



# About Science Prof Online PowerPoint Resources

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# Immune System I:

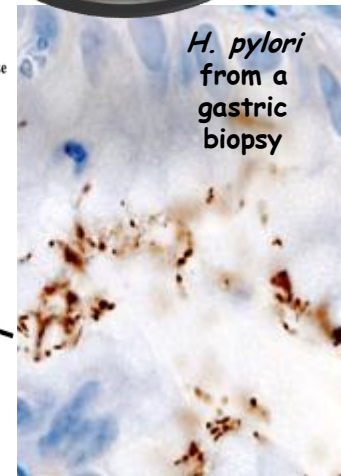
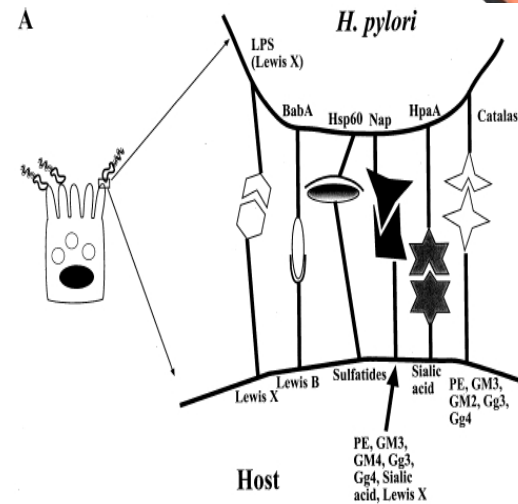
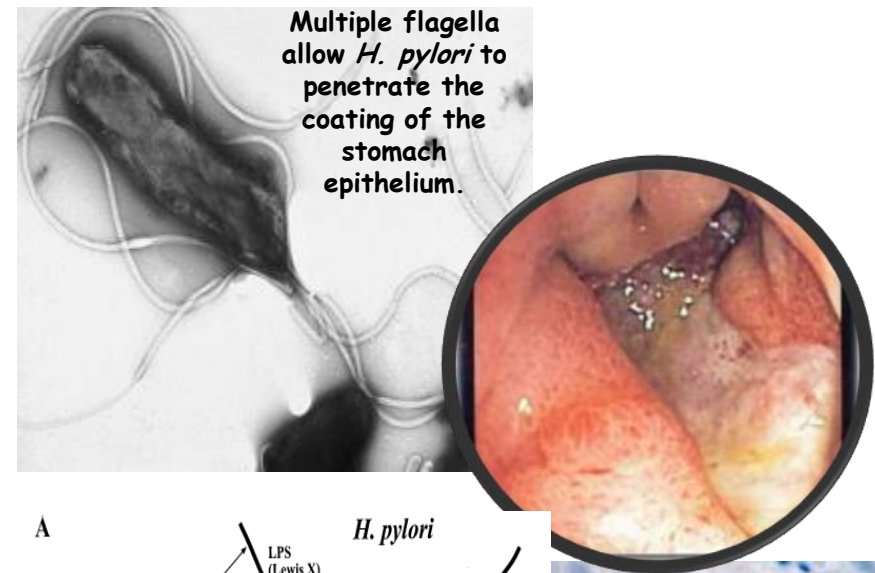
## Innate Immunity



# It Isn't Easy Being a Pathogen

*What a pathogen must do in order to cause disease:*

1. Gain access to the body.
2. - Attach to, and/or enter cells of its host.
  - Receptors on pathogen must fit, lock-and-key, with receptor sites on host cell.
3. Reproduce while avoiding host's immune system long enough to produce harmful changes.



- 
- Protect the body by competing with potential pathogens.

- This is called \_\_\_\_\_.

- Normal microbiota protect us by:

- Consuming nutrients that would otherwise be available to pathogens.
- Sometimes change the pH of the area they inhabit in ways that help them and hinder competing microbes.
- Presence stimulates certain parts of the second line of immune defense, helping the body defend itself from invaders.
- Normal flora of the intestines improve our overall health by producing several types of vitamins.



- 
- First two lines of immune defense considered together.
  - *Q: Why do you think that they are called innate immunity?*
  - Innate immunity is relatively **nonspecific**, meaning that these lines of defense work against a wide range of pathogens.

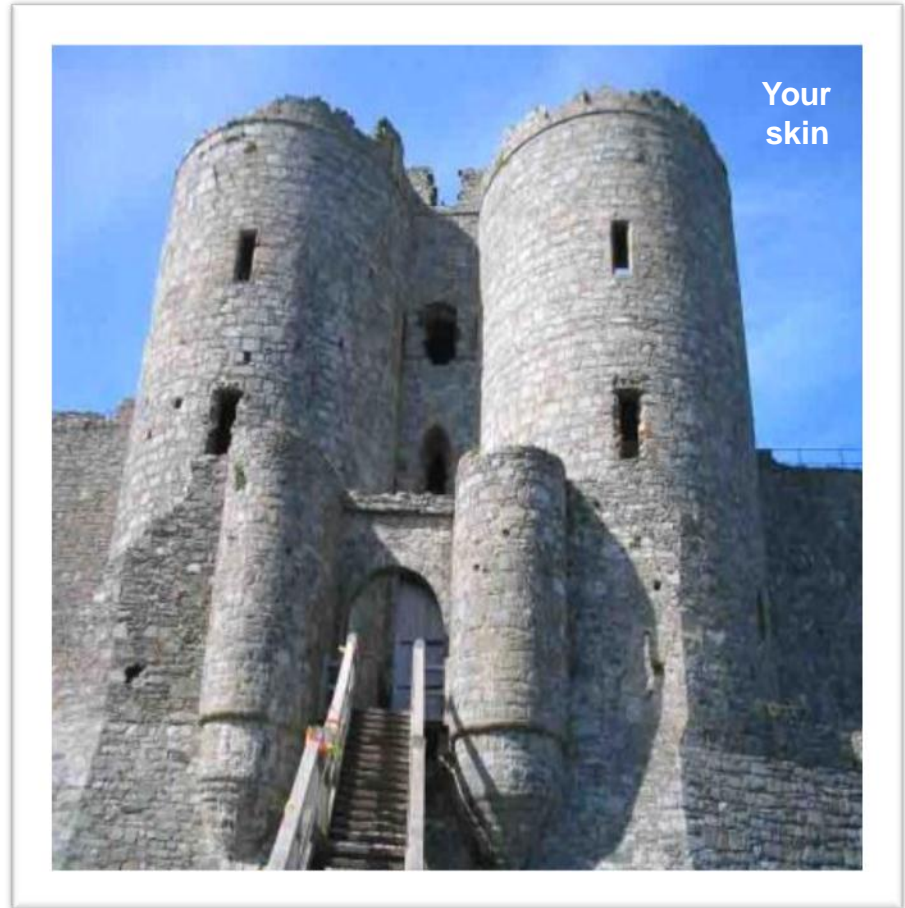




# First Line of Defense

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- Structures, chemicals, processes that work to *prevent pathogens entering the body.*
- Includes the \_\_\_\_\_ and \_\_\_\_\_ of the respiratory, digestive, urinary, and reproductive systems.

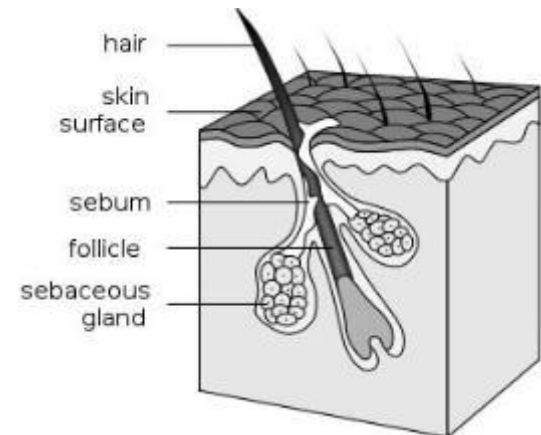


*First Line of Defense*



# Skin - \_\_\_\_\_ Components of Defense

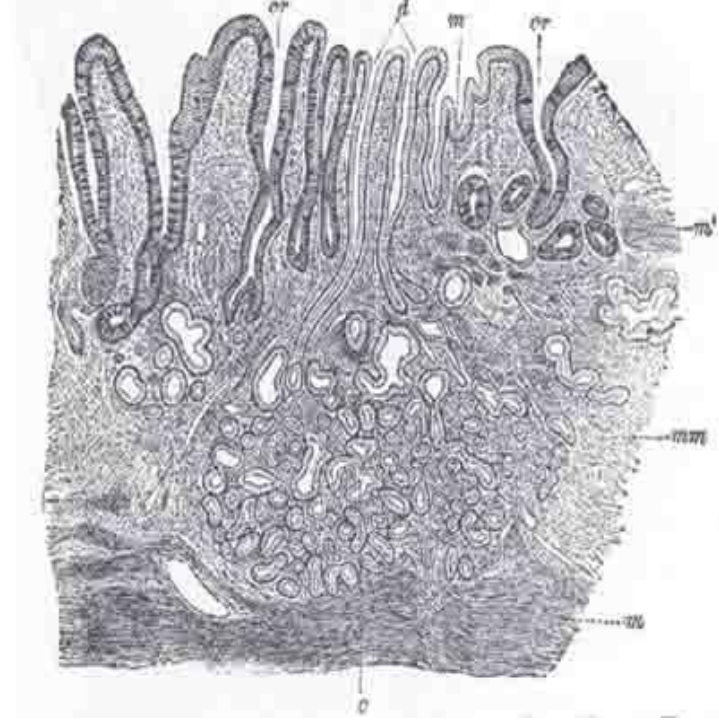
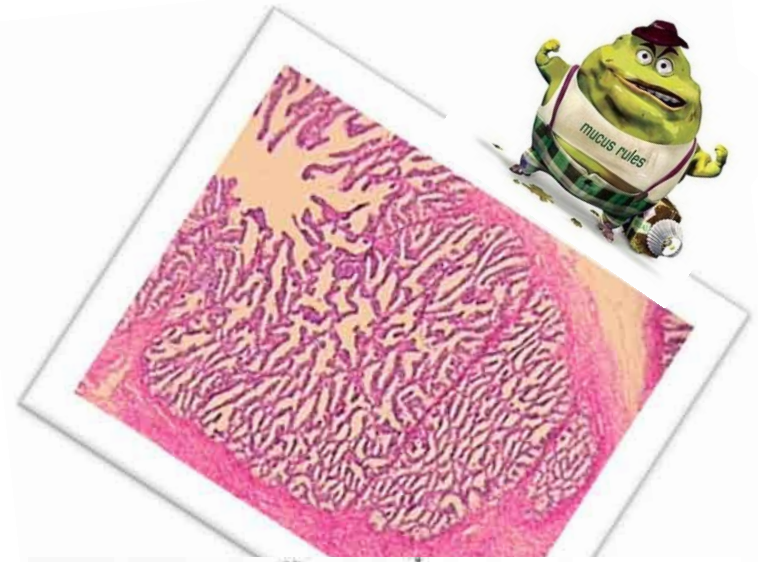
- \_\_\_\_\_ secreted by sweat glands
  - Salt- inhibits growth of pathogen by drawing water from their cells
  - Antimicrobial peptides
  - Lysozyme- destroys cell wall of bacteria
- \_\_\_\_\_ secreted by sebaceous (oil) glands
  - Helps keep skin pliable and less likely to break or tear
  - Lowers pH of skin to a level inhibitory to many bacteria



*First Line of Defense*



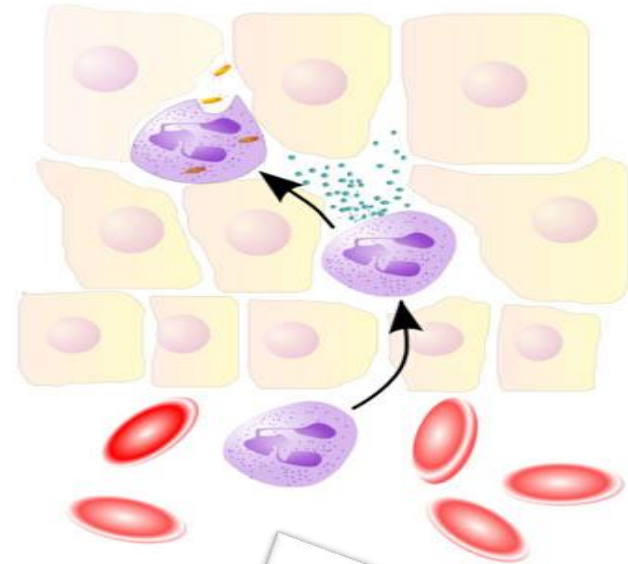
- 
- Line all body cavities open to the outside environment.
  - Unlike surface epidermal cells, epithelial cells are living.
  - Epithelial cells packed tightly to prevent entry of pathogens, but often only one cell layer thick, so pathogens sometimes breach the barrier.
  - Continual shedding of cells carries attached microorganisms away
  - Besides producing mucus, mucous membranes also produce lysozyme and other antimicrobial peptides.
  - **OMG U R Nasty** > Every day you swallow and digest about 1 liter of mucus.



*First Line of Defense*

# Line of Defense -

- Operates when pathogens penetrate skin or mucous membranes
- Cells, antimicrobial chemicals, and processes, but no physical barriers
- Many of these components are contained or originate in the blood



*Second Line of Defense*

# Blood

Composed of cells and portions of cells within a fluid called **plasma**.

Plasma is mostly water containing electrolytes, dissolved gases, nutrients, and protein.

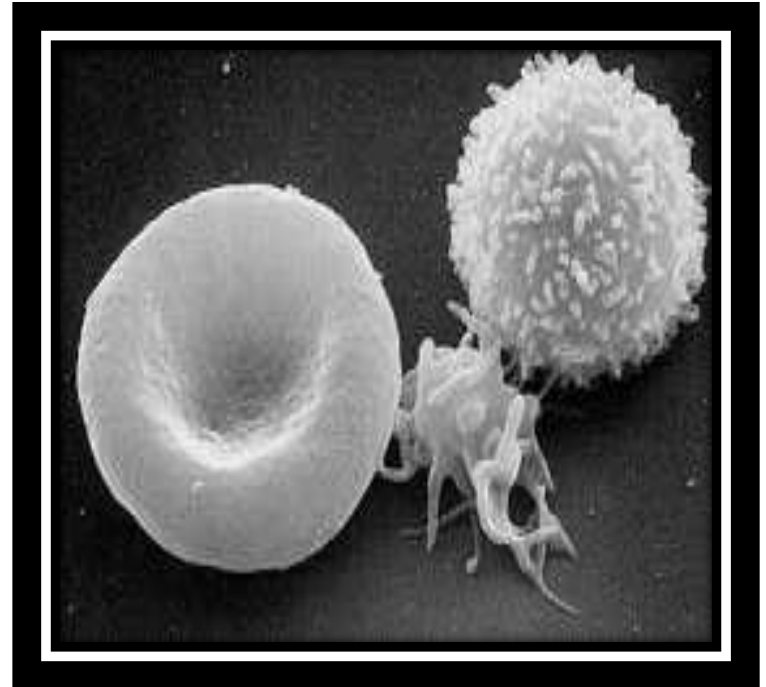
The cells and cell fragments in plasma are called \_\_\_\_\_.



# Formed Elements

## Three types of formed elements

- \_\_\_\_\_ - red blood cell, carry oxygen & carbon dioxide in the blood.
- \_\_\_\_\_ - involved in blood clotting (also called thrombocytes).
- \_\_\_\_\_ - white blood cells; involved in defending the body against invaders.
  - 2 groups
    - Granulocytes
    - Agranulocytes



Scanning electron micrograph of formed elements

RBC (*left*)

platelet (*center*)

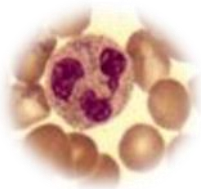
leukocyte (*right*)

Second Line of Defense

# Leukocytes >

Category of white blood cells characterized by presence of **granules** in their cytoplasm.

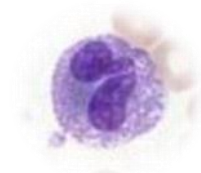
3 types:



Neutrophils - Most abundant white blood cell. Predominant cells in pus, accounts for its whitish appearance. Respond quickly following tissue injury. Hallmark of acute inflammation.

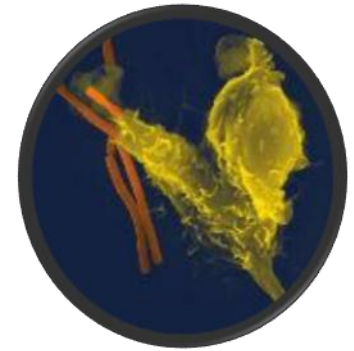
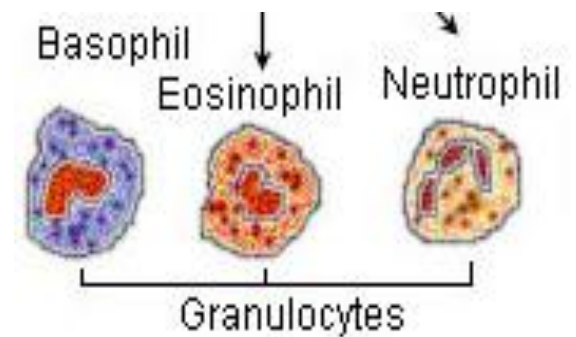


Eosinophils - Least common granulocyte. When activated, release histamine and other inflammatory chemicals.



Basophils - Main effector cells in allergic responses & asthma. Also fight helminth (worm) colonization.

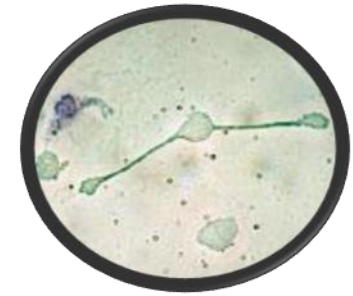
**Neutrophils** and **eosinophils** can *phagocytize* pathogens.



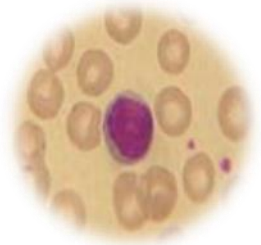
Second Line of Defense



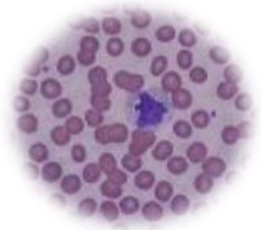
# Leukocytes >



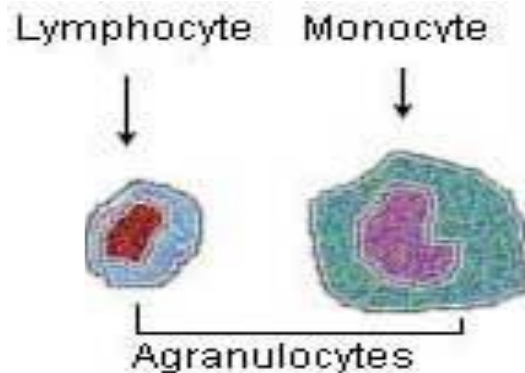
2 types:



\_\_\_\_\_ - most involved in specific immunity  
(3<sup>rd</sup> line of immune defense),

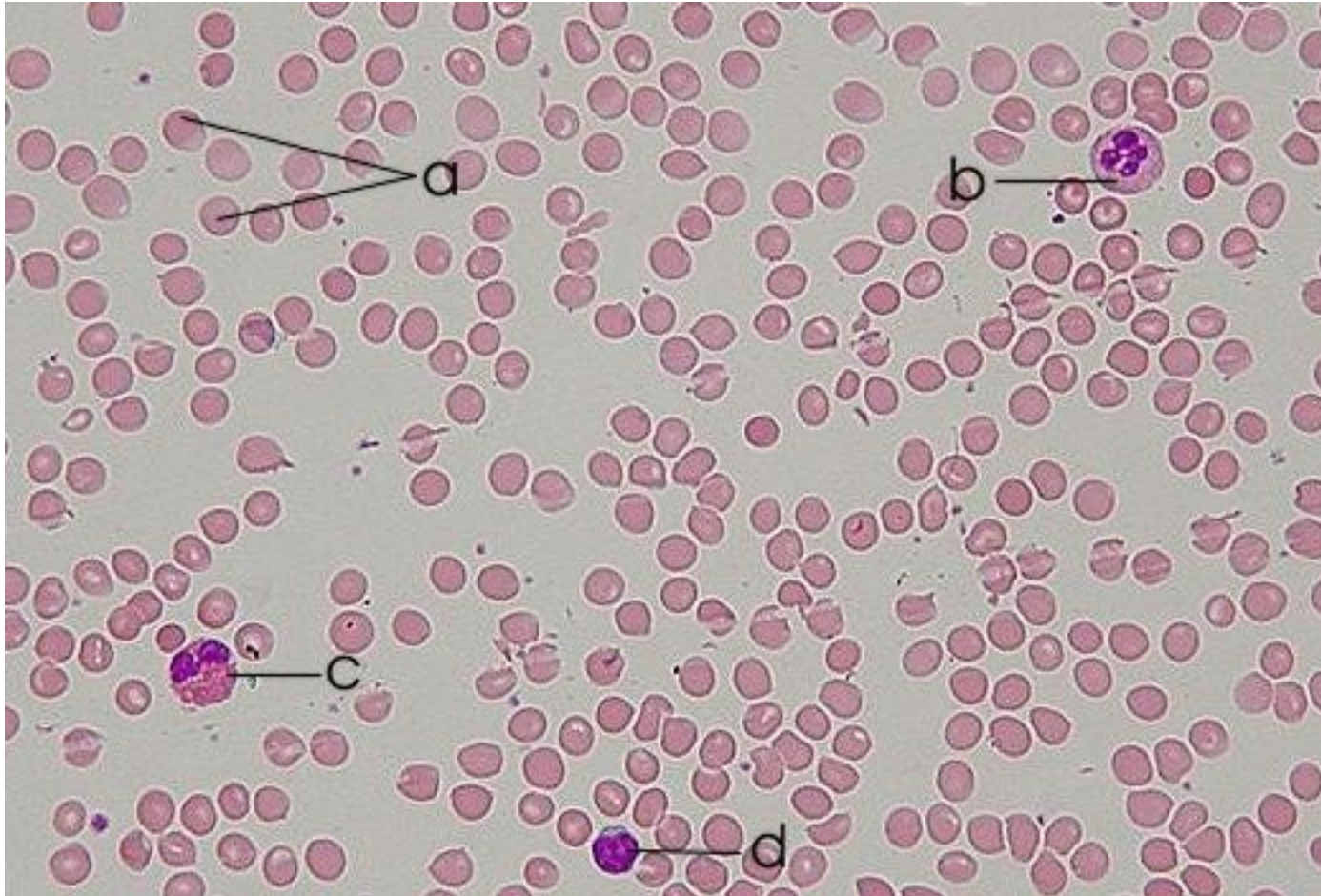


\_\_\_\_\_ - leave the blood and mature into  
**macrophages** (phagocytic cells of the second line of defense).



Second Line of Defense

# Formed Elements in Blood Smear

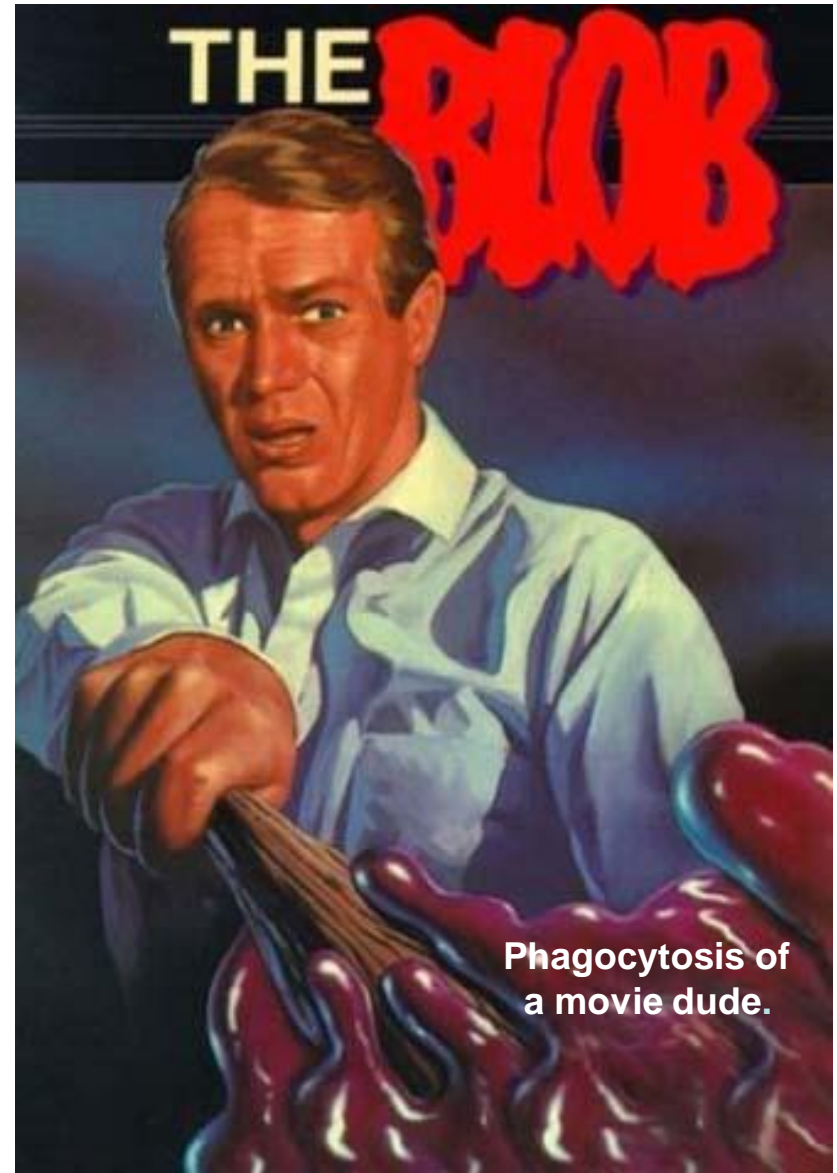


a. erythrocyte, b. neutrophil, c. eosinophil, d. *Q: What is d?*

# Components of the Second Line of Defense

## 1. Leukocytes

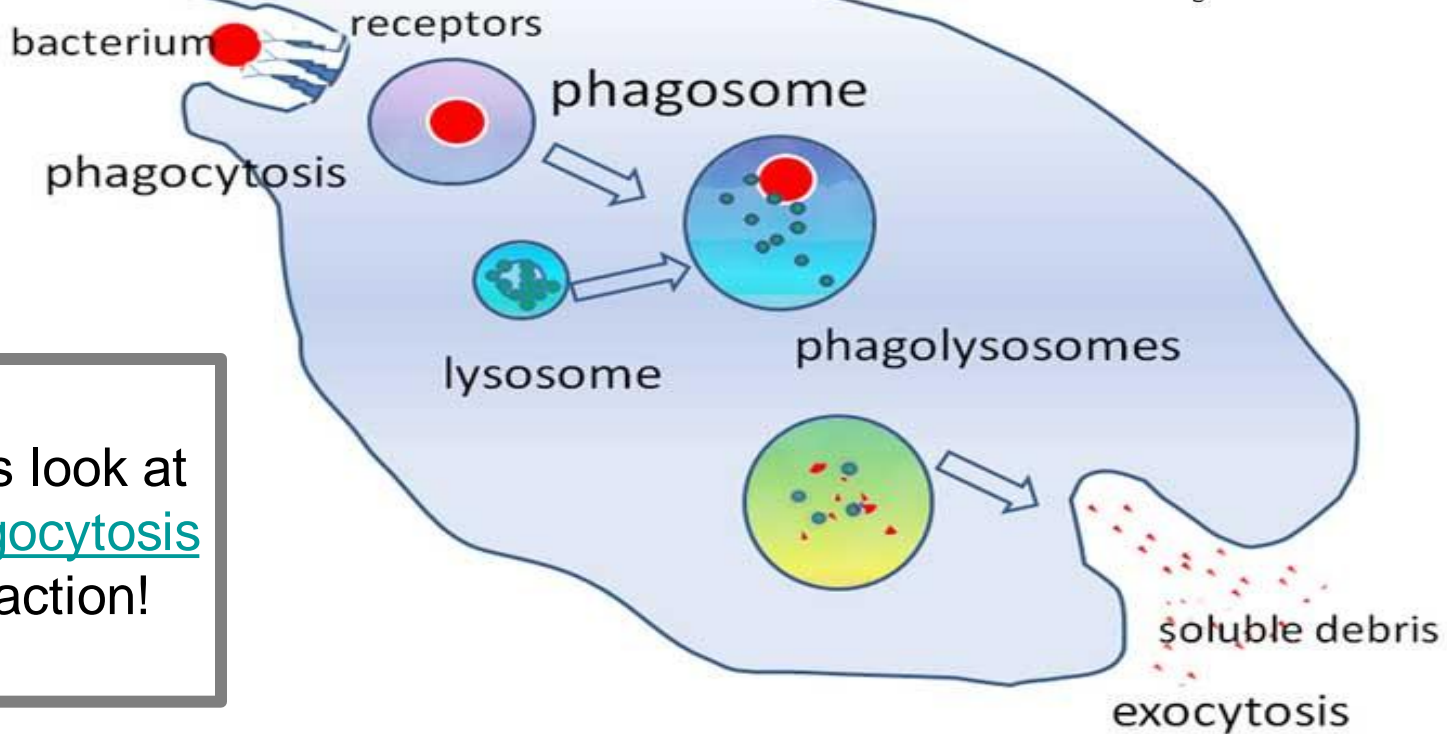
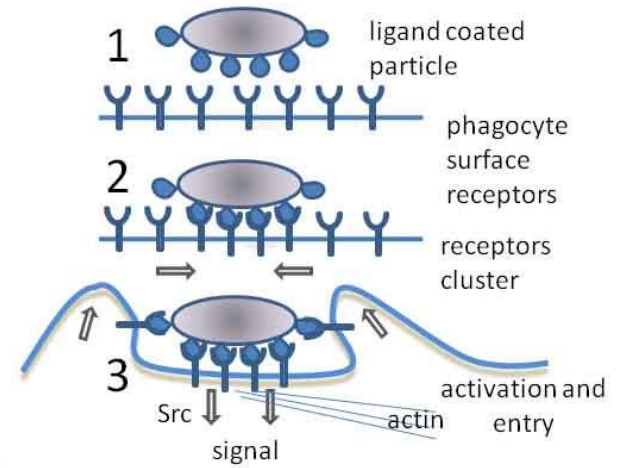
- \_\_\_\_\_  
How phagocytes ingest and destroy foreign matter such as microorganisms or debris.
- Extracellular killing by leukocytes
  1. Nonspecific chemical defenses
  2. Inflammation
  3. Fever



*Second Line of Defense*



# Leukocytes: Phagocytosis



Let's look at phagocytosis in action!

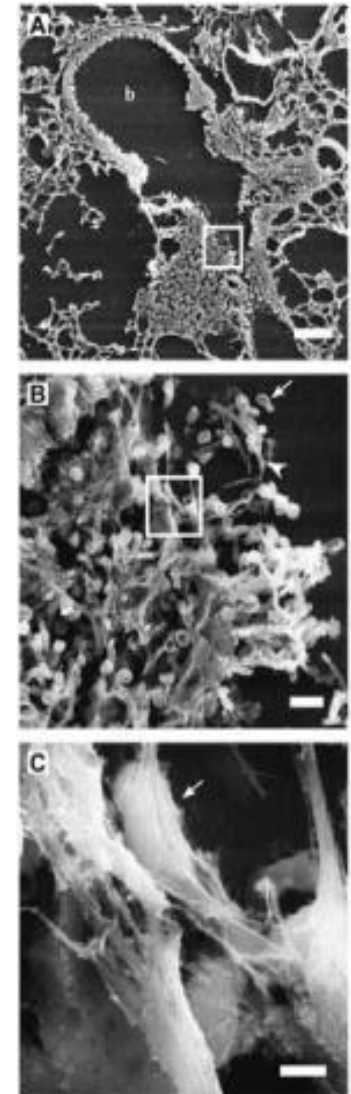
Second Line of Defense



# Leukocytes: Extracellular Killing

## 3 Cell Types That Kill Extracellularly:

- \_\_\_\_\_ **lymphocytes** (NK cells)
  - Secrete toxins onto surface of virally infected cells & tumors.
  - Differentiate normal body cells because they have membrane [proteins](#) similar to the NK cells.
- \_\_\_\_\_
  - Mainly attack parasitic worms by attaching to their surface.
  - Secrete toxins that weaken or kill worm.
  - Elevated eosinophil levels, is often indicative of a helminth (parasitic worm) infection.
- \_\_\_\_\_
  - Can create the active ingredient in bleach to kill nearby microbes.
  - Fibers called neutrophil extracellular traps (NETs) can ensnare and kill bacteria and fungi. Secrete antimicrobial proteins.

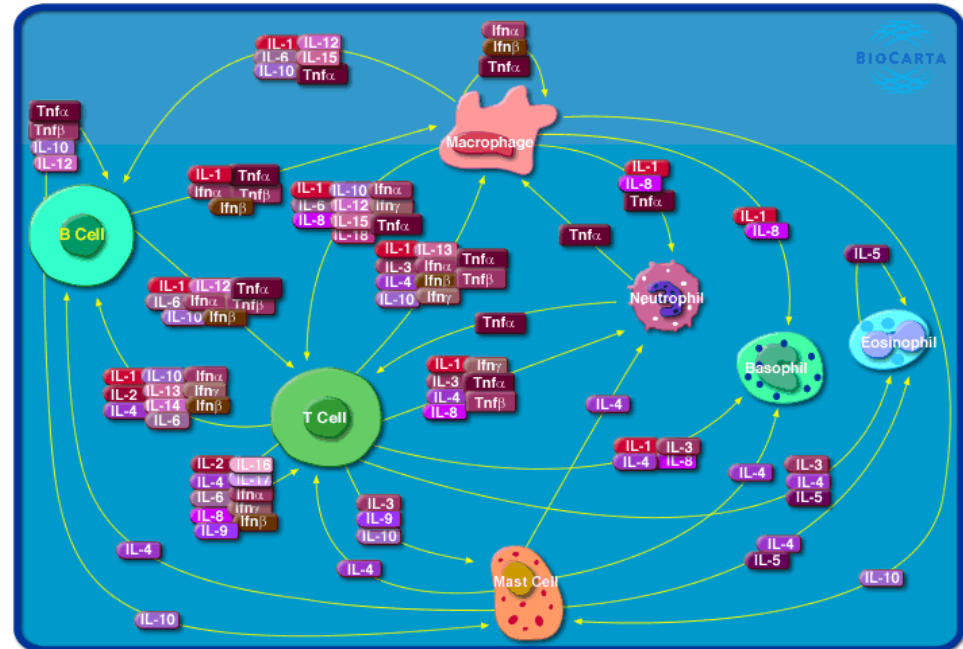
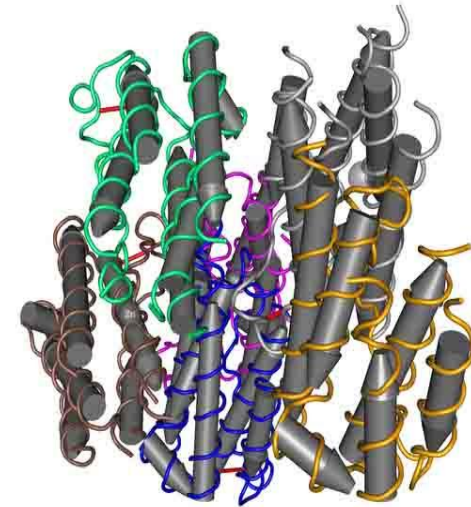


*Second Line of Defense*



# Components of the Second Line of Defense

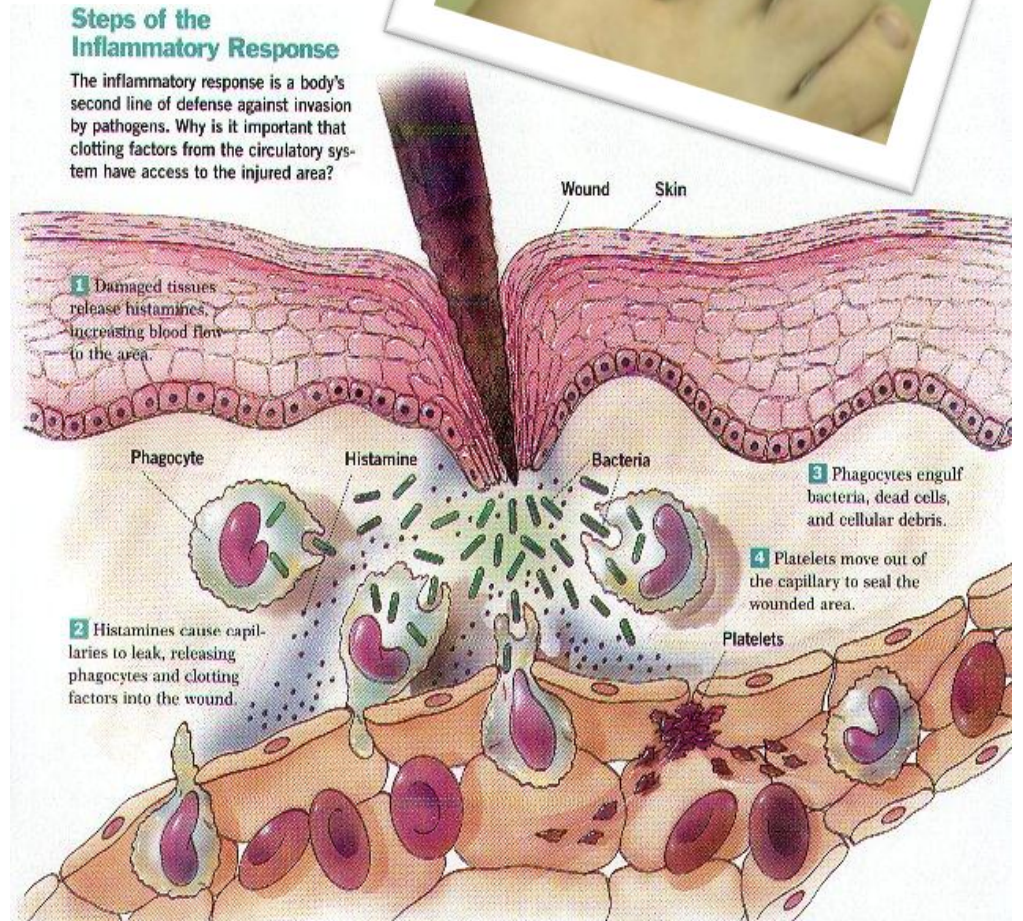
- Leukocytes
  - Phagocytosis
  - Extracellular killing by leukocytes
- \_\_\_\_\_
- Lysozyme, Defensins & Cytokines (including interferons and interleukins).
- Augment phagocytosis
- Some attack pathogens directly
- Some enhance features of nonspecific resistance
- Inflammation
- Fever



Second Line of Defense

# Components of the Second Line of Defense

- Leukocytes
  - Phagocytosis
  - Extracellular killing by leukocytes
- Nonspecific Chemical Defenses
  - Ex. Lysozyme, Defensins & Cytokines
- Inflammation
  - Nonspecific response to tissue damage.
  - Damages cells release histamines, which increase vasodilation.
  - Heat, swelling pain.
- Fever



Second Line of Defense

# Components of the Second Line of Defense



- Leukocytes
  - Phagocytosis
  - Extracellular killing by leukocytes
- Nonspecific Chemical Defenses
  - Ex. Lysozyme, Defensins & Cytokines
- Inflammation
  - Nonspecific response to tissue damage.
  - Damages cells release histamines, which increase vasodilation.
  - Heat, swelling pain
- **Fever**

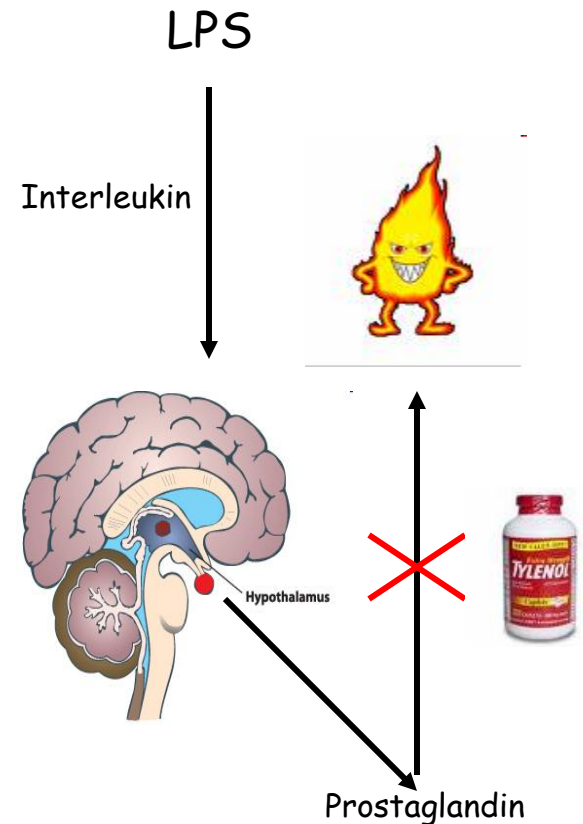
- ✓ Body temp above normal range of 36.5-37.5 °C (98-100 °F).
- ✓ Results when chemicals called \_\_\_\_\_ trigger the hypothalamus to increase body's core temperature.
- ✓ Various types of pyrogens
  - ❖ Bacterial toxins
  - ❖ Cytoplasm of bacteria released by lysis
  - ❖ Antibody-antigen complexes
  - ❖ Interleukin-I (IL-1 a cytokine)
- ✓ Benefits
  - ❖ Speed of immune system reaction increased
  - ❖ Inhibits growth of some temp sensitive microorganisms

*Second Line of Defense*



# Fever Triggered by Gram- Bacteria

1. When infected with a Gram- bacteria...
2. 2<sup>nd</sup> line of defense responds with **phagocytes**.
3. Macrophages engulf invader in a vesicle called a **phagosome**.
4. The phagosome fuses with a **lysosome**. *Q: What happens to the bacteria when the phagosome and lysosome fuse?*
5. When the macrophage is **exposed to Lipid-A** (part of the LPS membrane that is a pyrogen) the **macrophage secretes interleukin** (a type of cytokine that is a pyrogen).
5. **Interleukin** is picked up by the blood and **transported to the brain**.
6. In the brain, interleukin stimulates the **hypothalamus to secrete prostaglandin**.
7. Prostaglandin attaches to receptors in the hypothalamus and cause it to **reset the thermostat → fever**.
8. **Ibuprophen** and **Acetaminophen** are **antiprostaglandins** (They temporarily remove the prostaglandin, interrupting the fever-generating process).



# Confused?

Here are links to fun resources that further explain cellular respiration:

- [Innate Immunity Main Page](#) on the Virtual Cell Biology Classroom of [Science Prof Online](#).
- [Phagocytosis](#) animation and quiz by McGraw-Hill.
- [Immune System](#) "Who Wants to Be a Millionaire" game.
- ["Fever"](#), song by Peggy Lee.
- [Immune System Defender](#), online game from the Nobel Prize website. Use your force of white blood cells to destroy invading bacteria, before they overpopulate and cause disease.
- ["Osmosis Jones"](#) movie trailer. If you haven't seen this movie yet, you must watch it immediately! It's awesome!
- [Immune System Game](#), a collection of online fun and educational games about immunology.

Smart Links





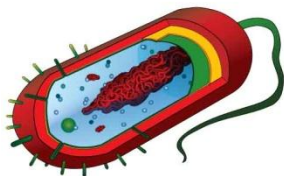
# Are microbes intimidating you?



*Do yourself a favor. Use the...*

## Virtual Microbiology Classroom (VMC) !

The VMC is full of resources to help you succeed,  
including:



- practice test questions
- review questions
- study guides and learning objectives

You can access the VMC by going to the Science Prof Online website

[www.ScienceProfOnline.com](http://www.ScienceProfOnline.com)