

# IMMUNOLOGY



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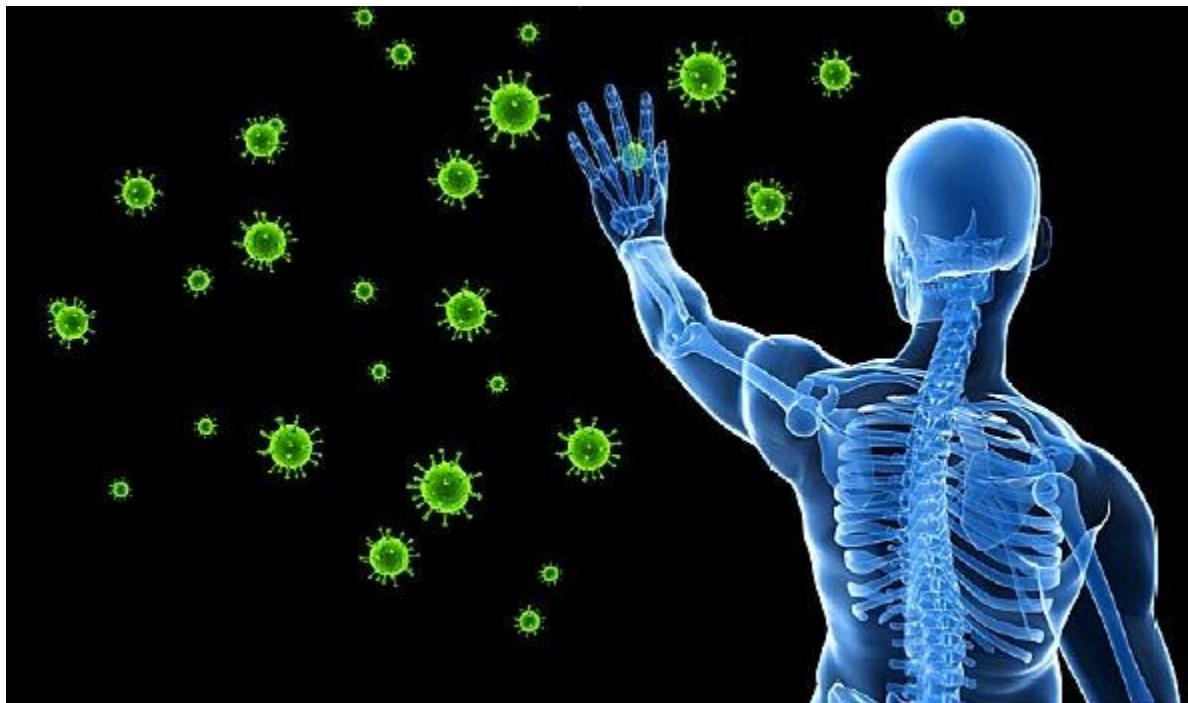
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Bennett University

# IMMUNOLOGY

Latin- Immunis = to exempt  
English= protection from disease

- The study of the mechanisms used by the body to protect against environmental agents that are foreign to the body ("challenges").
- The study of how the body defends itself against infectious agents and pathogens.

- **Bacteria**
- **Fungi**
- **Toxins**
- **Virus**
- **Parasites**
- **Abnormal cells**

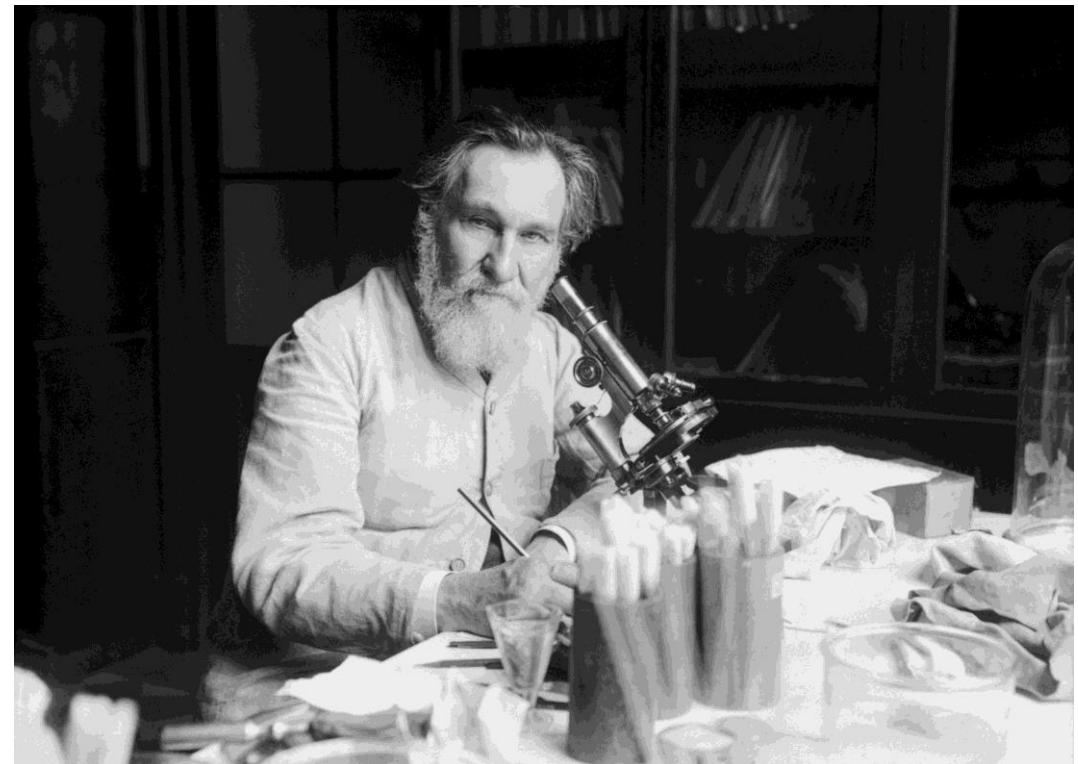
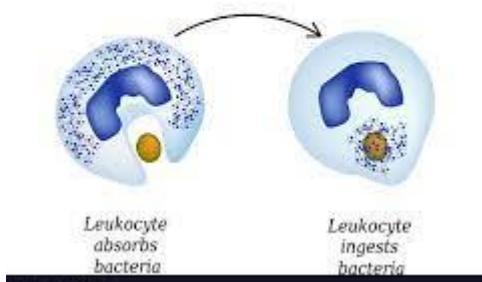


# IMMUNOLOGY

Ilya Mechnikoff, 1906 Nobel Prize

- He pinned small thorns into starfish larvae and noticed unusual cells surrounding the thorns.
- First observed the phenomenon of phagocytosis.

## Phagocytosis of leukocytes



# IMMUNITY

Immunity is resistance to infection after a foreign antigen has penetrated the first line of defense,

Immunity is achieved naturally, by having the disease or the artificial immunization.

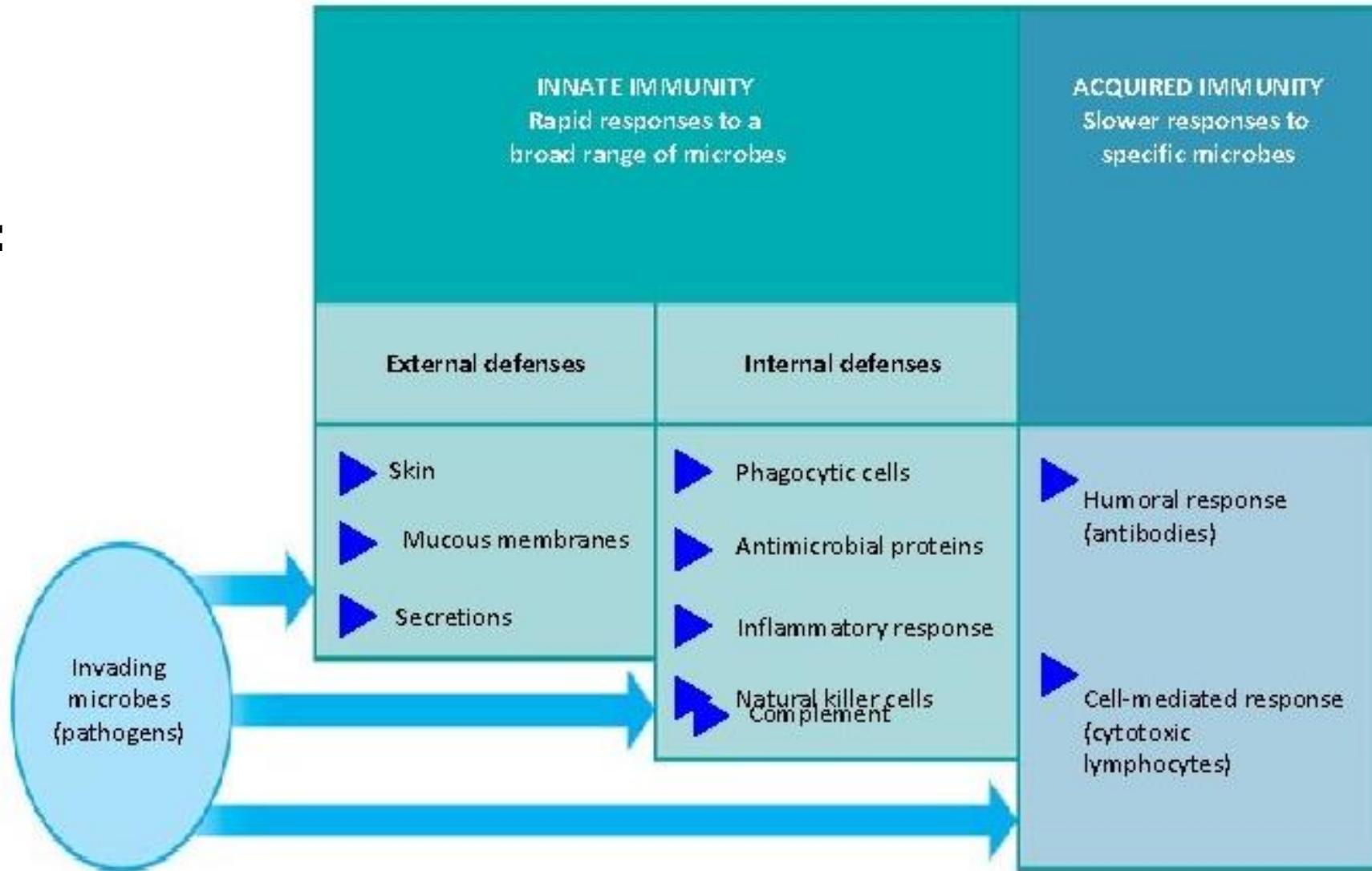
Immunity is acquired actively; that is, intentionally by receiving a vaccine or having had the diseases.



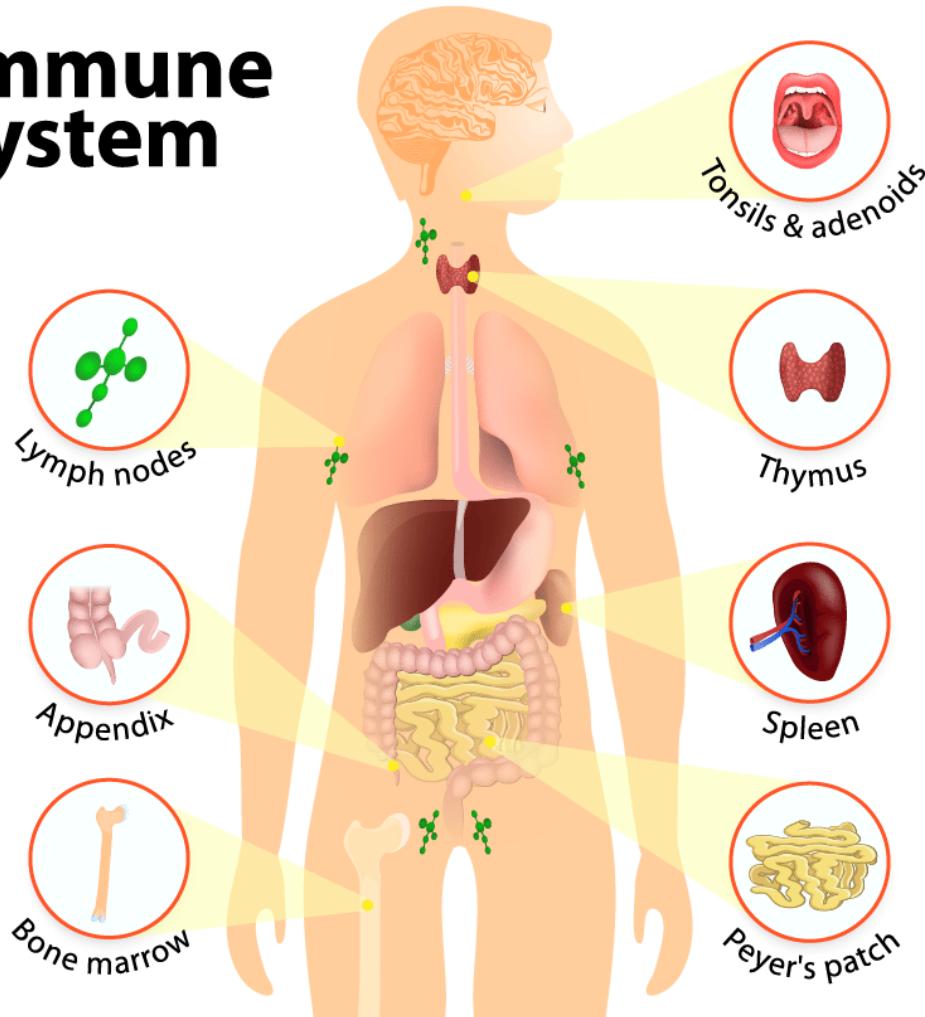
# A typical immune response

FIRST LINE  
Of DEFENSE

SECOND LINE  
Of DEFENSE



# Immune system

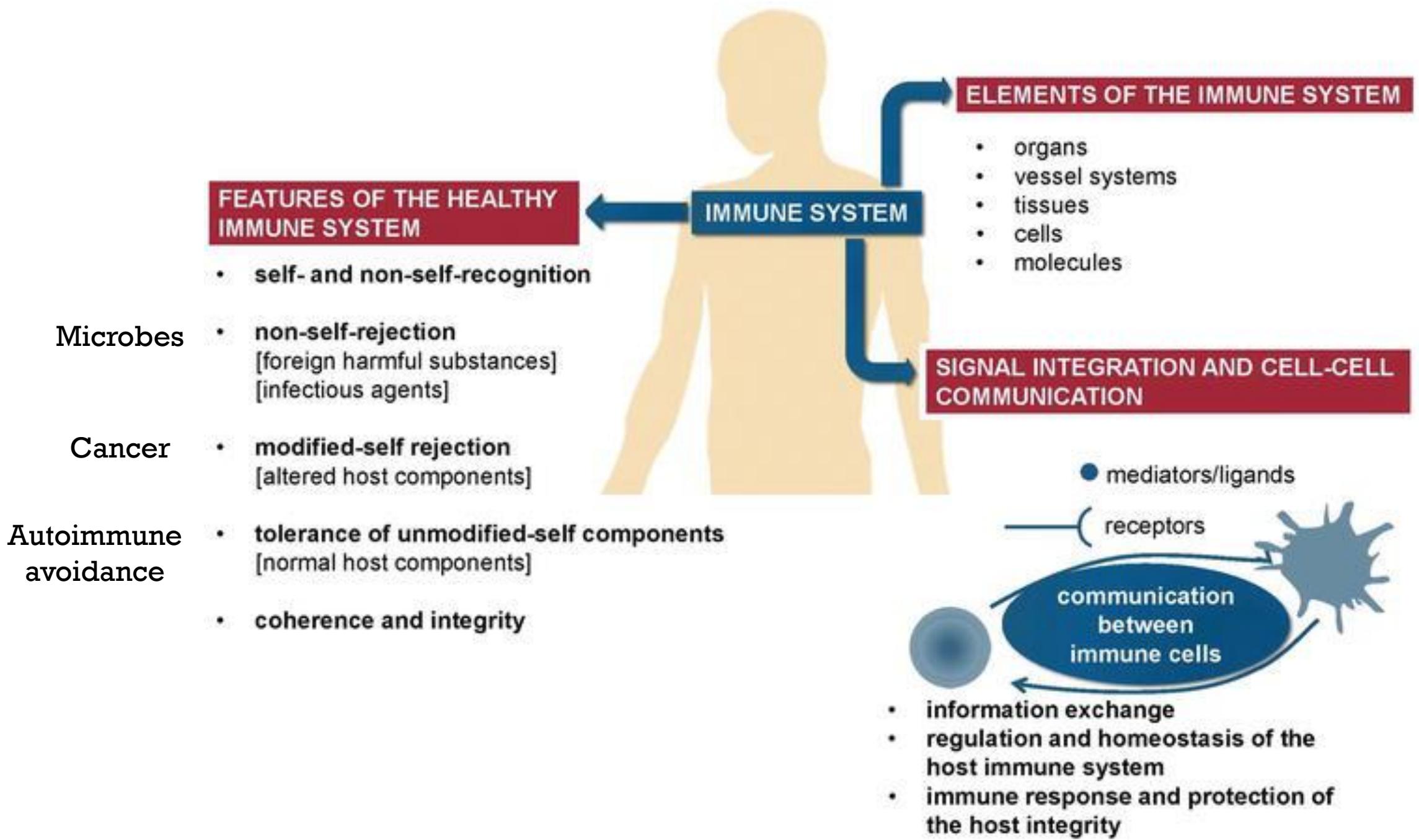


**Immune System-** is a functional system not an organ system

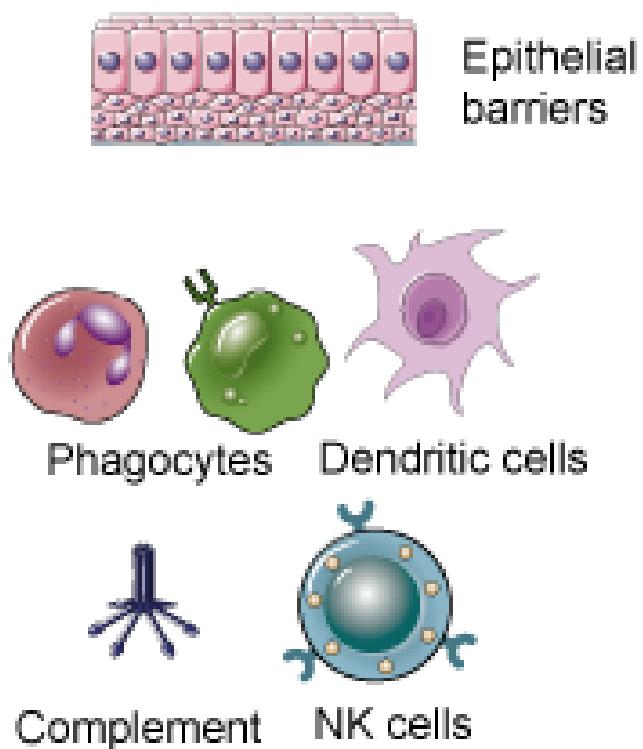
- Skin
- Lining of mucus
- Red and white blood cells (RBC/WBC)
- Most tissues have presence of immune cells as guards

## Examples of self-care:

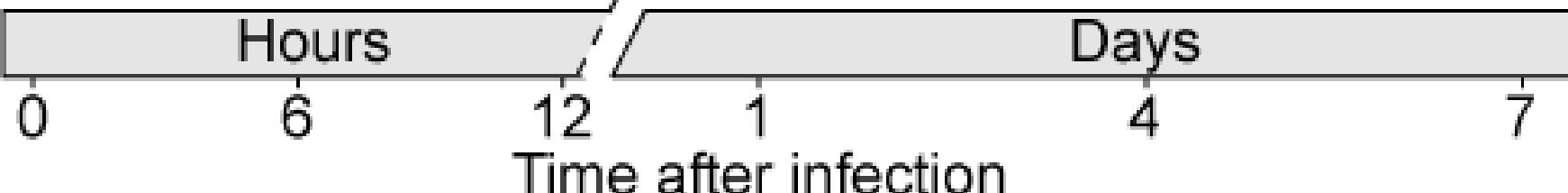
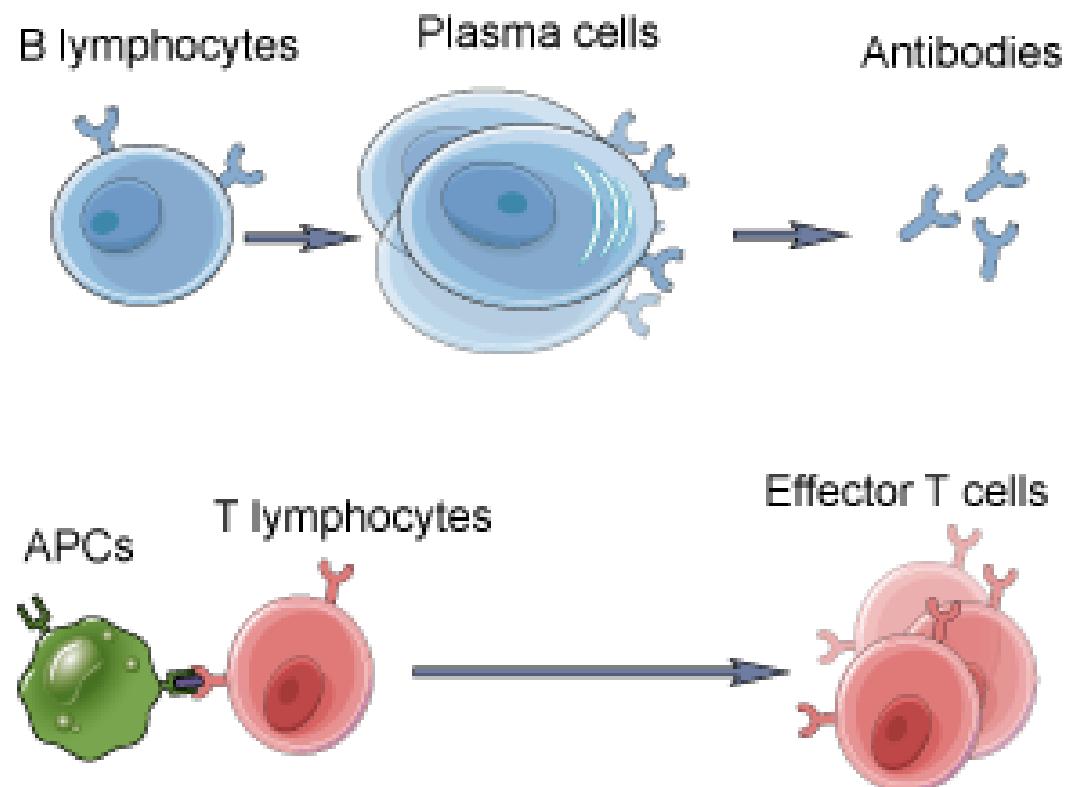
- Removal of old RBCs and tissue debris (scar/ wounds/ disease)
- Rejection of 'foreign' stuff (organ transplant)
- Allergies



## Innate immunity

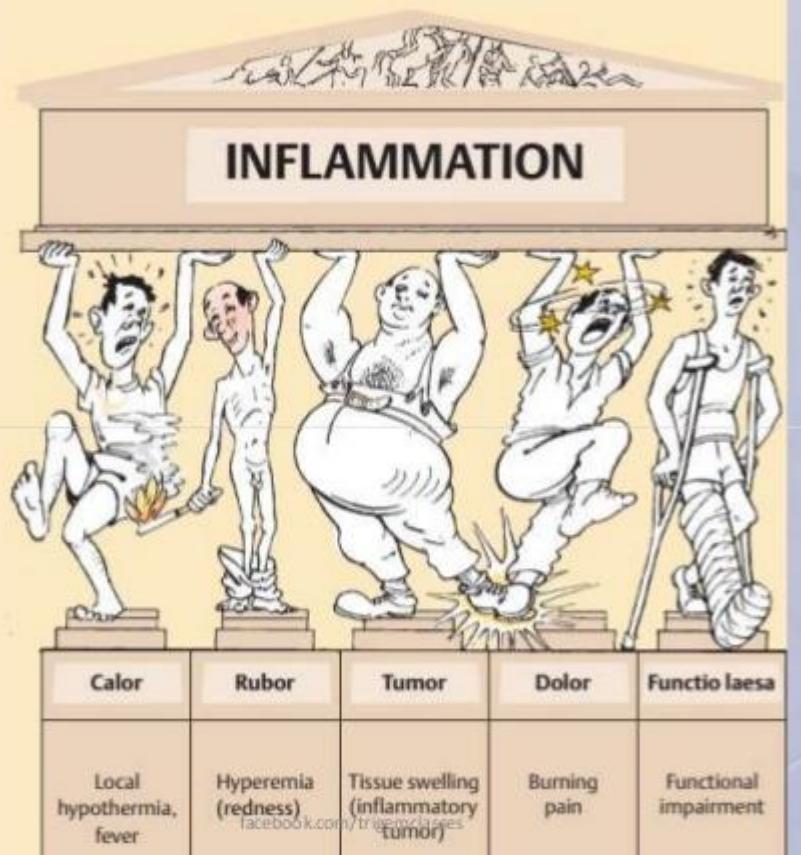


## Adaptive immunity

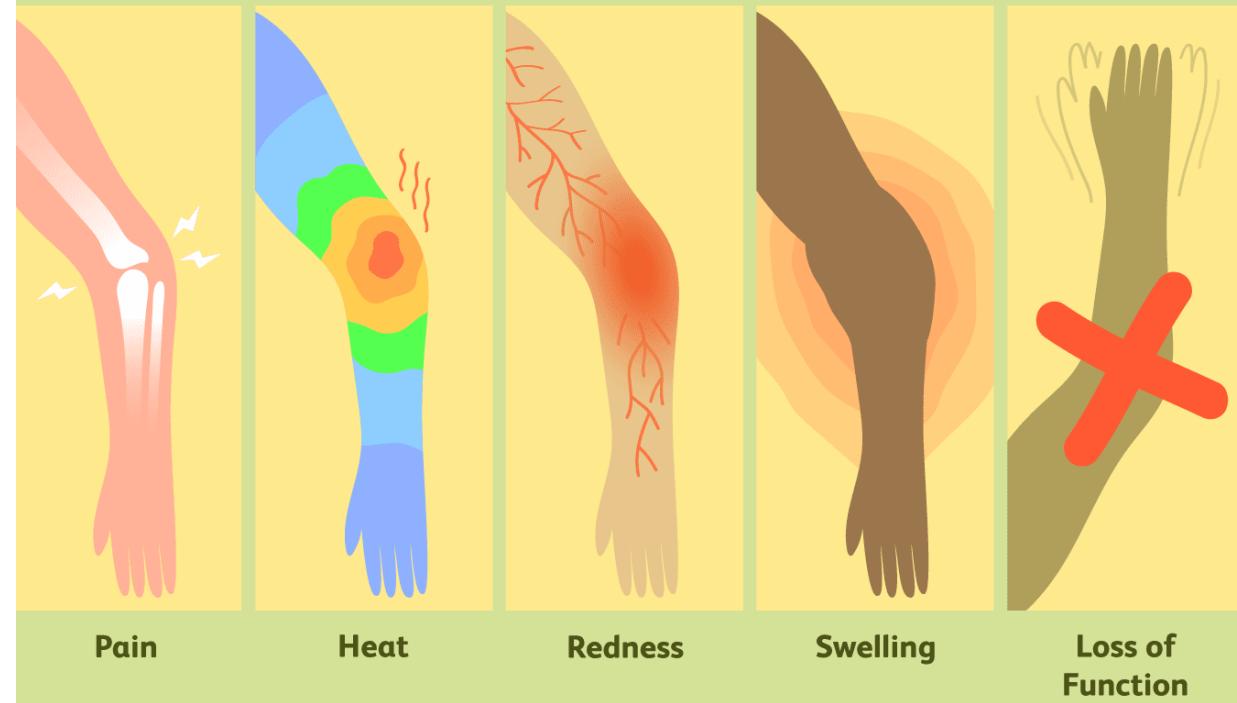


# **Components of Innate Immunity**

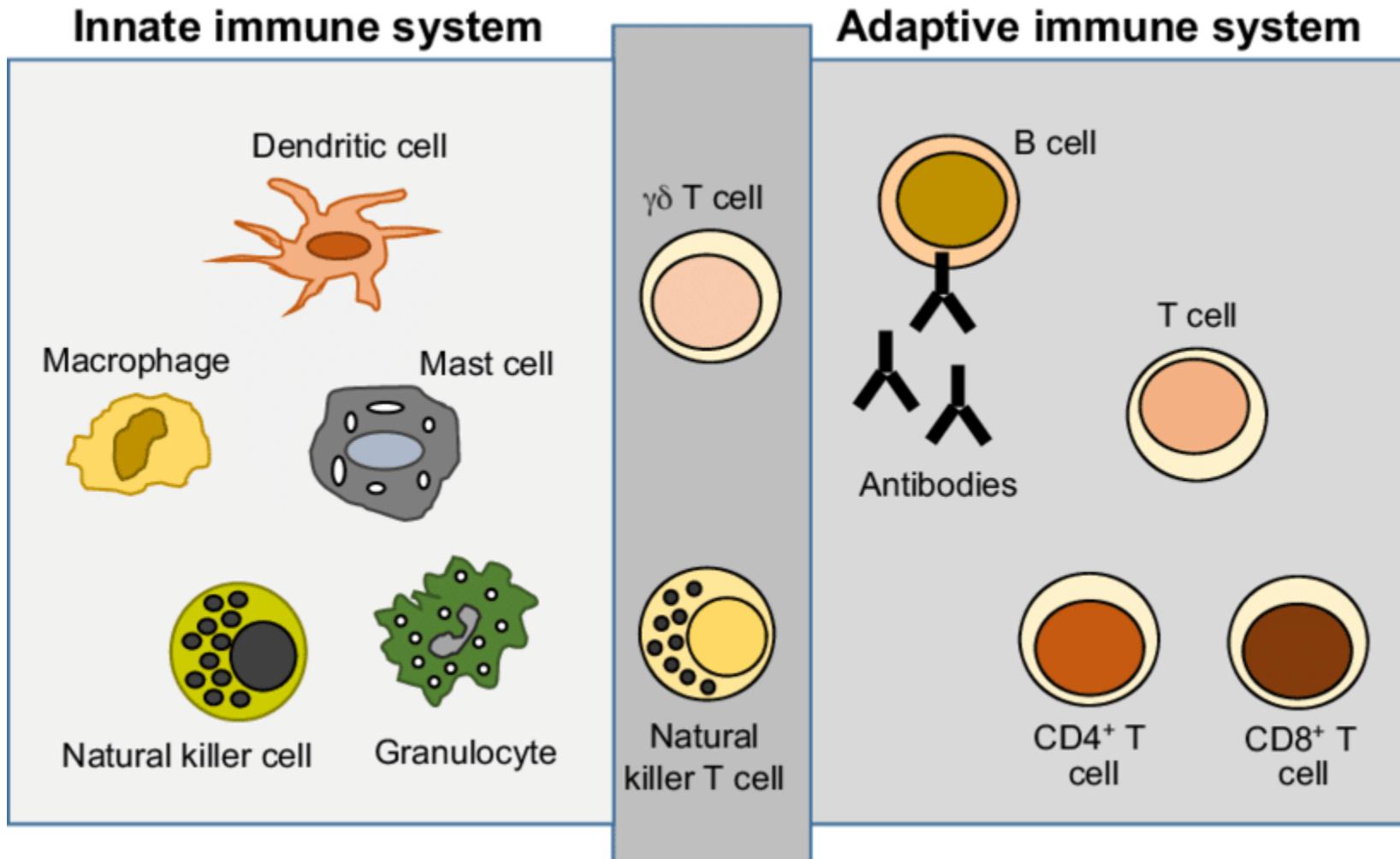
- Physical/Chemical barriers
  - Intact skin, epithelial layer, cough, fever
- Nonspecific chemical factors
  - Antimicrobial peptides and fatty acids, gastric pH, lysozyme
- Inflammation
  - phagocytes (engulf & digest microbes)
  - proinflammatory factors (cytokines, complement proteins)
- Natural killer cells (nonspecific cytotoxic cells)
- Interferon (produced by virus-infected cells and induces anti-viral state in neighboring uninfected cells)

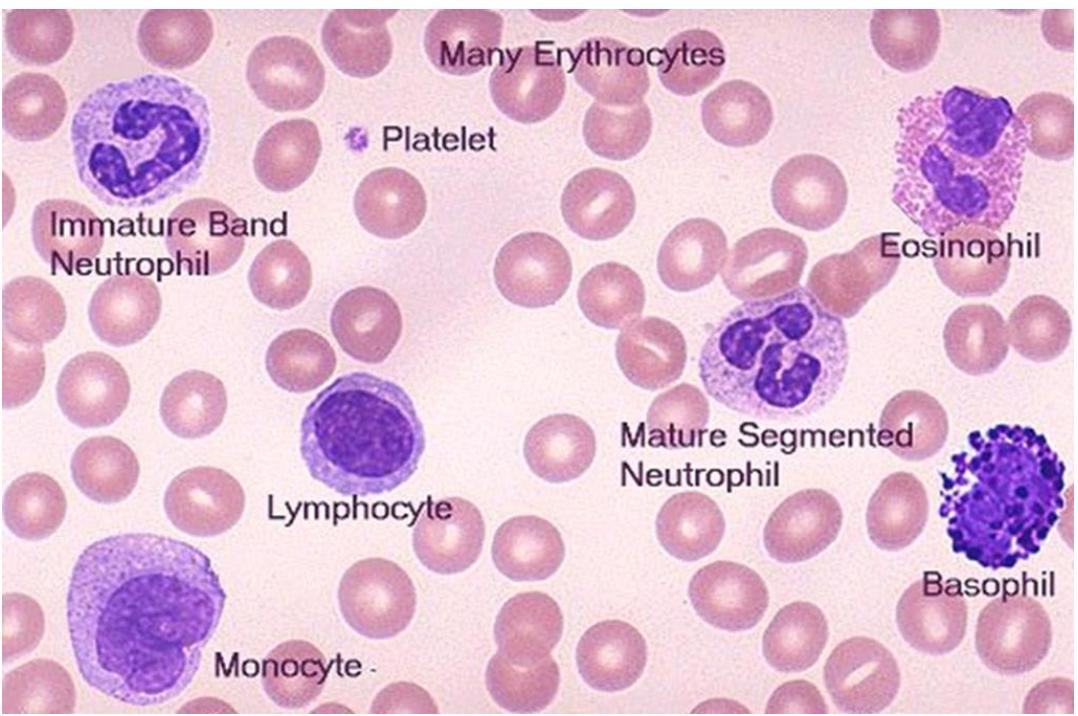


## 5 Cardinal Signs of Inflammation

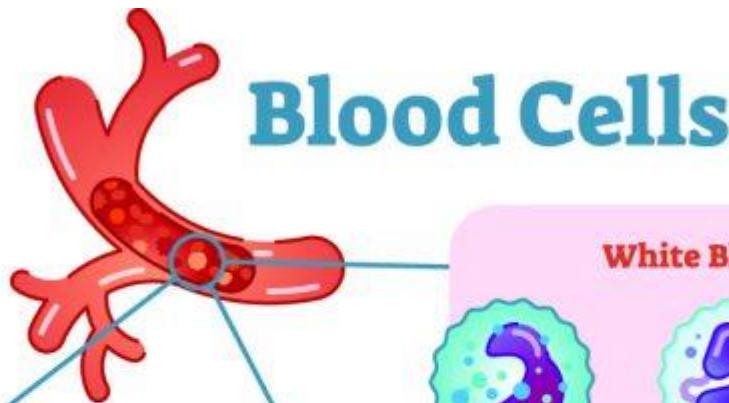


# KEY PLAYERS PROTECTING US

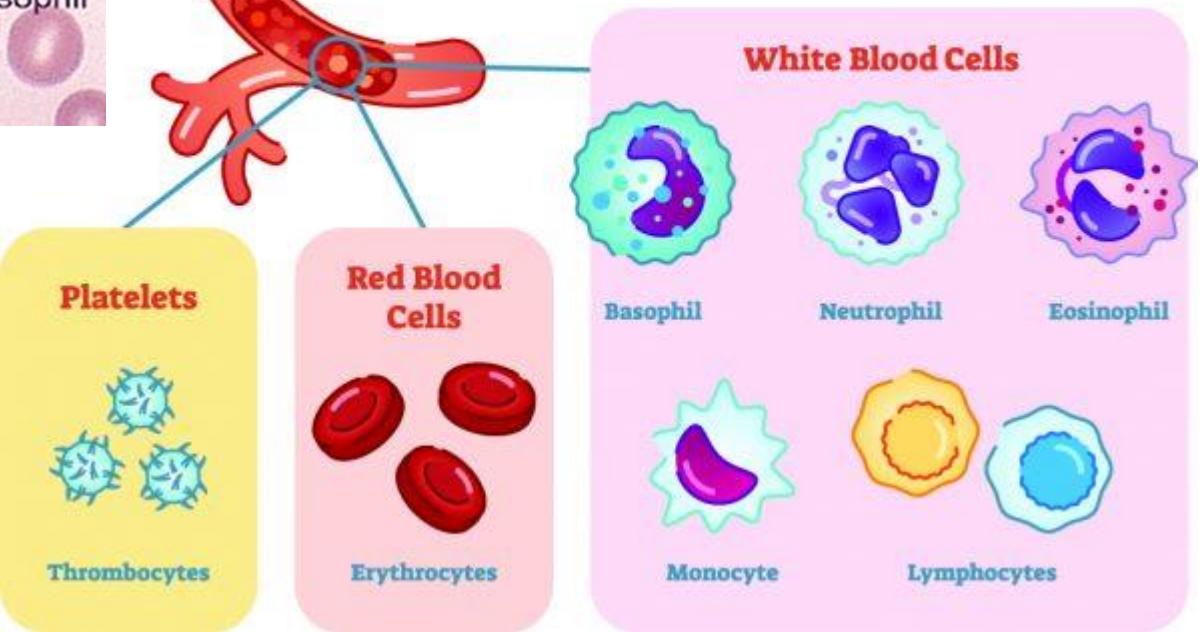
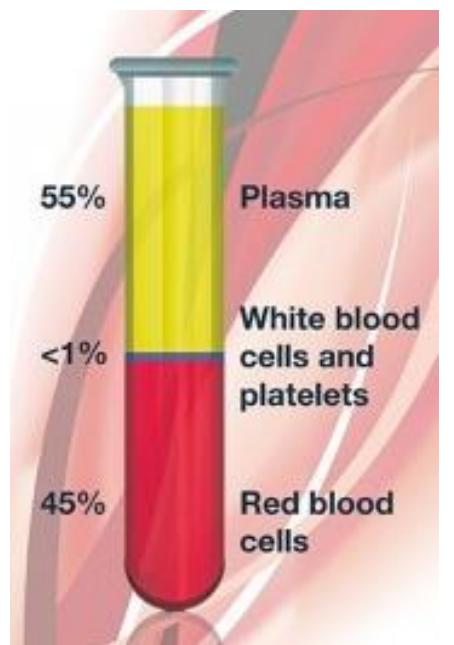




← Blood under microscope



## Blood Cells



Granulocytes

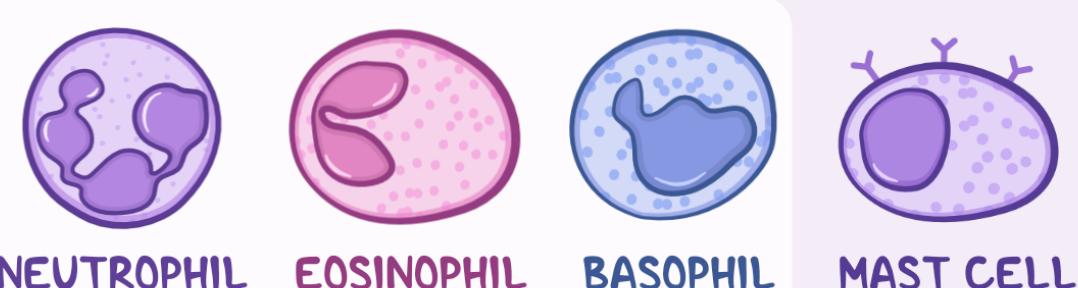
NK cells  
T-cells  
B-cells

Leukocytes



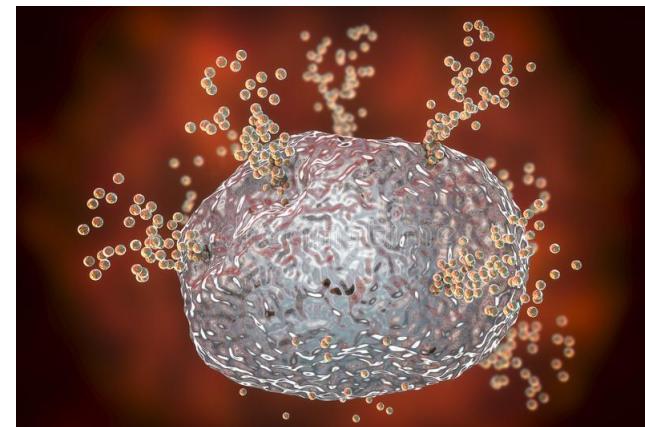
# GRANULOCYTES

- \* TYPE of WHITE BLOOD CELL; therefore ASSIST IMMUNE SYSTEM
- \* CONTAIN GRANULES (released when helping to fight off invaders)
- \* DEVELOP in BONE MARROW



↑ in GRANULOCYTOSIS

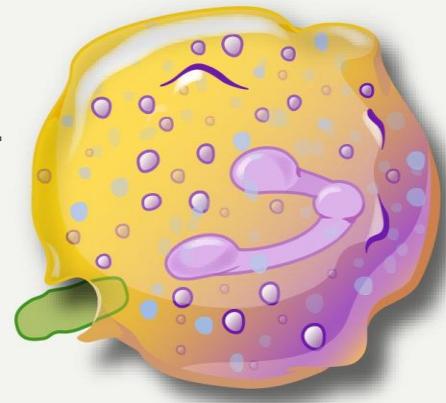
- **Eosinophils (↑ in parasitic infections or allergies)**
  - phagocytosis of antigen-antibody complexes, allergens and inflammatory chemicals
  - release enzymes to destroy parasites
- **Basophils (↑ in chicken pox, sinusitis, diabetes)**
  - secrete histamine (vasodilator)
  - secrete heparin (anticoagulant)



**Mast Cells**  
**Release histamines mediating allergies**

# Neutrophil

White Blood Cell



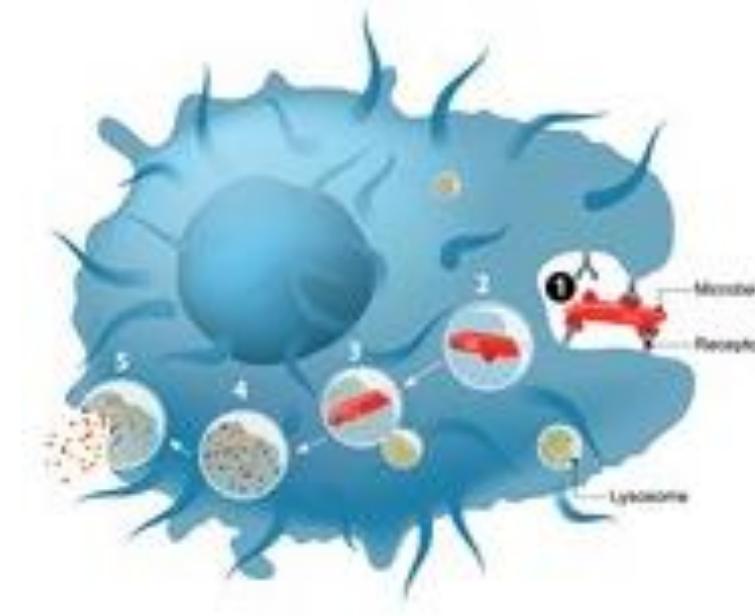
**Function:** Neutrophils engulf and destroy bacteria and other pathogens.

They are the most abundant type of white blood cell in most people's bloodstreams and play a large role in fighting many types of infection.

**Disease:** Because of genetic anomalies, some people are born with too few neutrophils, a condition known as neutropenia, or with neutrophils that do not function properly. This causes people to be more prone to infections.

**Location:** Neutrophils circulate in the blood and quickly move to sites of infection or injury to fight off pathogens.

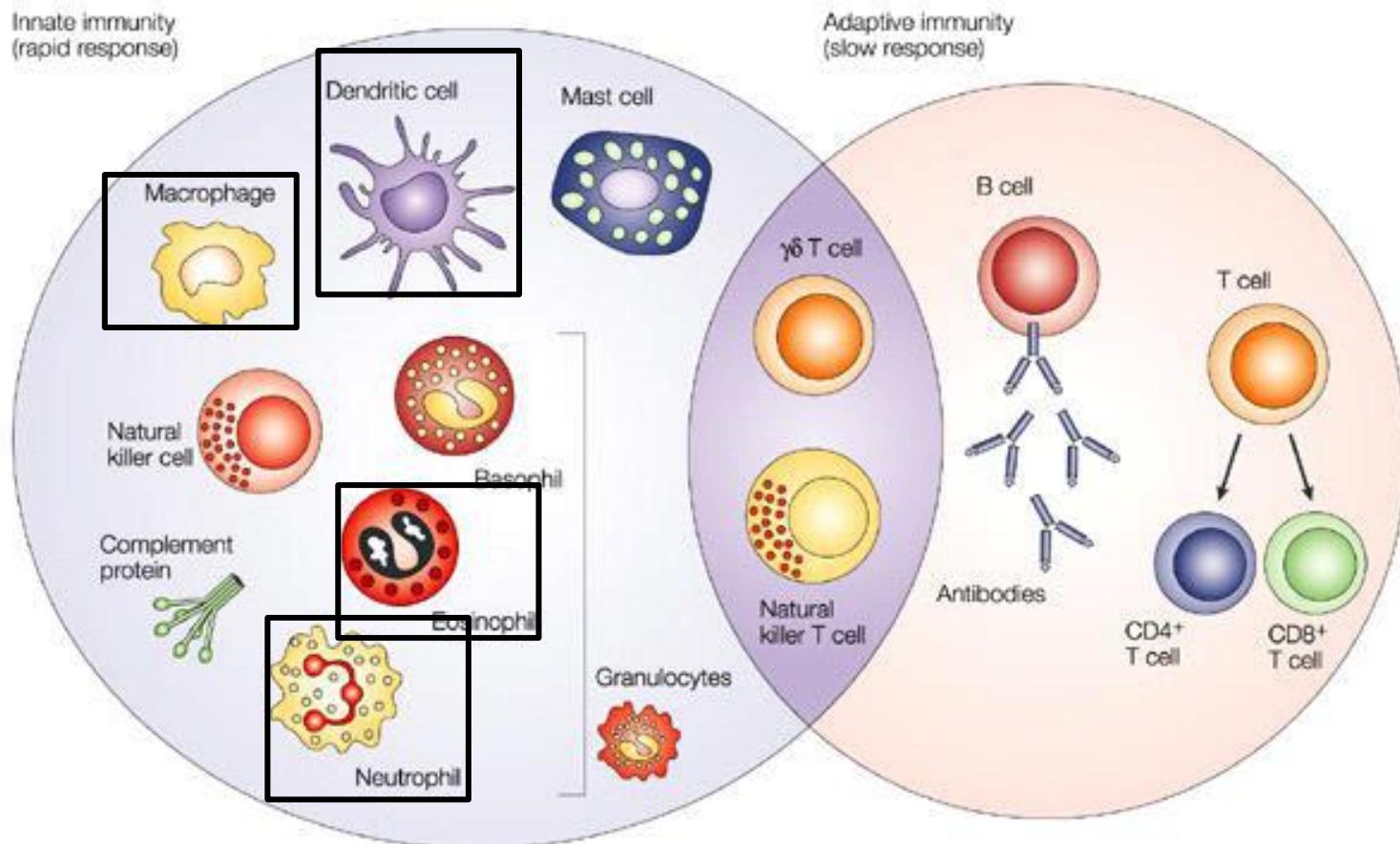
- Most abundant (~50% of WBC)
- Most important cells of innate immunity arm
- First responders on microbe attack by secreting:
  - a. Lysozymes- digest
  - b. Defensins- pores
- Perform phagocytosis efficiently



1. Phagocytosis
2. Phagosome formation
3. Fusion with lysosome → Phagolysosome
4. Digestion
5. Release of microbial products

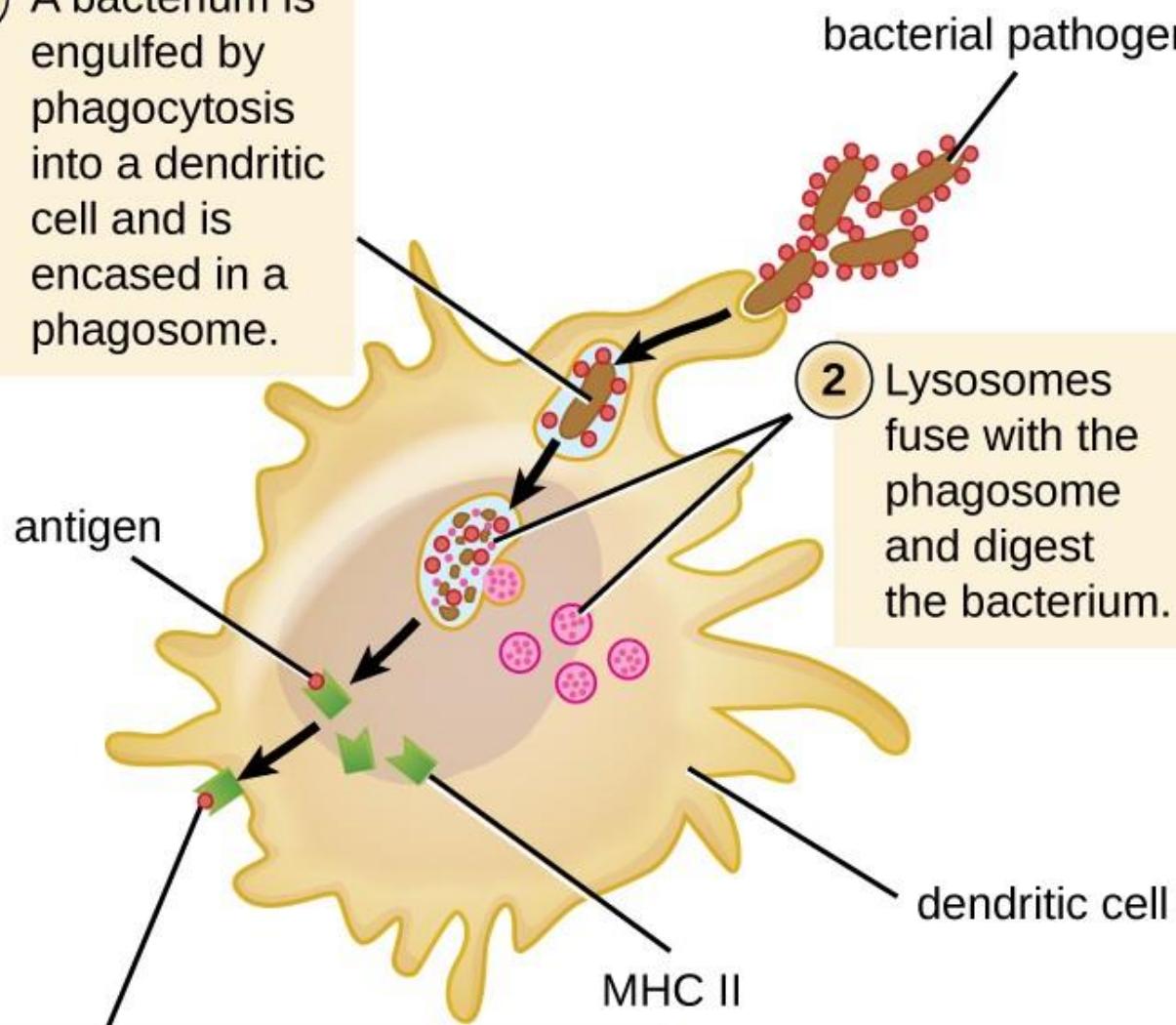
## Neutrophil eating microbe

# PHAGOCYTOSIS



# ANTIGEN PRESENTATION

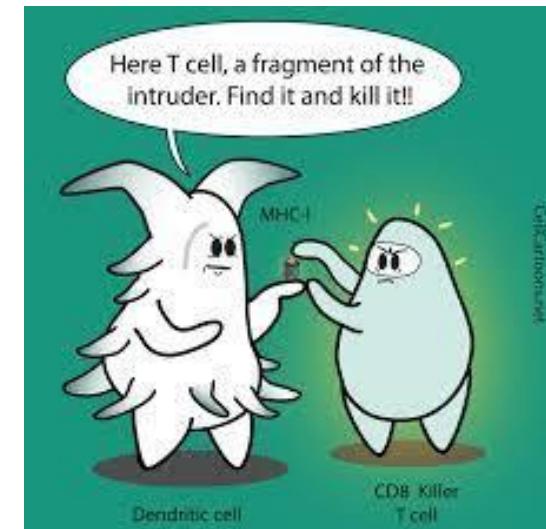
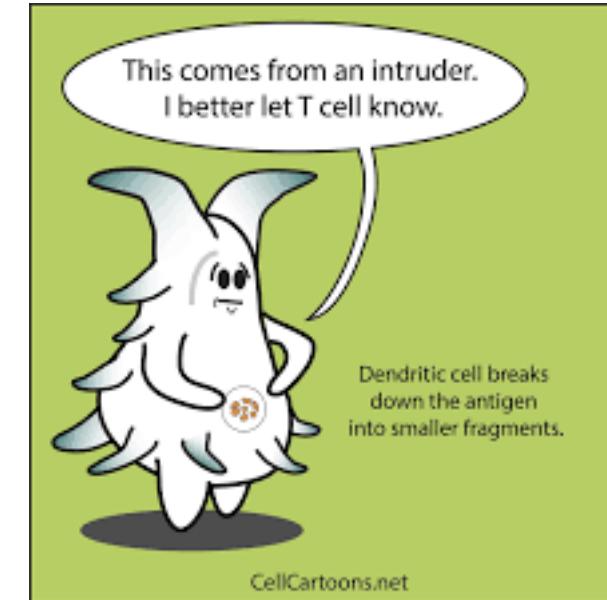
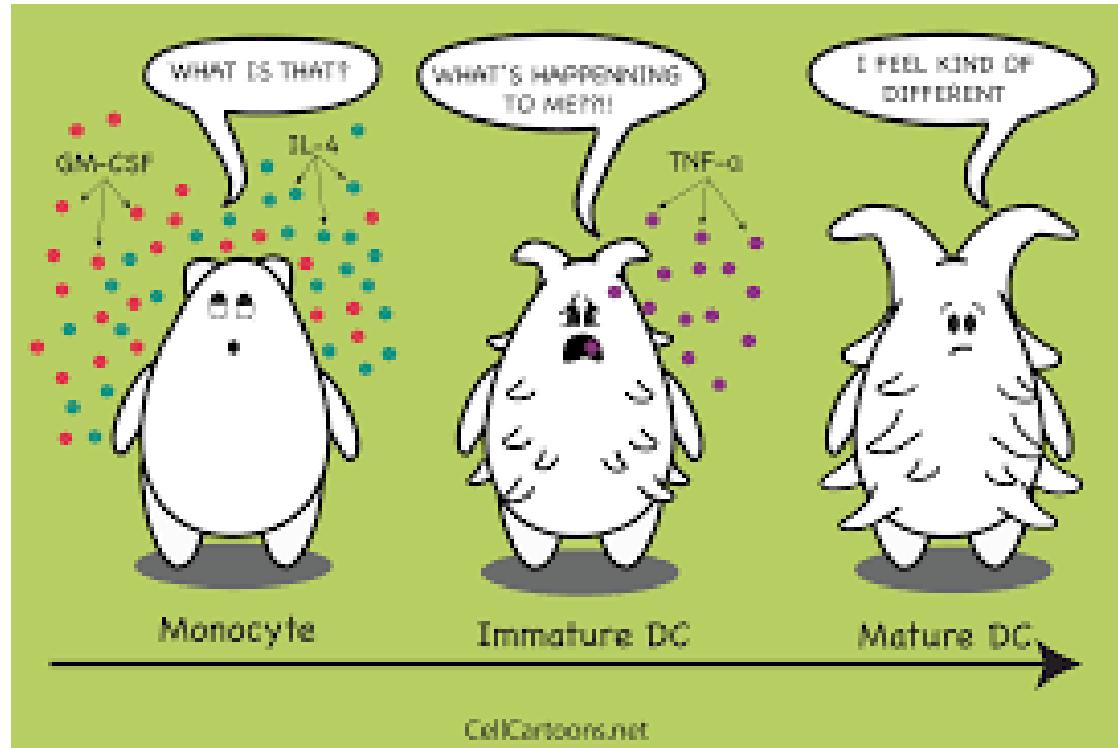
1 A bacterium is engulfed by phagocytosis into a dendritic cell and is encased in a phagosome.

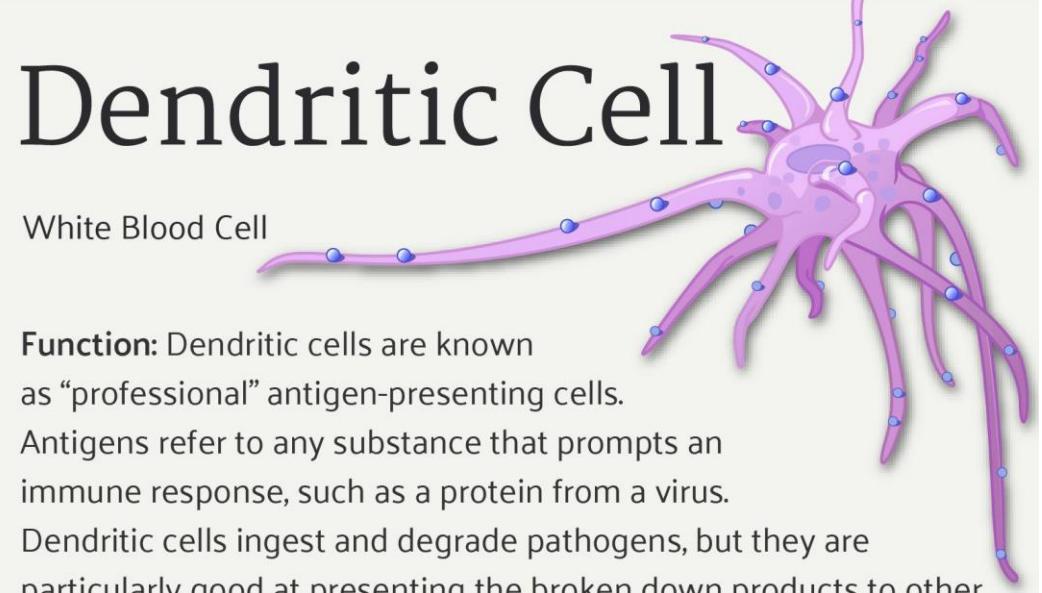


**Macrophage**  
**Dendritic Cell**  
**B-cell**  
**T-cell**

3 Immunodominant epitopes are associated with MHC II and presented on the cell surface.

# DENDRITIC CELLS





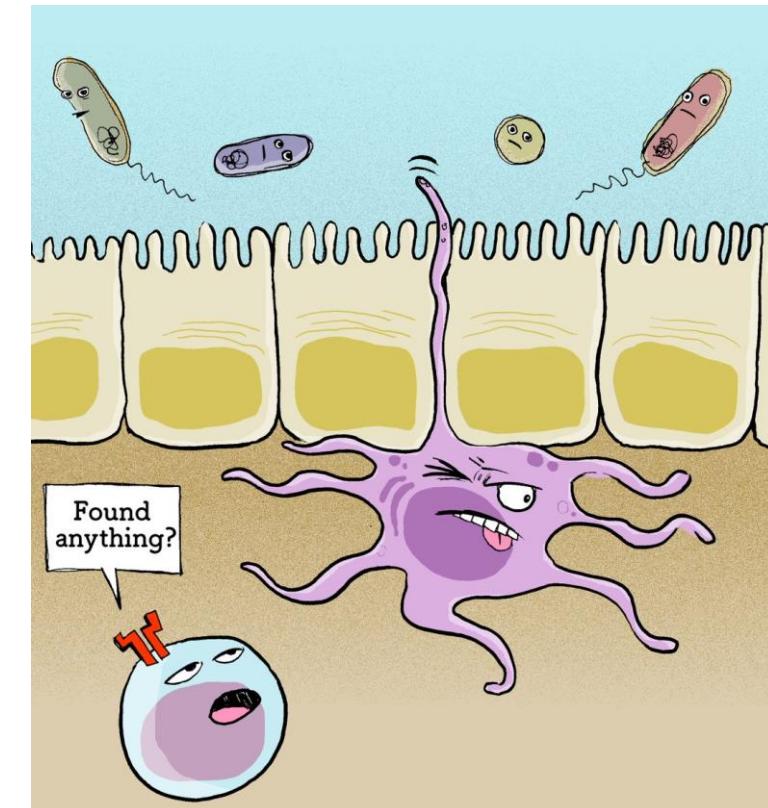
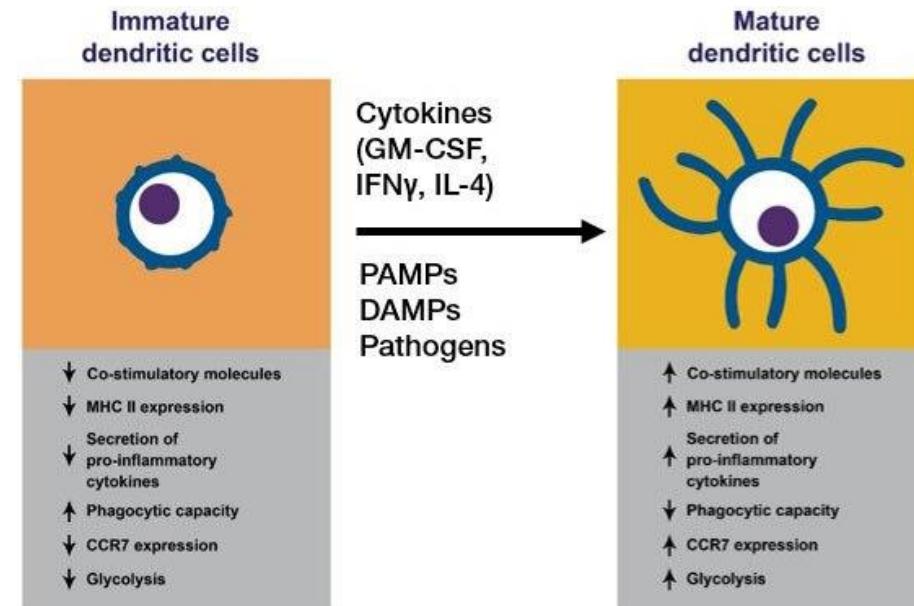
**Function:** Dendritic cells are known as “professional” antigen-presenting cells.

Antigens refer to any substance that prompts an immune response, such as a protein from a virus.

Dendritic cells ingest and degrade pathogens, but they are particularly good at presenting the broken down products to other cells of the immune system as antigens. Other immune cells can present antigens, but none do so as efficiently as dendritic cells.

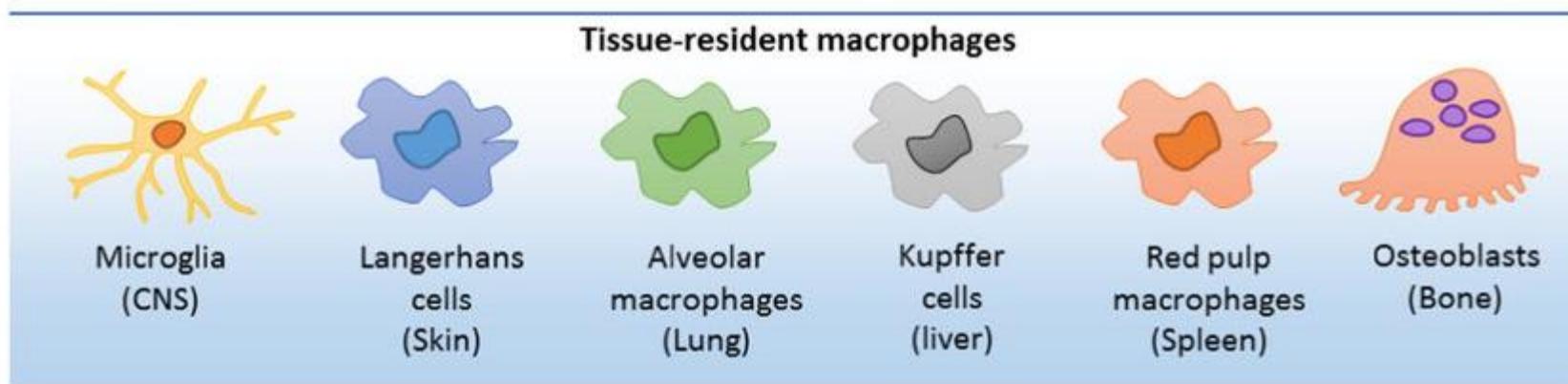
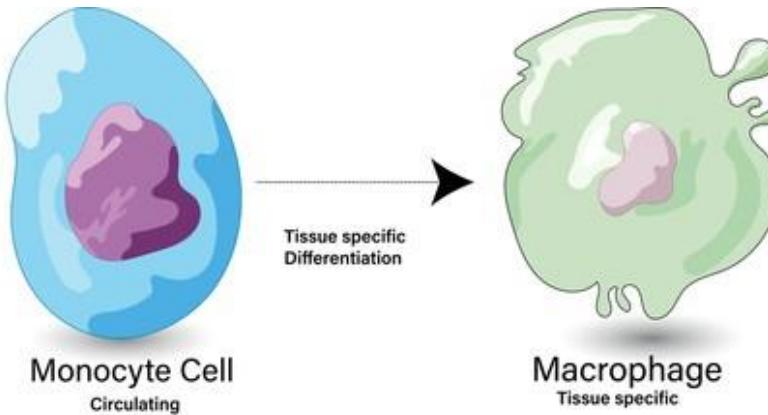
**Disease:** Some microbes have evolved to attack dendritic cells and replicate inside of them. Because dendritic cells move between body tissues when they present antigens, any infectious agent tagging along may spread more easily throughout the body.

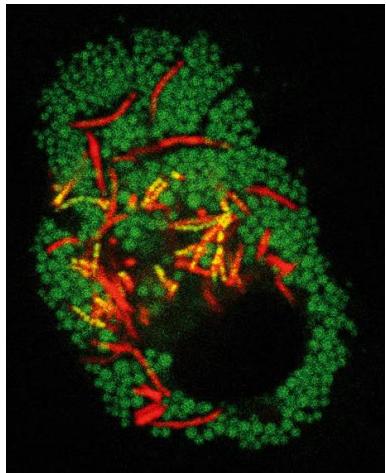
**Location:** Dendritic cells are most common in body tissues that interact with the external environment, like the skin, lungs and gut lining. They travel to lymph nodes and the spleen when they have a concerning antigen to present to other immune cells.



# MONOCYTES

- 3-8% of WBC
- Recruited to the sites of inflammation
- Macrophage precursor cells





*Mycobacterium tuberculosis* (red)  
residing in macrophage  
cell (lipids-green)

# Macrophage

White Blood Cell

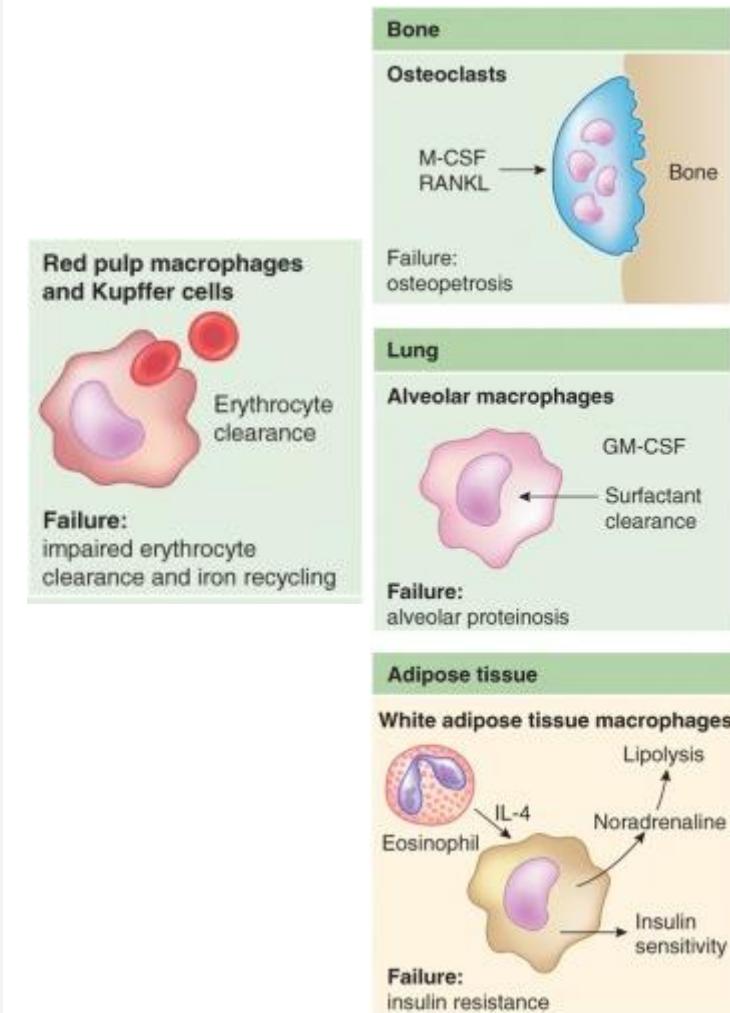


**Function:** Also known as “big eater” cells, macrophages ingest pathogens, cancer cells and microscopic debris, which are then destroyed, degraded and recycled with harsh chemicals and enzymes.

**Disease:** Unfortunately, macrophages sometimes fail to destroy ingested pathogens, which then may replicate inside the macrophage and hide from other immune responses. Macrophages also play a large role in controlling inflammation and their malfunction can impact inflammatory diseases.

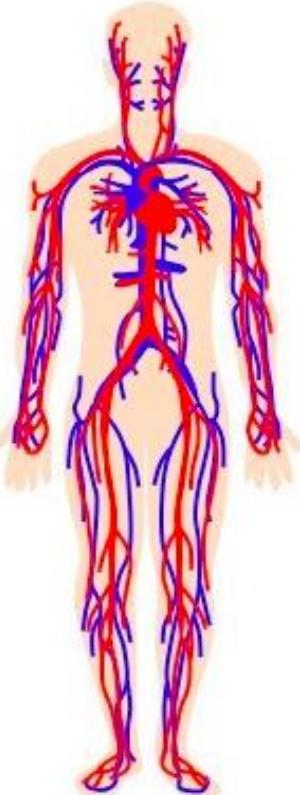
**Location:** Macrophages develop in the bone marrow as “monocytes,” which circulate in the blood stream and then settle down in other body tissues. Macrophages are given different names depending on the type of tissue they are found in. For example, they are called microglia in the central nervous system and osteoclasts in bone.

**In diseased state!**

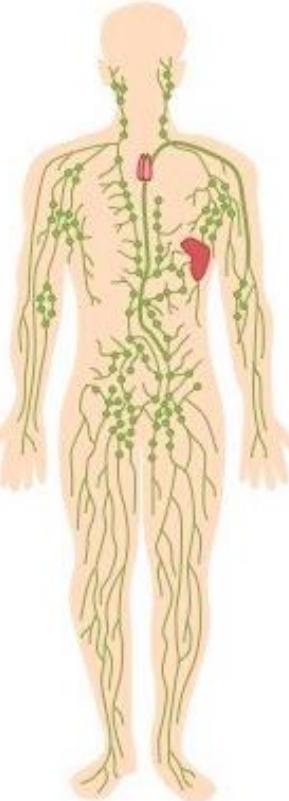


# LYMPHATIC DRAINAGE SYSTEM

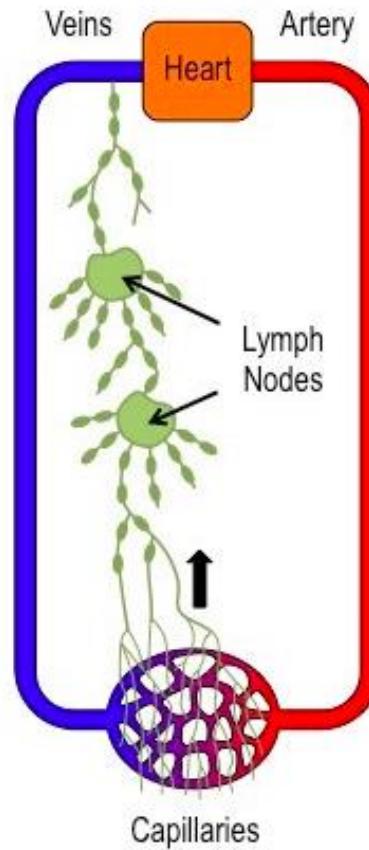
Circulatory System



Lymphatic System



Inter-relationship between systems



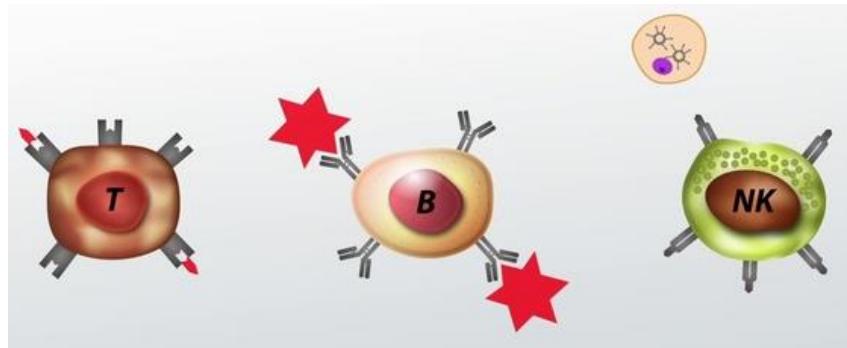
## Circulatory system

- **Blood**→ collecting and distributing O<sub>2</sub>, nutrients and hormones to tissues of body
- **Blood flows**→ in a **continuous loop** throughout the body by arteries, capillaries and veins

## Lymphatic system

- **Lymph**→ collecting and removing of waste products left behind by tissues of body
- **Lymph flows**→ in a **open circuit** from tissues to lymphatic vessels. Is unidirectional, has valves to stop from flowing backwards

# LYMPHOCYTES



## Natural Killer (NK) Cells

- Innate Immunity

## T-cells

- Adaptive Immunity

## B-cells

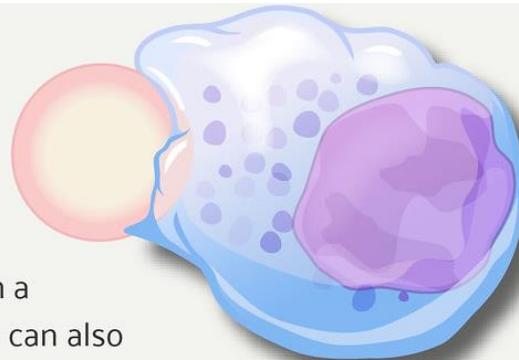
- Adaptive Immunity

Found in lymph hence called lymphocytes  
Marked by large nucleus

# NATURAL KILLER CELLS

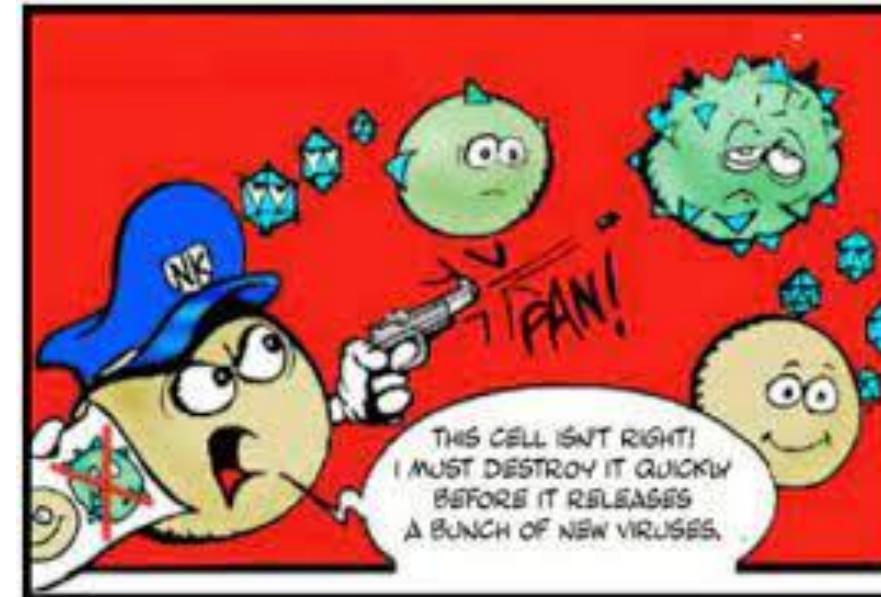
White Blood Cell

**Function:** These immune cells can recognize and kill the cells of someone's body that have been infected with a pathogen. Natural killer cells can also recognize and destroy tumor cells.

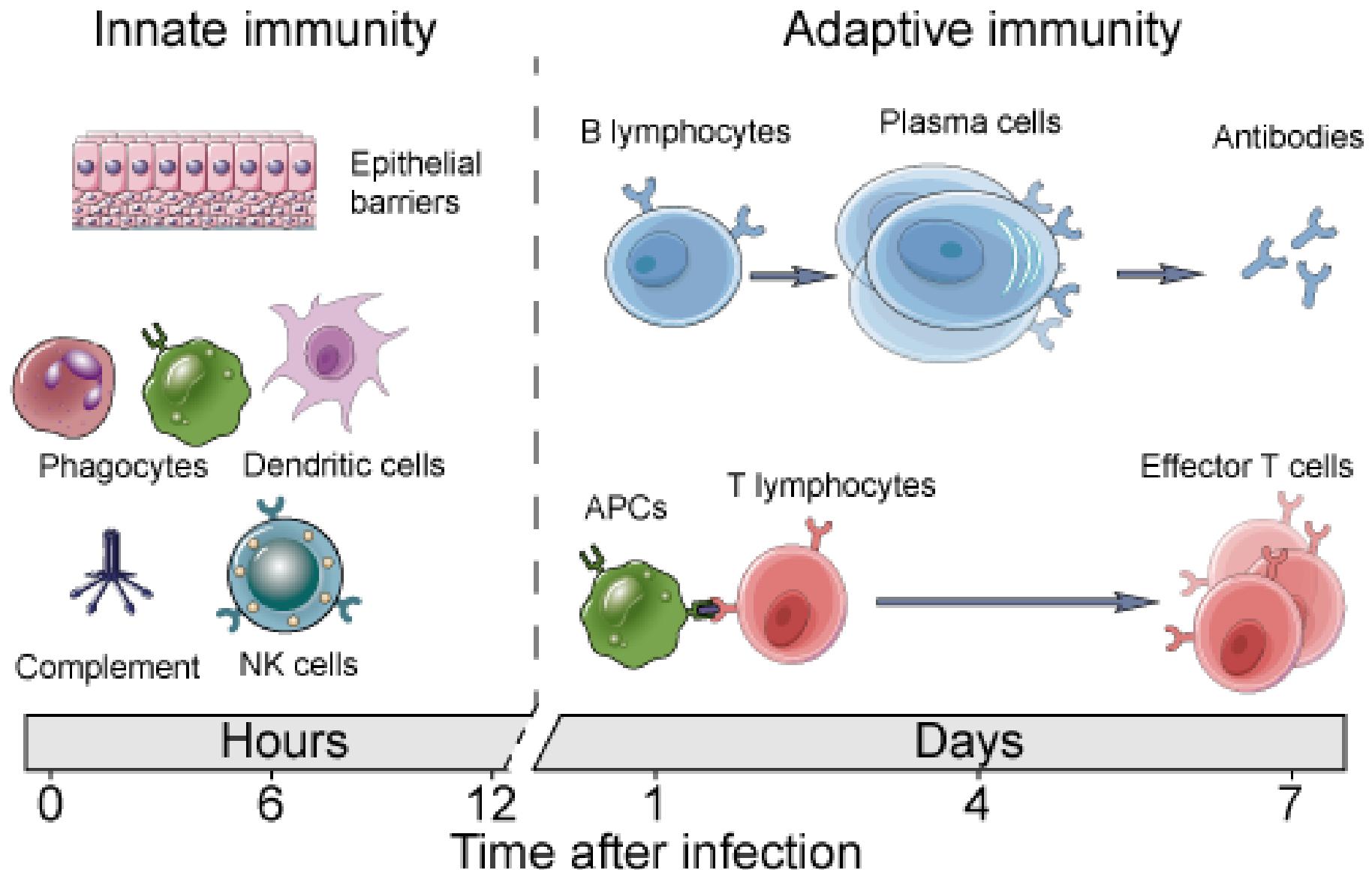


**Disease:** People who have deficient natural killer cells, usually because of an inherited immune disorder, may be more prone to certain viruses.

**Location:** Natural killer cells, or NK cells, are present in the blood and can move into other tissues to find targets.



Cancer cell  
Virus-infected  
Bacterium-infected



## Adaptive Immunity

### Humoral Immunity

### Cell mediated Immunity

Humoral immunity refers to a component of the adaptive immunity where B cells secrete antibodies, which circulate in the blood as a soluble protein

Mediated by B cells

Acts on extracellular microbes and their toxins

Recognizes unprocessed antigens

Plasma B cells secrete antibodies

Rapid

Does not act on the tumor cells and transplants

Cell mediated immunity refers to the other component of the adaptive immunity, which is mediated by the activated, antigen-specific T cells

Mediated by T cells

Acts on intracellular microbes such as viruses, bacteria, and parasites and tumor cells

Antigens are processed and presented by MHC complexes

T cells secrete cytokines

A delayed type hypersensitivity

Acts on tumor cells and transplants

### HUMORAL RESPONSE



B Cell



Plasma Cell

### CELLULAR RESPONSE



Macrophage



Helper T Cell



Cytotoxic T Cell

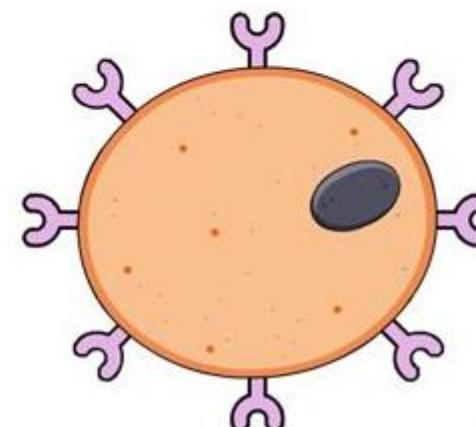
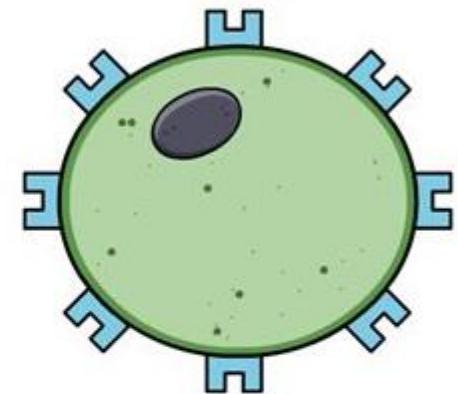


Active Cytotoxic T Cell

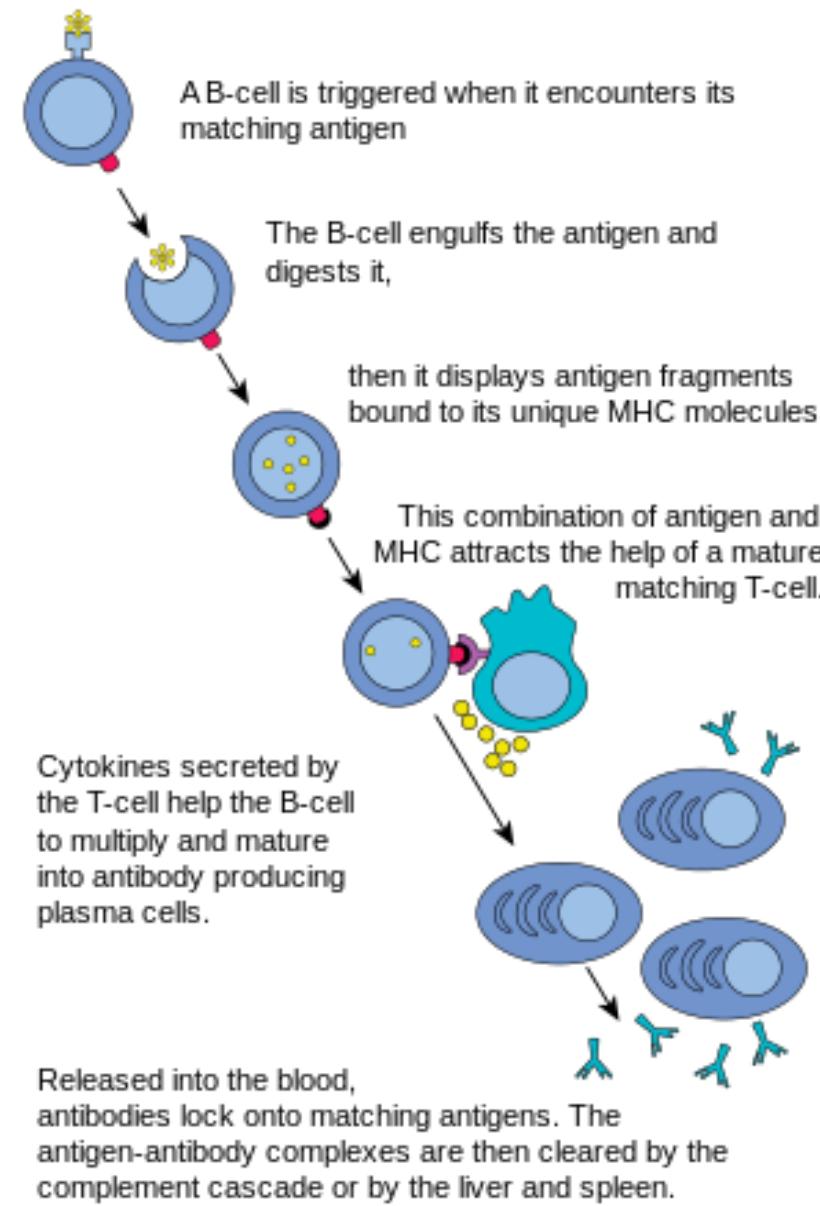
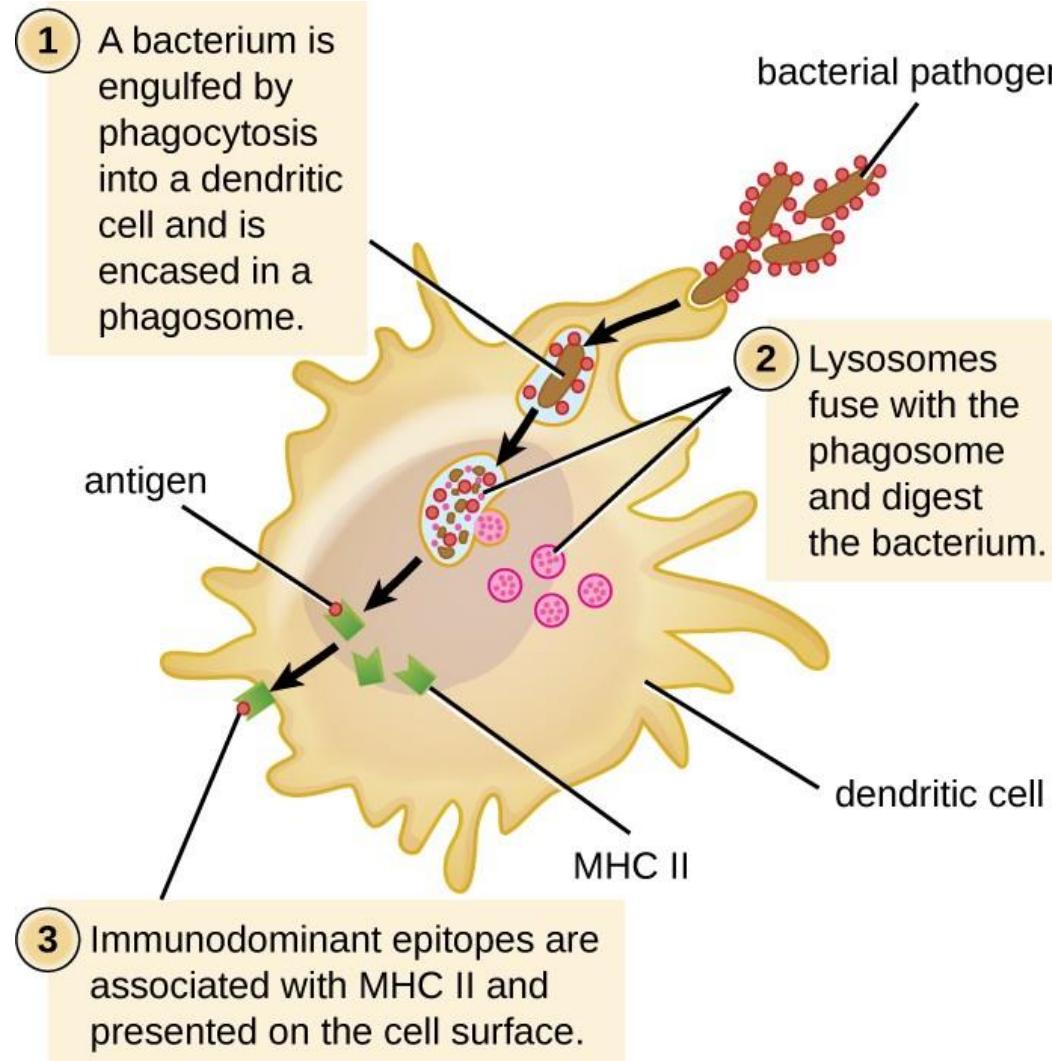
# LYMPHOCYTES

**Lymphocytes** are a type of white blood cell found in the blood or lymph nodes and made by bone marrow. There are several types of lymphocyte, including:

- **T-lymphocytes** – recognise antigens on pathogens and either attack them directly or co-ordinate the activity of other cells of the immune system.
- **B-lymphocytes** – recognise antigens and produce special chemicals called **antibodies**.



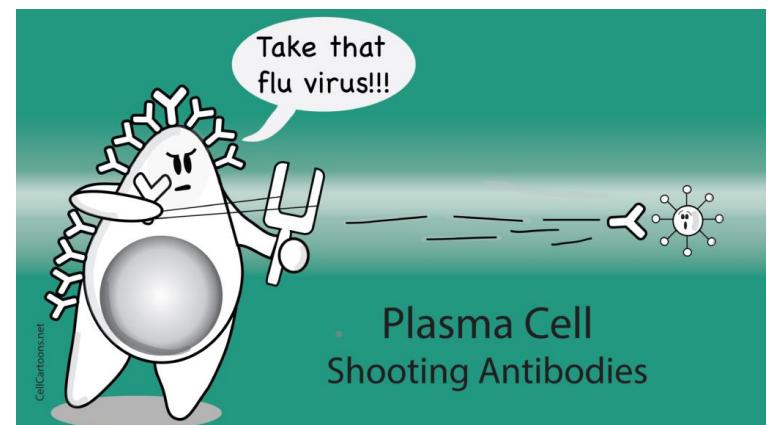
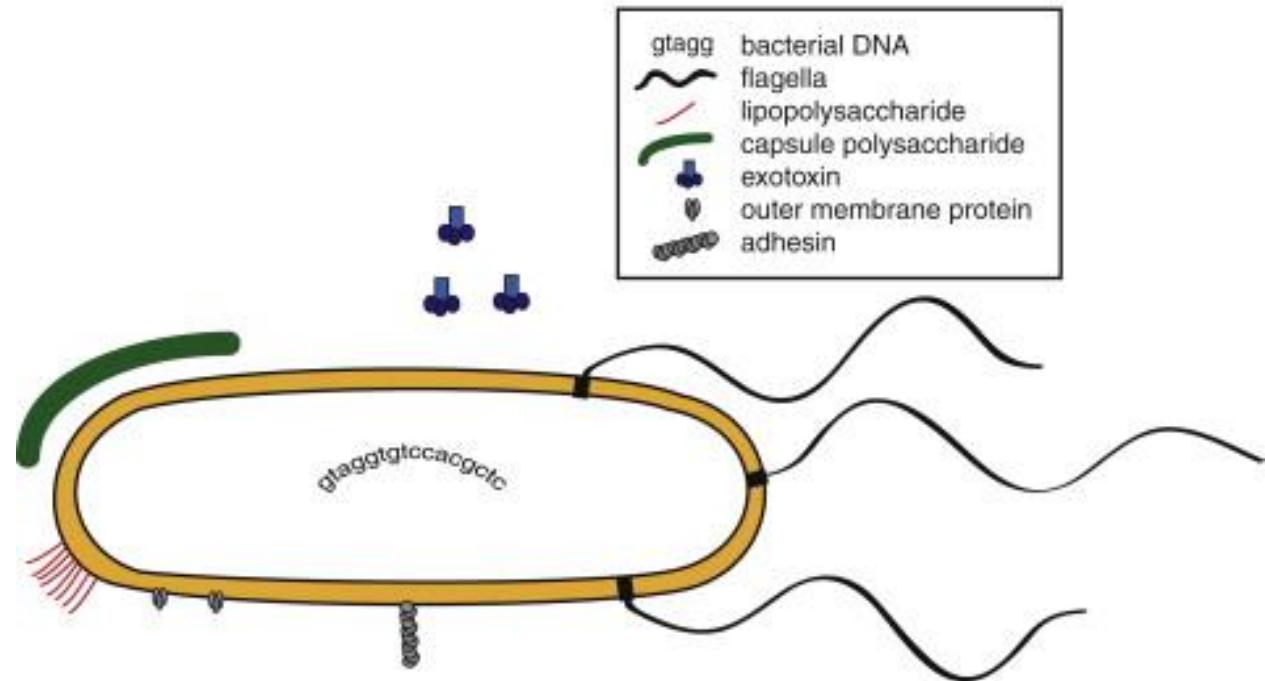
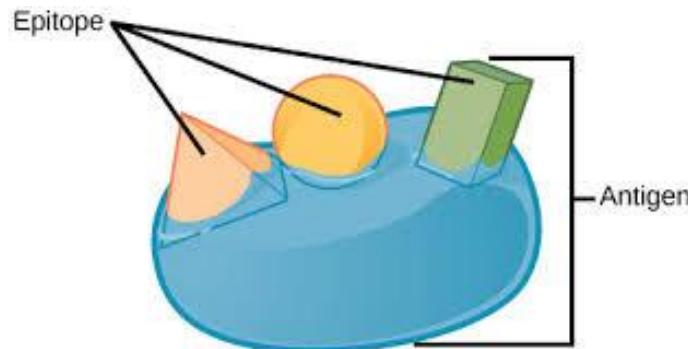
# HUMORAL IMMUNITY



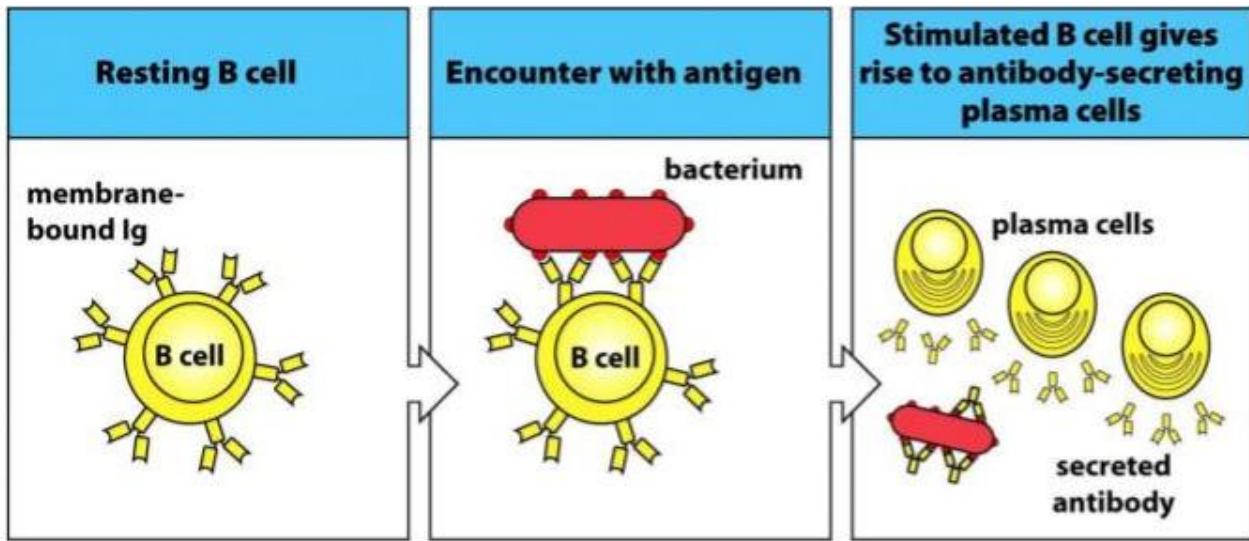
# ANTIGEN

## **Anti+Gen= Antibody generating**

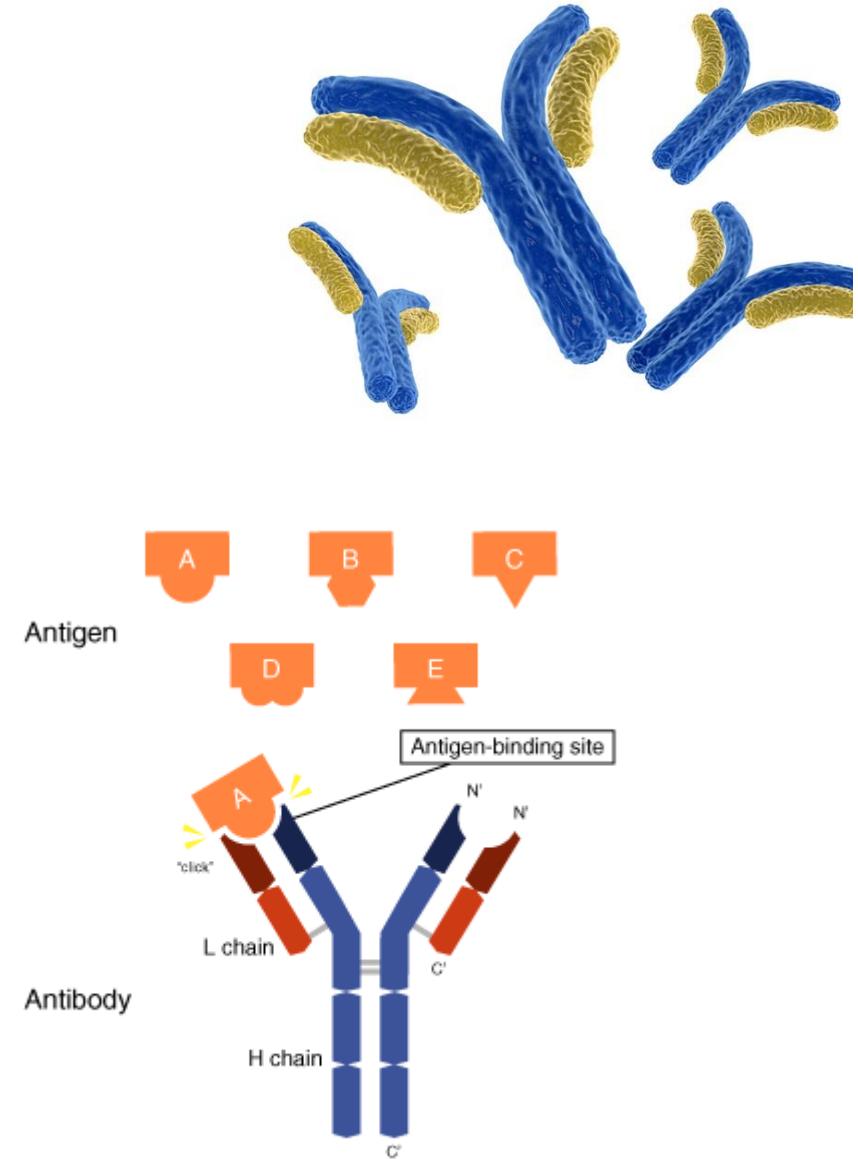
- Agents that initiates an immune response.
- Each antigen reacts with a specific antibody.
- Most are proteins or large polysaccharides from a foreign substance.
  - Microbes: Capsules, cell walls, toxins etc.
  - Non microbes: Pollen, egg white , red blood cell surface molecules.
- **EPITOPE-**
  - smallest unit of antigenicity.
  - Any given antigen may have several epitopes.
  - Each epitope is recognized by a different antibody.



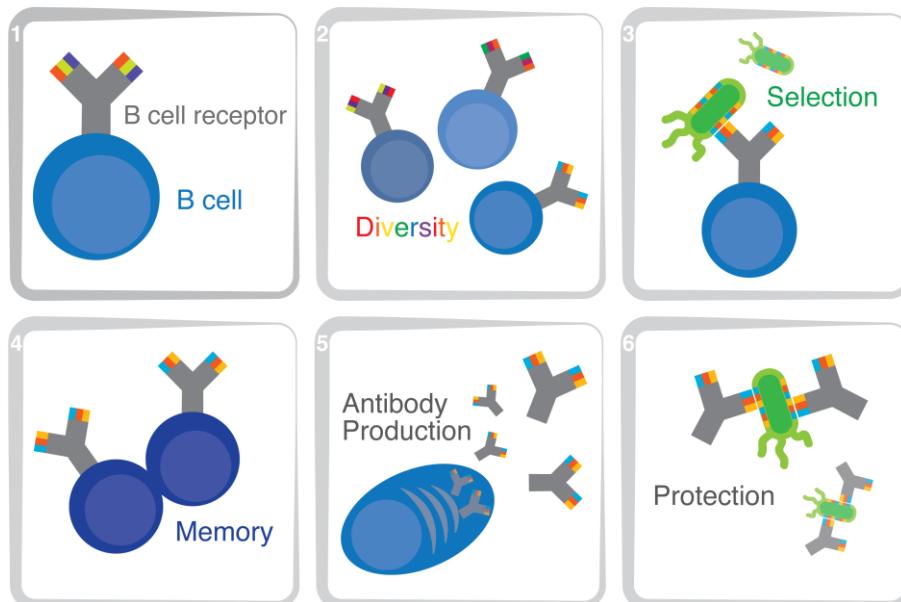
# ANTIBODY



**It has been estimated that humans generate about 10 billion different antibodies, each capable of binding a distinct epitope of an antigen**



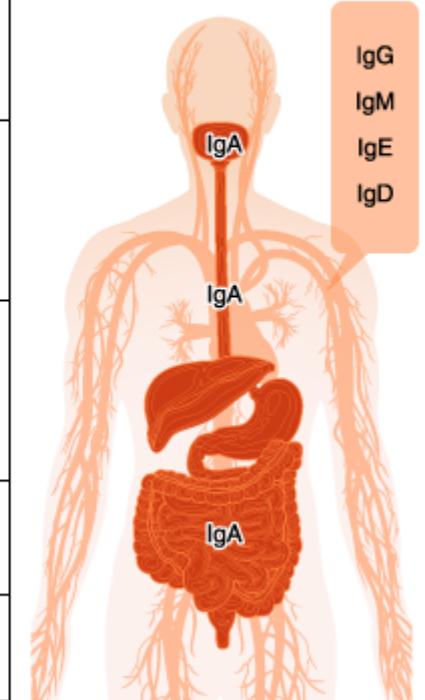
# ANTIBODY / IMMUNOGLOBULINS



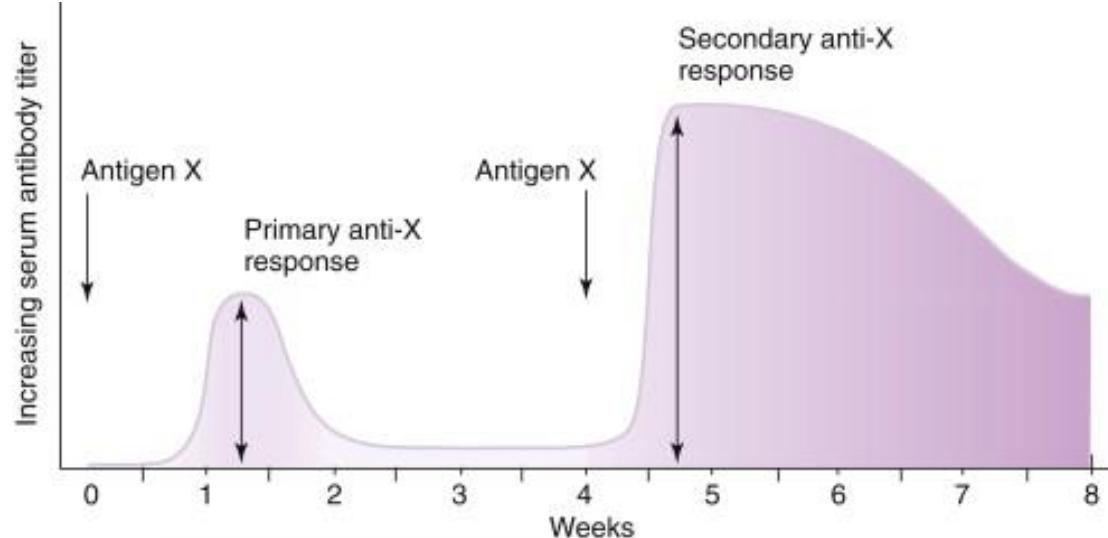
Types and characteristics of antibodies

IgG		<ul style="list-style-type: none"> <li>Highest opsonization and neutralization activities.</li> <li>Classified into four subclasses (IgG1, IgG2, IgG3, and IgG4).</li> </ul>
IgM		<ul style="list-style-type: none"> <li>Produced first upon antigen invasion. Increases transiently.</li> </ul>
IgA	 or  or 	<ul style="list-style-type: none"> <li>Expressed in mucosal tissues. Forms dimers after secretion.</li> </ul>
IgD		<ul style="list-style-type: none"> <li>Unknown function.</li> </ul>
IgE		<ul style="list-style-type: none"> <li>Involved in allergy.</li> </ul>

Distribution in the body

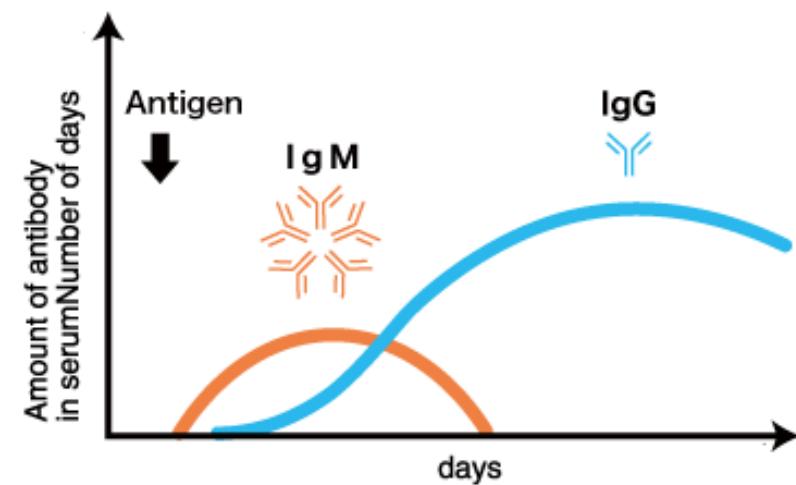


# PRIMARY AND SECONDARY IMMUNE RESPONSE



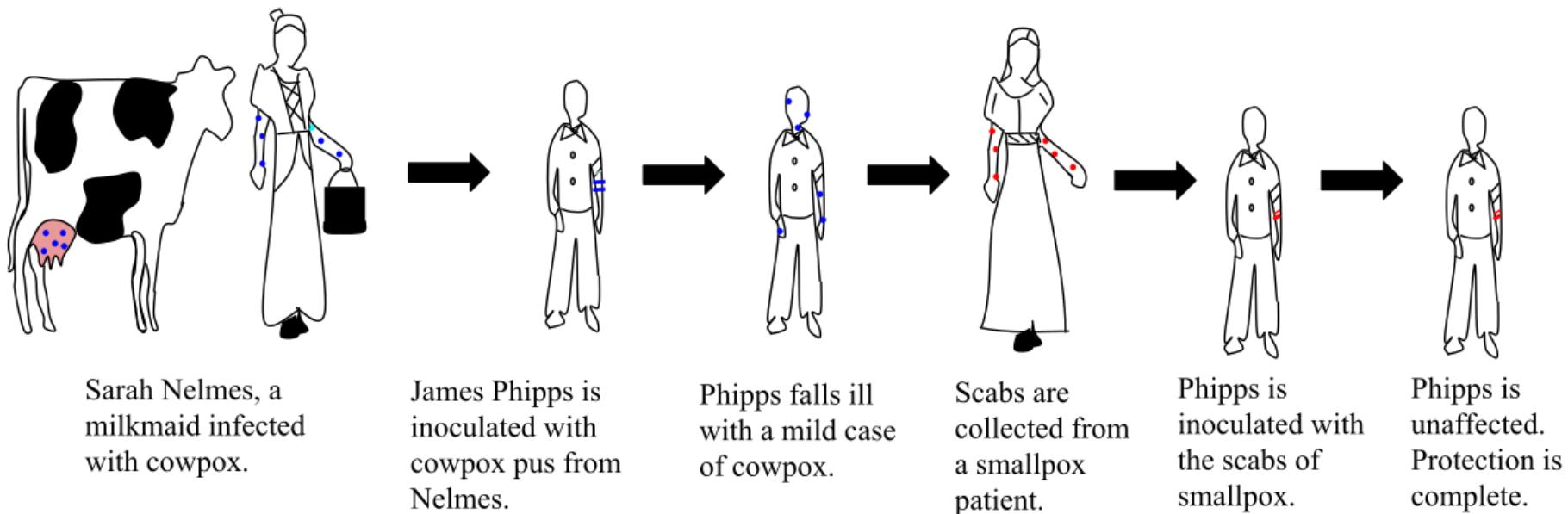
Property	Primary response	Secondary response
Type of B cell involved	Naive B cell	Memory B cell
Lag time	4–7 days	1–3 days
Time of peak response	7–10 days	3–5 days
Magnitude of peak response	Depends on antigen	100-1000x higher than primary response
Isotype produced	IgM predominates	IgG predominates

Levels of circulating antibodies to a specific antigen



# FIRST VACCINE ATTEMPT

Edward Jenner, English Physician and Scientist



# EDWARD JENNER



Dr. Edward Jenner (1749-1823) performing his first vaccination on James Phipps on May 14, 1796.  
Painting by E. Board in the Wellcome Museum, London. Undated painting. Bettmann Archive/Getty Images.

## Known:

Smallpox is more dangerous than variolation and cowpox less dangerous than variolation.

## Hypothesis:

If target is infected with cowpox, then target is immune to smallpox.

## Test:

If variolation after infection with cowpox fails to produce a smallpox infection, immunity to smallpox has been achieved.

## Consequence:

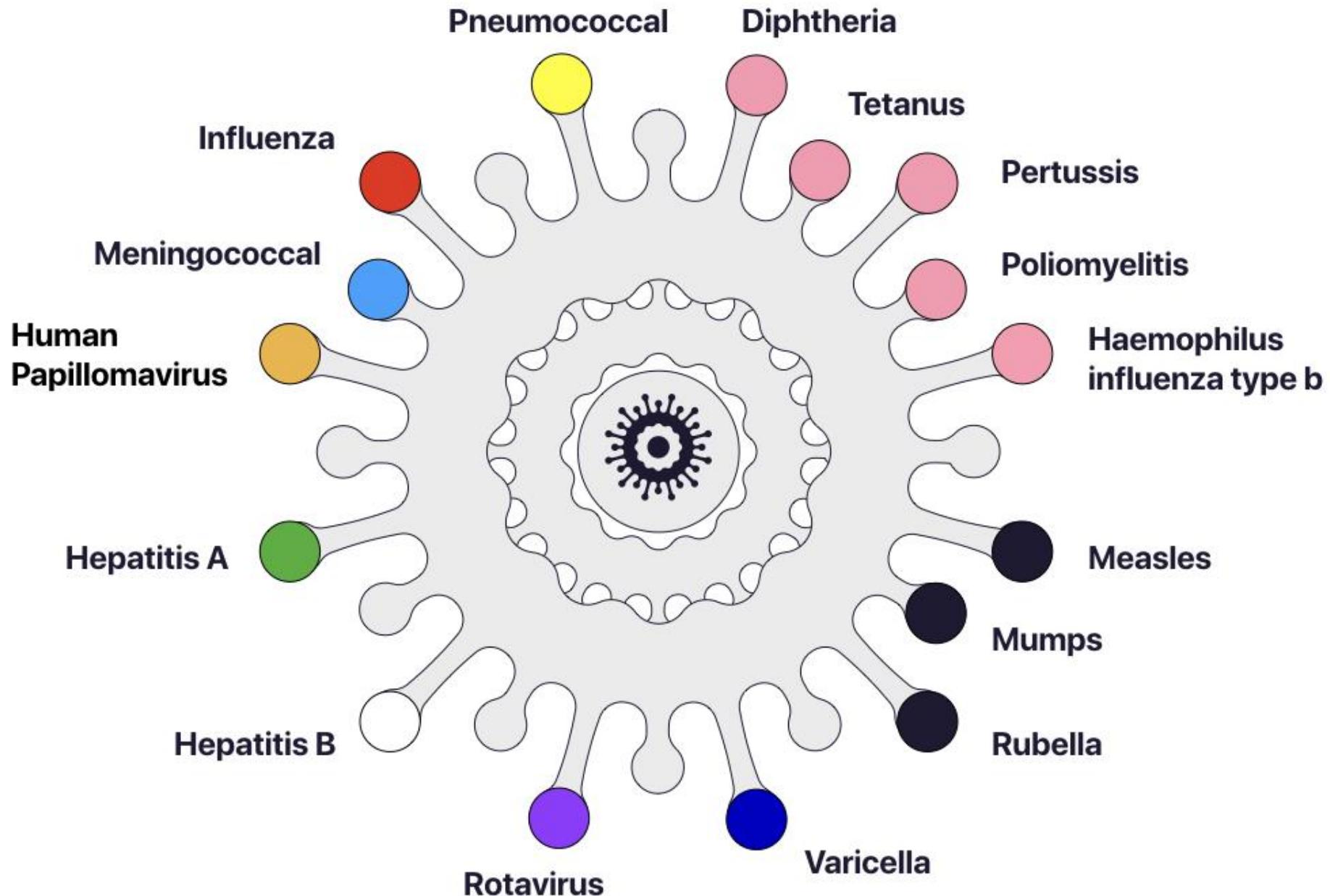
Immunity to smallpox can be induced much more safely than by variolation.

# SMALLPOX IS HISTORY

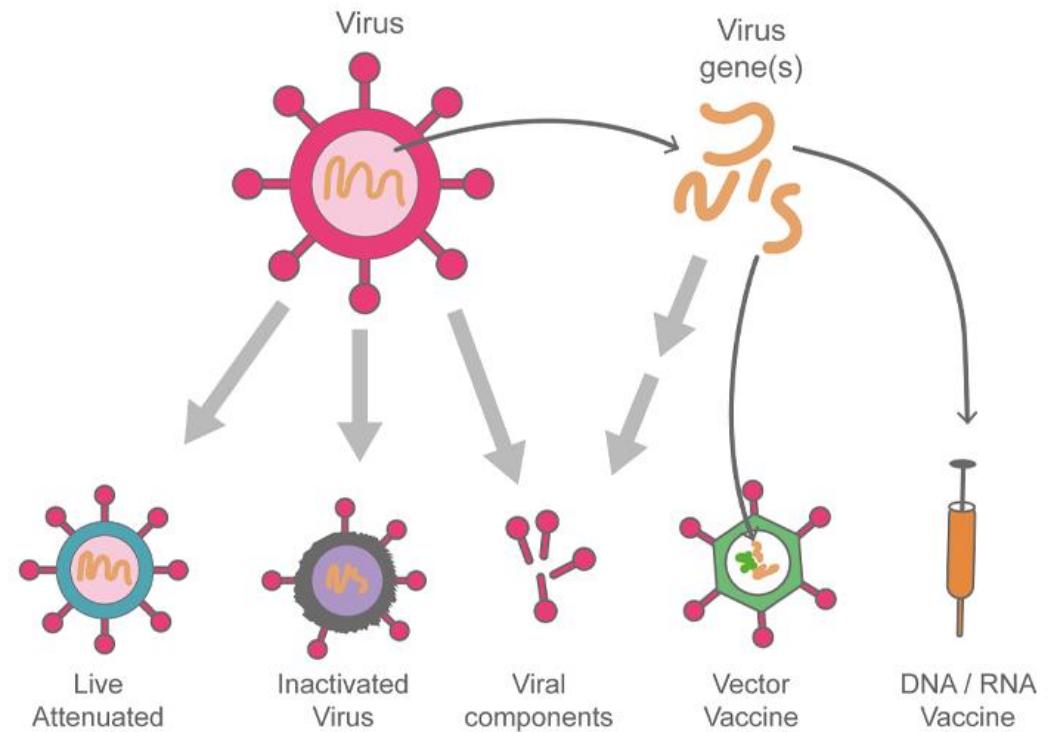
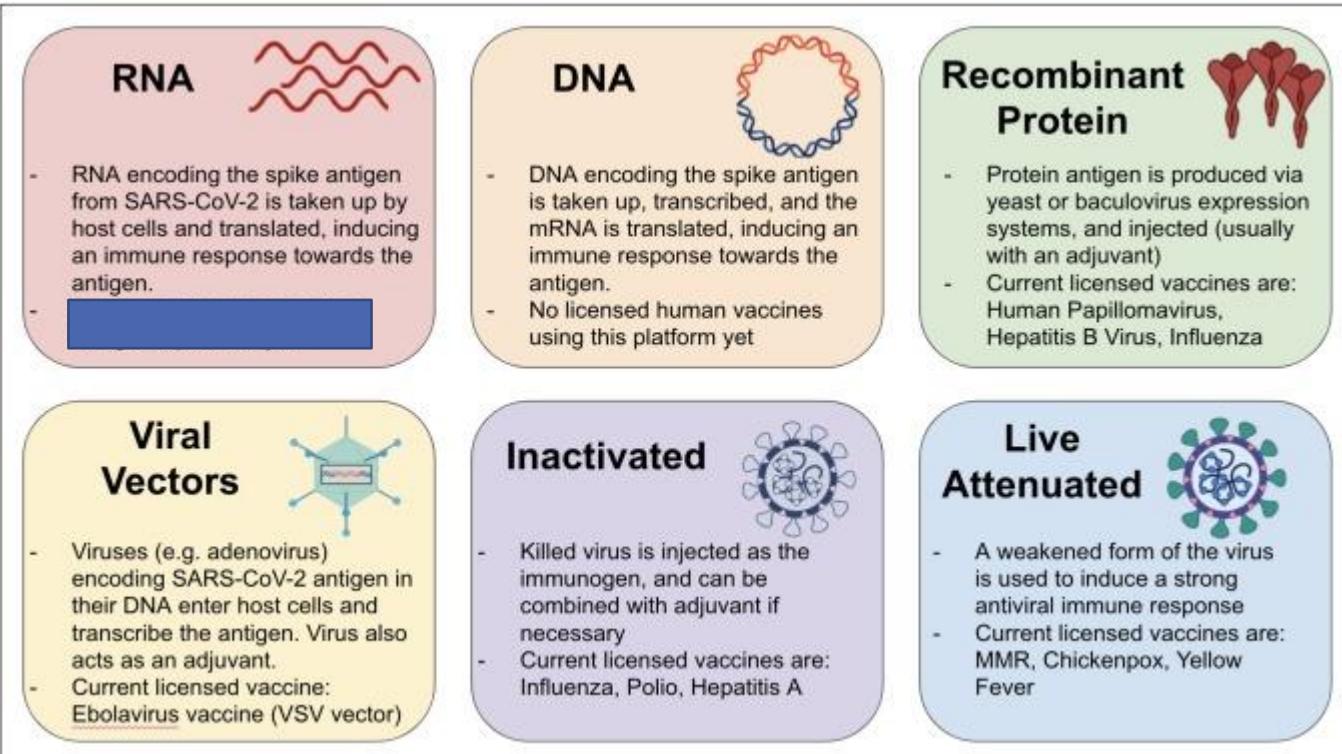
- 1796- Edward Jenner develops smallpox vaccine**
- 1948- WHO established**
- 1959- WHO commences vaccination drives against smallpox**
- 1978- Janet Parker is the last person to die of smallpox**



# Vaccine-Preventable Diseases



# TYPES OF VACCINE



Covaxin

Sputnik/ Covishield

Pfizer/Moderna

# Autoimmune Diseases

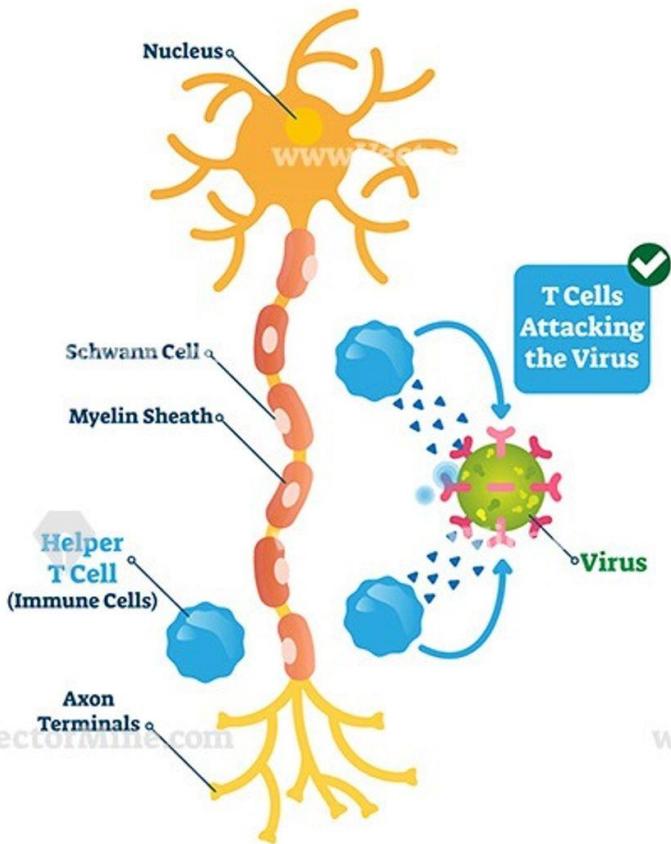
www.VectorMine.com



www.Vect

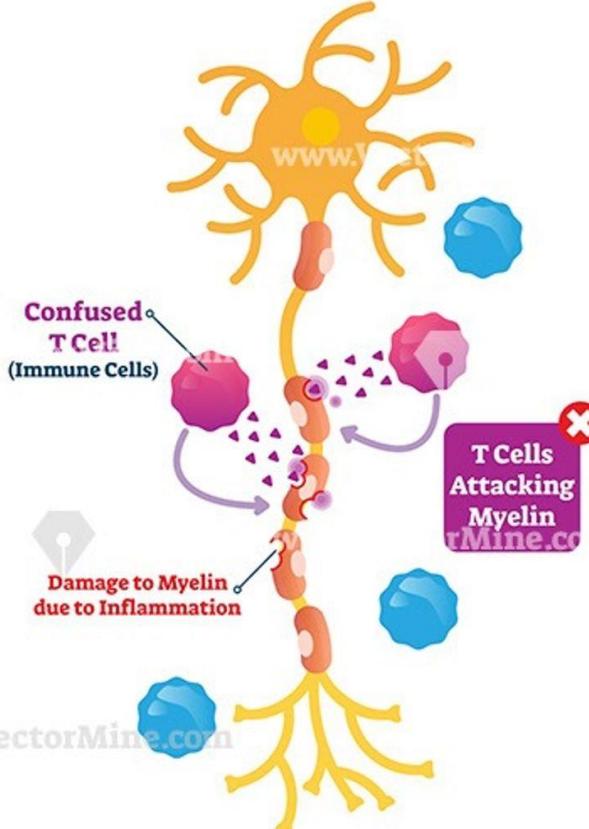
## HEALTHY

Neuron  
(Nervous System Cell)

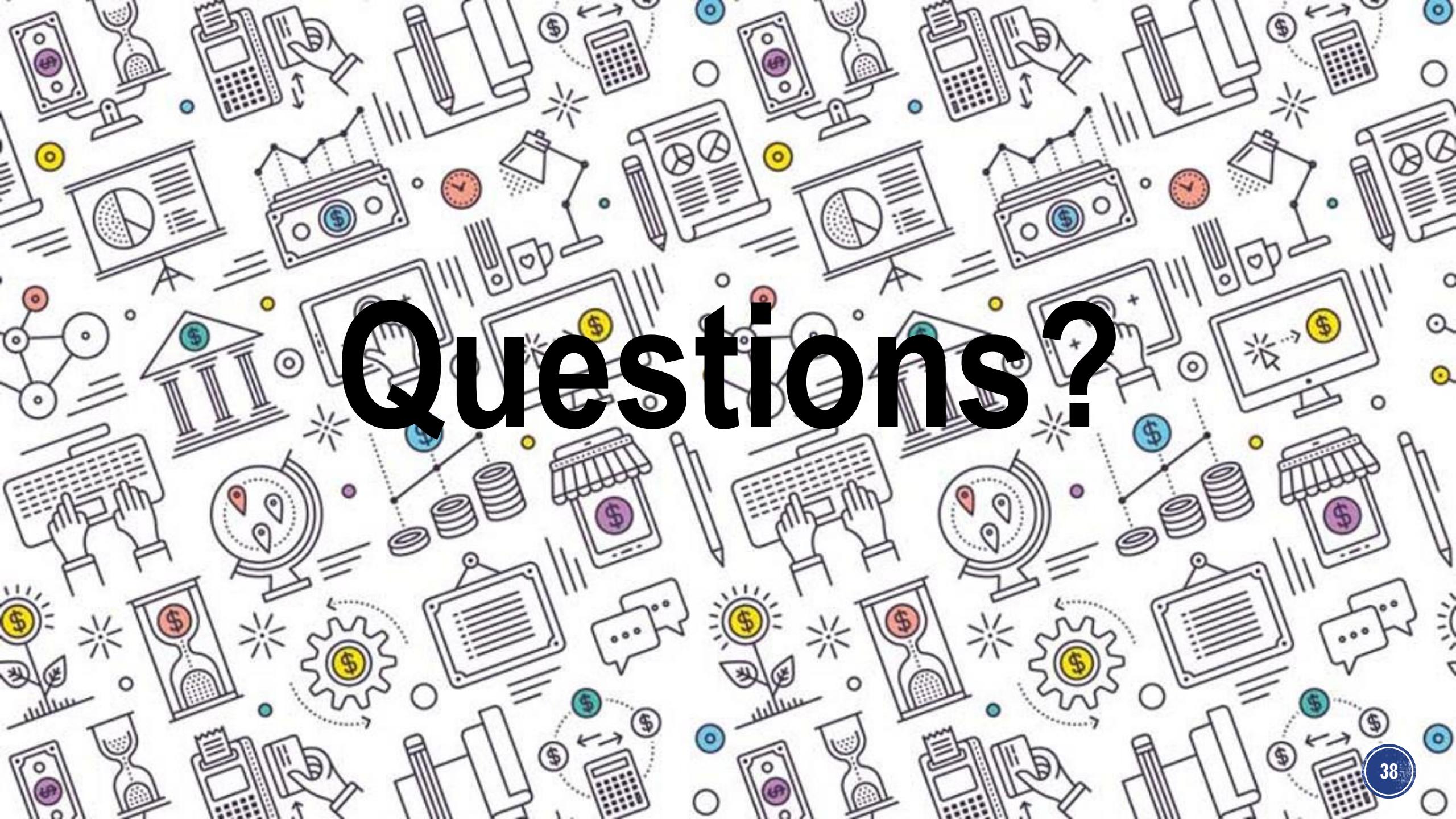


## AUTOIMMUNE DISEASE

Neuron  
(Nervous System Cell)



- **Multiple Sclerosis**
- **Rheumatoid Arthritis**
- **Lupus**
- **Asthma**



# Questions?