UNDERSTANDING IMMUNITY

Praveen Deepak
Assistant Professor of Zoology
S. S. College, Jehanabad

Introduction

- The word immunity comes from the Latin word '*immunis*' meaning '*exempt*'.
- Immunity is the ability of the body to protect itself from viruses, bacteria, protozoans, and other none-self.
- Many harmful microbes reside in the body as symbionts; sometimes they invade our body to make us sick – defense mechanism activated.
- It is achieved naturally as the coordinate function of different cells, organs, and small mediator molecules.
- It can be artificially implanted through immunization or vaccination.

Types

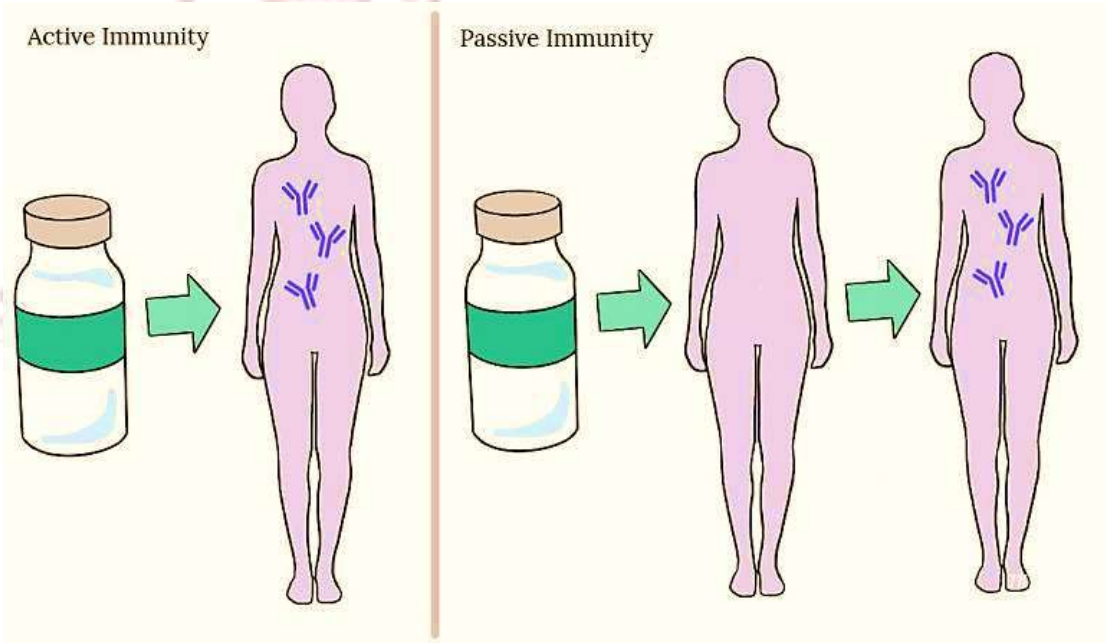
Two types:

- ***Innate immunity:*** the immunity which comes by birth, including physical barriers (skin, body hair, etc.), defense mechanisms (saliva, mucus, gastric acid, etc.), general immune response (inflammation).
  - It is non-specific and less diverse
  - It is quick (as quick as 15 minutes).
  - Cells involved are phagocytes (macrophages and neutrophil), natural killer cells.
  - It may be humoral (known as innate humoral immunity) due to active role of complement protein.
- ***Adaptive immunity:*** the immunity that develops from immunological memory. The body must have exposed to the pathogens. Subsequent exposure may lead to rapid onset of immune response.
  - It is highly specific and much diverse.
  - It takes few days to achieve an optimal response.
  - Lymphocytes (B and T cells).

Types

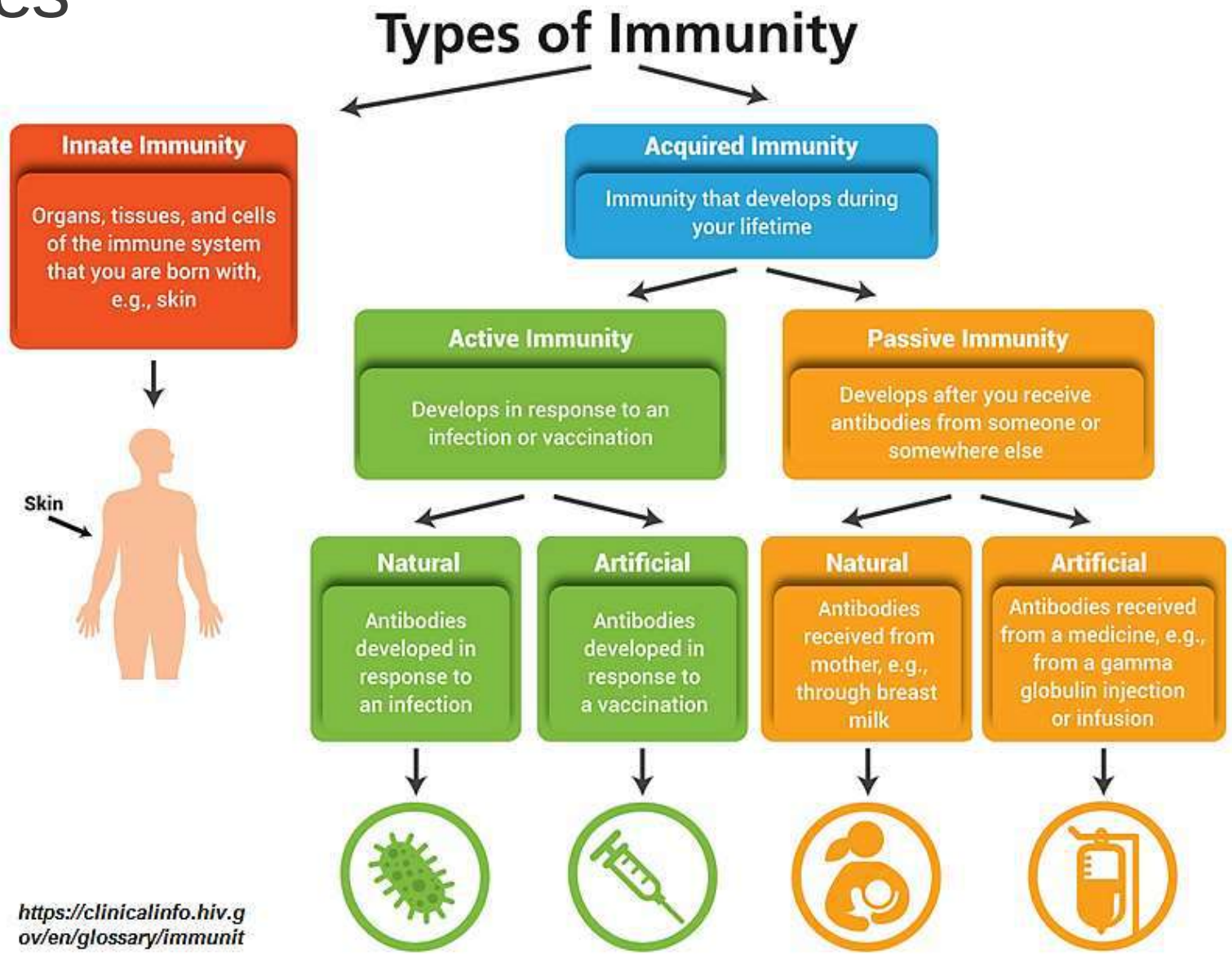
Adaptive immunity:

- ***Active immunity:*** the immunity which results from the production of antibodies by the immune system in response to the presence of an antigen.
- ***Passive immunity:*** the short-term immunity which results from the introduction of antibodies from another person or animal.



<u>On the basis of body's involvement</u>

Types



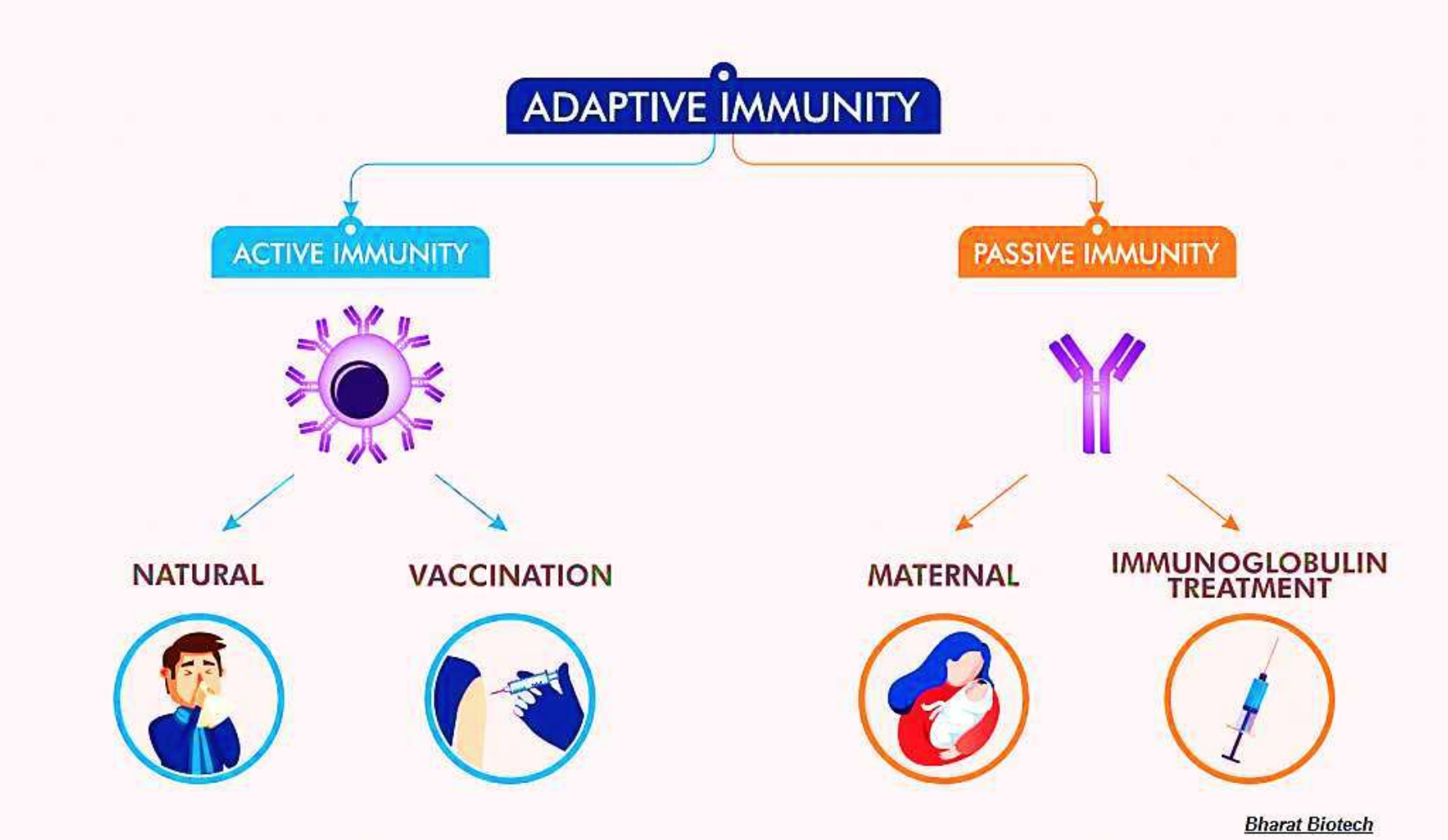
https://clinicalinfo.hiv.gov/en/glossary/immunit

Types

Active immunity:

- ***Natural Active immunity:*** It occurs when the person is exposed to a live pathogen, develops the disease, and becomes immune as a result of the primary immune response. First infection takes up to 14 (7 to 14 days) days to resolve and leads to the generation of memory cells with a high specificity for the inducing antigen. However, subsequent infection takes only 3 to 5 days to resolve the infection.
- ***Artificial Active immunity:*** the immunity provided by intentional exposure of a person to antigens, so as to produce an active and lasting immune response. Vaccination is an example of artificial active immunity. By artificially stimulating the adaptive immune defenses, a vaccine triggers a primary immune response which includes memory cell production.

Types


ADAPTIVE IMMUNITY
ACTIVE IMMUNITY
PASSIVE IMMUNITY
NATURAL
VACCINATION
MATERNAL
IMMUNOGLOBULIN TREATMENT
Bharat Biotech

Types

Passive immunity:

- ***Natural passive immunity***: It is the Immunity that is passed along from mother to child. Before the child is born, antibodies, specifically IgG are passed through the placenta to protect and after the birth through the first milk (colustrum) to infant to protect from illness.
- ***Artificial passive immunity:*** immunity is an immediate, but short-term immunization provided by the injection of antibodies, such as gamma globulin, that are not produced by the recipient's cells. These antibodies are developed in another individual or animal and then injected into another individual.

Types

Immunity:

- ***Humoral immunity***: Innate and adaptive immunity both have humoral arm of immunity. It is the immunity conferred by soluble factors dissolved in the blood plasma.
  - Innate humoral immunity: The complement protein confers innate immunity to the individual upon infection.
  - Adaptive or acquired humoral immunity: The antibody confers acquired or adaptive immunity to the individual.

- ***Cell-mediated immunity:*** It signifies the involvement of cellular component of immune system in eliciting immune response. It is the part of adaptive immune system only. However, there are cell components in the innate immune system, they do not confer cell-mediated immunity. It involves direct cell-to-cell contact between immune cell and pathogen infected cells.

Barriers of Immune System

Innate Immunity

- **Anatomic barriers**
  - The skin and the mucosal surfaces provide protective barriers against infection
- **Physiologic barriers**
  - temperature, pH, and various soluble and cell associated molecules
- **Phagocytic/endocytic barriers**
  - internalize, kill, and digest
- **Inflammatory barriers (NO, TNF-α, PGE_2)**
  - Vasodilation
  - Increase in capillary permeability
  - influx of phagocytes
    - redness, swelling, heat, pain

Adaptive Immunity

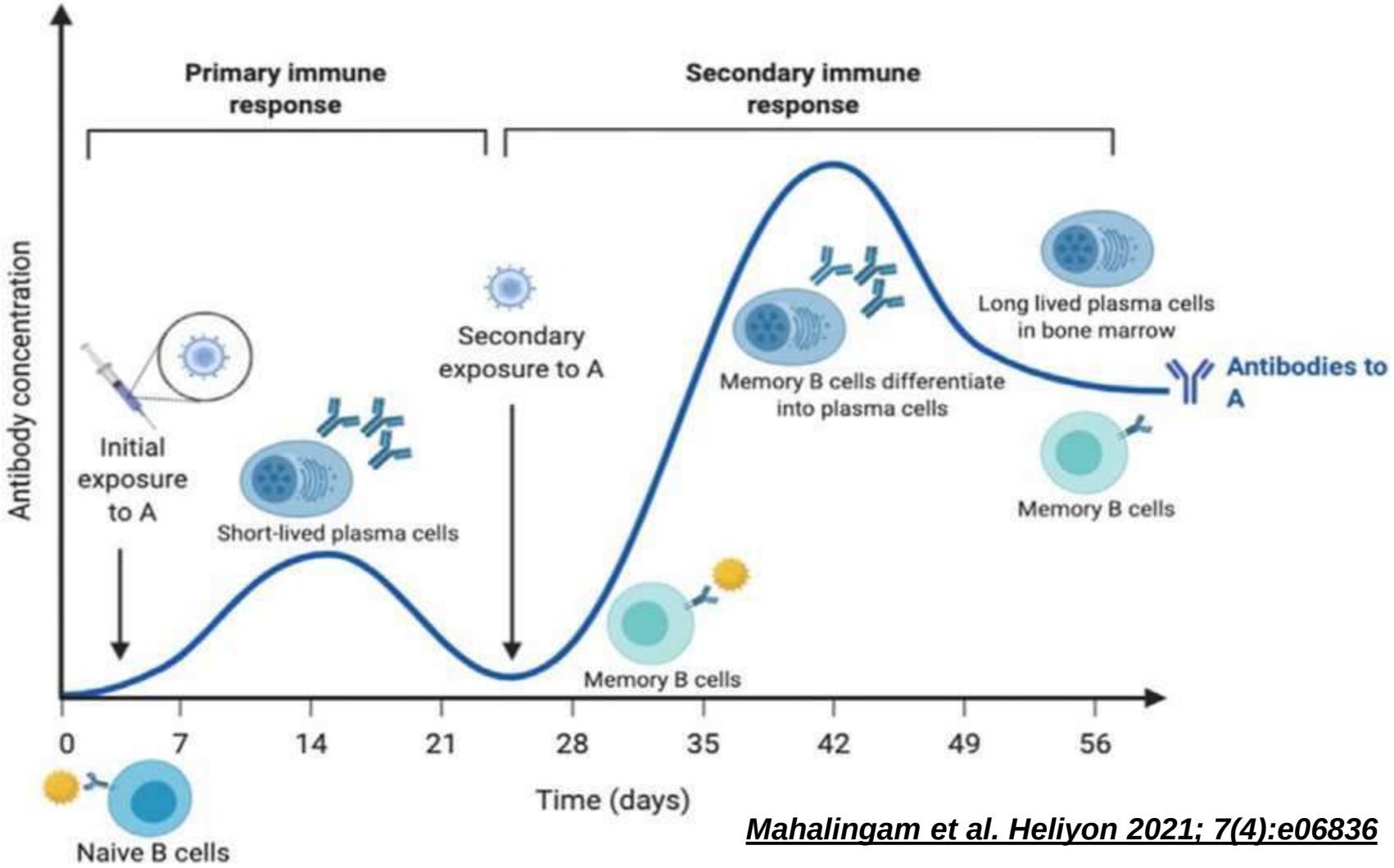
- **Humoral immune response : Antibody, complement**
- **Cell-mediated immune response**
  - B cell, T cell, macrophage, dendritic cell

Primary and Secondary Immune Response

Sl.No	Primary Immune Response	Secondary Immune Response
1	It occurs as a result of primary contact with an antigen.	It occurs as a result of second and subsequent contacts with the same antigen.
2	Antibody level reaches peak in 7 to 10 days.	Antibody level reaches peak in 3 to 5 days.
3	Prolonged period is required to establish immunity.	It establishes immunity in a short time.
4	There is rapid decline in antibody level.	Antibody level remains high for longer period.
5	It appears mainly in the lymph nodes and spleen.	It appears mainly in the bone marrow, followed by the spleen and lymph nodes.

https://www.brainkart.com/article/Immune-responses_38098/

Primary and Secondary Immune Response



Mahalingam et al. Heliyon 2021; 7(4):e06836

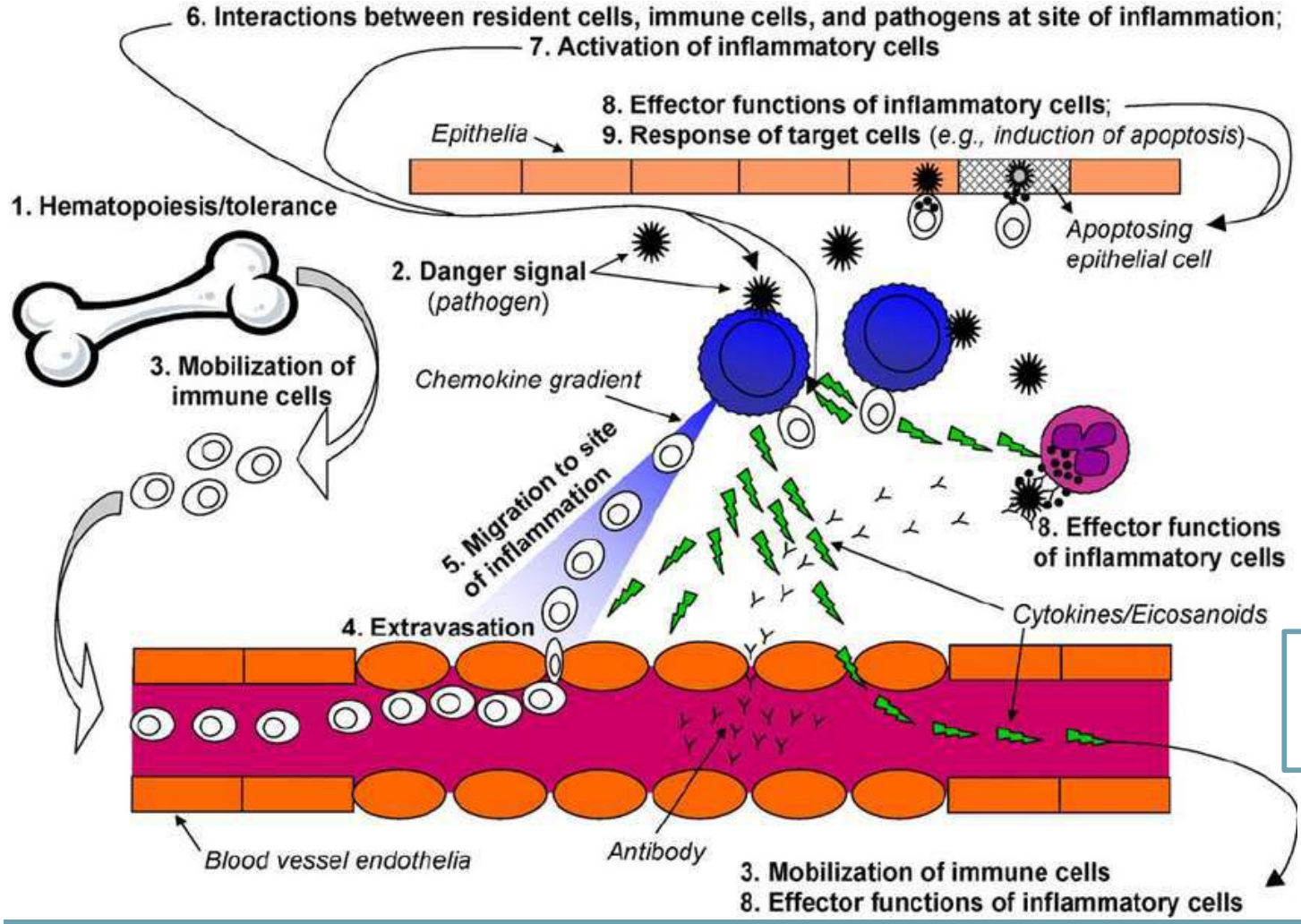
Phases of Immune Response

Inflammation

Phase of immune response	Description
Hematopoiesis/homeosta-sis/tolerance	The generation and differentiation of immune cells and maintenance of their number in circulation and tissues; prevention of self-reactivity.
Danger signal	Innate recognition of and response to pathogenic foreign substances or stress.
Mobilization of immune cells	Systemic soluble mediators informing immune cells in circulation and lymphoid tissues of danger.
Extravasation	The process of circulating immune cells crossing from blood into peripheral tissues and secondary lymphoid tissues.
Migration to site of inflammation	The process of immune cells, after extravasation, reaching the site of inflammatory insult, including chemoattraction, adhesion to substrates, and degradation of extracellular matrix.
Interactions between resident cells, immune cells, and pathogens at site of inflammation	Interactions between resident cells, immune cells, and pathogens at site of inflammation–how infiltrating cells interact with the resident inflammatory cells, non-immune cells (e.g., epithelia), pathogens, and other infiltrating cells, that leads to activation of effector functions.
Activation of inflammatory cells	The signaling pathways and transcription factors stimulated by activating, co-stimulatory, and inhibitory receptors that leads to activation, proliferation, differentiation, and survival of responding immune cells.
Effector functions of inflammatory cells	The factors produced/released by immune cells in attempt to resolve the pathogenic insults, including release of cytotoxic/cytostatic mediators and mediators to enhance or fine-tune the immune response.
Response of target cells	The pathways in non-immune cells (e.g., epithelia) activated in response to the effector functions of immune cells.
Resolution of immune response vs. chronic inflammation	The pathways that lead to the downregulation of immune responses and inflammation after the pathogenic insult is cleared; the factors maintaining late-phase immune responses when the insult is not totally resolved.

doi:10.1371/journal.pone.0001035.t002

Phases of Immune Response



doi:10.1371/journal.pone.0001035.g001

Disorders of Immune System

1. **Allergies**
2. **Autoimmunity**
3. **Immunodeficiency**
4. **Acquired Immunodeficiency Syndrome (AIDS)**

Functional Importance of Immune System

Role of the immune system	Implications
Defense against infections	Deficient immunity results in increased susceptibility to infections; exemplified by AIDS Vaccination boosts immune defenses and protects against infections
Defense against tumors	Potential for immunotherapy of cancer
Clearance of dead cells and tissue repair	Deficient immunity can lead to secondary infections after injury, and excessive immune reposnes can lead to fibrosis and organ dysfunction
The immune system can injure cells and induce pathologic inflammation	Immune responses are the cause of allergic, autoimmune, and other inflammatory diseases
The immune system recognizes and responds to tissue grafts and newly introduced proteins	Immune responses are barriers to transplantation and gene therapy

Further reading

- Abbas A.K. & Andrew H. 2001. Basic Immunology. Saunders Publication, Philadelphia, USA.
- Abbas A.K., Litchman A.H., Pillai S. 2022. Cellular and Molecular Immunology 10th Edition. Elsevier Inc., Philadelphia, USA.
- Punt J., Stanfor S., Jones P., Owen J. 2019. Kuby Immunology 8th Edition. W. H. Freeman, New York, USA.
- Cellular and Molecular Immunology, 10th Edition.
- Murphy K. & Weaver C. 2022. Janeway's Immunobiology 9th Edition. Garland Science, New York, USA.