
بسم الله الرحمن الرحيم

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Immunity

Prof Dr. Saeed ur Rahman

MBBS, M.Phil, Ph.D, CHPE

Objectives

At the end of lecture, students of 3rd year should be able to

1. Describe the functions & types of immunity
2. Describe the characteristics, origin and functions of cells of immune system.
3. Enlist the three lines of defenses and outline their properties
4. Compare innate and acquired immunity.
5. Compare the mechanism of active & passive immunity.

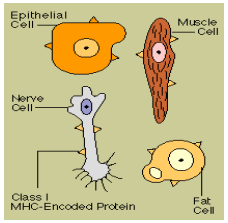
The Immune system

- Immunity is a state of relative resistance to disease.
- A functional immune system confers a state of health **through effective elimination of infectious** agents (bacteria, viruses, fungi, and parasites) and **control of malignancies** by protective immune surveillance.
- It is a body-wide network of cells and molecules.

SIGNIFICANCE OF THE IMMUNE SYSTEM

- **Beneficial**:
  - Protection from Invaders
  - Elimination of “altered self”
- **Detrimental** (harmful):
  - Discomfort (inflammation)
  - Damage to self (autoimmunity)

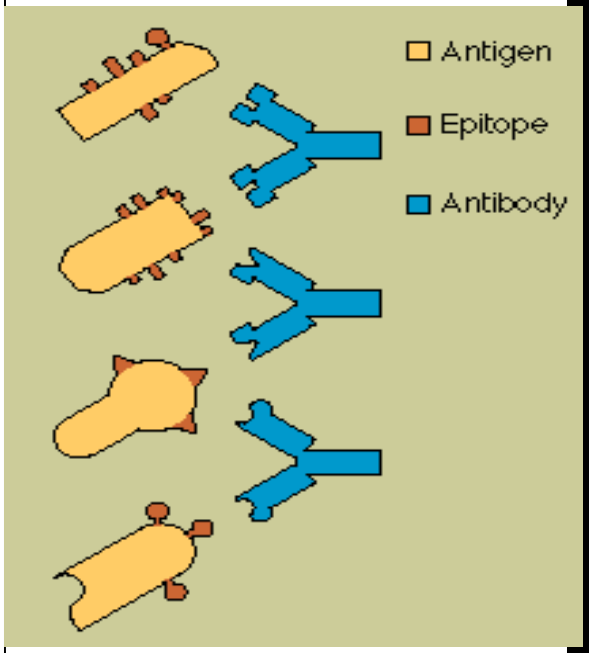
MARKERS OF SELF



- Each body cell carries distinctive molecules (markers) on its surface that differentiate it as "self."
- The **main task** of the immune system is to distinguish between “self and non-self”.
- Components of the innate immunity have **pattern-recognition receptors** that **identify** **pathogen-associated molecular pattern (PAMP)** present on the surface of many microbes (that is not present on human cells).

MARKERS OF NON-SELF

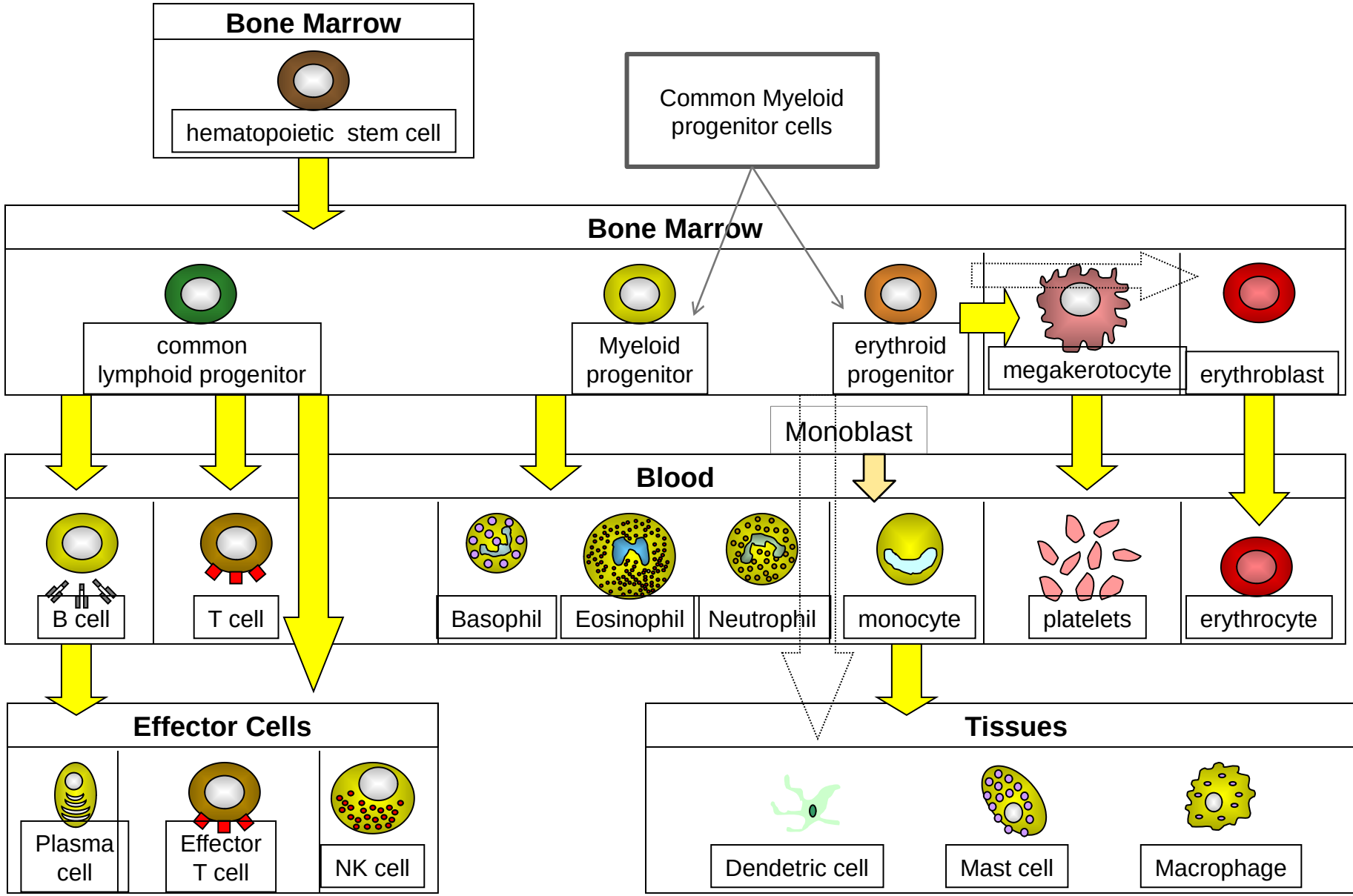
- Foreign molecules, carry distinctive markers, with characteristic shapes called **epitopes** that protrude from their surfaces.
- The immune system recognizes many millions of distinctive non-self molecules, and responds by producing **antibodies.**
- Any substance capable to trigger an immune response is called **antigen**.



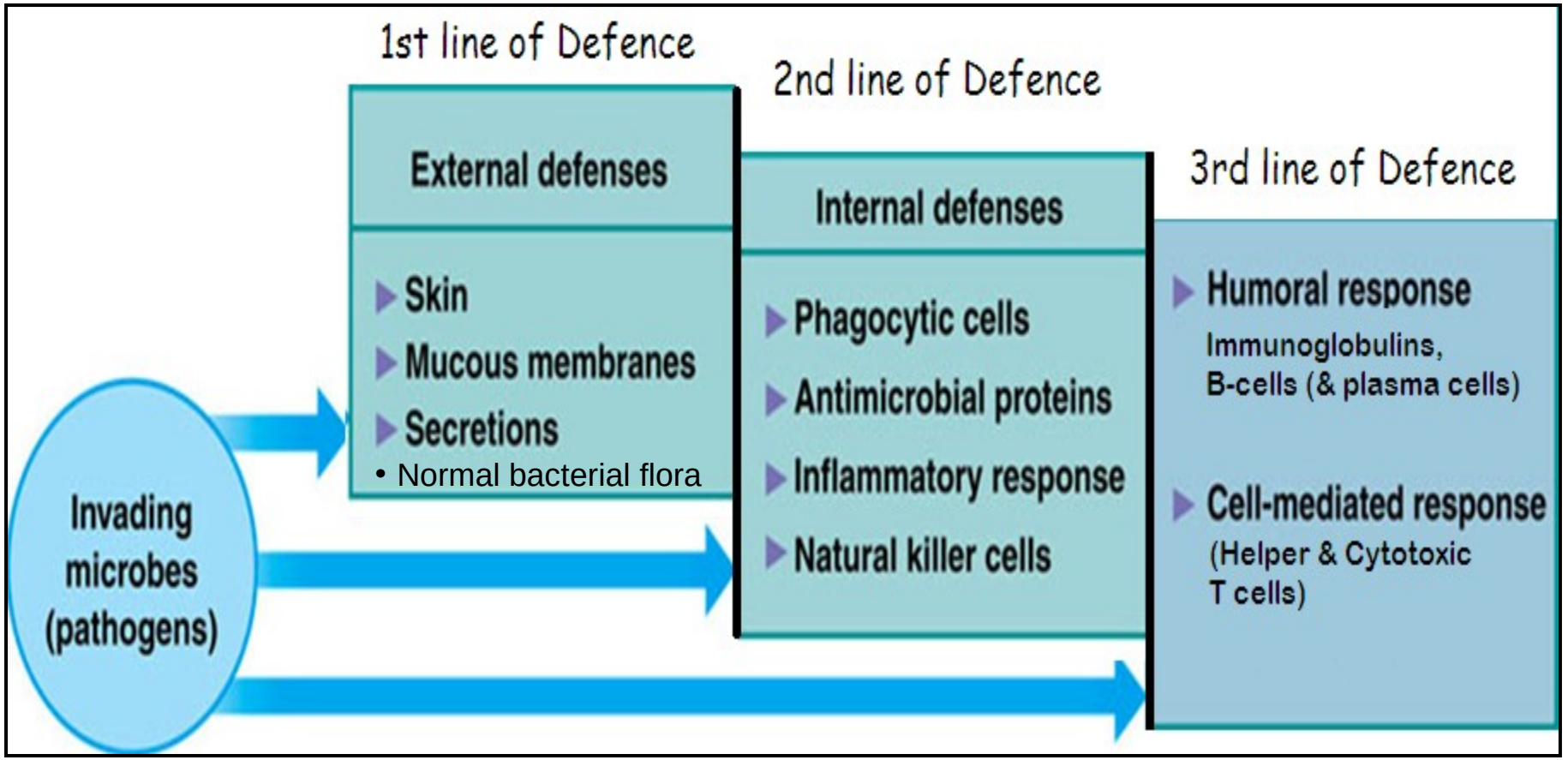
- The main **components** of the immune system are lymphocytes, phagocytes, antigen presenting cells, antibodies, cytokines and complement system
- The immune system acts in three phases

1. First phase is '**recognition**' with the help of B- cell receptors (BCR – the surface immunoglobulin) and T- cell receptors (TCR).
2. The second phase is **'activation'** of metabolic processes inside the cells.
3. The third phase is the **'effector'** phase in which the activated cells produce chemicals (cytokines) to activate other cells. Memory cells are also generated in this phase.

IMMUNE CELLS ORIGINATE FROM PRECURSORS IN BONE MARROW



DEFENSES

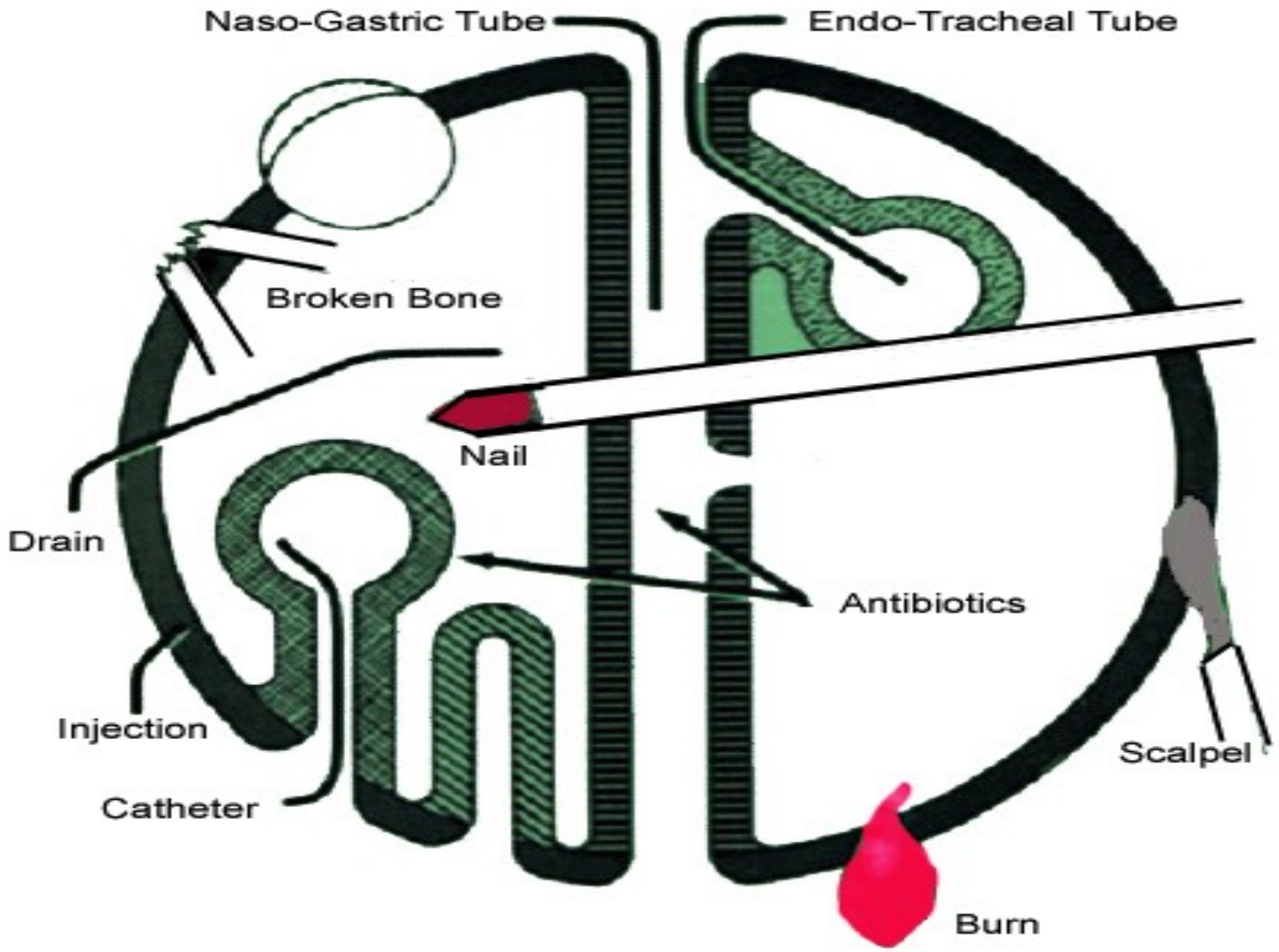

1st line of Defence
2nd line of Defence
3rd line of Defence
External defenses
Skin
Mucous membranes
Secretions
• Normal bacterial flora
Internal defenses
Phagocytic cells
Antimicrobial proteins
Inflammatory response
Natural killer cells
Humoral response
Immunoglobulins,
B-cells (& plasma cells)
Cell-mediated response
(Helper & Cytotoxic
T cells)
Invading
microbes
(pathogens)

1st line: Physical and Chemical barriers

- skin and mucous membranes (form continuous barrier)
- low pH (3 & 5) of sweat, sebum,
- digestive enzymes in saliva, lysozymes in tears,
- ciliary escalator/ elevator of respiratory mucosa, alveolar macrophages, mucous hairs in nose etc.
- **GIT**: hydrolytic enzymes in saliva, acid in stomach, various degradative enzymes and macrophages in small intestine, peristalsis, Low pH, bile acid, flushing

- Low pH of vagina in adult women (due to *Lactobacilli),*
- Defensin (α in GIT & β in LRT) (are + charged peptides that creates pores in bacterial cell membrane).
- Normal commensal flora,
- Inflammatory response, cough, sneezing reflexes,
- Fever (IL-I)

PHYSICAL BARRIERS ARE COMPROMISED

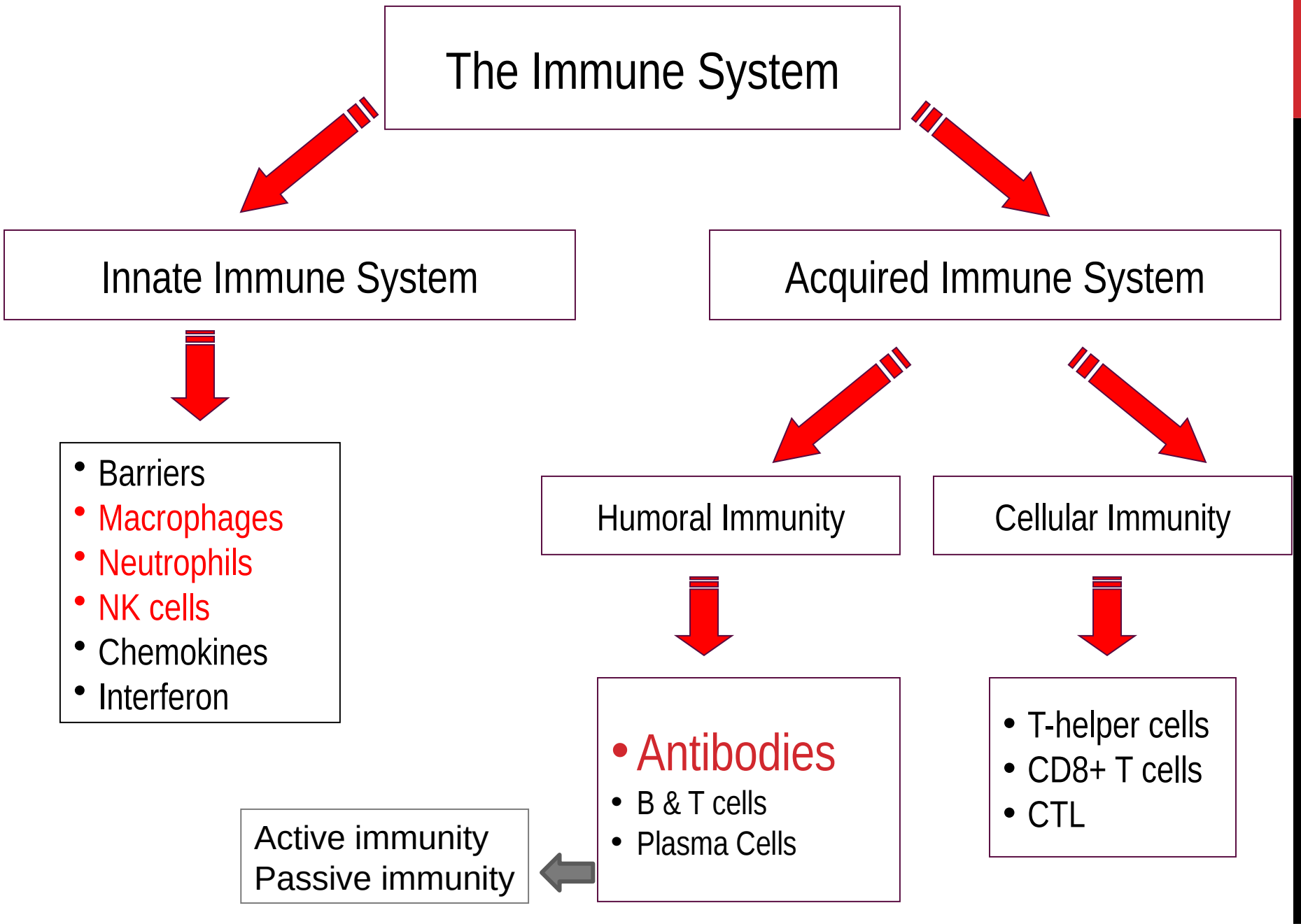


2nd line: molecular and Cellular (innate and nonspecific)

- neutrophils, basophils, mast cells, macrophages, eosinophil and NK cells (can kill invaders (either by phagocytosis or extracellular killing).
- complement cascade (plasma proteins) causes lysis of foreign cells
- interferons (protect cells from viral infection),

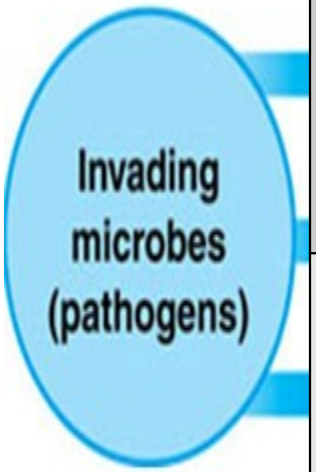
3rd line: Cellular (specific acquired)

- antigen specific mechanisms involving B and T lymphocytes to produce antibodies and (cytotoxic) T-cells.


The Immune System
Innate Immune System
Acquired Immune System
• Barriers
• Macrophages
• Neutrophils
• NK cells
• Chemokines
• Interferon
Humoral Immunity
Cellular Immunity
• Antibodies
• B & T cells
• Plasma Cells
• T-helper cells
• CD8+ T cells
• CTL
Active immunity
Passive immunity

DEFENSES

Adaptive immunity



Innate Immunity (rapid response to broad range of microorganisms)		Acquired Immunity (Slower response to specific microbes)
1st Barriers	2nd	3rd
• Physical • Chemical • Biological	• Phagocytic cells • Complements • Inflammatory response	• Humoral immunity • Cell mediated immunity

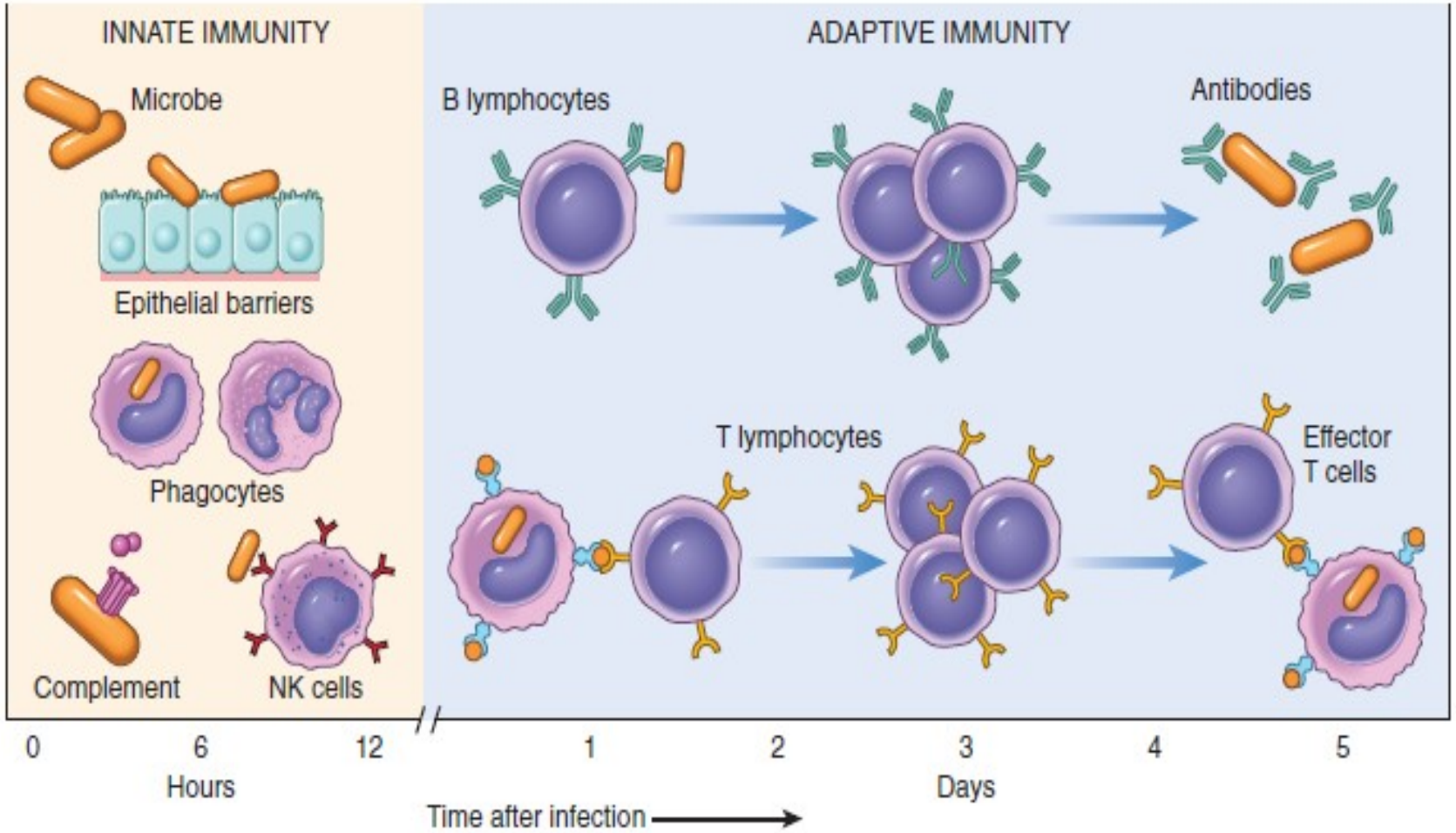


Figure 4–1 The principal mechanisms of innate immunity and adaptive immunity. NK, natural killer.

Innate Immunity

It is an inborn ability that depends on genetic factors. The elements of the non-specific (innate) immune system include:

1. Physio-chemical and biological barriers
2. Cellular components
3. Secretary molecules

Physico-chemical barriers to infections

System/ Organ	Active component	Effector Mechanism
Skin	1. Squamous cells; 2. Sweat	Desquamation; flushing, organic acids (modify pH)
GI tract	Columnar cells	Peristalsis, low pH, bile acid, flushing
Lung	Tracheal cilia	Mucocialiary elevator, surfactant
Nasopharynx and eye	1. Mucus, 2. saliva, 3. tears	Flushing, lysozyme

Circulation and lymphoid organs	Phagocytic cells NK cells and K-cell	1. Phagocytosis and intracellular killing 2. Direct and antibody dependent cytolysis 3. IL2-activated cytolysis
Serum	Lactoferrin and Transferrin	deprive organisms of iron by binding with iron.
	Interferons	Antiviral proteins (inhibit viral replication and activate other cells which kill pathogens
	TNF-alpha	suppresses viral replication and activates phagocytes.
	Lysozyme	(in serum and tears) breaks down the bacterial cell wall (peptidoglycan hydrolysis)
	Fibronectin	coats (opsonizes) bacteria and promotes their rapid phagocytosis.
	Complement	Opsonization, enhanced phagocytosis, inflammation

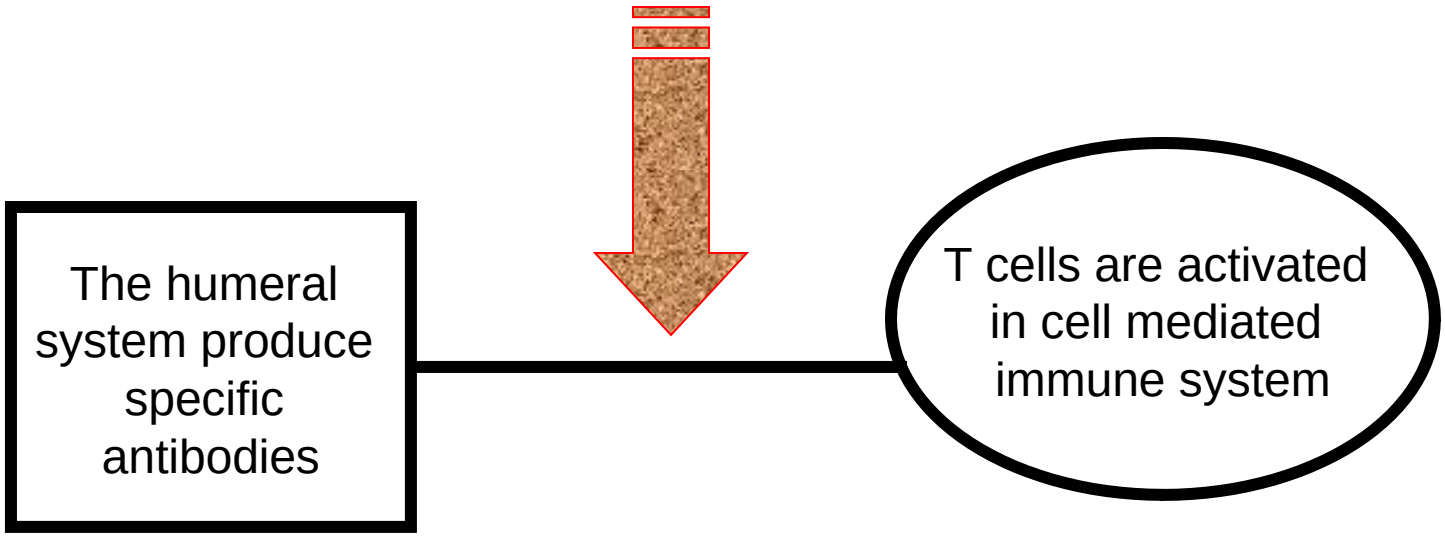
1. Secretory factors or chemicals used by the different immune cells to communicate.
2. Signaling molecules released by one cell to cause a response in another. Sometimes referred to as chemical messengers.

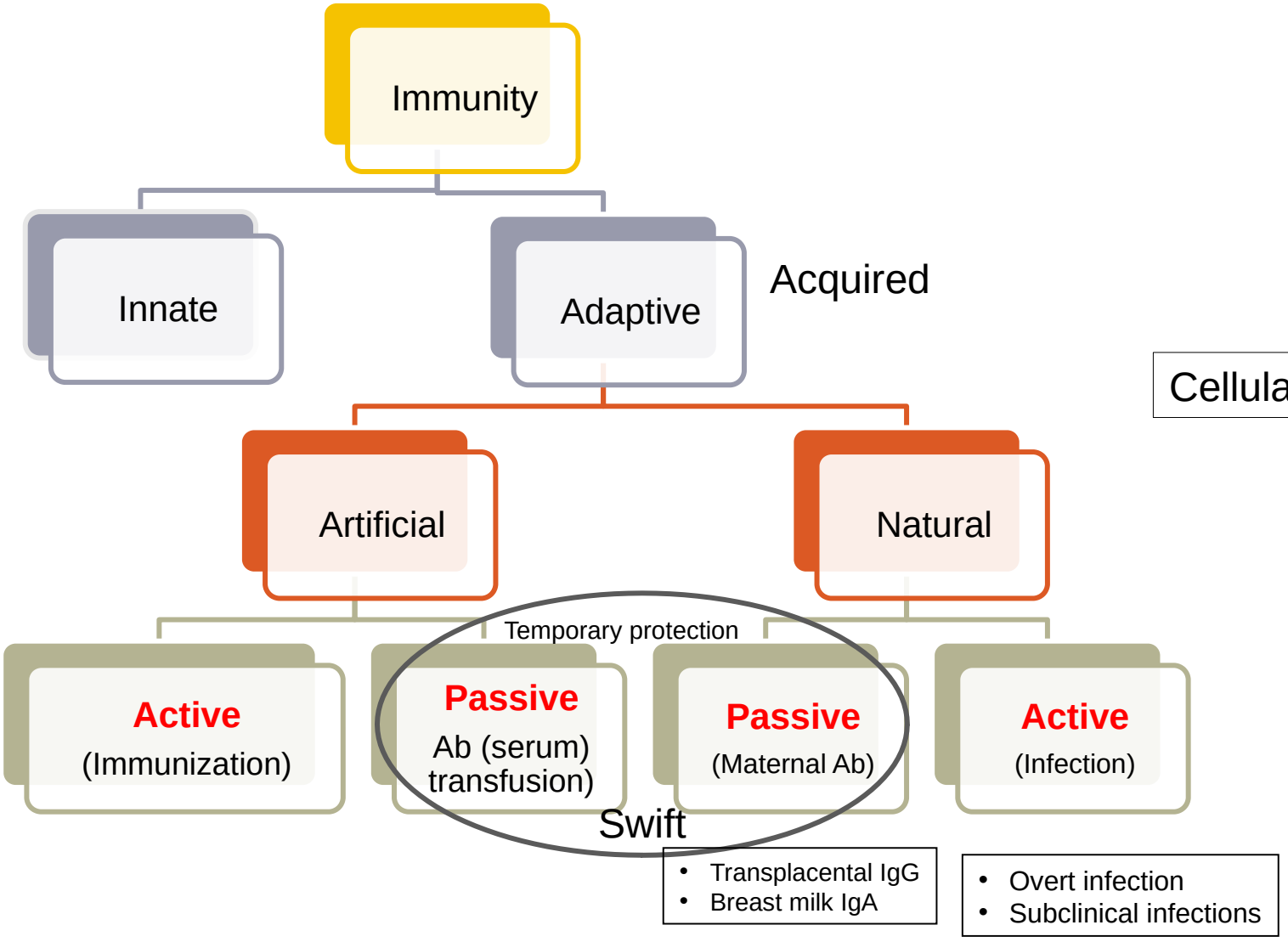
Polypeptide molecules released by

- infected tissues cells,
- local endothelial cells,
- resident neutrophils & macrophages

to attract cells of the immune system.

When the invading agents breach innate body defenses and reach inside the body, Specific immune system becomes effective




Immunity
Innate
Adaptive
Acquired
Cellular
Artificial
Natural
Temporary protection
Active
(Immunization)
Passive
Ab (serum)
transfusion)
Passive
(Maternal Ab)
Active
(Infection)
Swift
• Transplacental IgG
• Breast milk IgA
• Overt infection
• Subclinical infections

ACQUIRED IMMUNITY

Active Immunity

- The immunity produced in response to an antigen, a part of an antigen, or contact with an infectious agent (disease or subclinical exposure)
- It takes time to develop but may be long lasting, even life long.
- Can be natural (infection) or artificial (stuck with a needle - vaccination)

Passive Immunity

- The process of providing IgG (antibodies) to protect against infection.
- Transfer of serum from survivor, snake anti-venom, anti-toxin
- Transfer of immunoglobulin (through placenta or mother's milk).

Innate Immunity

= non-specific, natural, native

- Antigen independent
- Not antigen specific
- No time lag (immediate)
- No Immunologic memory

Adaptive Immunity

= specific = acquired

- Antigen dependent
- Antigen specific
- A lag period
- Develops memory

Table 2: Features of Non-Specific and Specific Immunity

Feature	Nonspecific (innate) immunity	Specific (Acquired/ Adoptive) immunity
Characteristic		
Specificity for microbes	Low-Minimal	High
Diversity	Limited	Large
Specialization	Low	Highly specialized
Memory	Nil	Present
Components		
Physical and Chemical Barriers	Skin, mucosal epithelia; anti-microbial chemicals in secretions such as defensins, lysozyme, acid in stomach, spermin etc.	Mucosal and cutaneous immune system and antibody molecules in secretions (secretory IgA)
Blood proteins	Complement and Cytokines (TNF, IFN-α)	Antibodies (IgG, IgA, IgM, IgE, IgD), Cytokines
Cells	Phagocytes (Neutrophils, Macrophages, NK cells)	Lymphocytes {B-lymphocytes, T-lymphocytes (Helper T-cells, Cytotoxic T-cells}

- Remarkable diversity (can respond to millions of Ag)
- Long memory (memory B & T cells are produced can respond after many years after initial exposure)
- Exhibit specificity and action against specific, initiating Ag)

THANK YOU