PSL301H—Blood and Immune System
Lecture 2: Pathogens and Innate Immunity

Lecture outline

What does our immune system do?
What kinds of pathogens are there?
How do we defend against pathogens?
What are the components of the immune system?
How does the innate immune system work?

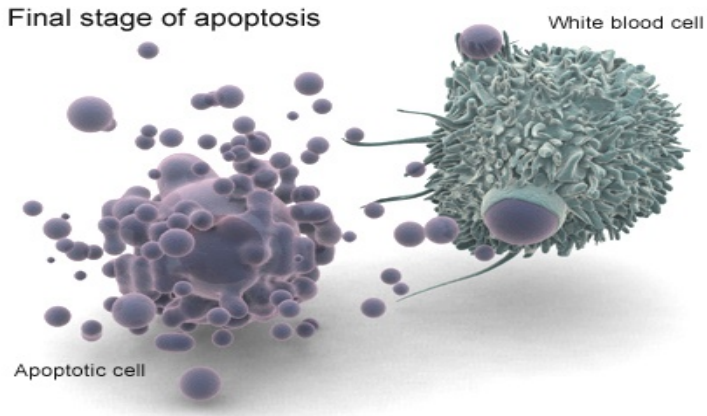
Textbook reading: 7th ed. 754-756
Interactive Physiology — Immune system
(6th ed. 802-814) (5th ed. 783-793)

What does our immune system do?

Destroys pathogens

Detects and kills abnormal cells

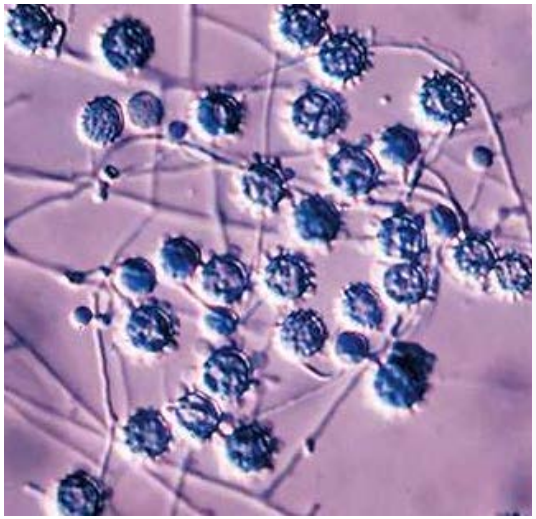
Remove cell debris from body



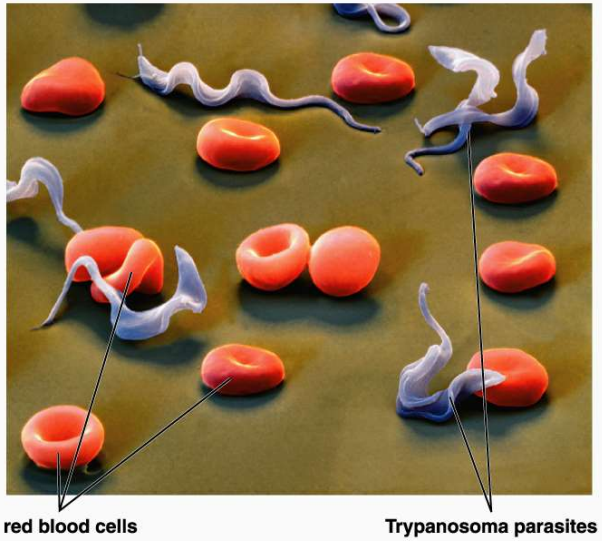
ghr.nlm.nih.gov/.../apoptosismacrophage.jpg

What kinds of pathogens are there?

Parasitic worms

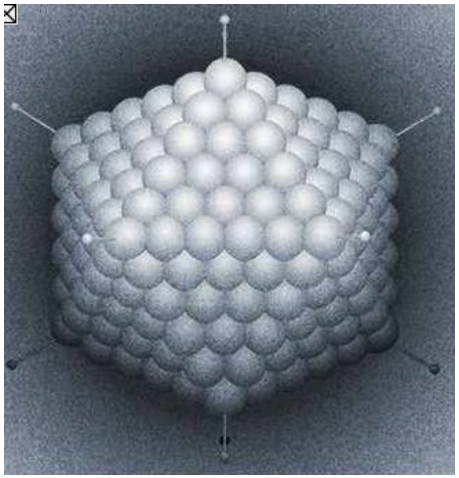


Fungi



Protozoa

Bacteria



Viruses

Intracellular and extracellular

Figures from Interactive Physiology

Viruses

Require cells to replicate

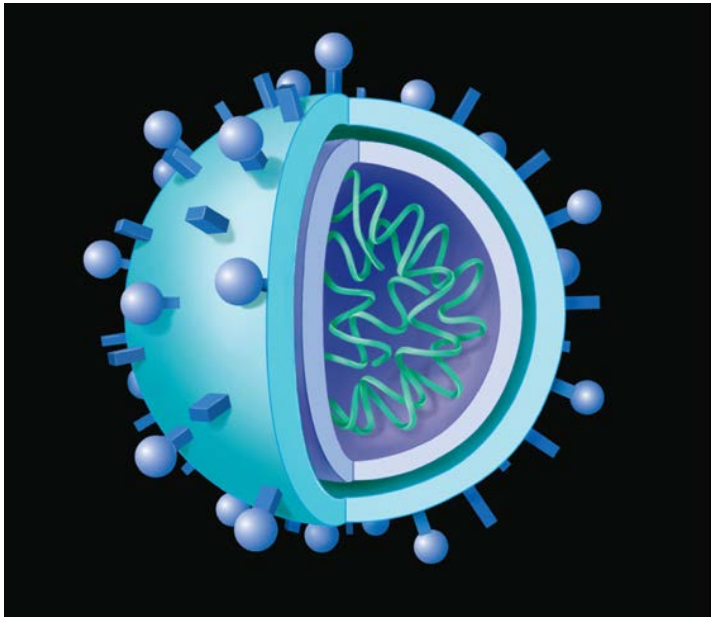
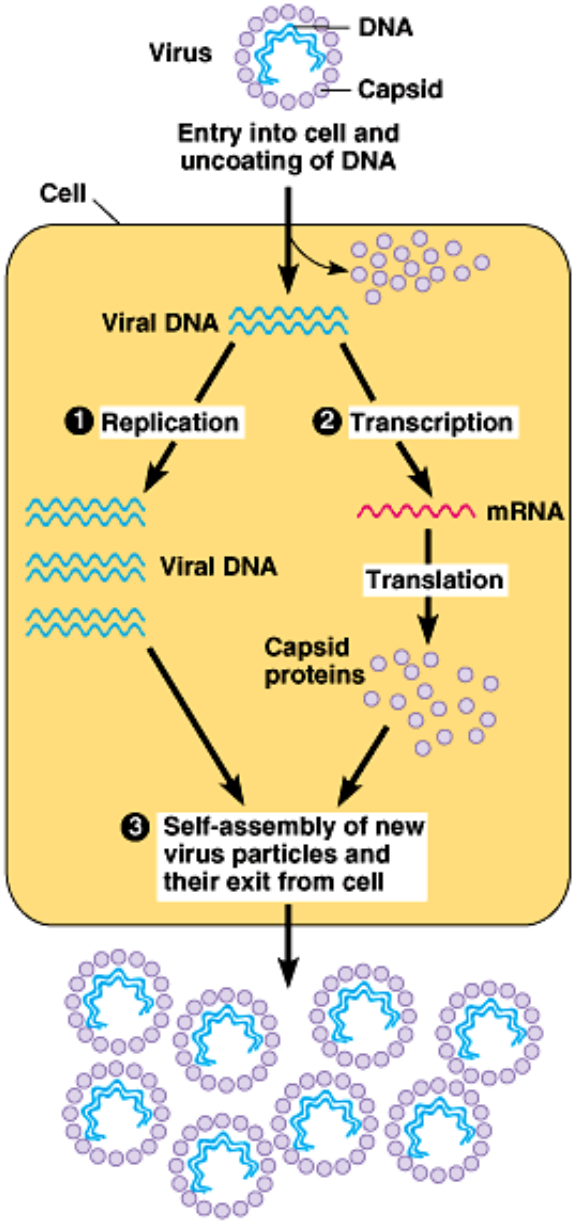


Figure 24.1



How do we defend against pathogens?

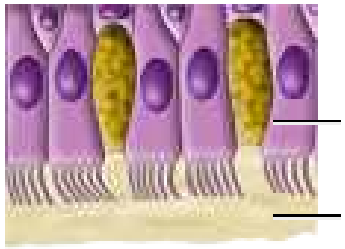
Physical Barriers
• skin, mucous, acid, lysozyme

Innate Immunity
• rapid, non-specific

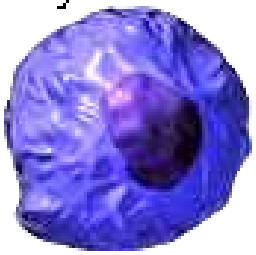
Acquired Immunity

Body

Skin and mucous membranes



Cells and chemicals in body fluids



Lymphocytes

T cells B cells

Castle

Castle walls and moat

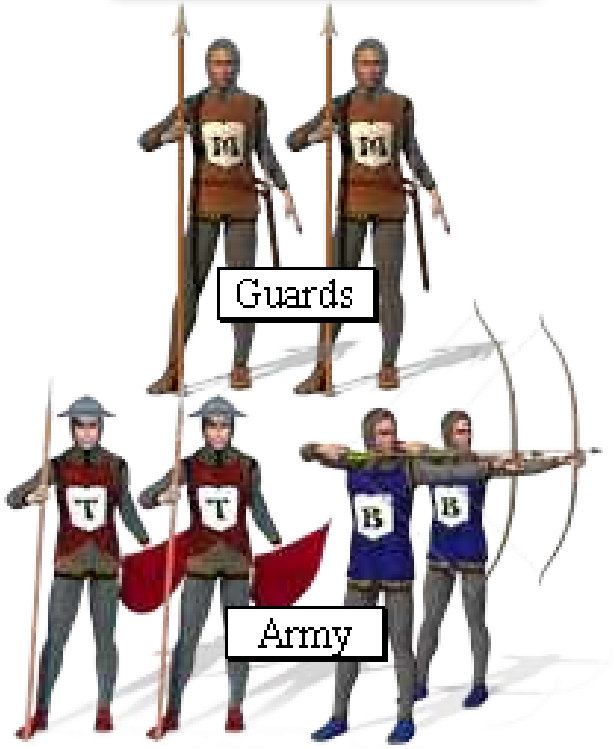
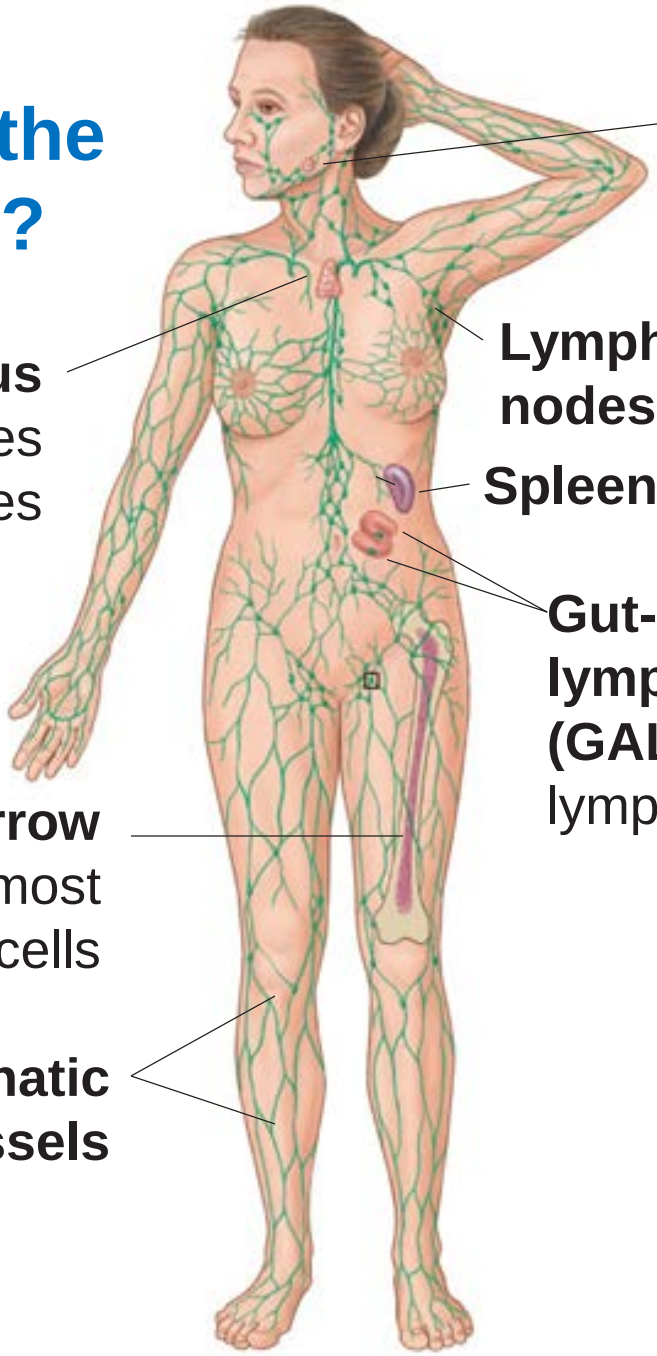


Figure from Interactive Physiology

What are the components of the immune system?



Tonsils are diffuse lymphoid tissue

Thymus produces T lymphocytes

Lymph nodes

Spleen

Encapsulated lymphoid tissues

Gut-associated lymphoid tissue (GALT) is a diffuse lymphoid tissue

Bone marrow produces most blood cells

Lymphatic vessels

Figure 24.3

Lymphatics

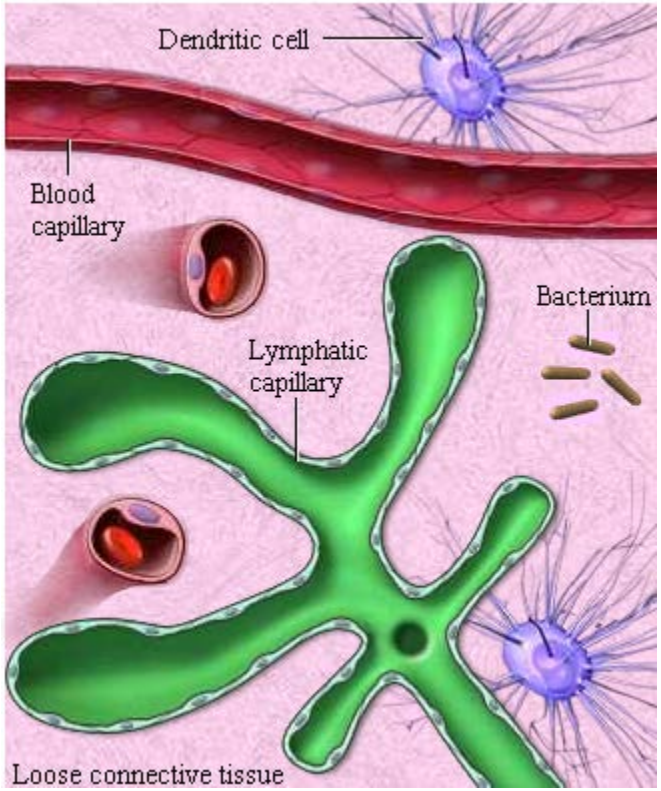


Figure from Interactive Physiology

1) Return excess tissue fluid to the blood
2) Transport pathogens/dendritic cells to lymph nodes
3) Transport fat from digestive system to the blood

Specialized lymphoid organs

Lymph nodes
- monitor lymph

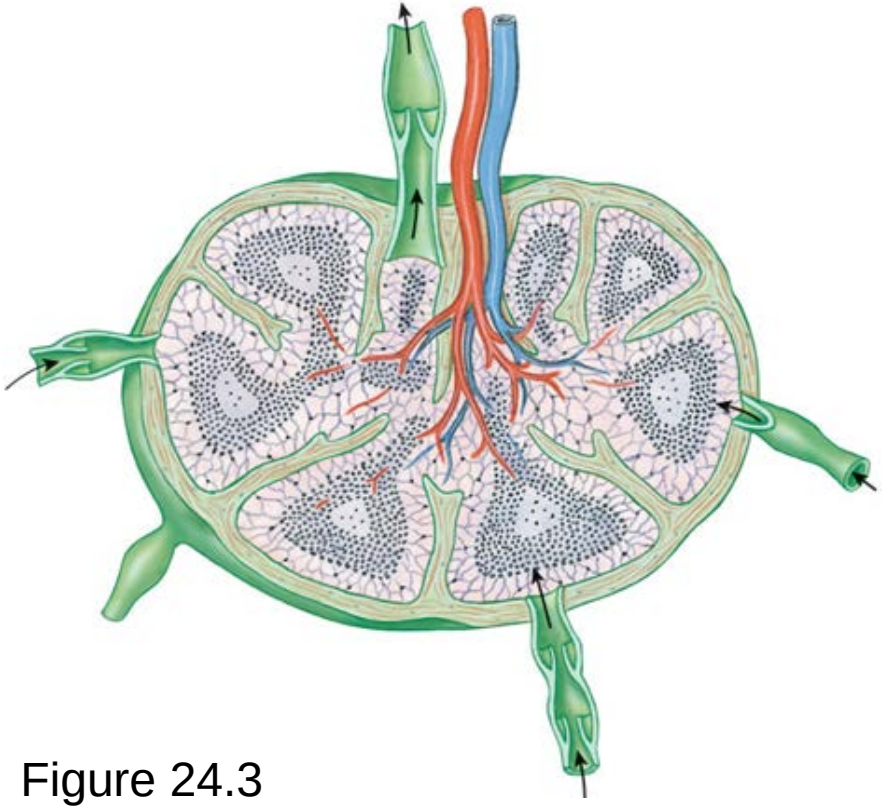


Figure 24.3

Spleen
- monitors blood

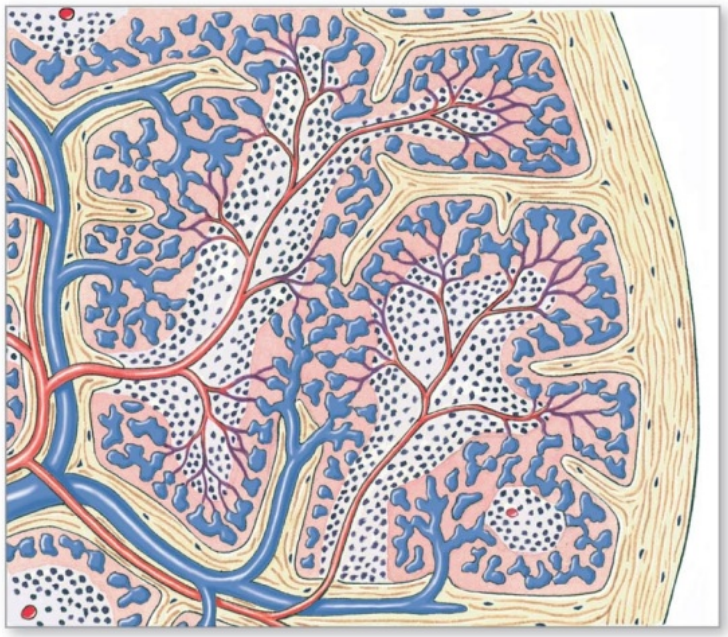


Figure 24.4

Both contain mature immune cells that interact with pathogens and initiate an immune response

Immune cells found in blood, lymph and tissues

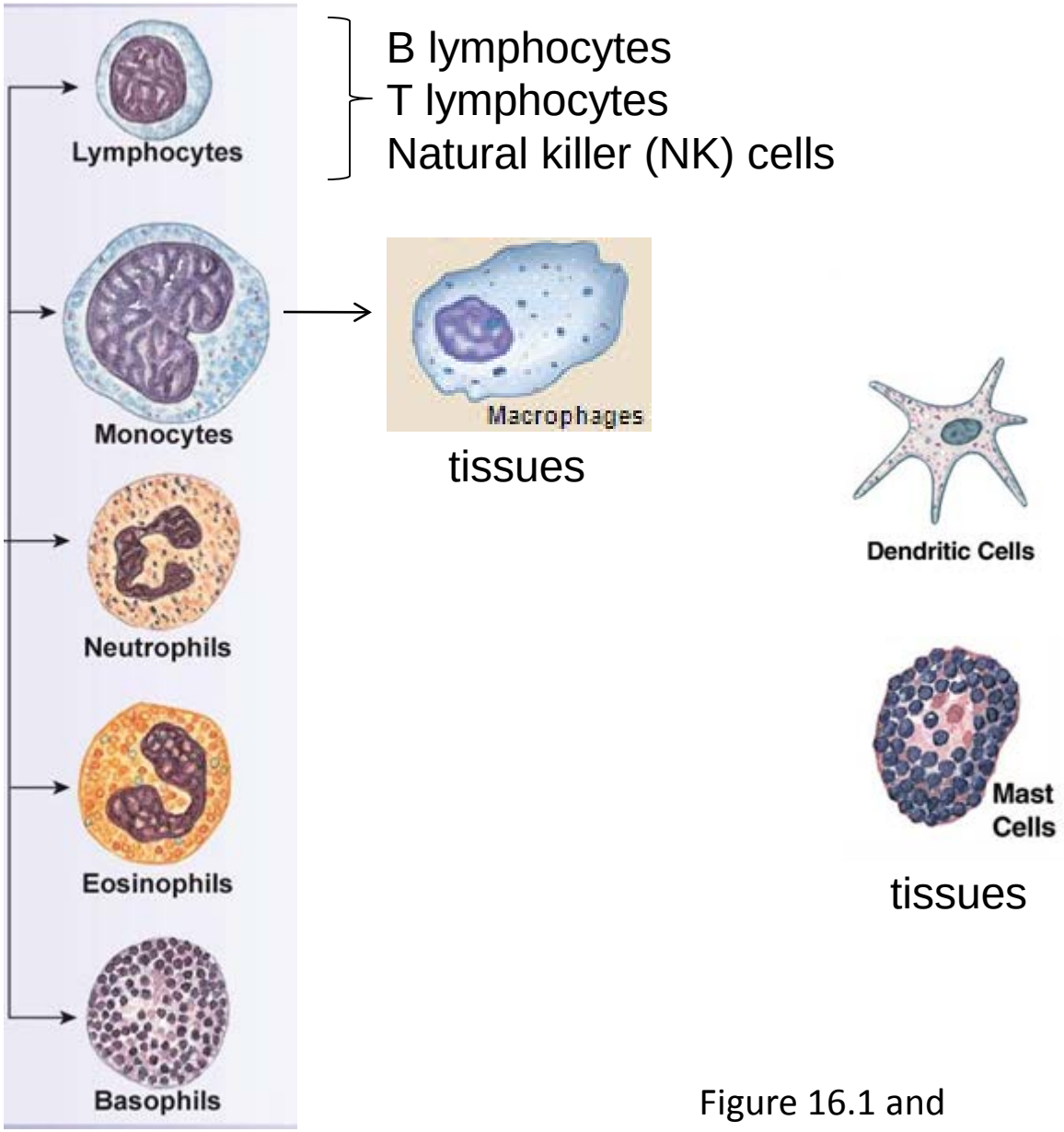


Figure 16.1 and
Figure 24.5

Three lines of defense

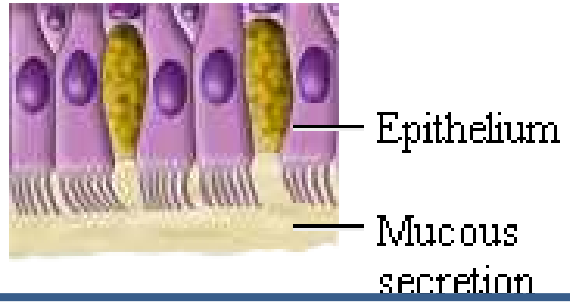
Body

Skin and mucous membranes

Castle

Castle walls and moat

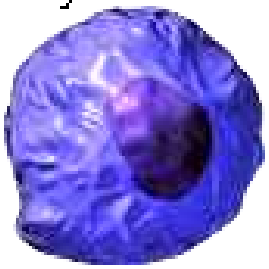
Physical Barriers



Innate Immunity

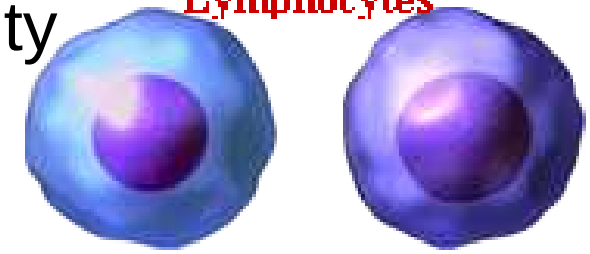
- rapid, non-specific

Cells and chemicals in body fluids



Acquired Immunity

Lymphocytes



T cells B cells

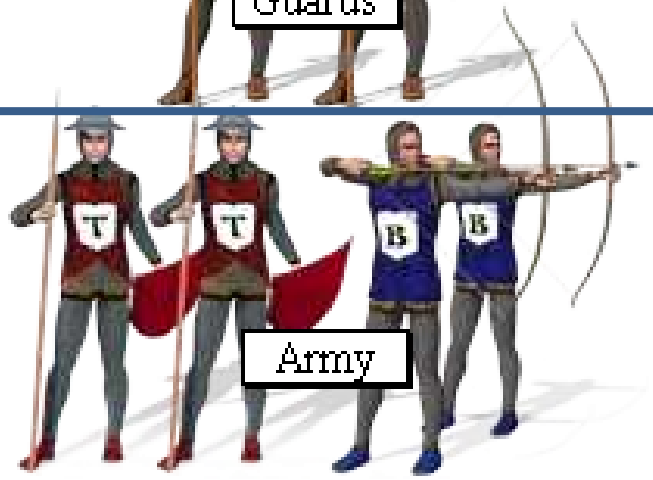
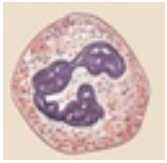


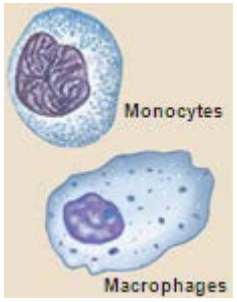
Figure from Interactive Physiology

How does the innate immune system work?

1) Phagocytes



neutrophils – 50-70% WBC, release cytokines (cause fever and inflammation)



macrophages
(dendritic cells)

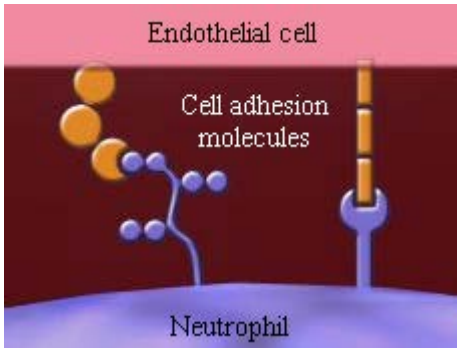
2) Natural killer (NK) cells

3) Antimicrobial proteins

4) Inflammation

5) Fever

1) Phagocytes



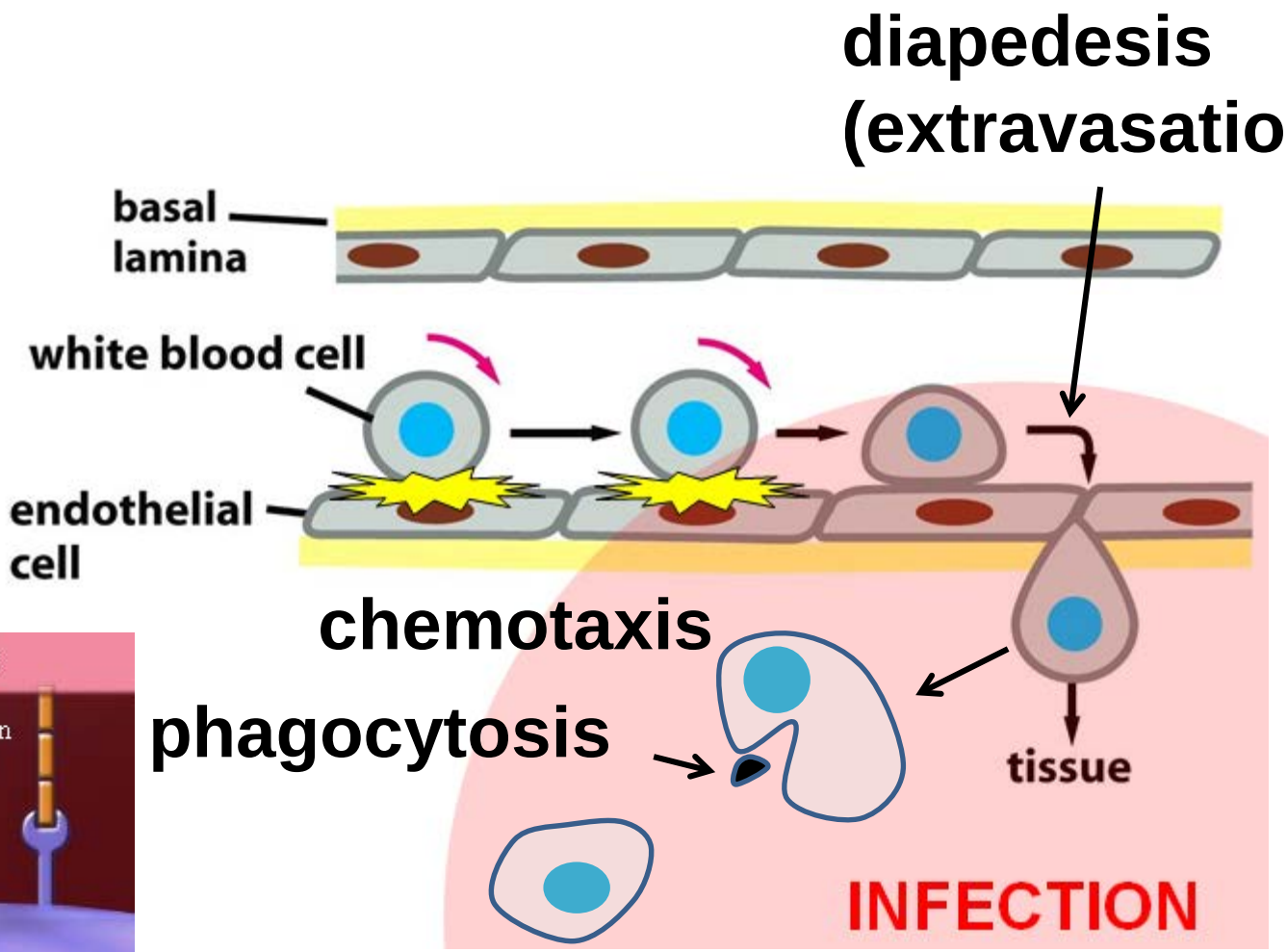


Figure modified from Molecular Biology of the Cell

chemotaxins = e.g. bacterial toxins, products of tissue injury, cytokines

Phagocytosis of pathogens

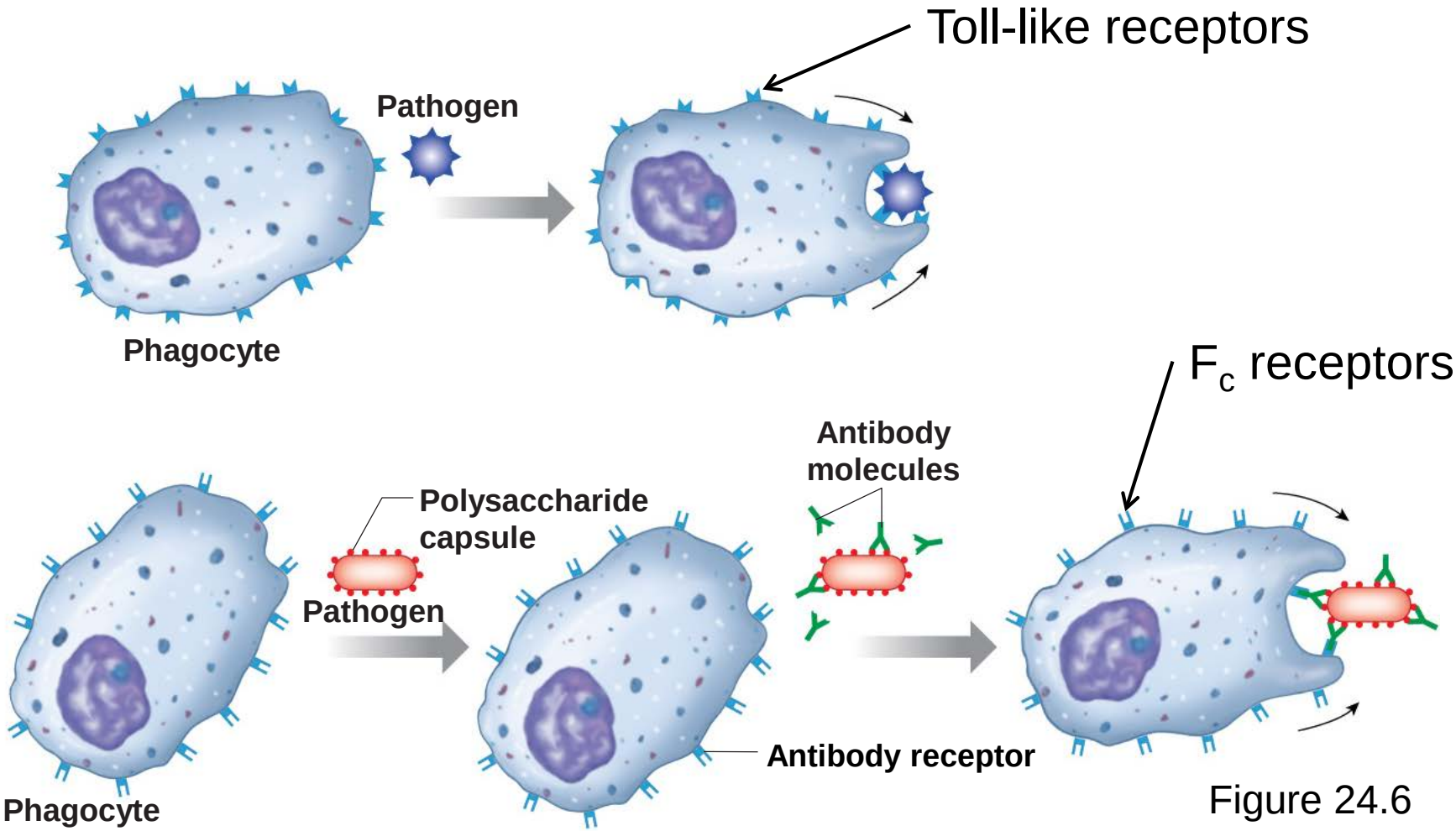


Figure 24.6

Antibody is an example of an opsonin

Coating substance with an opsonin = opsonization

Macrophages and dendritic cells display antigen fragments

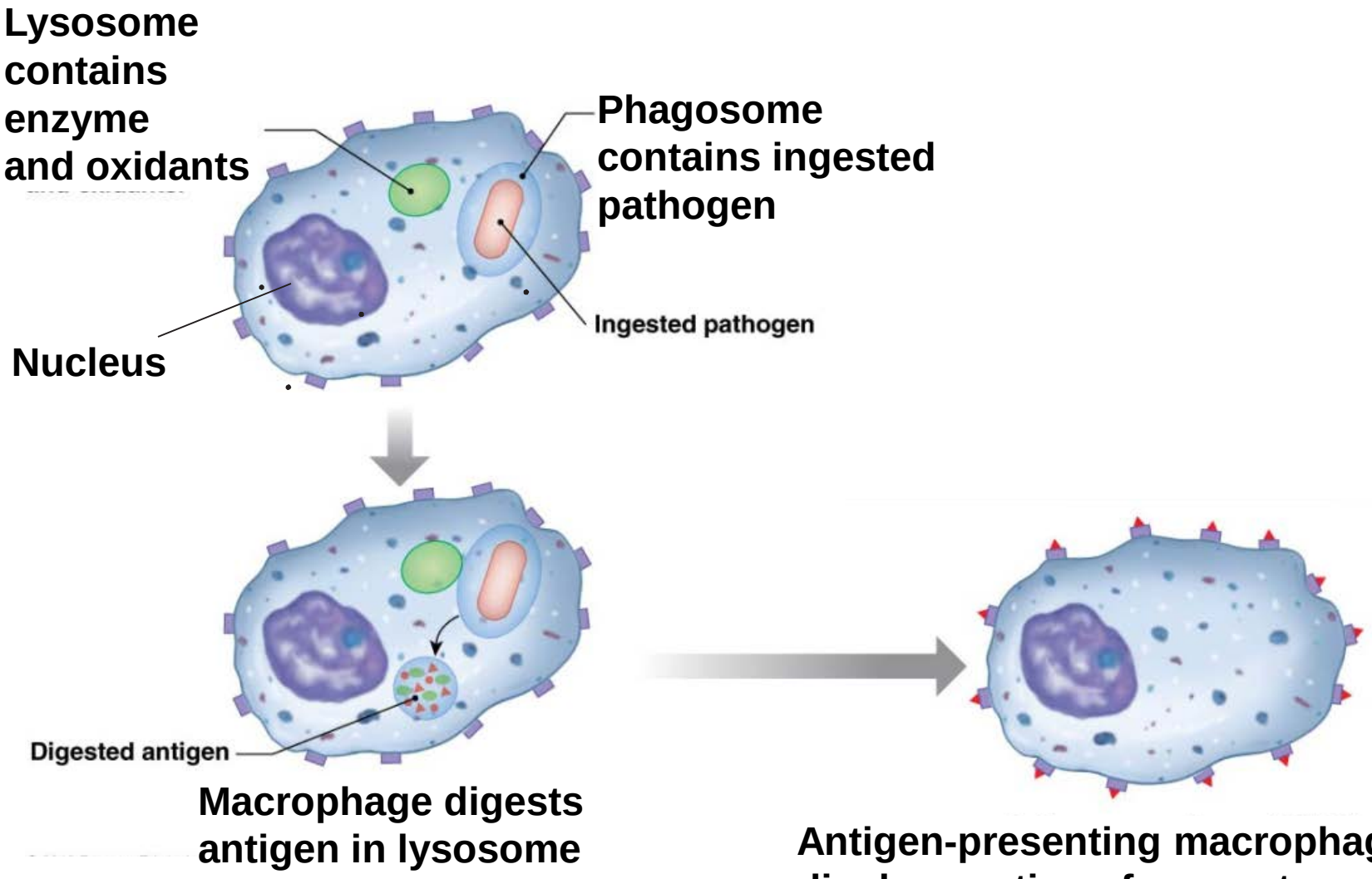


Figure 24.6

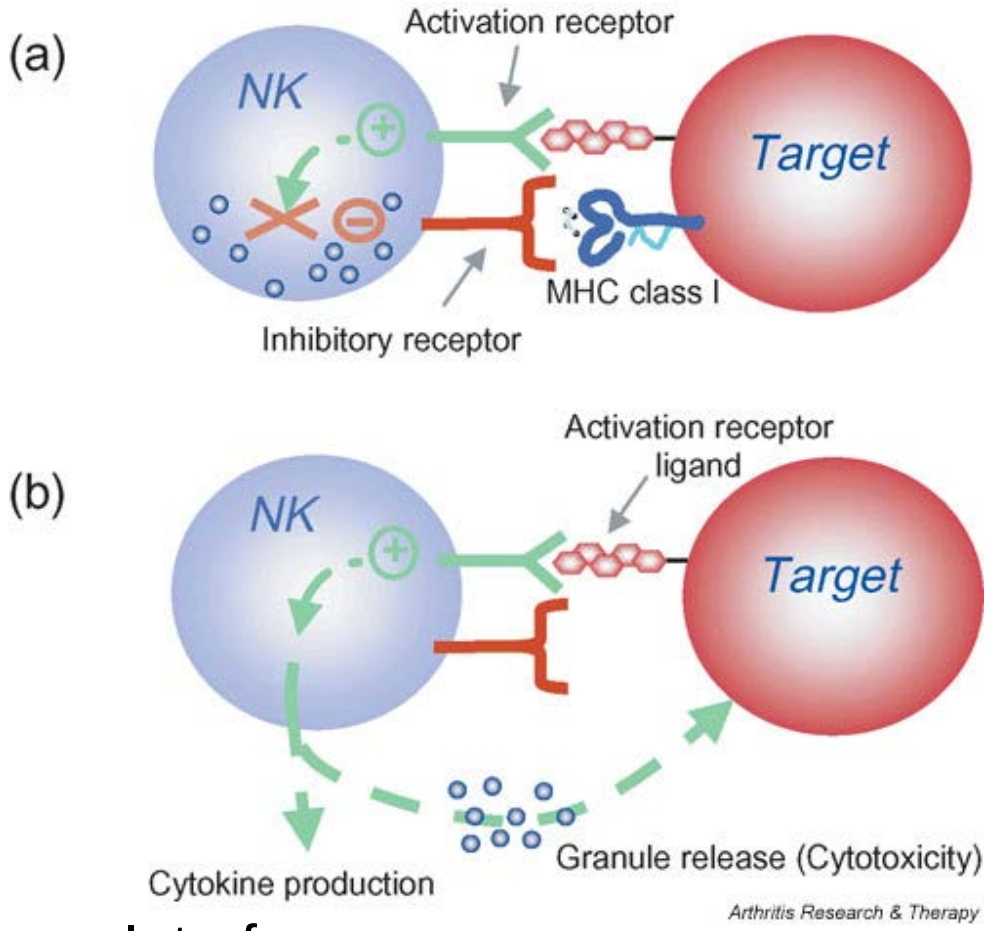
Review

1) What is the function of opsonins?

A) poison invading cells
B) mark pathogens for phagocytosis
C) digest invading cells
D) bind to neutrophils to decrease their activity

2) Natural killer (NK) cells

Kill cells when the cells are infected with a virus or cancerous



Normal cell

Virally-infected cell or cancerous cell
- MHC class I is down regulated makes the cell susceptible to killing by NK cells

Interferons

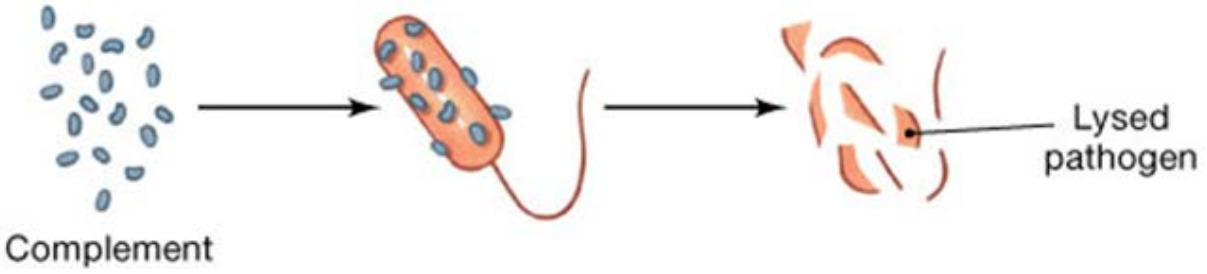
Fig. from: Arthritis Res Ther 2004 6:8

3) Antimicrobial proteins

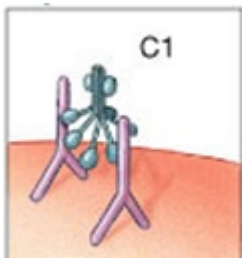
Interferon: α and β **–** prevent viral replication in cells
γ **–** activate macrophages and other immune cells

Complement:

~25 plasma proteins
Destroy target cell membranes
Stimulate inflammation
Attract phagocytes
Enhance phagocytosis



Complement



Classical Pathway
Antigen-antibody complex

Lectin Pathway
Microorganism's cell wall polysaccharide

Alternative Pathway
No inhibitors on microbe surface

C3

C3b

C3a

Opsonization

C3b

Causes inflammation

C5b

C5a

C6

C8

C7

C9

Membrane attack complex

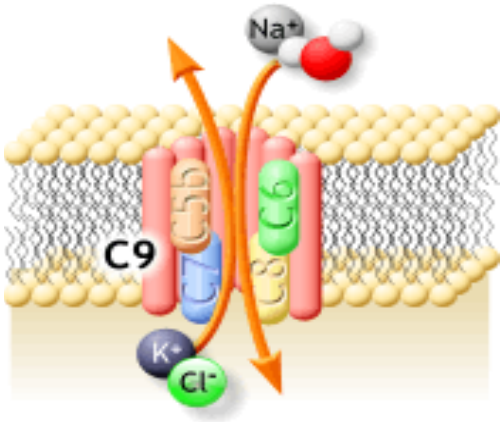


Figure modified from Interactive Physiology

Review

Which of the following is **NOT** a role for complement proteins?

A) Act as opsonins
B) Bind to antibody
C) Form part of the membrane attack complex
D) Activate apoptosis in host cells

4) Inflammation

Localized tissue response to injury producing

Swelling, redness, heat and pain

Roles

- Slowing the spread of pathogens
- Mobilization of local, regional, and systemic defenses
- Sets the stage for repair

Figure from Interactive Physiology

Inflammatory response

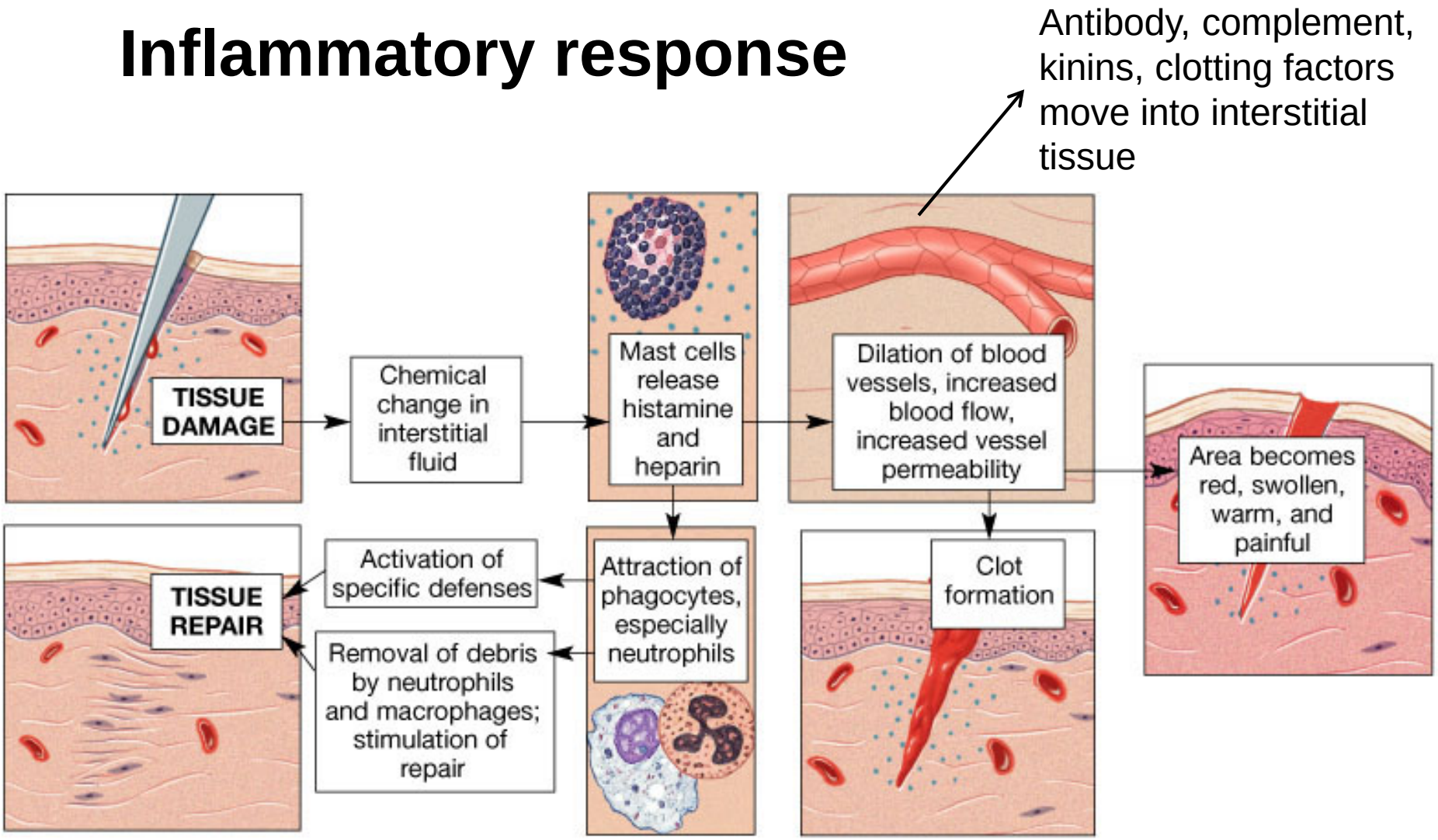


Figure from Martini (2006) *Fundamentals of Anatomy and Physiology*

Kinin cascade leads to formation of bradykinin – vasodilator and stimulates pain receptors

5) Fever

Body temperature > 37.2 C

Cause: Pyrogens change the thermoregulatory set point in the hypothalamus

Roles:

- Speeds up metabolic activity of host
- Inhibits some pathogens

Figure from Interactive Physiology

Pyrogens: e.g. bacterial components, interleukin-1 released from activated macrophages

Innate Immunity Summary

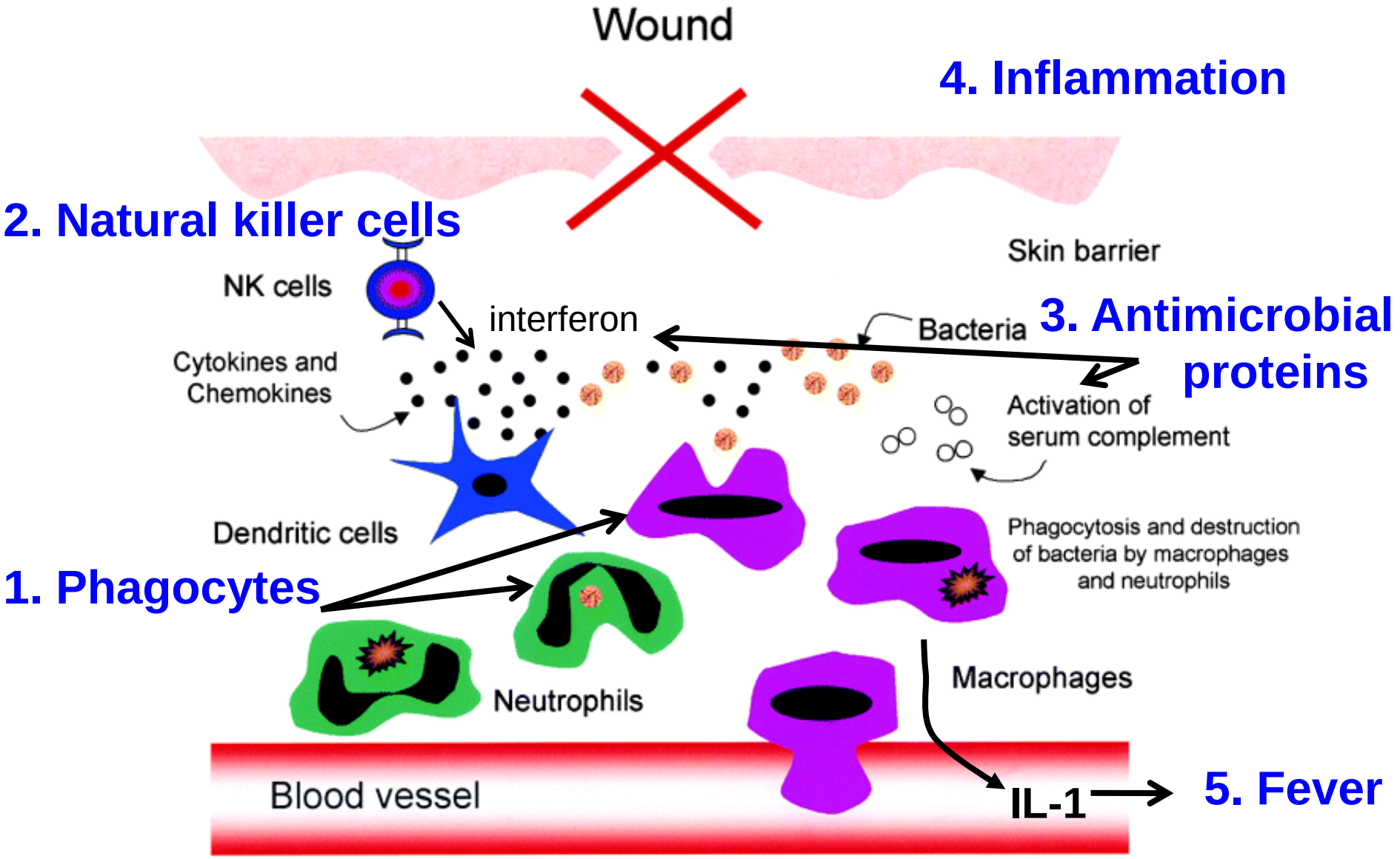


Figure from Rabb H (2002) Kidney International 61:1935–1946

Review

Robert acquires a condition in which his Fc receptors are not displayed on the plasma membrane of his macrophages, which process will be impaired?

A) Internalization of pathogens
B) Opsonization of pathogens
C) B cell activation
D) Destruction of internalized pathogens