Overview of the Immune System

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(Immunity)

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Lecture 1.

- **Immunology**
  Study of the components and function of the immune system

- **Immune System**
  Molecules, cells, tissues and organs which provide non-specific and specific protection against
  - ✓Microorganisms
  - ✓Microbial toxins
  - ✓Tumor cells

  Crucial to human survival

- **Immunity**
  the state of protection from infectious disease
  has both a less specific and more specific component
- **Immune response**
  Innate (non-specific)
  Adaptive (specific)
    Primary
    Secondary

- **Acquisition of Immunity**
  Natural
  Artificial

To protect humans from

- 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

Immunity

- **Immunity** is body's ability to resist or eliminate potentially harmful foreign materials or abnormal cells

Consists of following activities:

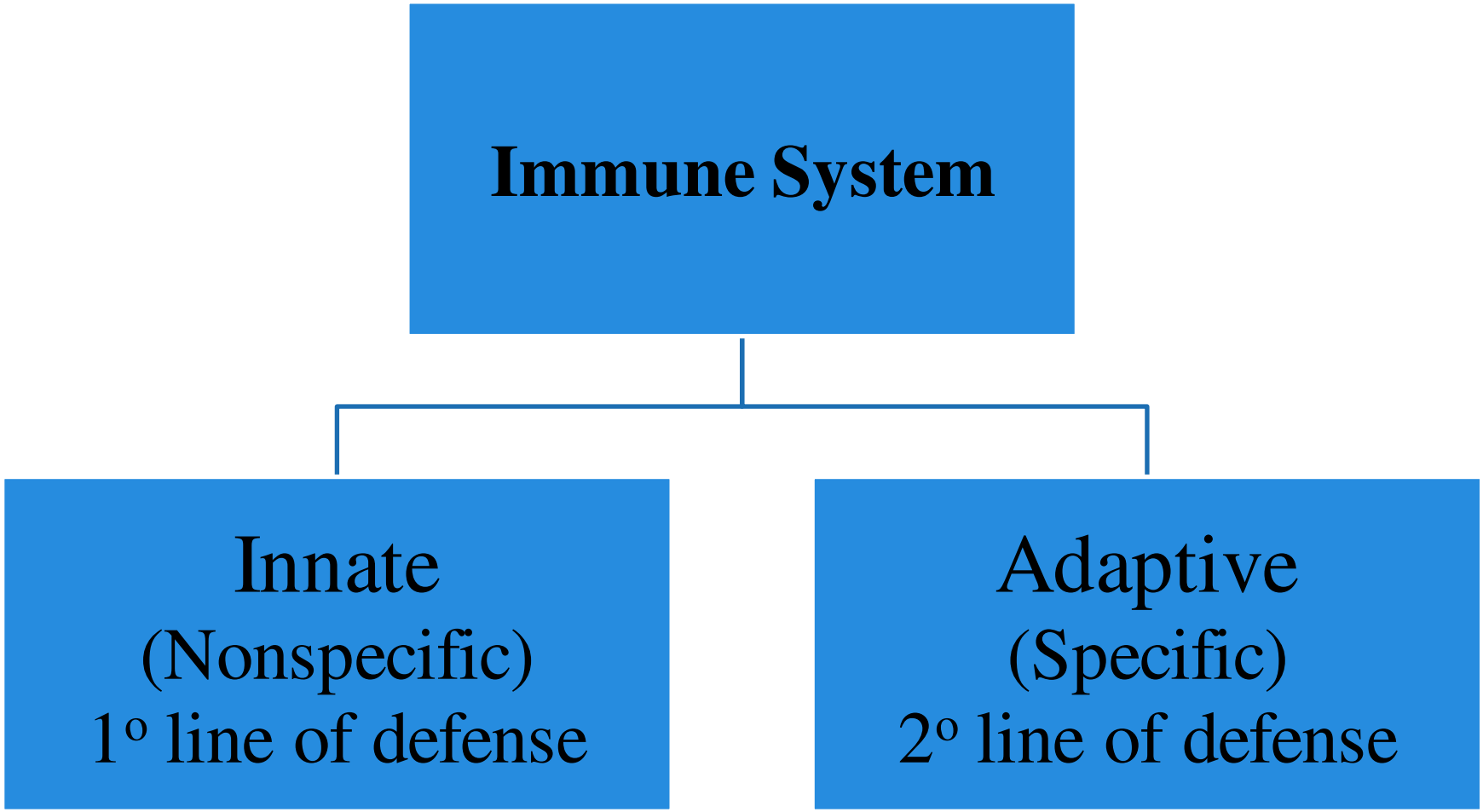
1. Defense against invading pathogens (viruses & bacteria)
2. Removal of 'worn-out' cells (e.g., old RBCs) & tissue debris (e.g., from injury or disease)
3. Identification & destruction of abnormal or mutant cells (primary defense against cancer)
4. Rejection of 'foreign' cells (e.g., organ transplant)

❑**Inappropriate responses:**

Allergies - response to normally harmless substances

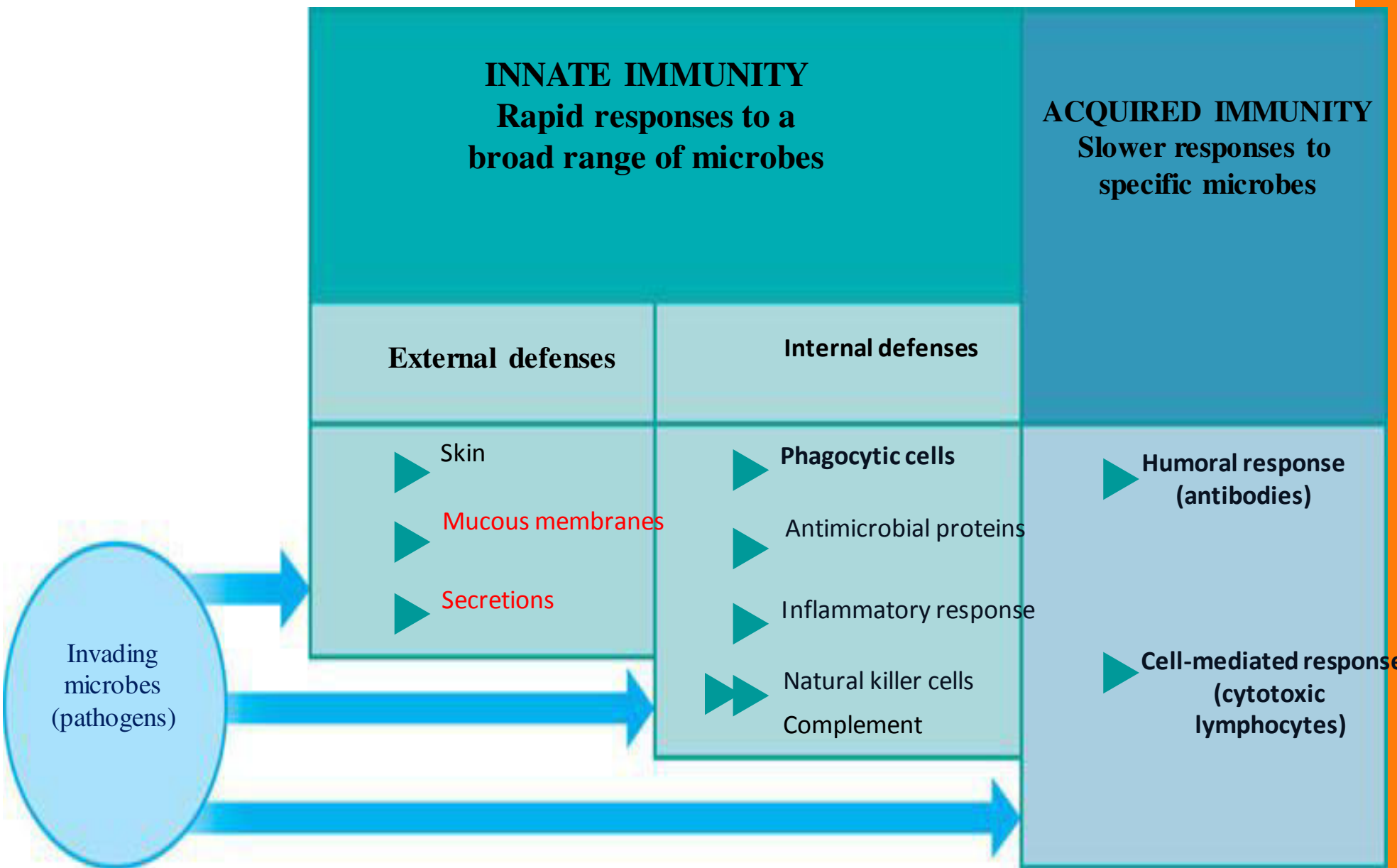
Autoimmune diseases

Overview of the Immune System

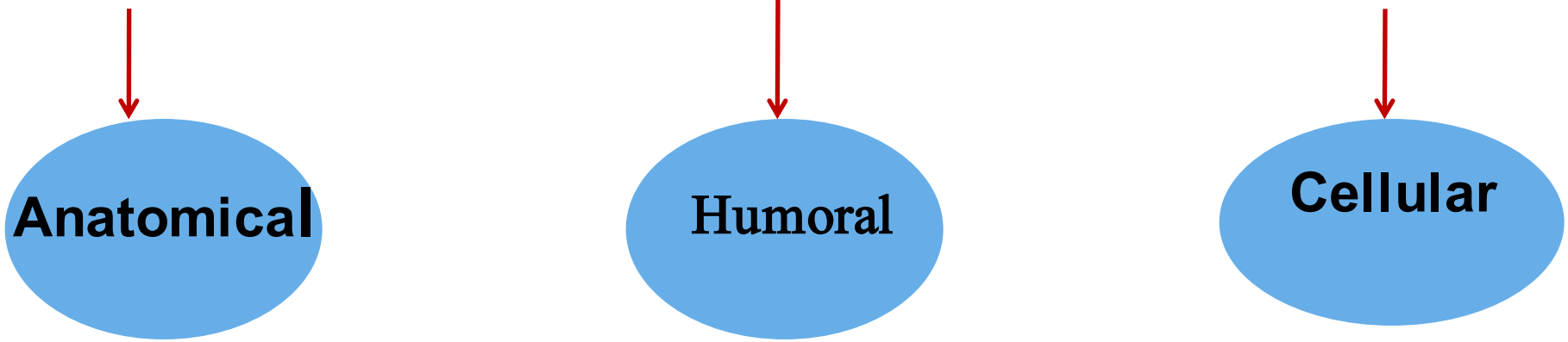


Interactions between the two systems

Body Defenses



Innate Immunity



1. Mechanical
2. Chemical
3. Biological

1. Complement
2. Acute phase protein
3. Cytokines

1. Cell of Innate
2. Macrophage
3. Neutrophile
4. NK

External Def.

Internal Def.

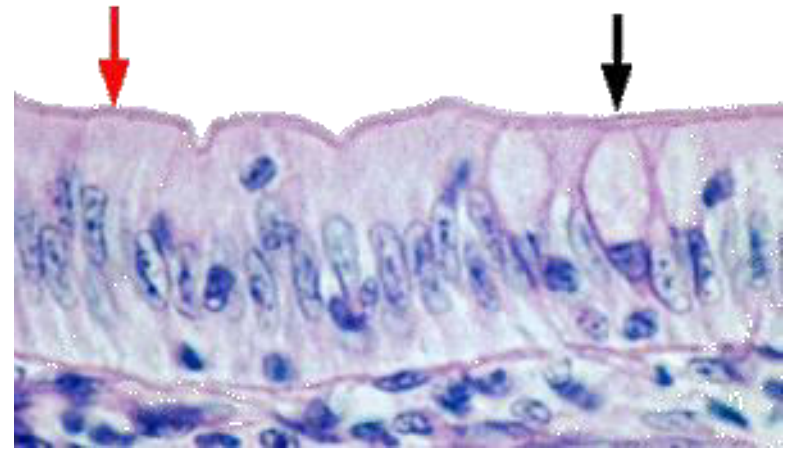
Innate (non-specific) Immunity

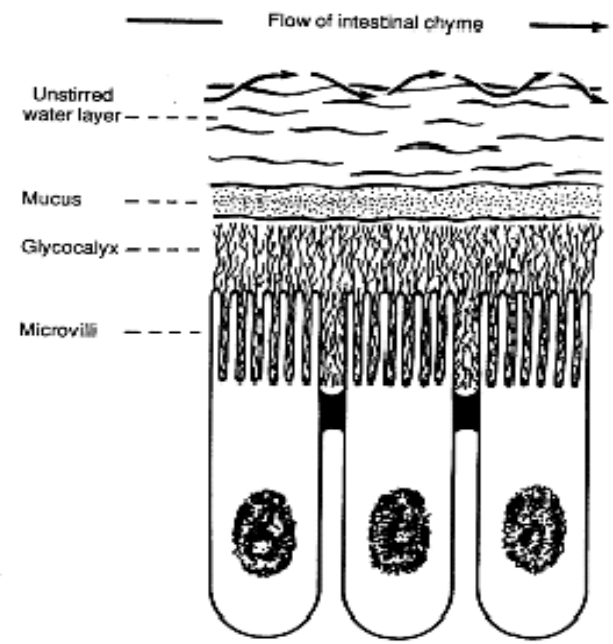
4 barriers to infection:

- ✓Anatomic
- ✓Physiologic
- ✓Phagocytic
- ✓Inflammatory

Innate (non-specific) Immunity

1) **Anatomic**
   skin -> epidermis w/ keratin
   mucus memb. ->inner surfaces
2) **Physiological**
   temperature, pH, soluble subst.
3) **Phagocytes**
   blood monocytes, tissue MØ, and neutrophils
4) **Inflammatory response**
   triggered by wound/foreign particle
   5 Cardinal signs reflect 3 major events of inflam response:
   -vasodilation
   - >capillary permeability
   -influx of phagocytes





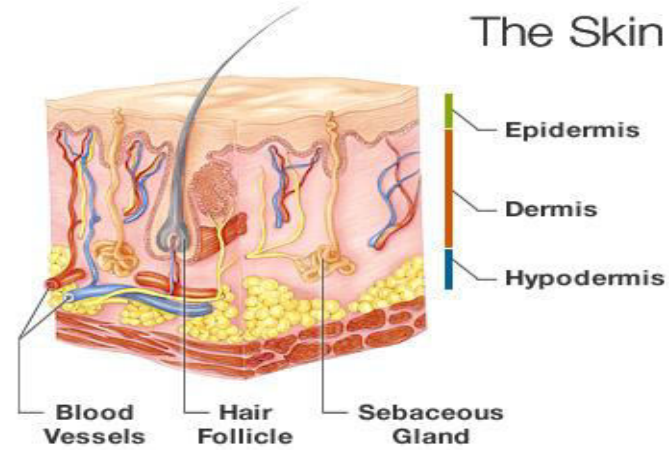
External defenses

First line of defense

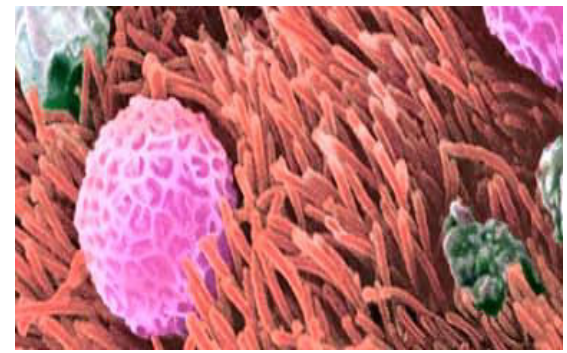
- Non-specific defenses are designed to prevent infections by viruses and bacteria. These include:
  - Intact skin
  - Mucus and Cilia
  - Phagocytes

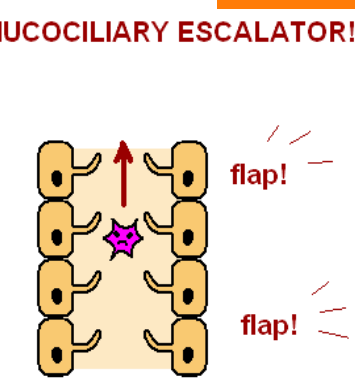
Anatomical Barriers - Mechanical Factors

- Skin

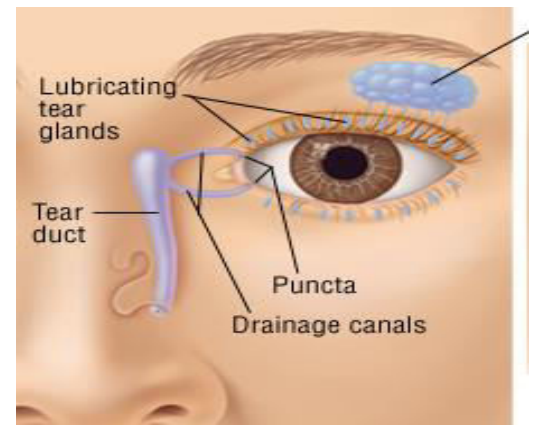


- Mucociliary escalator



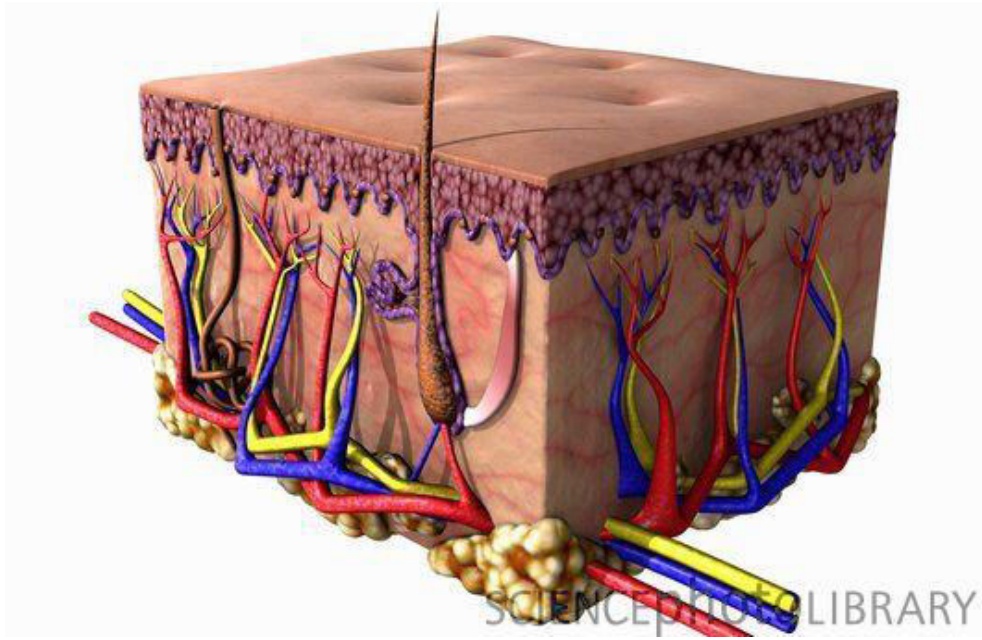


- Flushing action of saliva, tears, urine



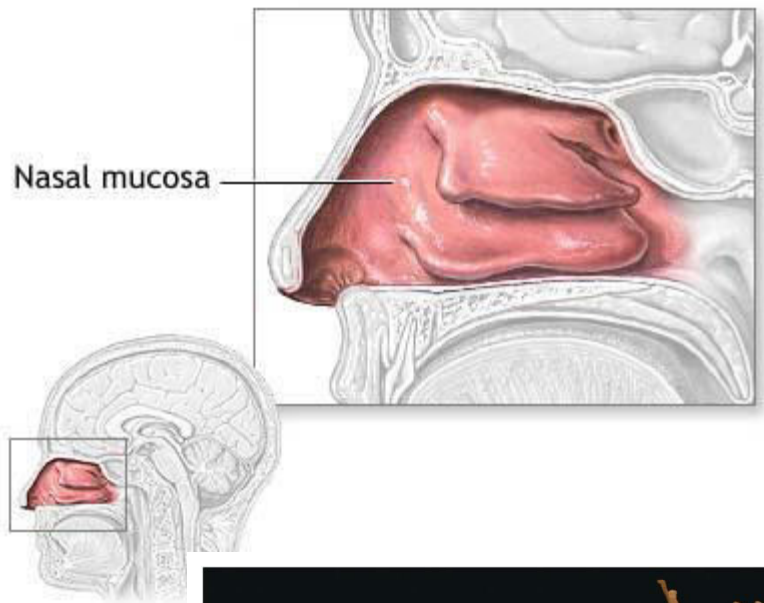
Role of skin

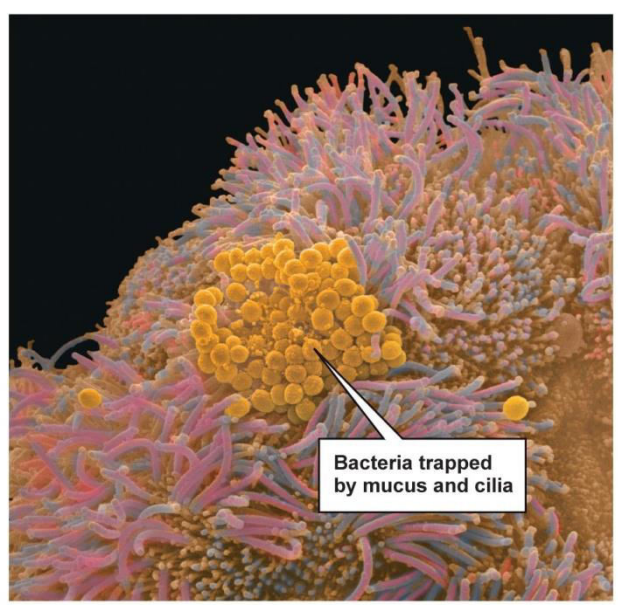
- Dead skin cells are constantly sloughed off, making it hard for invading bacteria to colonize.
- Sweat and oils contain anti-microbial chemicals, including some antibiotics.



Role of mucus and cilia

- Mucus contains lysozymes, enzymes that destroy bacterial cell walls.
- The normal flow of mucus washes bacteria and viruses off of mucus membranes.
- Cilia in the respiratory tract move mucus out of the lungs to keep bacteria and viruses out.



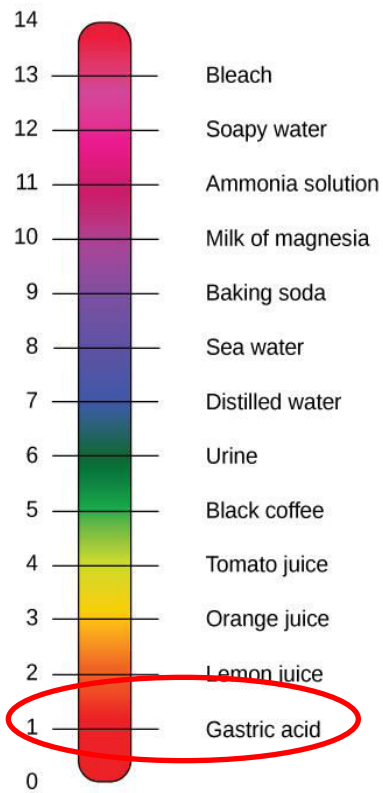


Anatomical Barriers – Chemical factors

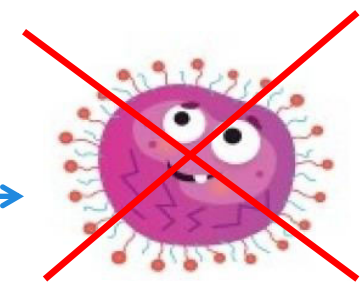
Peptides in sweat

Antimicrobial

HCl in stomach

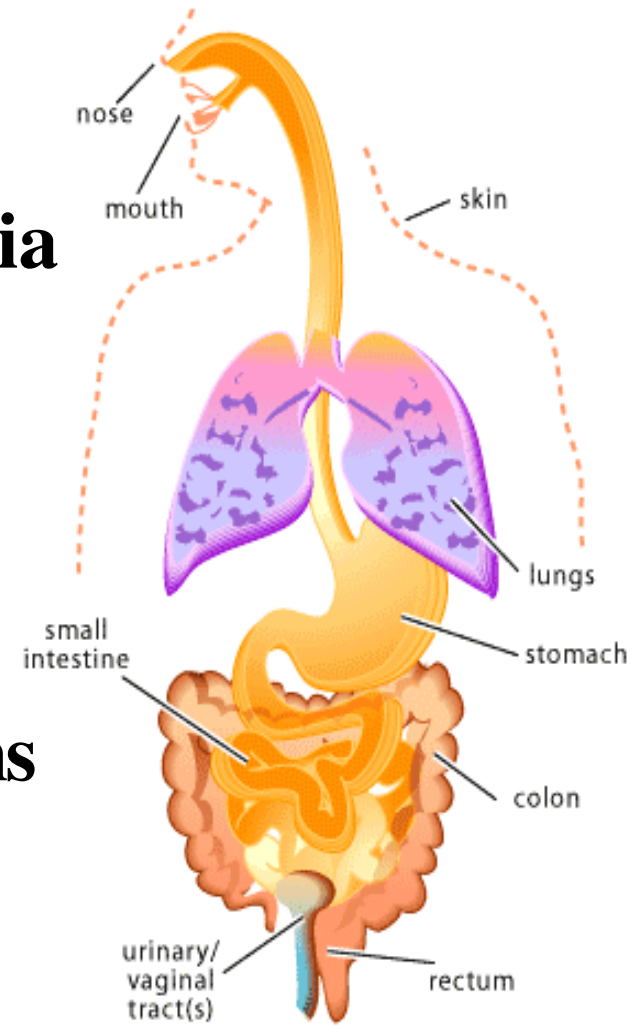


Lysozyme in tears /saliva



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



Internal defenses

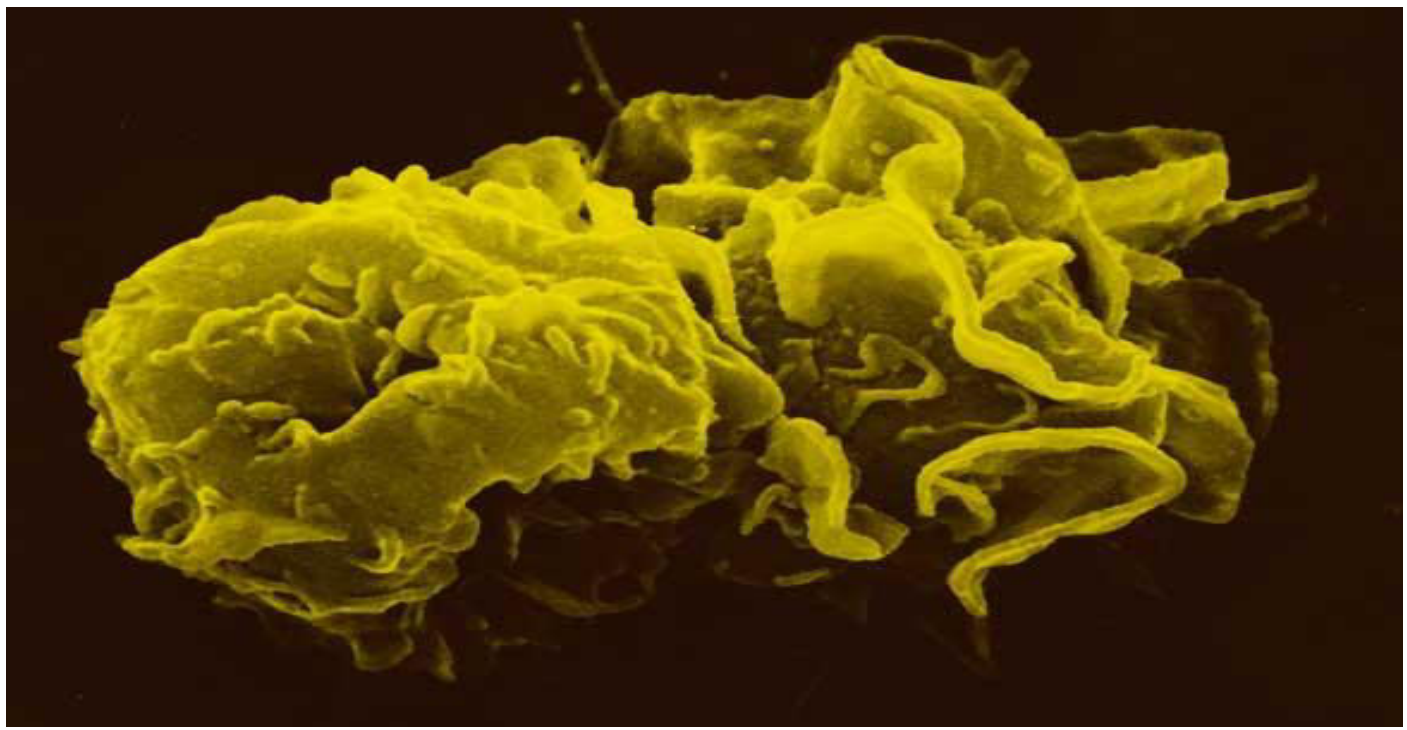
- Phagocytic Cell
- Inflammatory immune responses
- Antimicrobial protein

Internal Cellular and Chemical Defenses

- Internal cellular defenses depend mainly on **phagocytosis**.
- **Phagocytes** are types of white blood cells that:
  - Ingest invading microorganisms.
  - Initiate the inflammatory response.

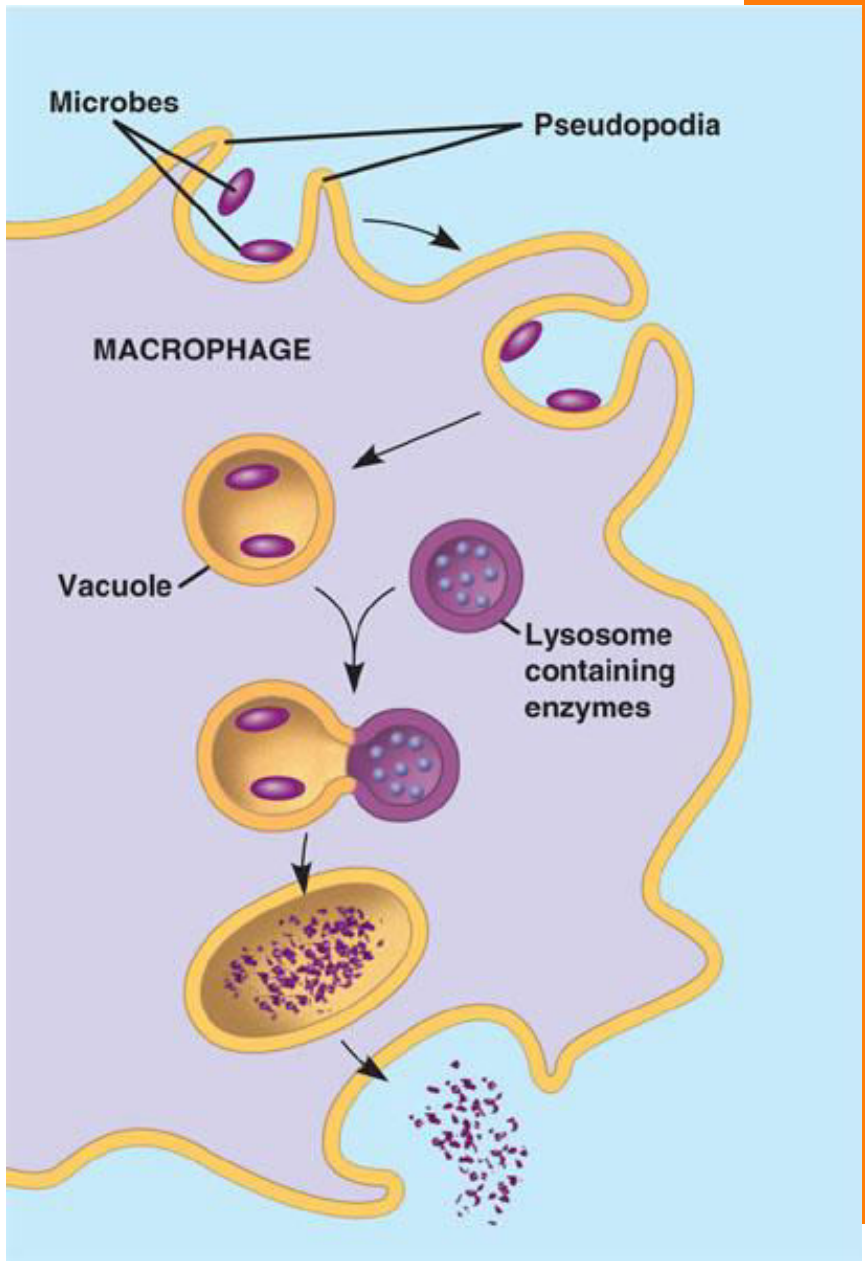
Phagocytic Cells

- **Macrophages**, a specific type of phagocyte, can be found migrating through the body.
  - Also found in various organs of the lymphatic system.



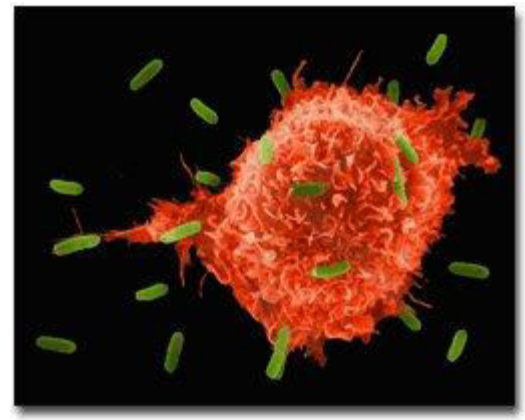
Phagocytic Cells

- Phagocytes attach to their prey via surface receptors and engulf them, forming a **vacuole** that fuses with a **lysosome**.

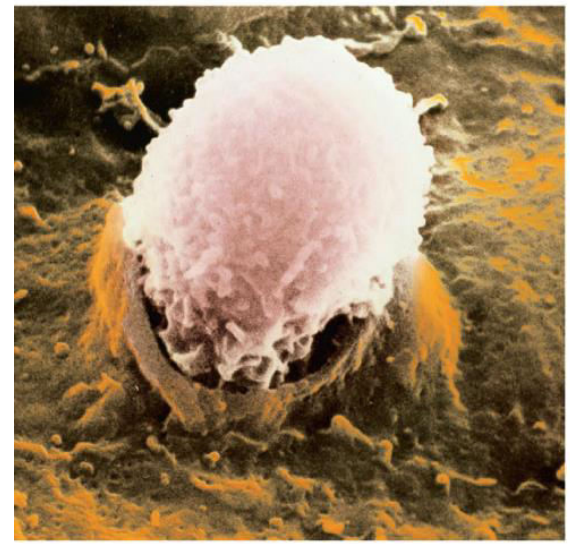


Role of phagocytes

- Phagocytes are several types of white blood cells (including macrophages and neutrophils) that seek and destroy invaders. Some also destroy damaged body cells.

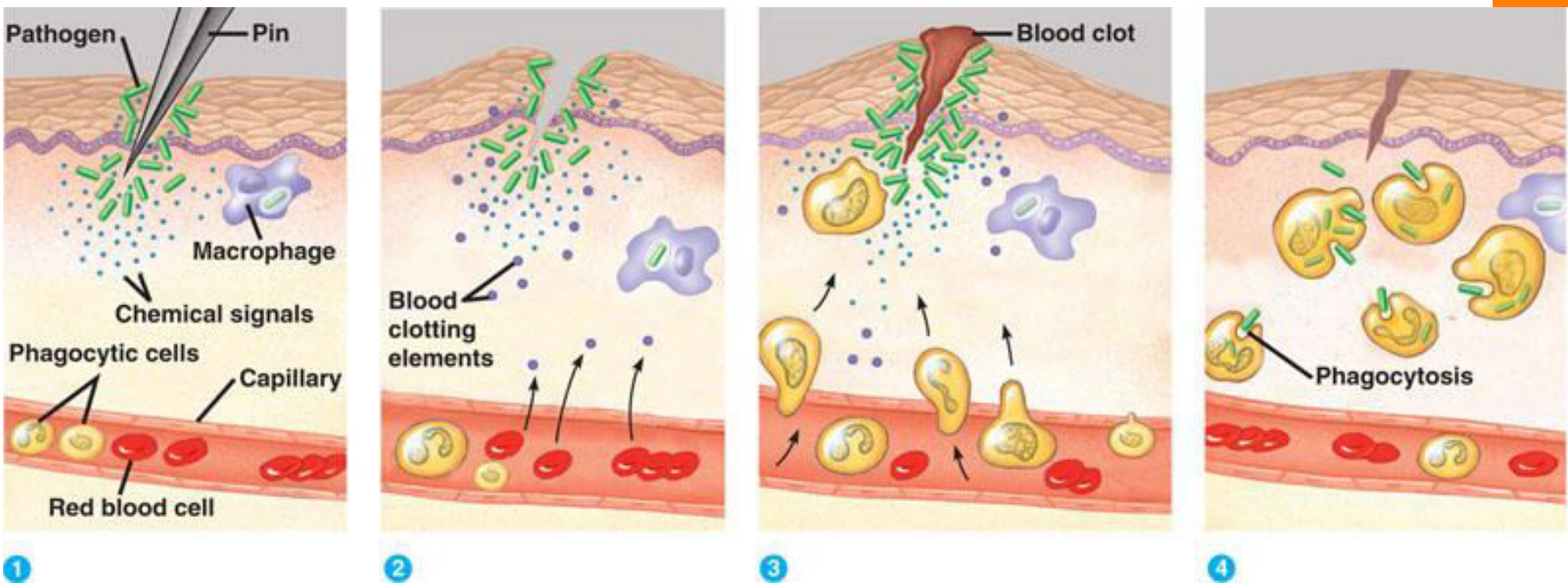


- Phagocytes are attracted by an inflammatory response of damaged cells.



Inflammatory Response

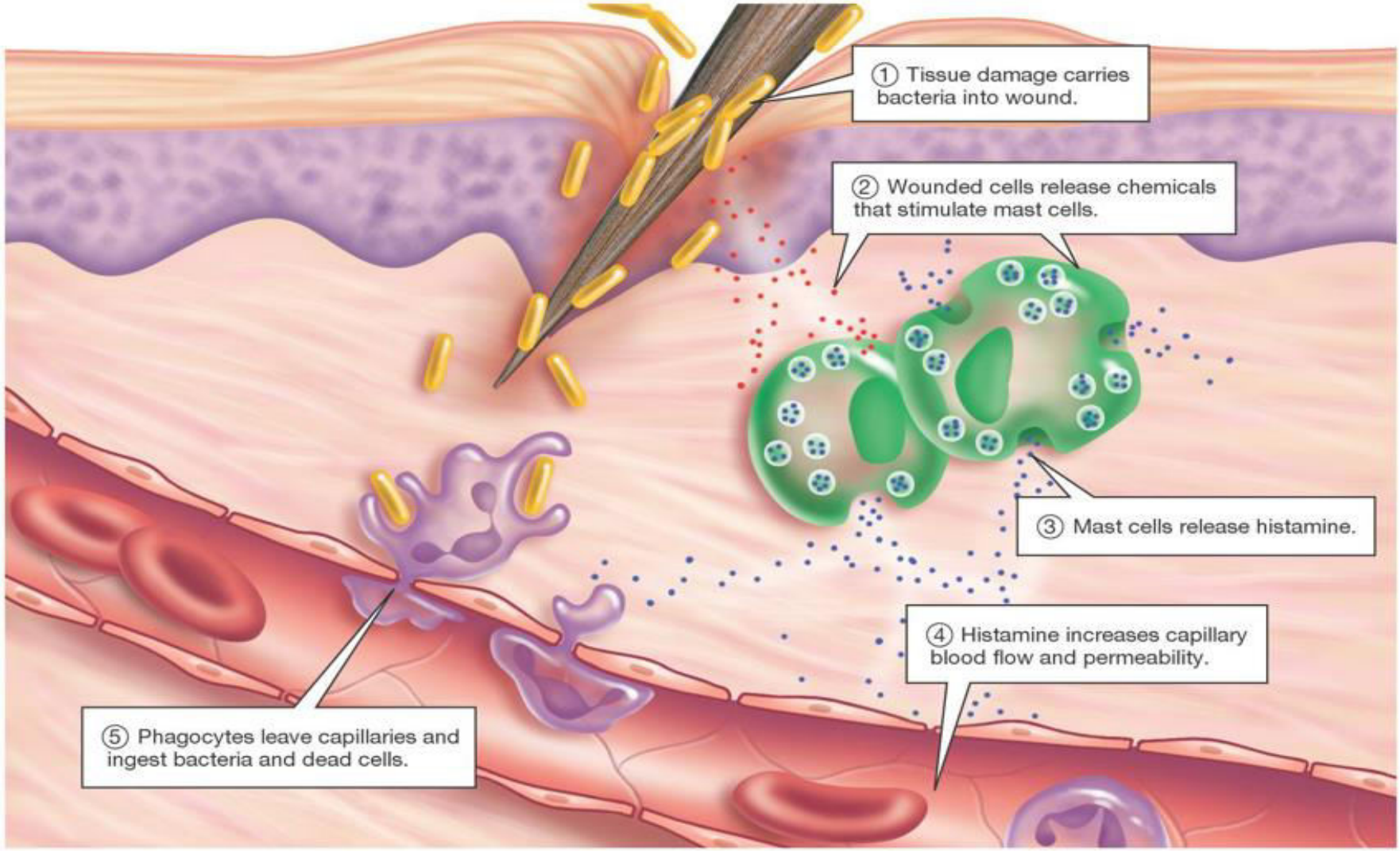
- In local **inflammation**, **histamine** and other chemicals released from injured cells promote changes in blood vessels that allow more fluid, more phagocytes, and antimicrobial proteins to enter the tissues.



Role of inflammation

- Inflammation is signaled by mast cells, which release histamine.
- Histamine causes fluids to collect around an injury to dilute toxins. This causes swelling.
- The temperature of the tissues may rise, which can kill temperature-sensitive microbes.

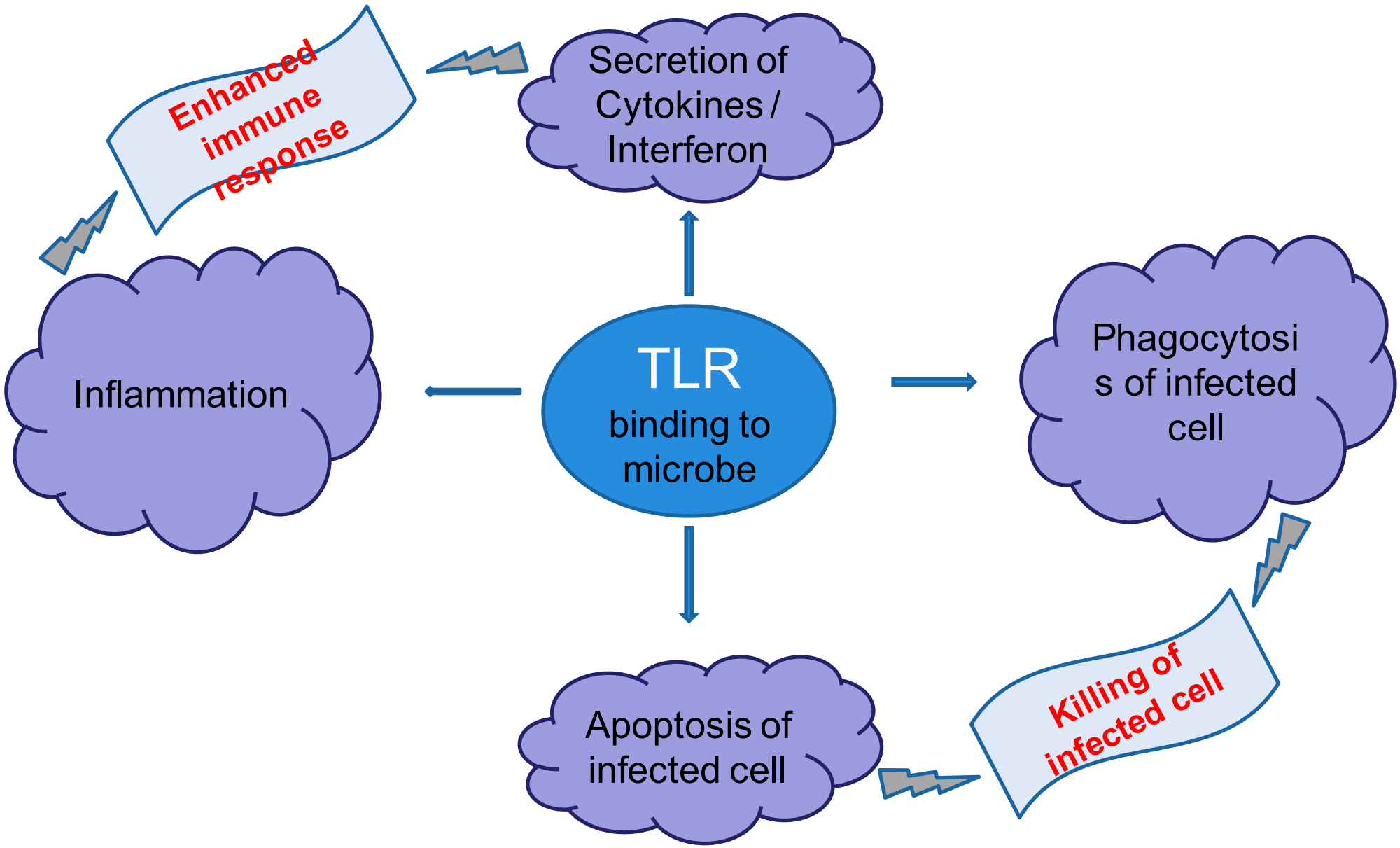
Ouch!



Internal defenses

1-CELLULAR

What happens when a TLR bind to a microbe ?



Internal Defences

2-Extra cellular

- Cytokines
- Complement

Antimicrobial Proteins

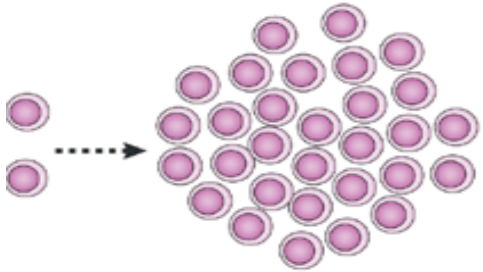
- About 30 proteins make up the **complement system**, which can :

1. cause lysis of invading cells and
2. help trigger inflammation.

- **Interferon's** provide :

1. innate defense against viruses and
2. help activate macrophages.

What to Interleukins do ?



Proliferation of immune cells

Inflammation

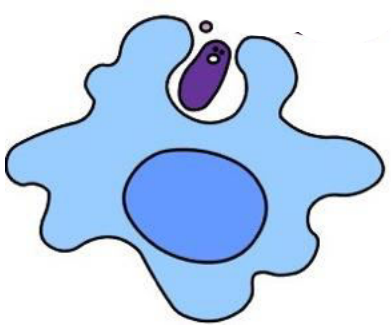
Interleukins

Increase antibody production

Activation of immune cells

Complement proteins: role in innate immune system

C`proteins



Facilitates phagocytosis

Direct lysis of pathogens

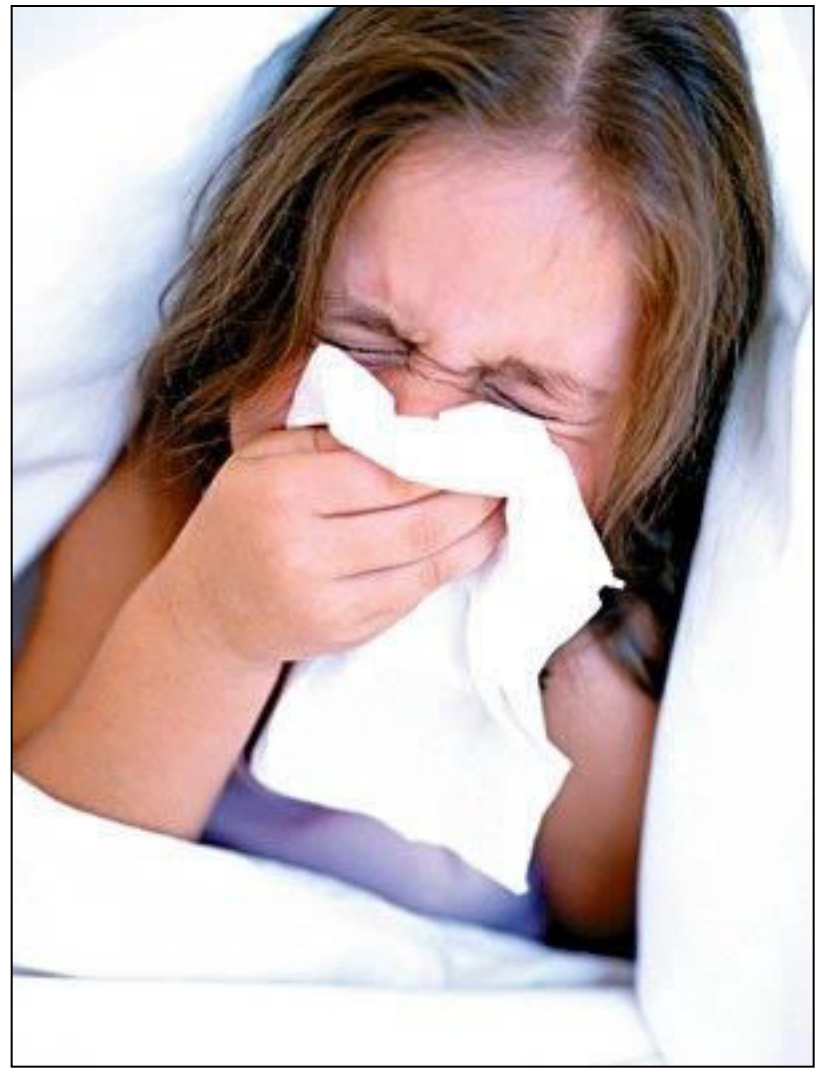
Inflammation

- You wake up one morning with a stuffy nose, slight fever, and fatigue. Do you have a cold or the flu? Or are they the same?
- Should you go to your doctor for an antibiotic? Why or why not?

WORK TOGETHER

The not-so-common cold

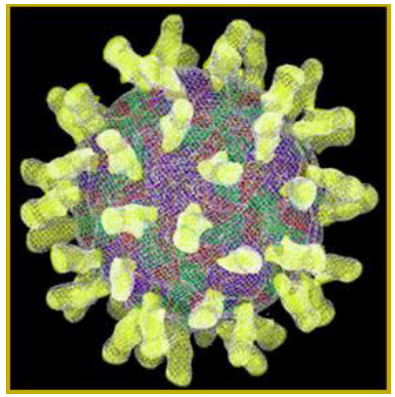
- A “cold” is an infection of the mucus membranes of the respiratory tract by a rhinovirus.
- Over 100 rhinoviruses have been identified, which is one reason why we don’t become immune to “the cold.”

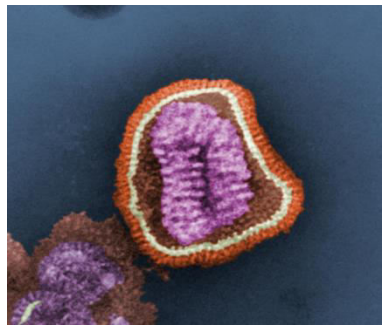


Virus vs. Bacteria

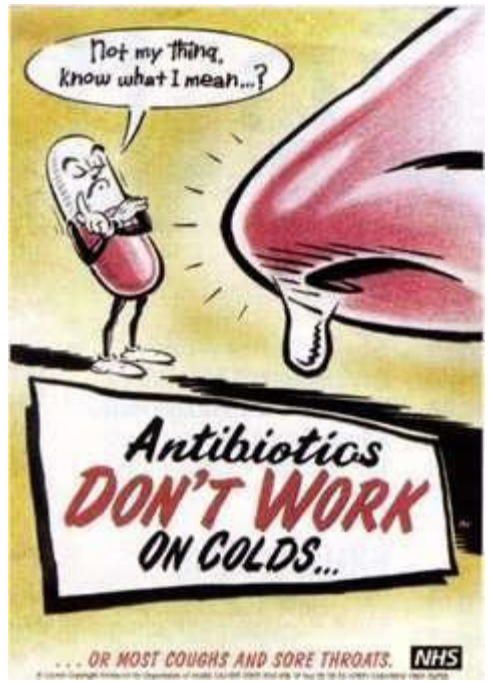
- **Colds and influenza are caused by viruses.**
- **Viruses are which is a non-living particle that contains genetic material, and hijacks your cells to reproduce.**
- **Viruses cannot be "killed" with antibiotics.**

Rhinovirus





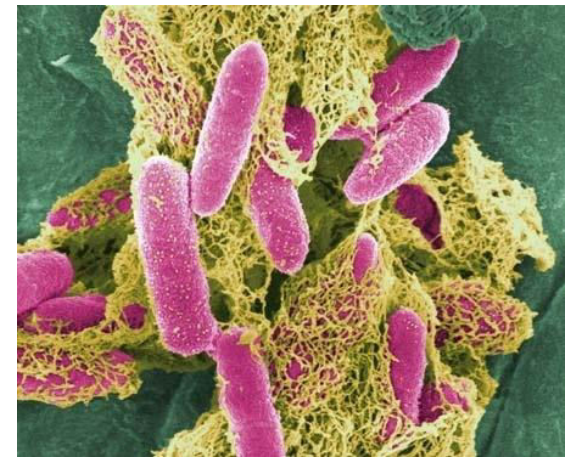
Influenza virus



Virus vs. Bacteria

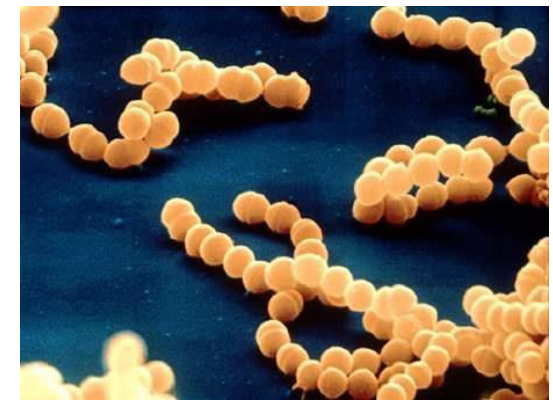
- Bacteria are living organisms that have a metabolism, have DNA, and can reproduce on their own.

- Bacteria can be killed with antibiotics because these substances target key processes in bacteria, such as production of the bacterial cell wall.



E. coli

Streptococcus



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