Nonspecific and Specific Immunity

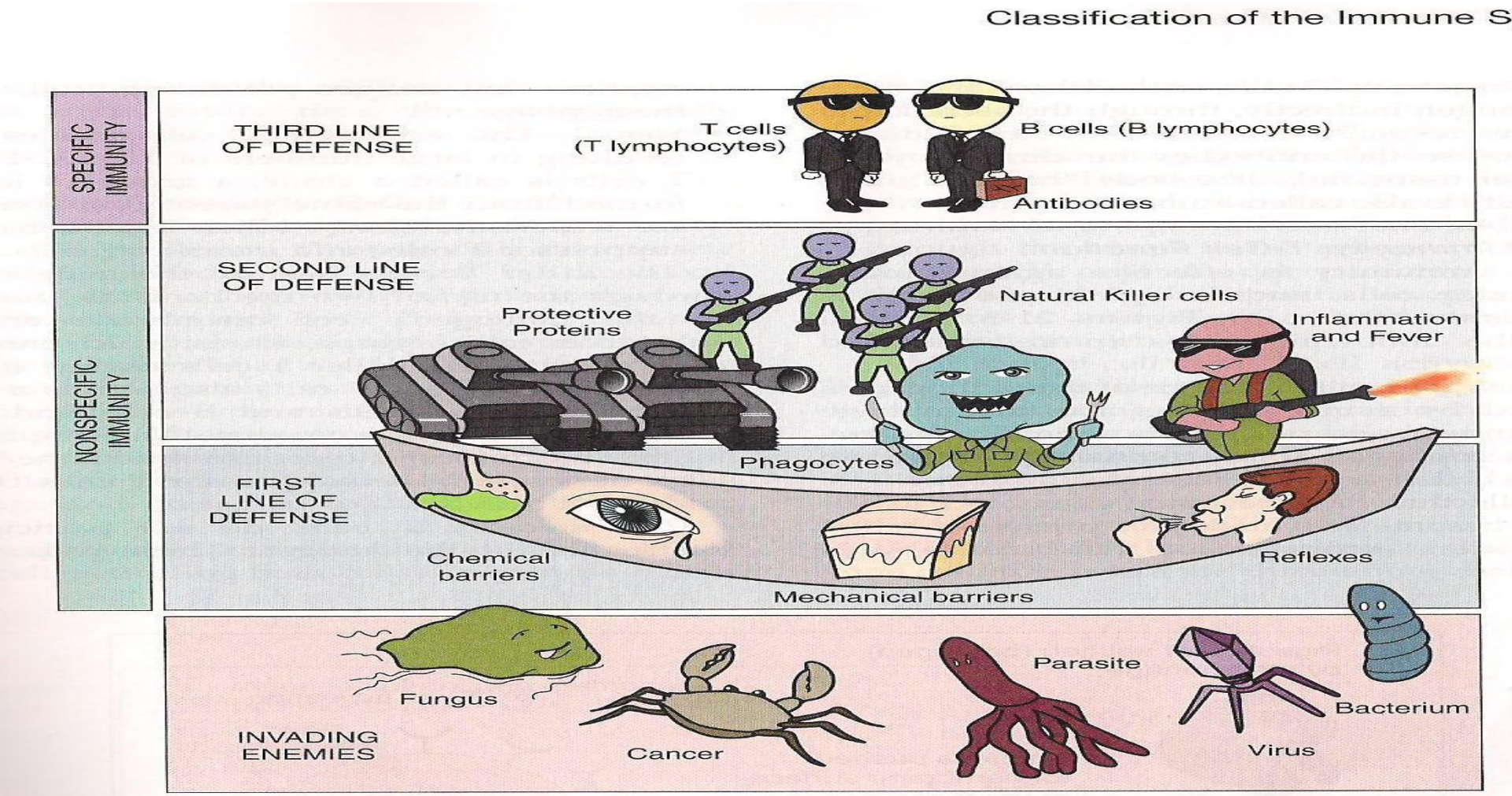

FIGURE 21-2 The immune system wages its battle with three lines of defense. (Read from bottom to to

By:

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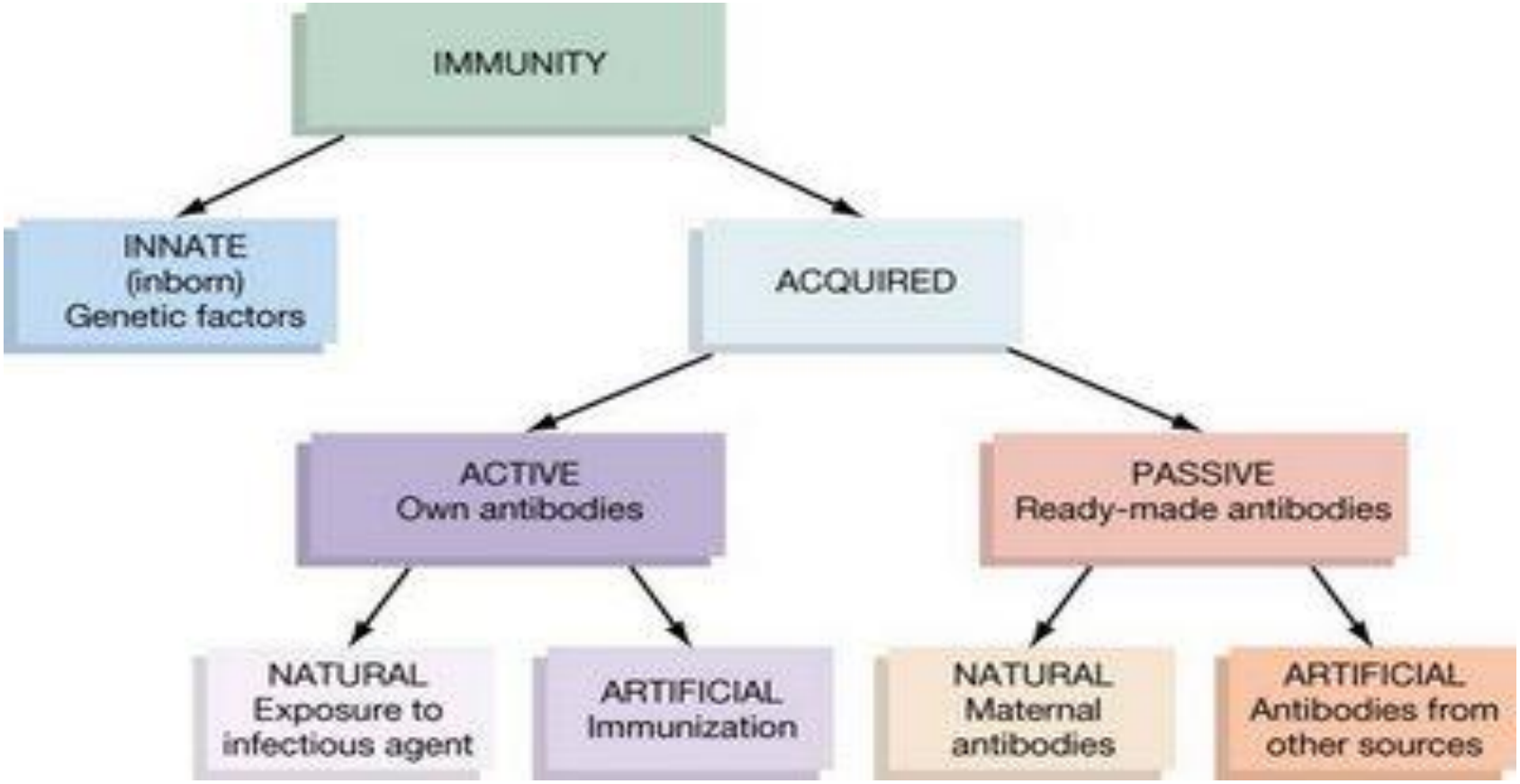
THE IMMUNE RESPONSE AND IMMUNITY

- **Immune response**
  - Innate (non-specific)
  - Adaptive or Acquired (specific)



Defense Mechanisms

Immunity

State of non-specific and specific protection

Nonspecific defense mechanisms		**Specific defense mechanisms (immune system)**
First line of defense	**Second line of defense**	**Third line of defense**
•Skin •Cilia •Physiological factors	**•Phagocytic white blood cells •The inflammatory response •Antimicrobial substances**	**•Lymphocytes •antibodies**

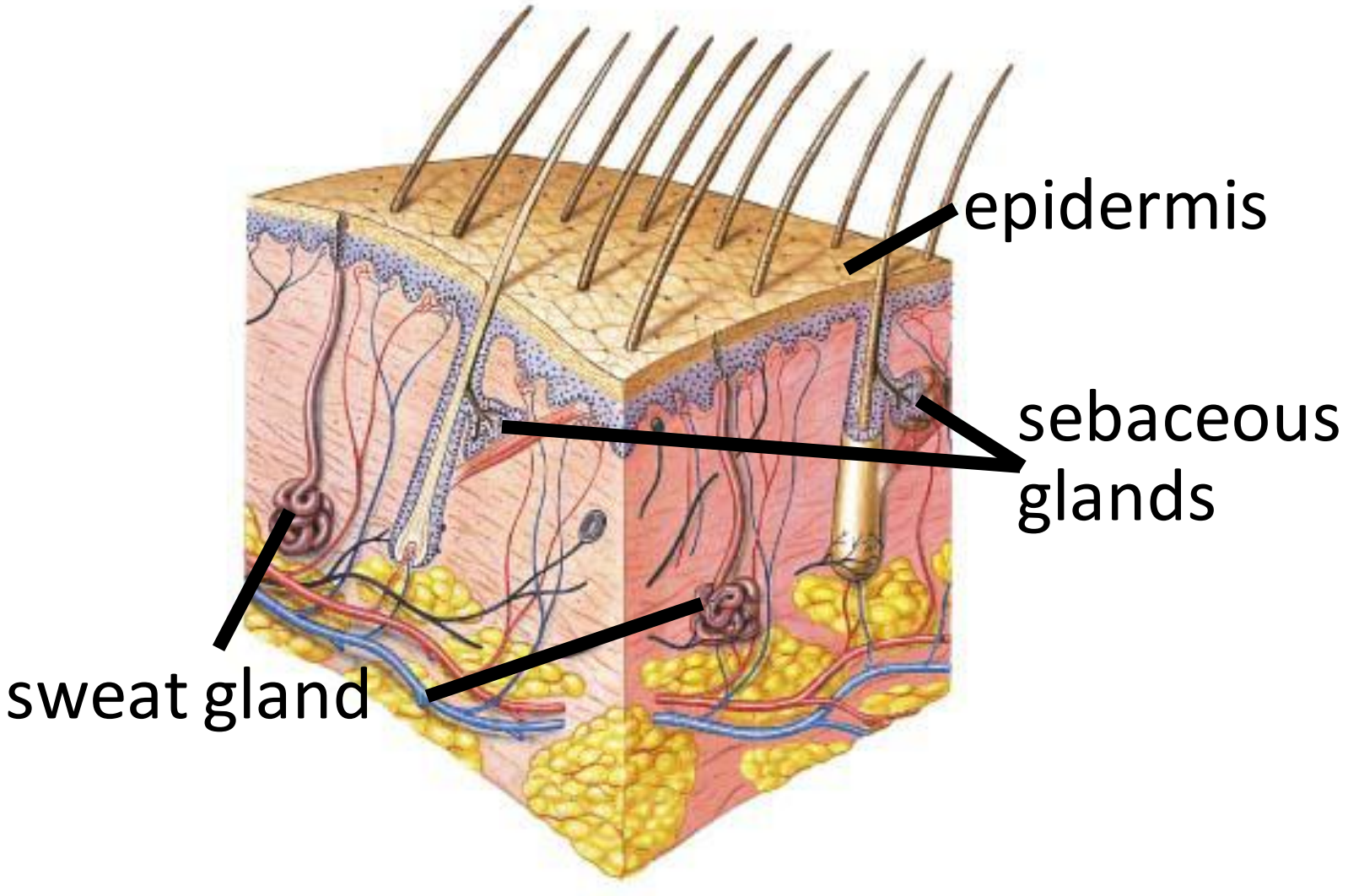
Nonspecific (Natural , Innate) Immunity: first line of defense

- **Composed of structural barriers to keep infectious agents out of the body.**
  - **Intact skin**
  - **Cilia**
  - **Physiological factors.**

Intact Skin

- **Difficult for a pathogen to penetrate,**
  - **Composed from closely packed cells, multiple layering, contanious sheding of cells, Presence of keratin.**
  - **Sweat creates high salt conditions, antibacterial enzyme (lysozyme).**
  - **Oil layer, fatty acids and acid pH present makes an inhospitable environment for microorganisms.**
- **Normal flora prevent other microorganisms from establishing an infection – “competitive exclusion”.**

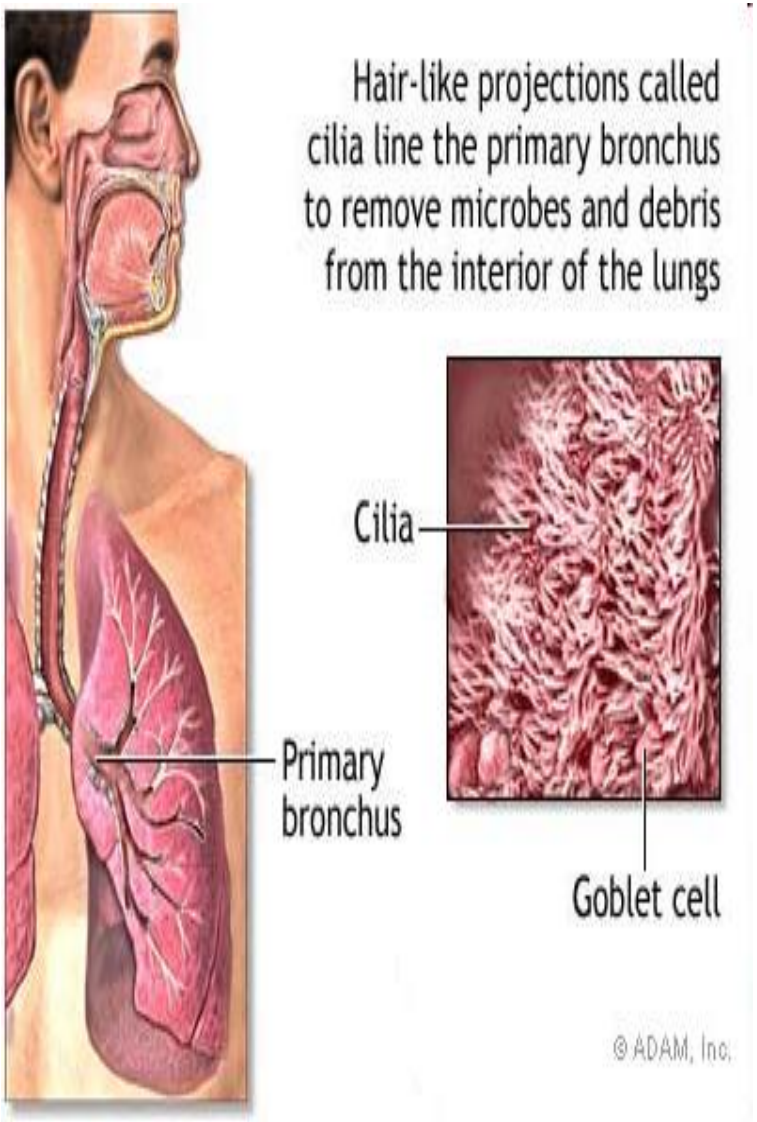
Body Coverings: The Skin



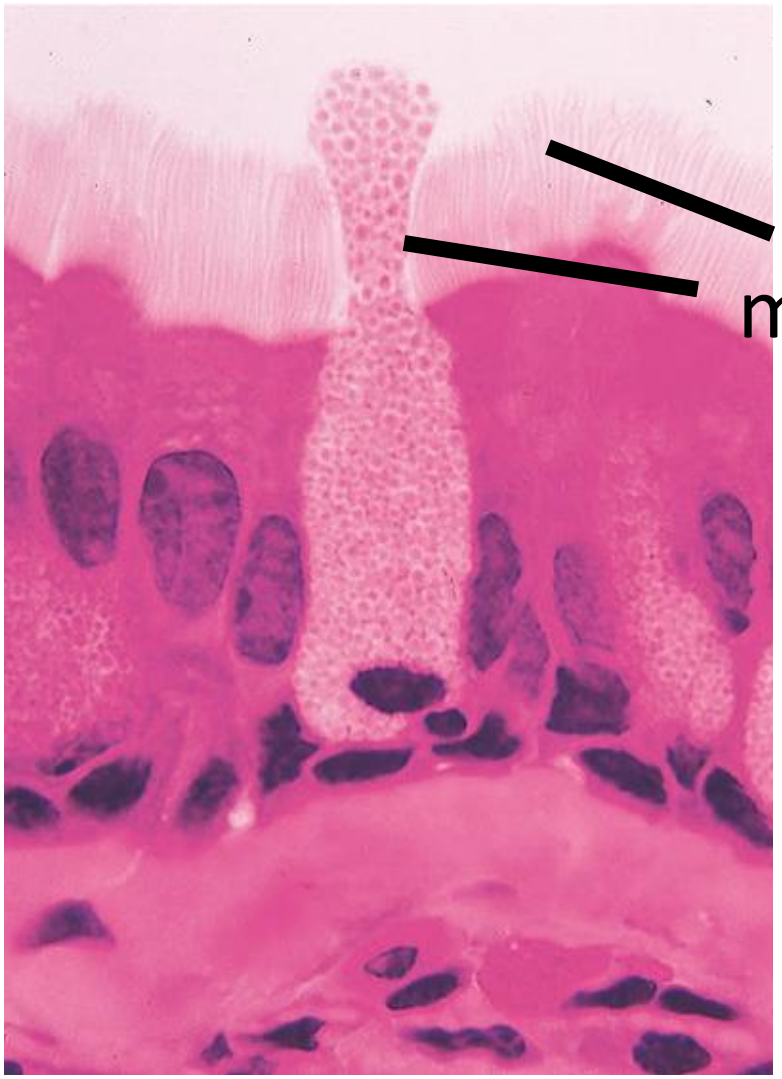
Respiratory Tract

- **Upper Respiratory Tract**
  - **Nasal hairs induce turbulence**
  - **Mucous secretions trap particles**
  - **Mucous stream to the base of tongue where material is swallowed**
  - **Nasal secretions contain antimicrobial substances**
  - **Upper respiratory tract contains large resident flora**
- **Lower Respiratory Tract**
  - **Particles trapped on mucous membranes of bronchi and bronchioles**
  - **Beating action of cilia causes mucociliary stream to flow up into the pharynx where it is swallowed**
  - **90% of particles removed by this way. Only smallest particles (<10µ in diameter) reach alveoli**
- **Alveoli**
  - **Alveolar macrophage rapidly phagocytize small particles**

Cilia



Mucous Membranes



Alimentary Tract

- General defense mechanisms
  - Mucous secretions
  - Integrity of mucosal epithelium
  - Peristaltic motions of the gut propel contents downward
  - Secretory antibody and phagocytic cells
- Stomach
  - Generally sterile due to low pH
- Small Intestine
  - Upper portion contains few bacteria
  - As distal end of ilieum is reached flora increases
- Colon
  - High numbers of microorganisms
  - 50-60% of fecal dry weight is bacteria

Genitourinary Tract

- **Male**
  - **Frequent flushing action of urine**
  - **Bactericidal substances from prostatic fluid**
  - **pH of urine**
  - **Bladder mucosal cells may be phagocytic**
  - **Urinary sIgA**
- **Female (Vagina)**
  - **Large microbial population (lactobacilli)**
  - **pH of urine**

Eye

- **Flushing action of tears which drain through the lacrimal duct and deposit bacteria in nasopharynx**
- **Tears contain a high concentration of lysozyme (effective against gram positive microorganisms**

Factors Modify Defense Mechanisms

- Age
- Hormones
- Drugs and chemicals
- Malnutrition
- Fatigue and stress
- Genetic determinants

Nonspecific Immunity, Second line of defense

Phagocytosis:

When the pathogens can penetrate the first line of defense (due to wounds, burns or loss of epithelia)the cell of innate immunity play aroule.

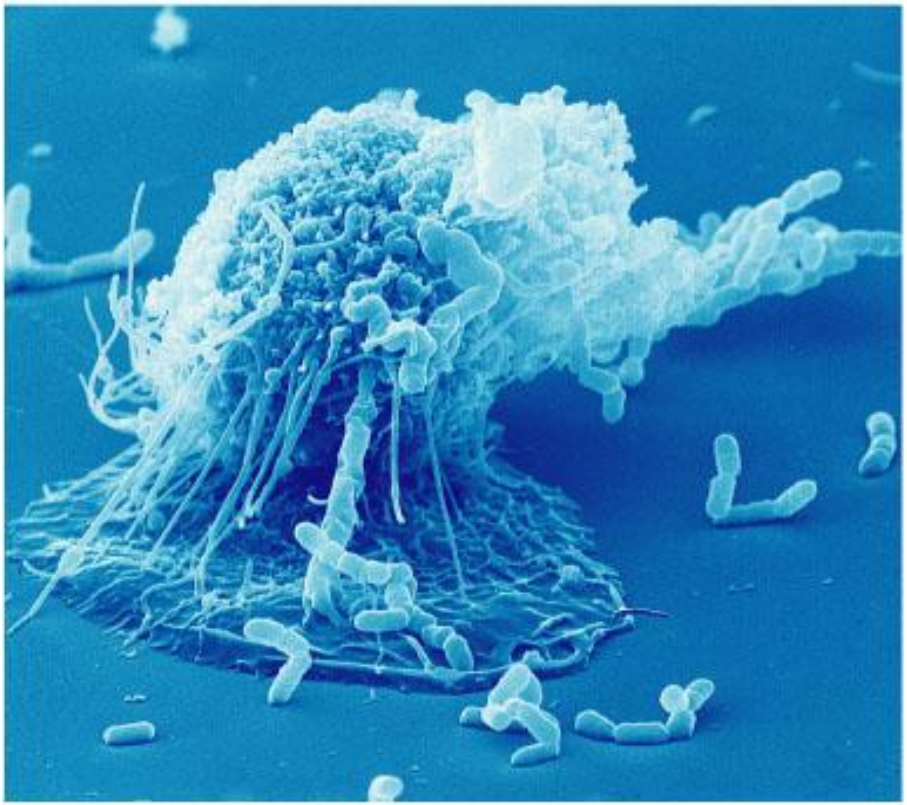
- Phagocytic cells
  - Neutrophils and macrophages
  - Natural Killer (NK) Cells: attack virus infected cells.

  The early responed phagocytic cells neutrophile followed by monocytic macrophages.

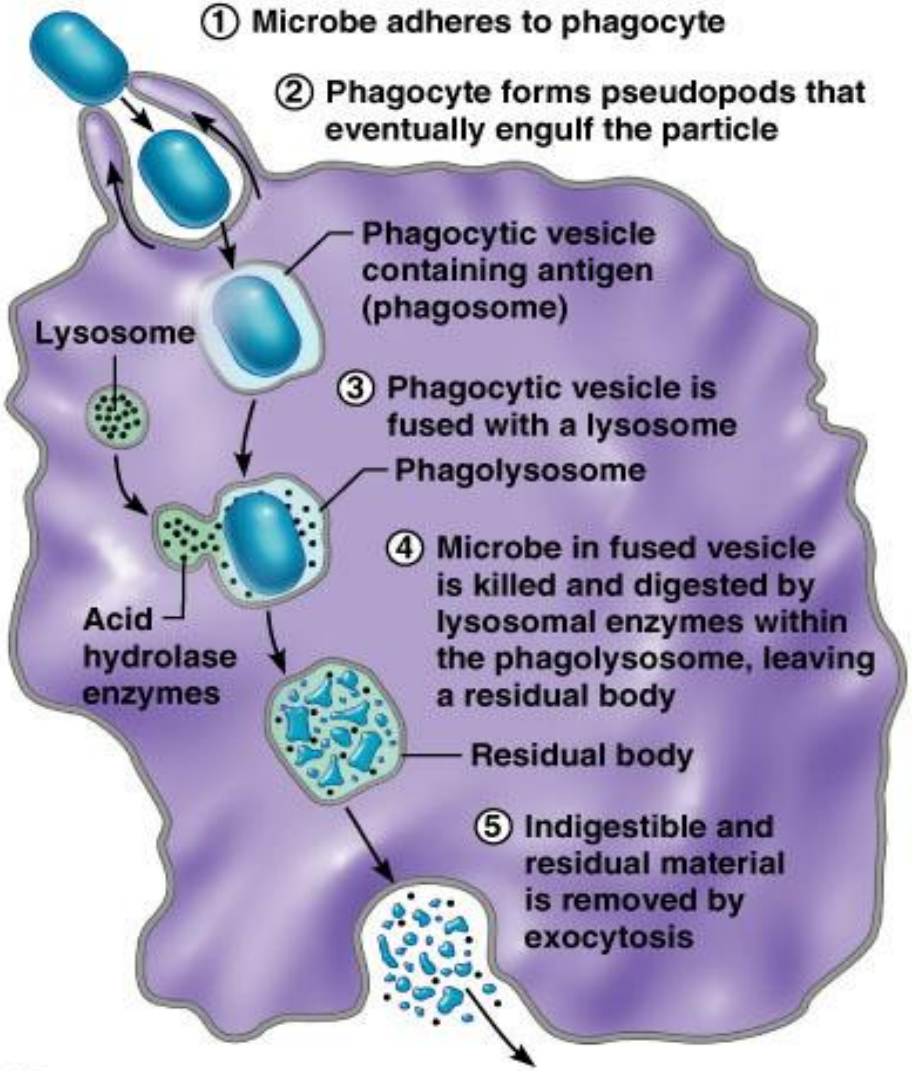
Phagocytosis

1. **Initiation** is caused by damage to the tissues, either by trauma or as a result of microbial multiplication.
2. **Chemotaxis**, attraction of leukocytes or other cells by chemicals.
3. **Opsonization** - Opsonization coating a pathogen by substances so as to enhance phagocytosis.
4. **Adherence** - firm contact between phagocyte and microorganism.
5. **Engulfment** into cytoplasm and enclosed in a vacuole.
6. **Digestion** enzymatic contents in vacuole destroy the microorganism.

Mechanism of Phagocytosis



(a)



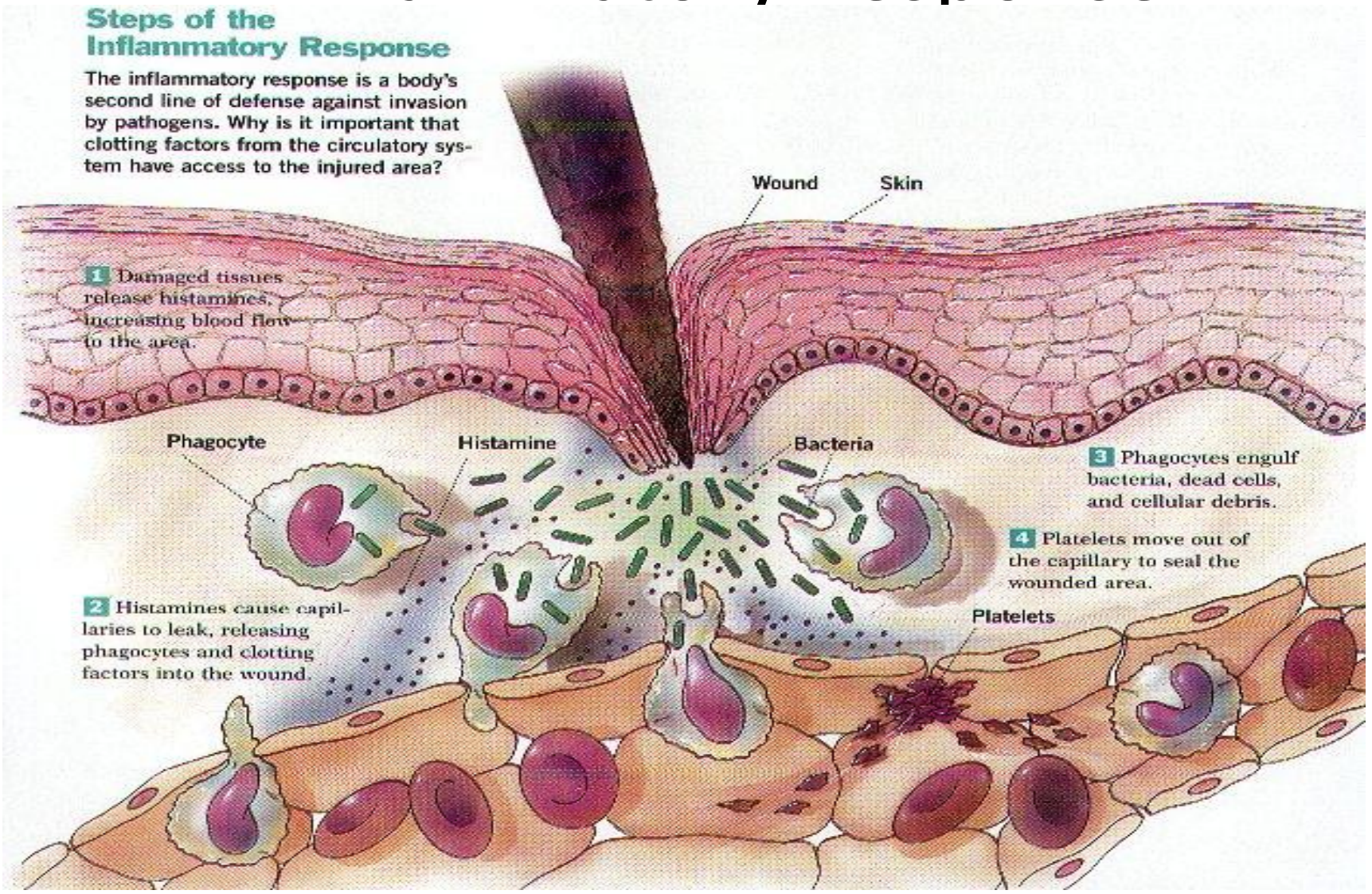
(b)

Macrophage

Inflammation

- **Inflammatory response** : is aprotective response act to eliminate the initial cause of cell injury as well as the necrotic cells and tissues.
- The mission of inflamation were completed by diluting, destroying or neutrilizing harmful agents(microbes and toxins) .
- *four classic signs of inflammation are redness, swelling, heat and pain*.
- **Steps of inflammatory response:**
  - **Dilation of capillaries** (hyperemia) to increase blood flow to area
  - **Chemotaxis** - chemicals released which cause phagocytic white cells to migrate to the area.
  - **Increased capillary permeability** allowing white cells to go to injured area, a process known as "**diapedesis**"
  - **Formation of exudate** - same composition as plasma and it contains antibacterial substances, phagocytic cells, and drugs and antibiotics, if present.

Inflammatory Response



Antimicrobial Substances

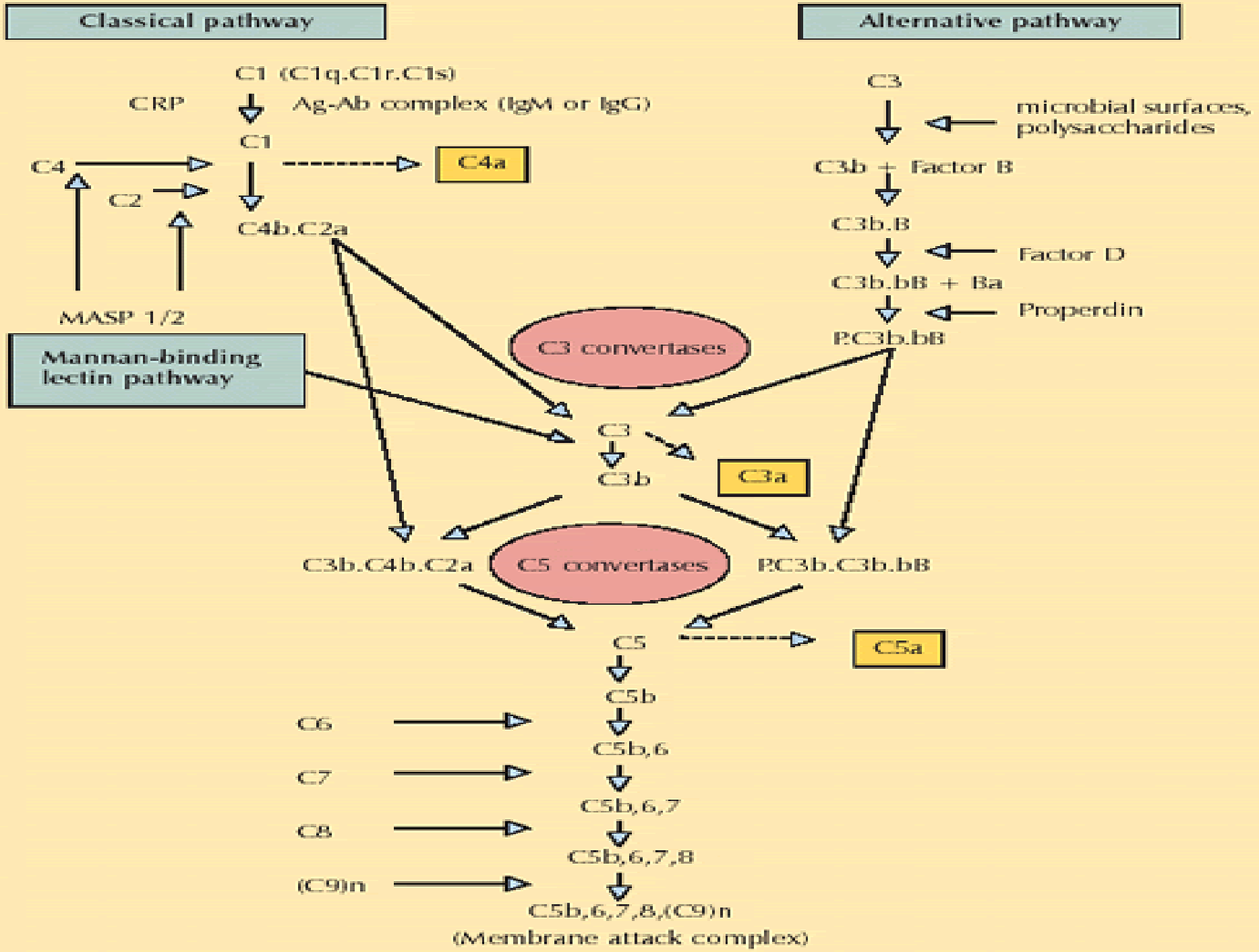
- Third major kind of nonspecific cellular and chemical defense
- Include many soluble tissue and serum substances help to suppress the grow of or kill microorganisms
- Includes complement and interferon
- Considered a second line of defense

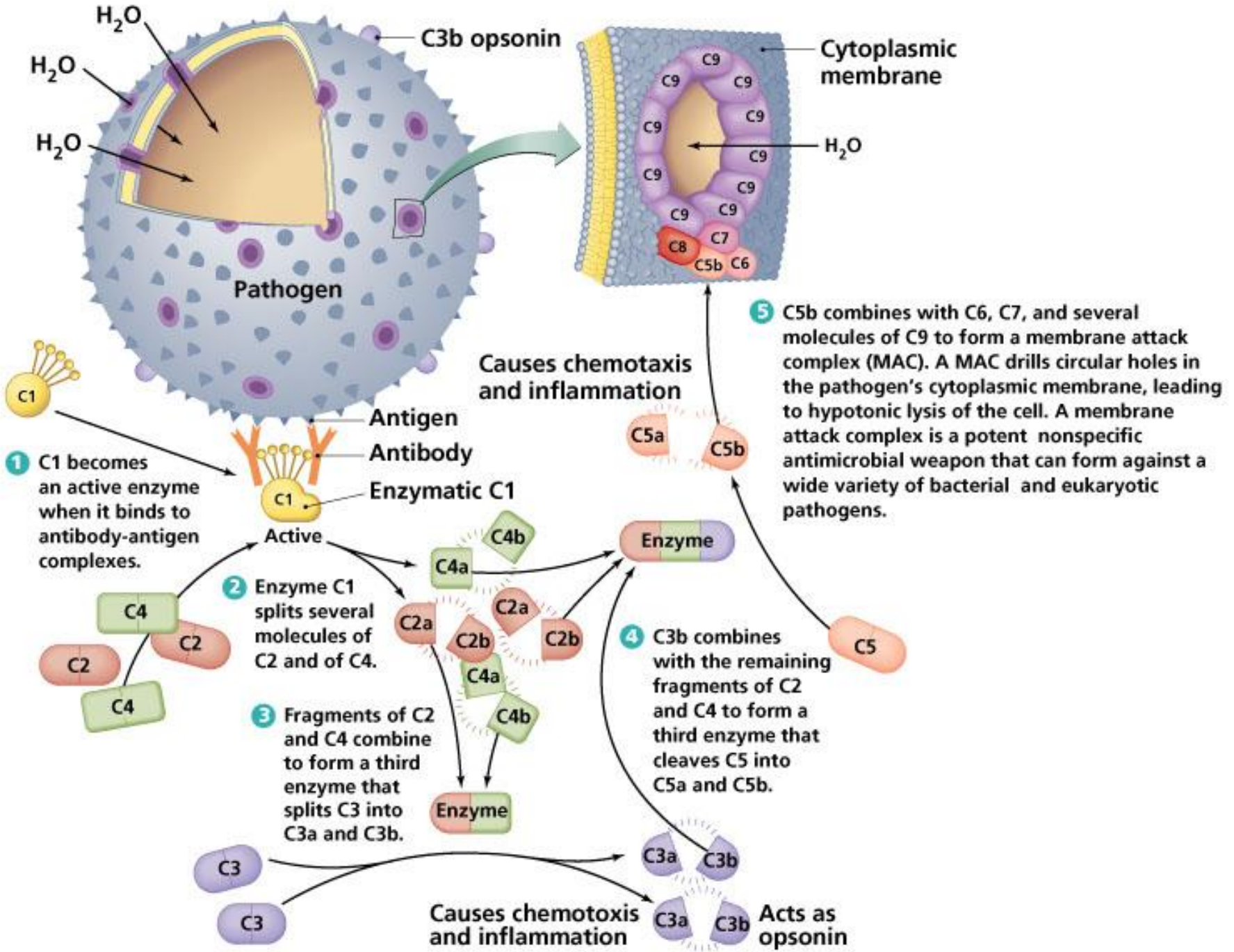
Complement

- A series of serum proteins involved in mediation of inflammation but also involved in
  - opsonization,
  - chemotaxis, and
  - cell lysis.

Complement Types

- Two major pathways.
- **Classical**:
  - 11 proteins
    - C1 – C9
      - C1 actually 3 protein
  - Initiation
    - Antibodies bind to pathogen
    - C1 binds to AP complex
    - Complement activated in sequence.
- Alternate Pathway
  - Triggered by interaction of 3 plasma proteins
    - Factors B, D, and P
    - These interact with carbos on cell surface of
      - Bacteria
      - Parasites
      - fungi


Classical pathway
Alternative pathway
C1 (C1q.C1r.C1s)
CRP
Ag-Ab complex (IgM or IgG)
C1
C4
C2
C4a
C4b.C2a
MASP 1/2
Mannan-binding lectin pathway
C3
microbial surfaces, polysaccharides
C3b + Factor B
C3b.B
Factor D
C3b.bB + Ba
Properdin
PC3b.bB
C3 convertases
C3
C3b
C3a
C3b.C4b.C2a
C5 convertases
PC3b.C3b.bB
C5
C5a
C5b
C6
C5b,6
C7
C5b,6,7
C8
C5b,6,7,8
(C9)n
C5b,6,7,8,(C9)n
(Membrane attack complex)



Complement Fragments

- Complement fragments:
  - Chemotaxis:
    - Attract phagocytes.
  - Opsinization:
    - Phagocytes have receptors for $C3_b$.
    - Form bridges between phagocyte and victim cell.
  - Histamine release:
    - Increase blood flow and capillary permeability.
    - Bring in more phagocytes.

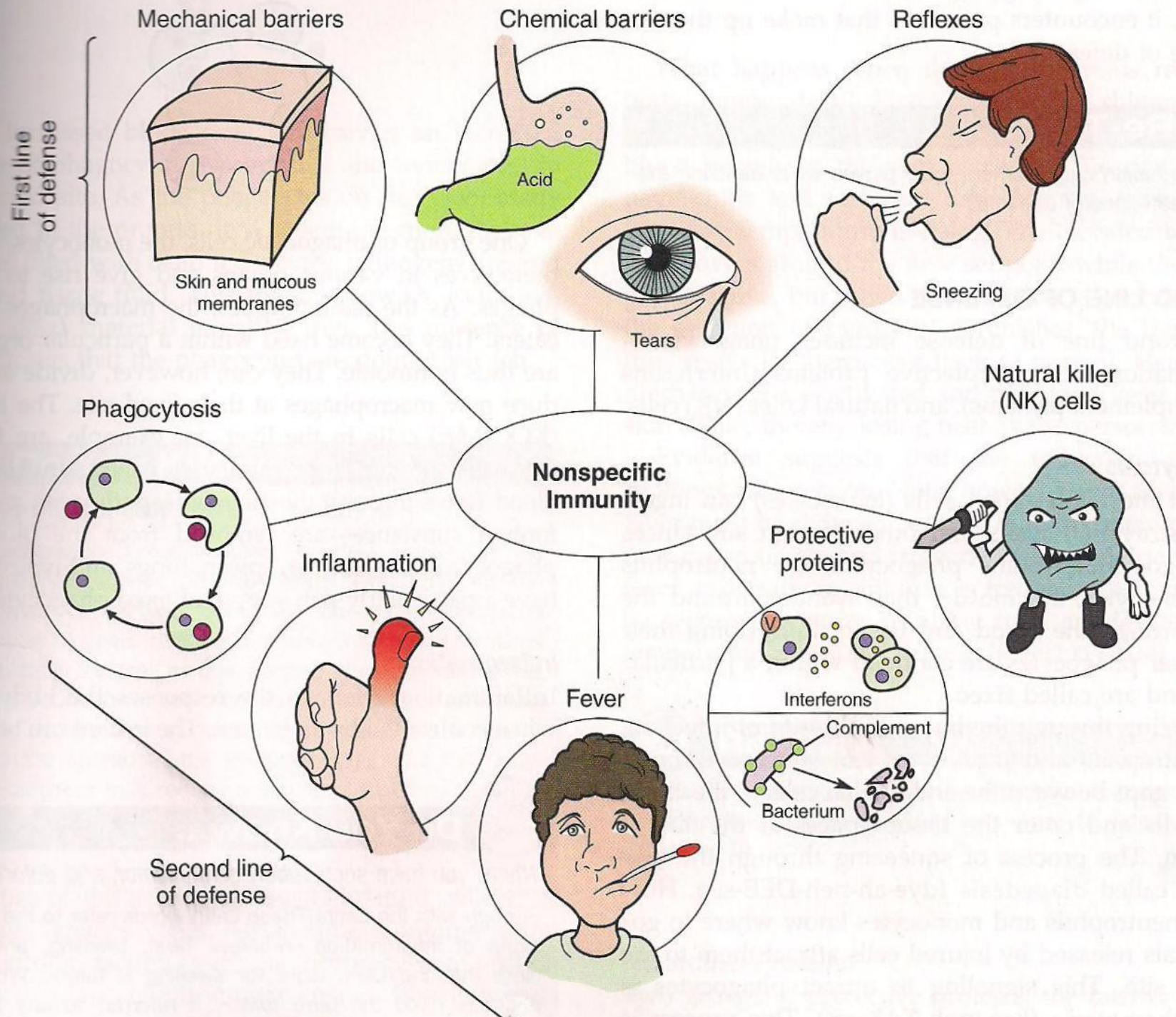
Interferon

- **Interferons**
  - Family of proteins which are important non-specific defense mechanisms against viral infections and cancer.
  - Act as messengers that protect other cells in the vicinity from viral infection.
  - Produced by most body cells, lymphocytes, NK cells
    - inhibit viral replication.
    - activates macrophages.

Fever

- kind of nonspecific cellular and chemical defense.
- Hypothalamus regulates body temp
  - Thermoregulatory center.
- Reset upward by endogenous pyrogen
  - May be interleukin-1 beta
    - First produced as a cytokine by WBCs
    - Then produced by the brain.

- **Endogenous pyrogens:**
- Cell wall of gram –ve bacteria contains endotoxin.
- Endotoxin stimulates monocytes and macrophages to release cytokines:
  - Interleukin-1, interleukin-2, TNF (tumor necrosis factor):
  - Increased activity of neutrophils.
  - Produce fever, increase sleepiness, and decrease plasma iron.


Mechanical barriers
Chemical barriers
Reflexes
First line of defense
Skin and mucous membranes
Acid
Tears
Sneezing
Phagocytosis
Natural killer (NK) cells
Nonspecific Immunity
Inflammation
Protective proteins
Interferons
Complement
Bacterium
Fever
Second line of defense

Specific defense mechanism immune system

Characteristics of Immunity

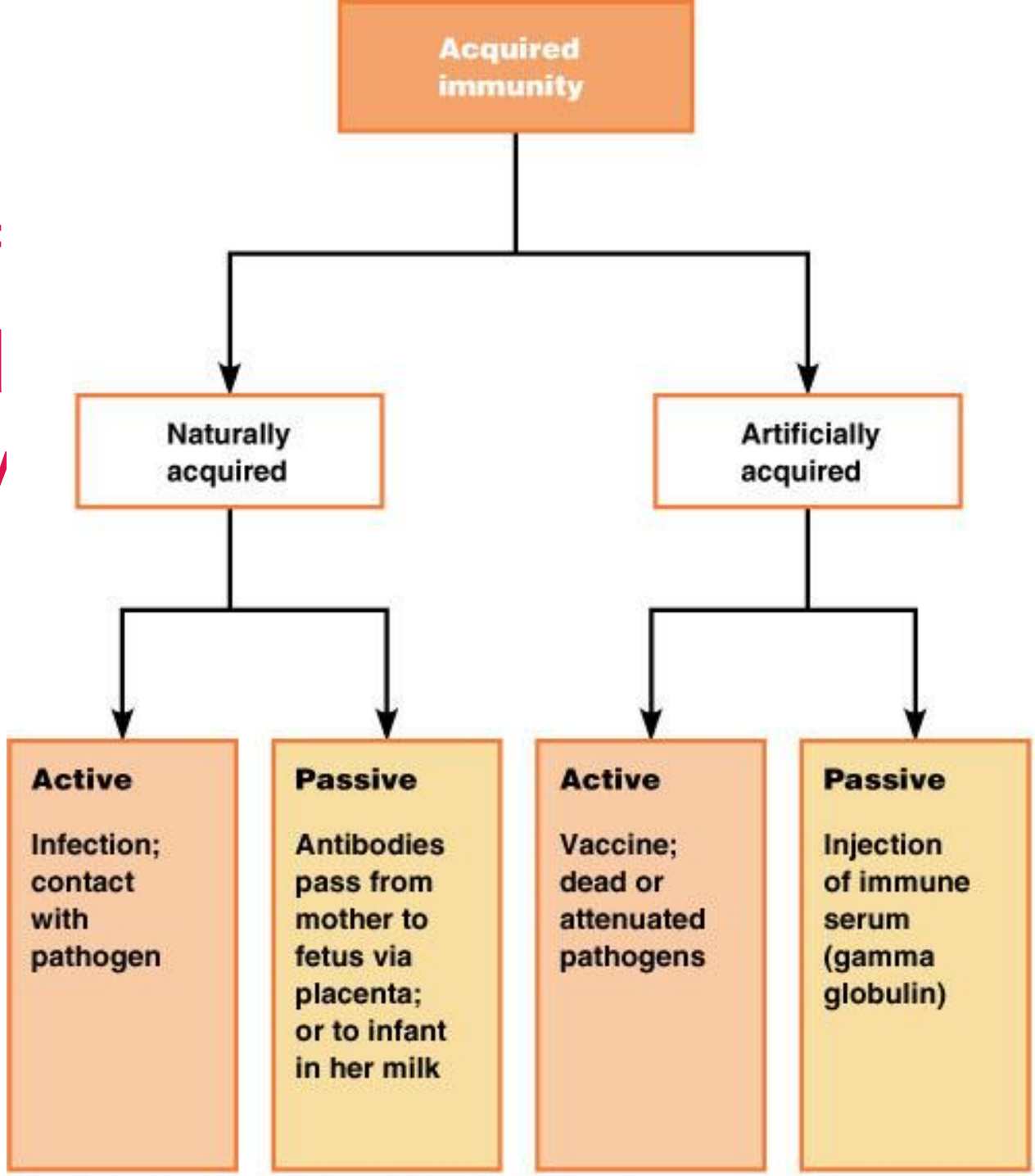
- Recognition of self versus non-self
- Response is specific
- Retains a “memory” allowing an accelerated second response
- Can respond to many different materials
- Involves lymphocytes and antibodies
- Cells involved in specific immunity are Lymphocytes and Plasma cells

Types of Immunity

- **Active Immunity**
- Naturally-Acquired Active Immunity
- Artificially-Acquired Active Immunity

- **Passive Immunity**
- Naturally-Acquired Passive Immunity
- Artificially-Acquired Passive Immunity

Types of Acquired Immunity



Active Immunity

- The production of antibodies against a specific disease by the immune system.
- Naturally acquired through disease
- Artificially acquired through vaccination
  - Vaccines include inactivated toxins, killed microbes, parts of microbes, and viable but weakened microbes.
- Active immunity is usually permanent

Passive Immunity

- **Passive Immunity**- Protection against disease through antibodies produced by another human being or animal.
- Effective, but temporary
- Ex. Maternal antibodies
- Colostrum.

- Passive immunity can be transferred artificially by injecting antibodies from an animal that is already immune to a disease into another animal.
  - Rabies treatment: injection with antibodies against rabies virus that are both **passive immunizations** (the immediate fight) and **active immunizations** (longer term defense).

Comparison of Active & Passive Immunity

Active immunity	Passive immunity
• Produced actively by host's immune system	• Received passively, no active host participation
• Induced by infection or by immunogen	• Readymade antibody transferred
• Durable effective protection	• Transient, less effective
• Immunity effective only after lag period	• Immediate immunity
• Immunological memory present	• No memory
• Booster effective	• Not effective
• Not applicable in the immunodeficient	• Applicable in immunodeficient