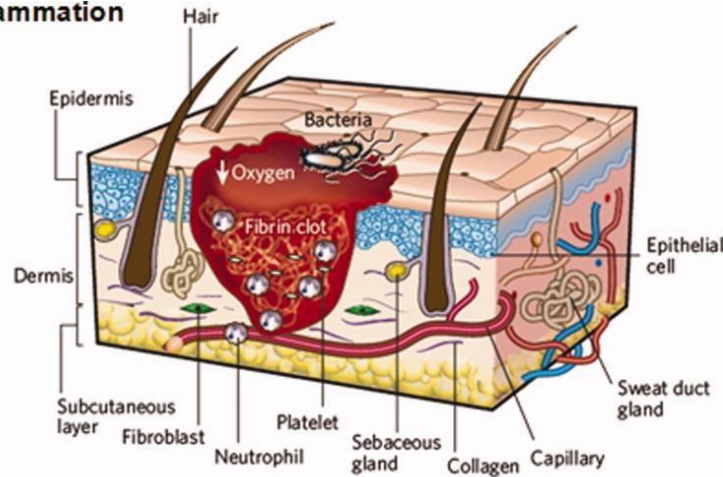
When blood is left alone in an upright test tube, the sedimentation increases over time, but the ESR stays the same, which indicates how quickly the sedimentation happens.



Increase in plasma fibrinogen levels → Sedimentation ↑ → ESR ↑

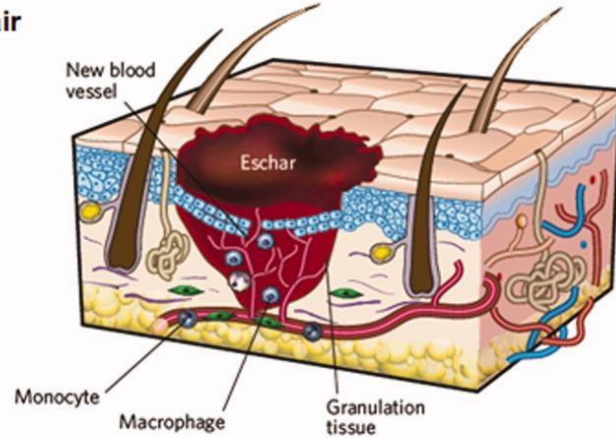
So high ESR may indicate active inflammation.

A Inflammation

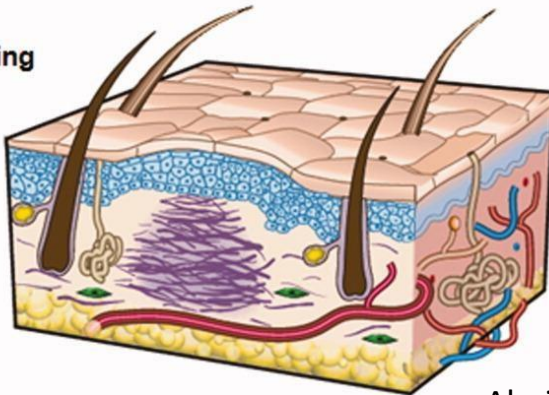


- (A) A fibrin clot is formed and inflammatory cells enter the wound site.
- (B) Re-epithelialization
- (C) Remodeling is the final stage of wound healing. ECM remodeling factors modulate and revise the scar tissue.

B Repair



C Remodelling



The first phase is dominated by thrombin cleavage of fibrinogen integrated with an acute inflammatory response that functions to contain tissue damage, stop the loss of blood, and prevent microbial infection. The second phase is dominated by plasmin dissolution of fibrin and other matrix proteins integrated with reparative inflammatory cells working to remodel and repair damaged tissue

Inflammation restores tissue homeostasis after injury.

- Early wound response: vasodilation and WBC recruitment, a blood clot may form to limit excessive bleeding from damaged vessels.
- Re-epithelialization: proliferation of healthy basal keratinocytes.
- Fibroblasts migrate to the wound and proliferate there, releasing ECM and initiating remodeling.

**These processes ultimately lead to complete wound healing,
inflammation playing a vital role**

رسالة من الفريق العلمي:



- كَلِمَتَانِ خَفِيفَتَانِ عَلَى اللِّسَانِ، ثَقِيلَتَانِ فِي الْمِيزَانِ، حَبِيبَتَانِ إِلَى الرَّحْمَنِ: سُبْحَانَ اللَّهِ وَبِحَمْدِهِ، سُبْحَانَ اللَّهِ الْعَظِيمِ.

خلاصة حكم المحدث : [صحيح]

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Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1			
V1 → V2			