Immune Function, Immune barriers, Immune cells

Lec. 2

Dr. Suhayla Hamad Shareef

Principal Function of The Immune System

- To protect humans from pathogenic microorganisms
- Pathogenic microorganisms (Pathogens)
  - Microorganisms capable of causing infection and/or disease
- Infection
  - Ability of pathogen to enter host, multiply and stimulate an immune response
- Disease
  - Clinical manifestations associated with infection

Functions of Immunity

- Immune defense
- Immune homeostasis
- Immune surveillance

Functions and Manifestation of Immunity

Functions	Normal Manifestation	Abnormal Manifestation
Immune Defense	Anti-infection	Hypersensitivity, Immunodeficiency
Immune Homeostasis	Eliminate injured and senile cells Tolerate self components	immune dis-modulation Autoimmune disease
Immune Surveillance	destroy transformed cells (anti-tumor) Prevent persistent infection	Tumor or Persistent virus infection

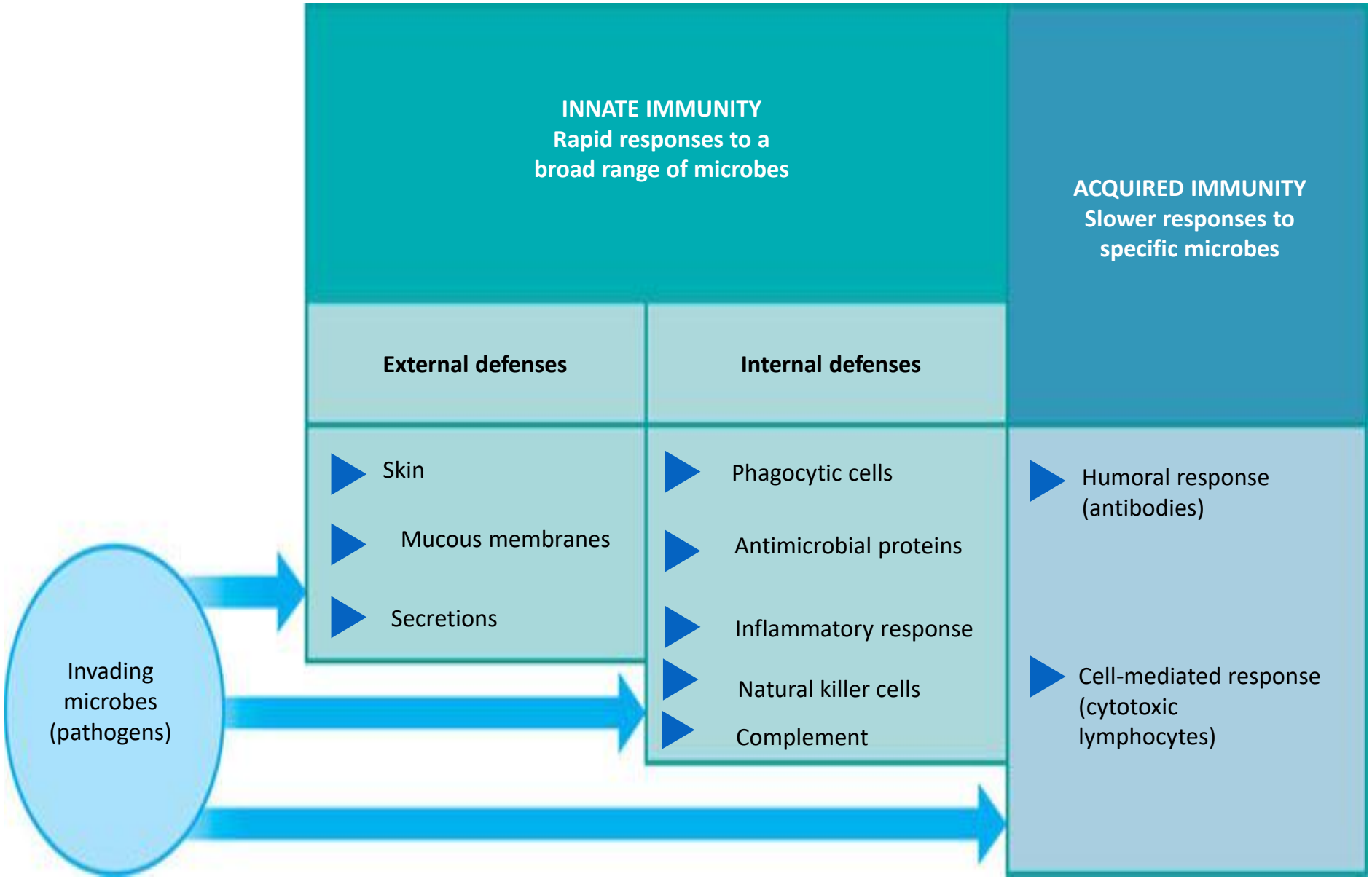
Host Defense

The body is under constant attack by microorganisms in the environment.

pathogen: an infectious agent that causes disease

An infectious disease occurs when a microorganism succeeds in evading or overwhelming host defenses to establish a local site of infection and replication. In order for a pathogen to enter the body, it must first overcome the epithelium and then the **innate immune response** and the **adaptive immune response**.

A typical immune response



Types of innate immunity:

- Innate defense system has two lines of defense
  - First - external body membranes (skin and mucosae)
  - Second - antimicrobial proteins, phagocytes, and other cells
    - Inhibit the spread of invaders
    - Inflammation most important mechanism

1- External defenses (first line of defense)

A. Physical barriers (Surface barriers)

1-Contact skin: The skin acts as the primary barrier to infection

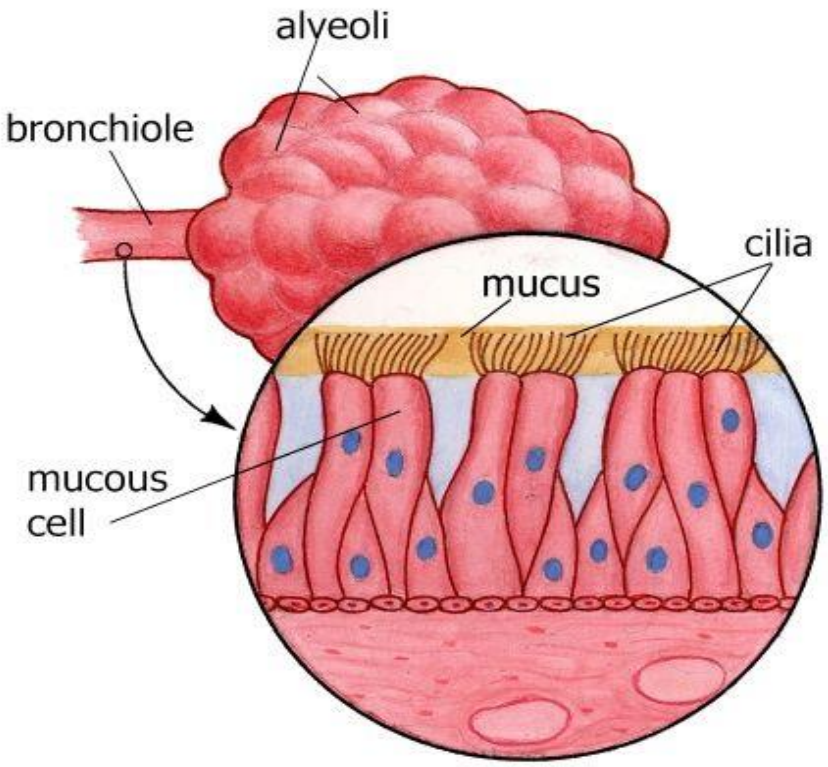
Key features of the Skin:

- Dry, acidic surface (resists microbial growth)
- Lipids in sebum, dermcidin in sweat – toxic
- Skin Normal flora (Competition for nutrients and colonization)
- Continual loss of outer dead skin layers removes potential pathogens

2-Mucous membrane and their secretions

- Globlet cells secrete mucus which both creates a physical barrier to infections but also contains lysozymes and IgA antibodies which can attack invading pathogens.
- Mucus serves to protect epithelial cells (that line the tubes) in the respiratory, gastrointestinal, and urogenital and continually produces mucus, a viscous glycoprotein that traps microbes and debris

- Flow of Mucus Prevents Bacterial Entry By Washing Them Away i.e inhibition of the entrance of many microbes

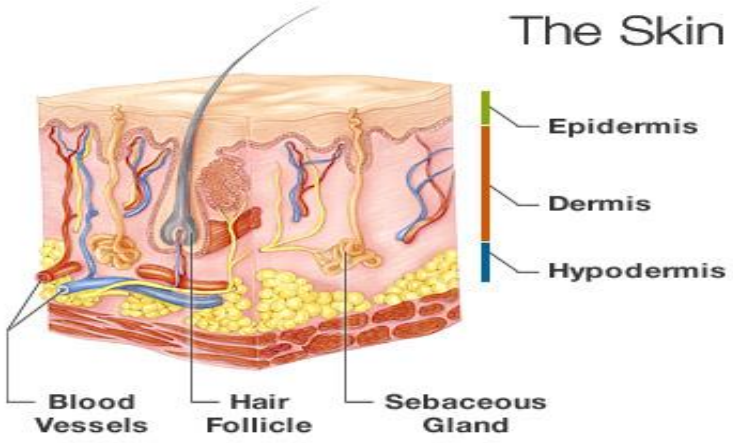


B. Mechanical barriers

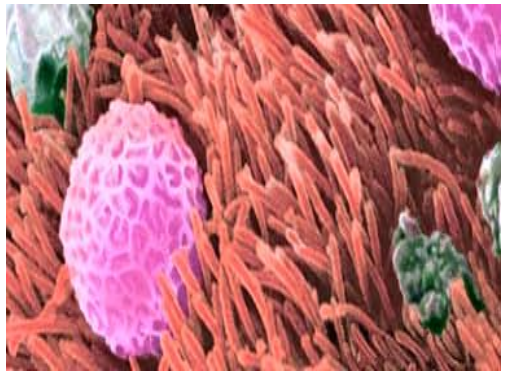
- Mucociliary movement in ciliated cells (ciliated epithelium moves particles toward the pharynx and therefore down the digestive tract away from the respiratory system.
- Cough reflex designed to aid expulsion of harmful substance
- Diarrhea helps to expel unwanted products and pathogens
- Hairs at nares, sneezing, tears, saliva

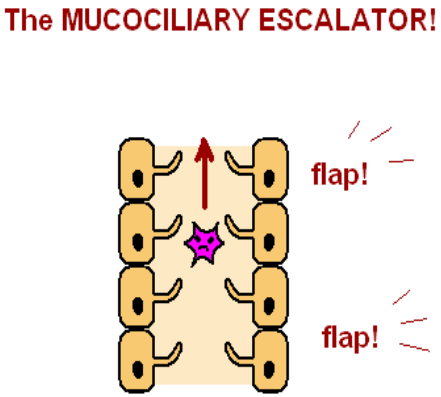
B. Anatomical Barriers - Mechanical Factors

- Skin

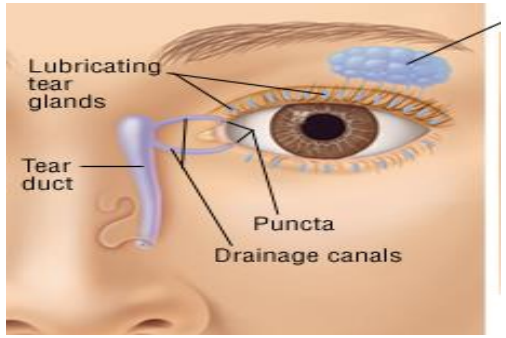


- Mucociliary escalator





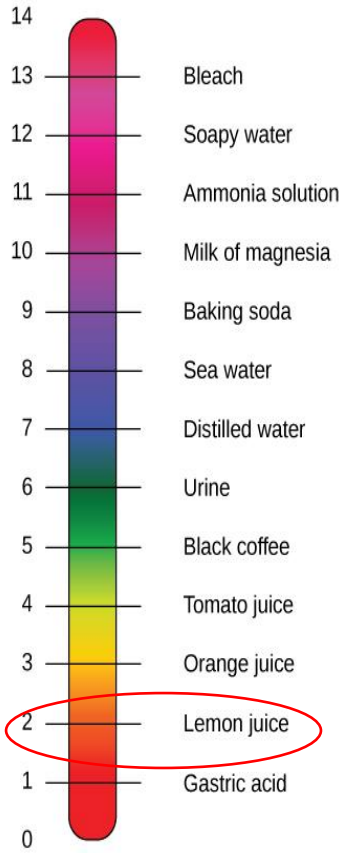
- Flushing action of saliva, tears, urine



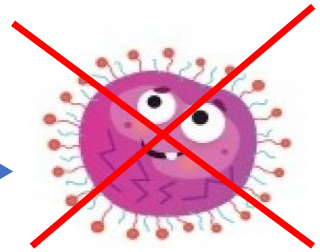
C. Anatomical Barriers – Chemical factors

Antimicrobial Peptides in sweat

HCl in stomach



Lysozyme in tears /saliva



C. Chemical Barriers

1-Fatty acids on skin, acid Ph of sweat, and sebaceous secretions inhibit the growth of microorganisms, due to their bactericidal effect.

2-Lysozyme in tears, nasal secretions, and saliva degrade peptidoglycan an essential element present in the bacterial cell wall.

3-Spermine and zinc In the semen are bactericidal effects.

4-Lactoperoxidase in milk- has bactericidal action.

5-Low pH (acidic environment) in vaginal and urinary tracts, and stomach inhibits the growth of many microbes.

6-Defensins: short antimicrobial peptides, insert into bacterial membranes and form pores

7-Interferon: are cytokines that trigger:

- macrophage activation
- production of substances to interfere with RNA viral reproduction

D. Microflora (commensal microorganisms): **Biological factors**

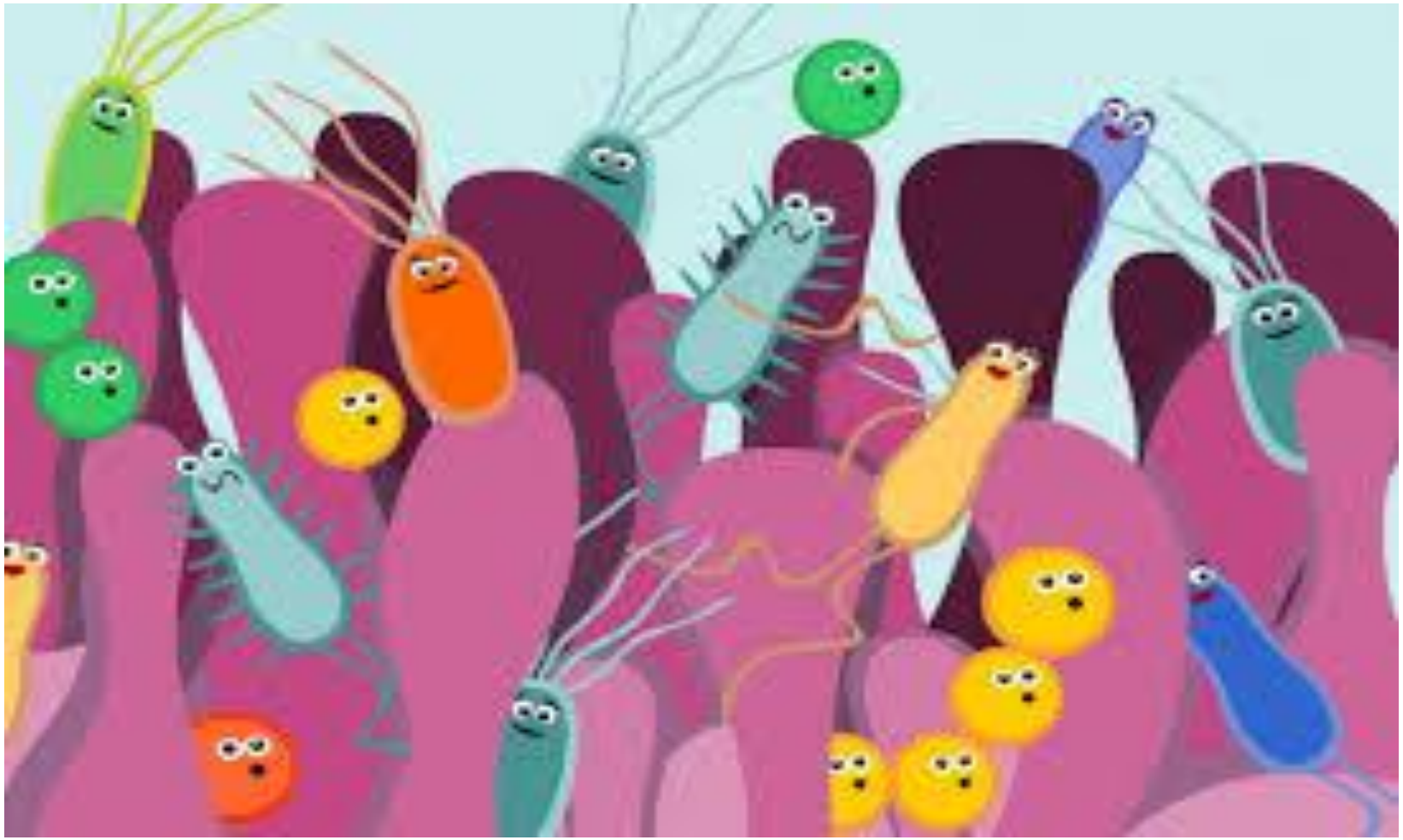
- **The "normal microbiota" are** the microorganisms that live on the body surfaces of a healthy individual and inhibit the growth of pathogens in the following ways:

➢ Acidifying body surfaces e.g., in the female reproductive tract, inhibits yeast inf.

➢ The production of bacteriocins and other toxins i.e., toxins that are specific for other microorganisms e.g., in the large intestine (*E. coli*)

➢ Competes with pathogens for nutrients and space

Normal flora: commensals

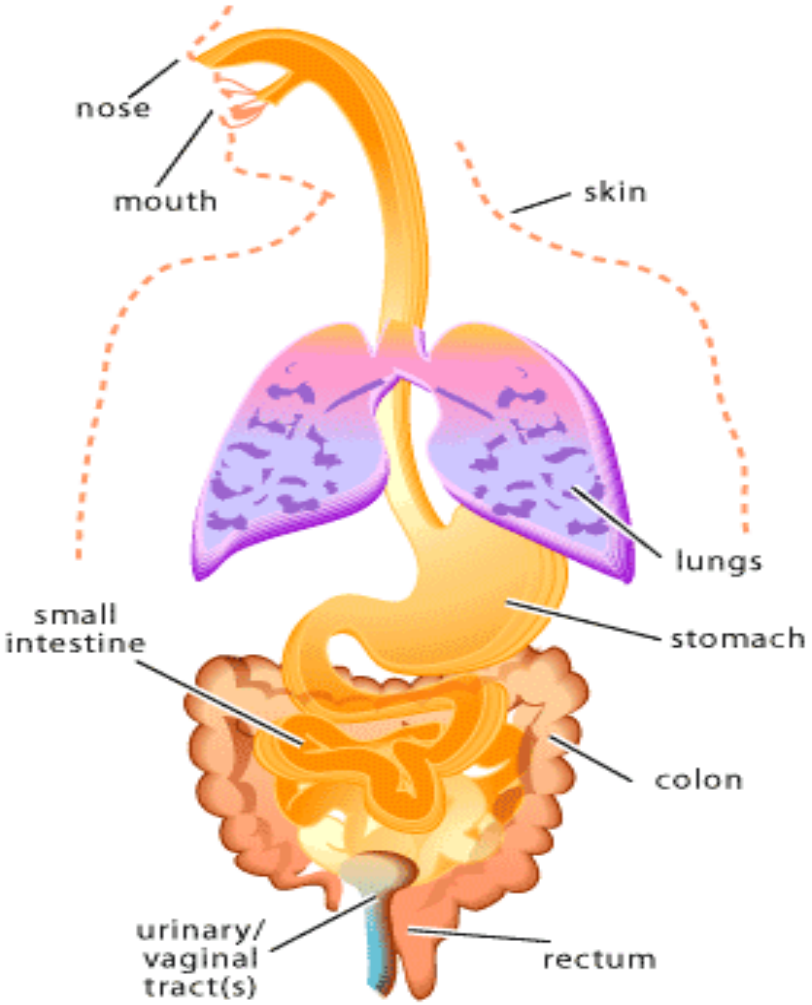


D. Anatomical Barriers – Biological factors

Normal flora – microbes in many parts of the body

Normal flora – > 1000 species of bacteria

Normal flora – competes with pathogens for nutrients and space



2- Internal defenses (second line of defense)
Internal Defenses: Cells and Chemicals

Necessary if microorganisms invade deeper tissues

- **Natural killer (NK) cells**
- **Phagocytes**
- **Antimicrobial proteins** (interferons and complement proteins)
- **Fever**
- **Inflammatory response** (macrophages, mast cells, WBCs, and inflammatory chemicals)

Natural Killer (NK) Cells

- Non-phagocytic large granular lymphocytes
- Attack cells that lack "self" cell-surface receptors

  (**NK cells** work to control viral infections)
- Secrete potent chemicals that enhance the inflammatory response

Phagocytosis

What is Phagocytosis?

It's the process by which a cell ingests a solid extracellular particle (such as a bacterium) by engulfing it within a membrane-enclosed vesicle

Chemokines are cytokines that attract macrophages and neutrophils to infected tissues

Opsonins attach to microbes to increase the ability of phagocytes to adhere (opsonization)

Cells that normally carry out this function are referred to as ***phagocytic,*** or simply as **phagocytes**

Types of Phagocytes

All of the phagocytes in the human body are types of white blood cells (leukocytes):

Neutrophils

•highly phagocytic cells that rapidly exit the blood into damaged or infected tissue, “gobble up” bacteria, etc…

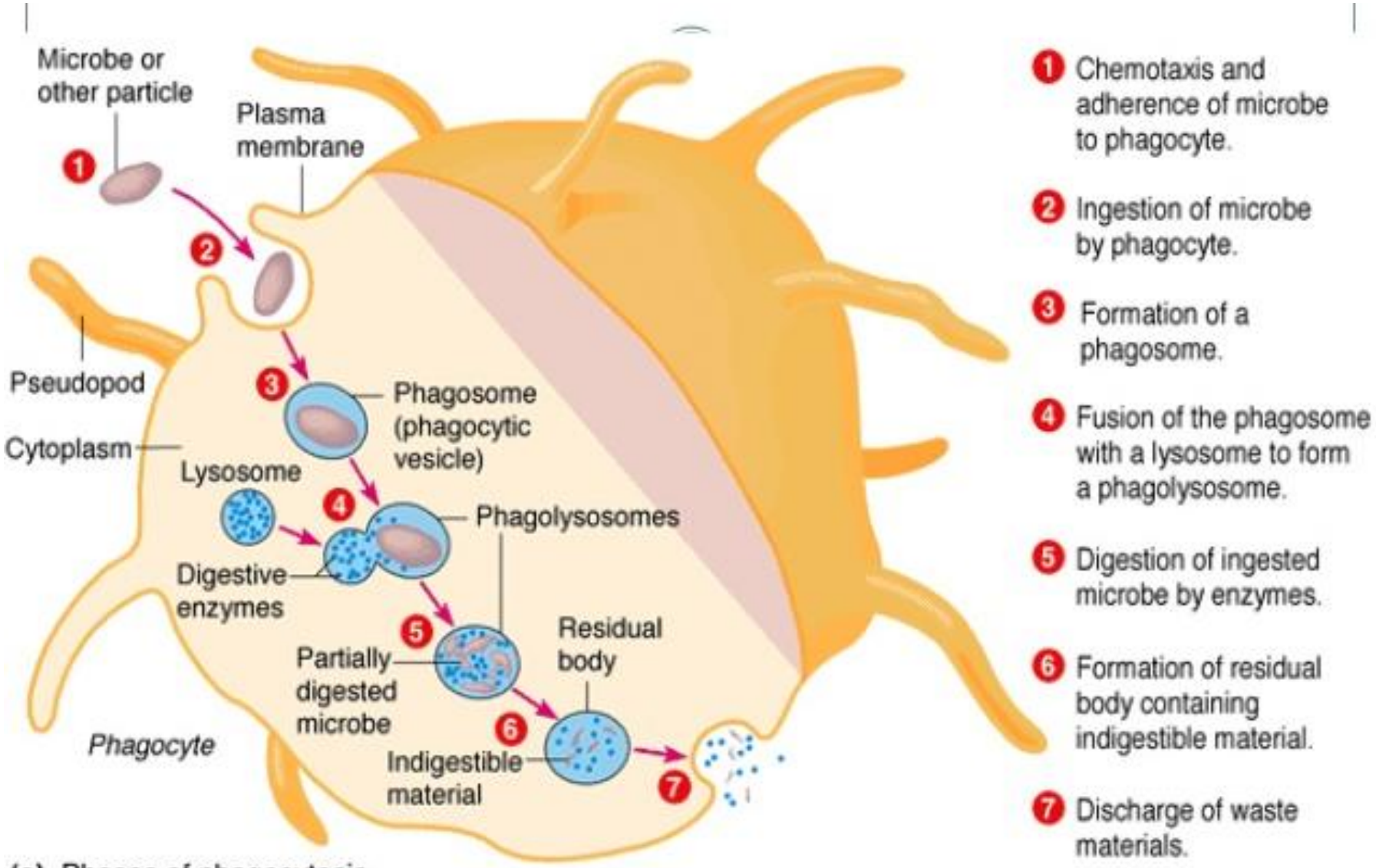
Macrophages

•monocytes migrate to damaged, infected tissue from blood & differentiate into highly phagocytic macrophages

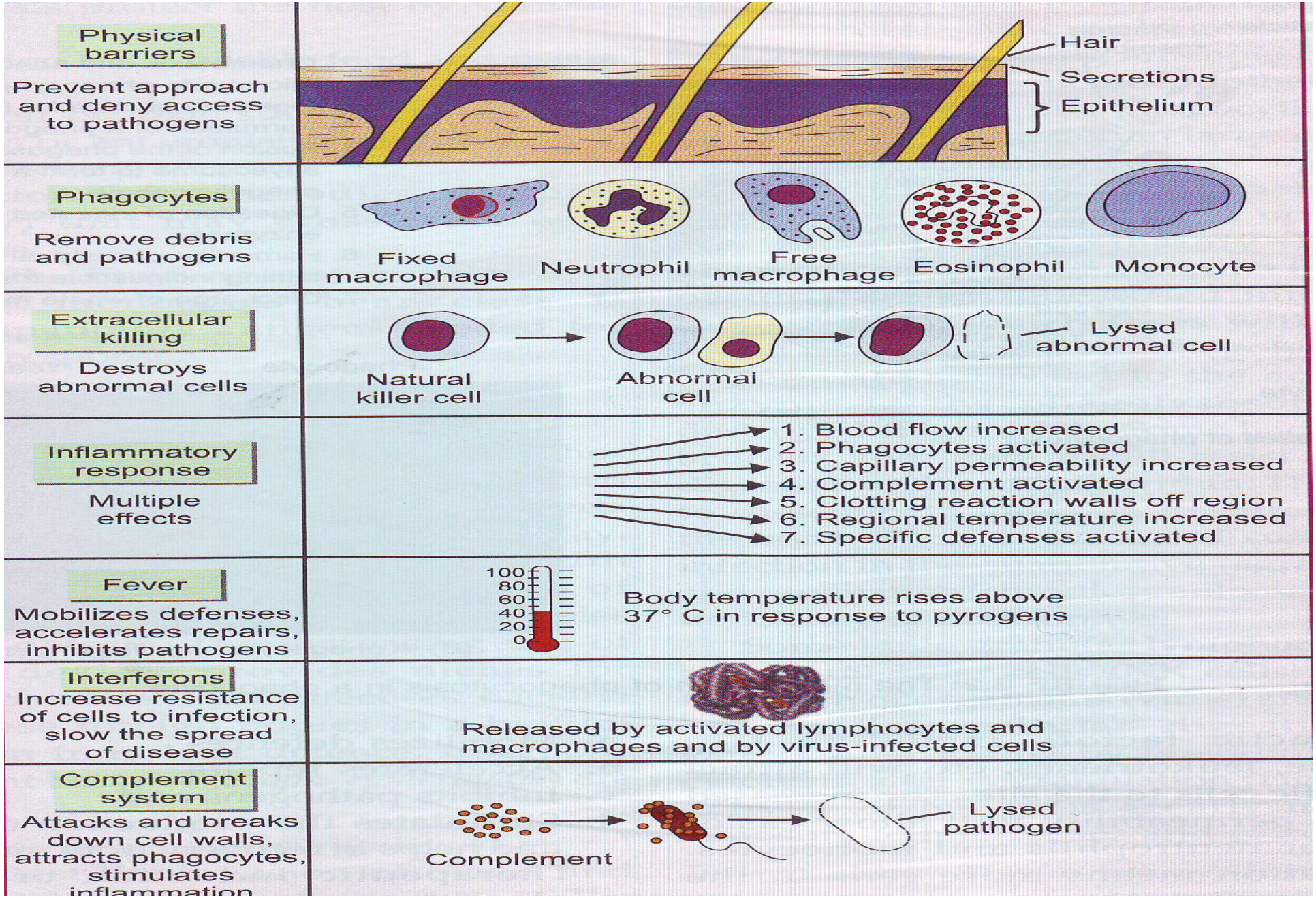
Dendritic Cells

•found in skin, mucous membranes, thymus, lymph nodes

•some are fixed (non-mobile) in various tissues & organs



(a) Phases of phagocytosis



Mechanism of innate immunity