

# General Biology 1

BIO1201 RM 1021

## Syllabus & Textbook:

<https://openlab.citytech.cuny.edu/oer-biology/lecture-schedule/>

**Lecturer:** Michael Gotesman, PhD

**Email:** mgotesman@citytech.cuny.edu

## Grade Breakdown:

**Lecture (60%)**

**Exams (4): 22.5% Each**

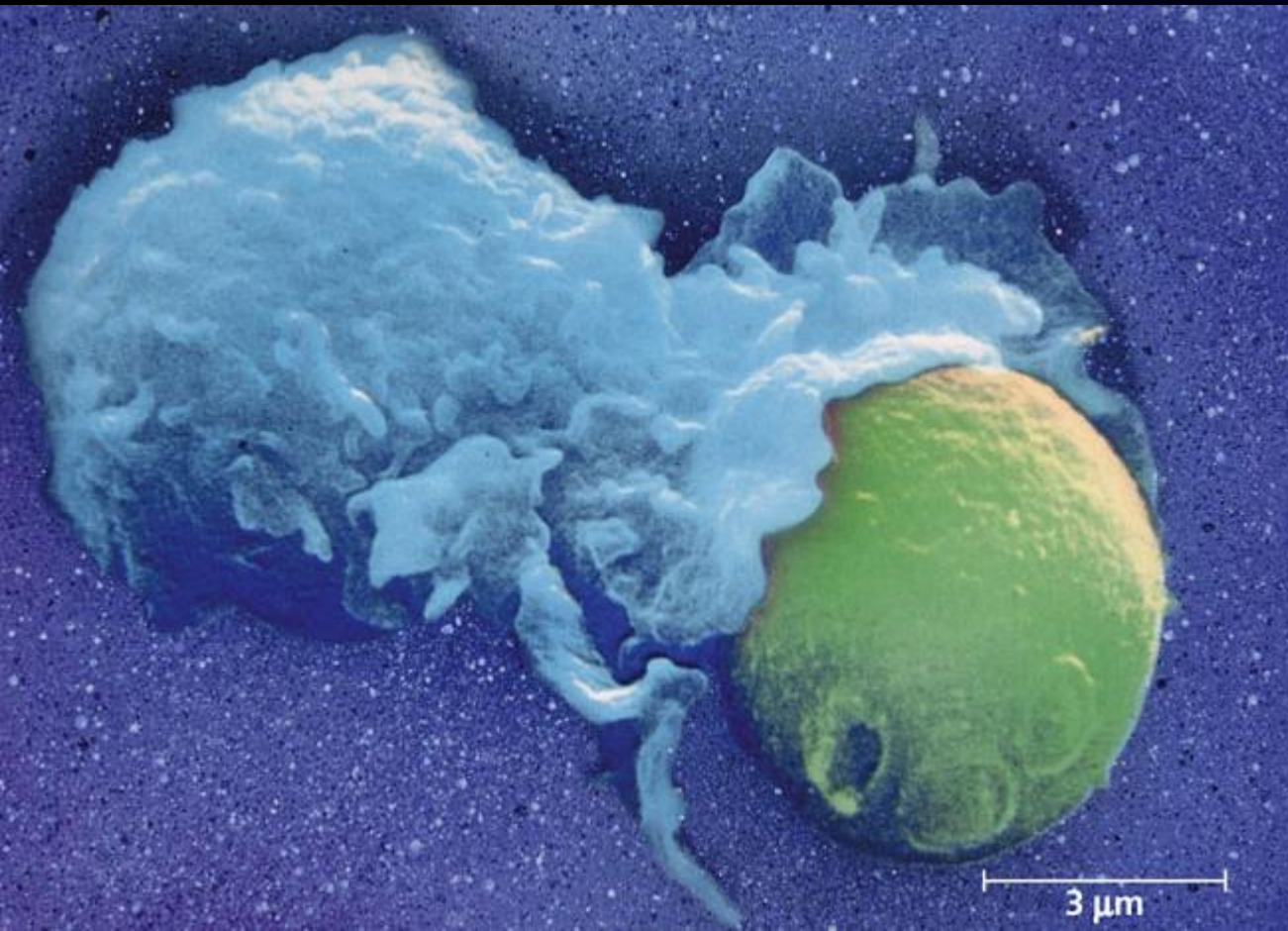
**Pop Quizzes (?): 10% Average**

**Lab (40%) – Lab Instructor**

<u>Letter Grade</u>	<u>Numerical Ranges</u>
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

# Lymph Transport & Immunity

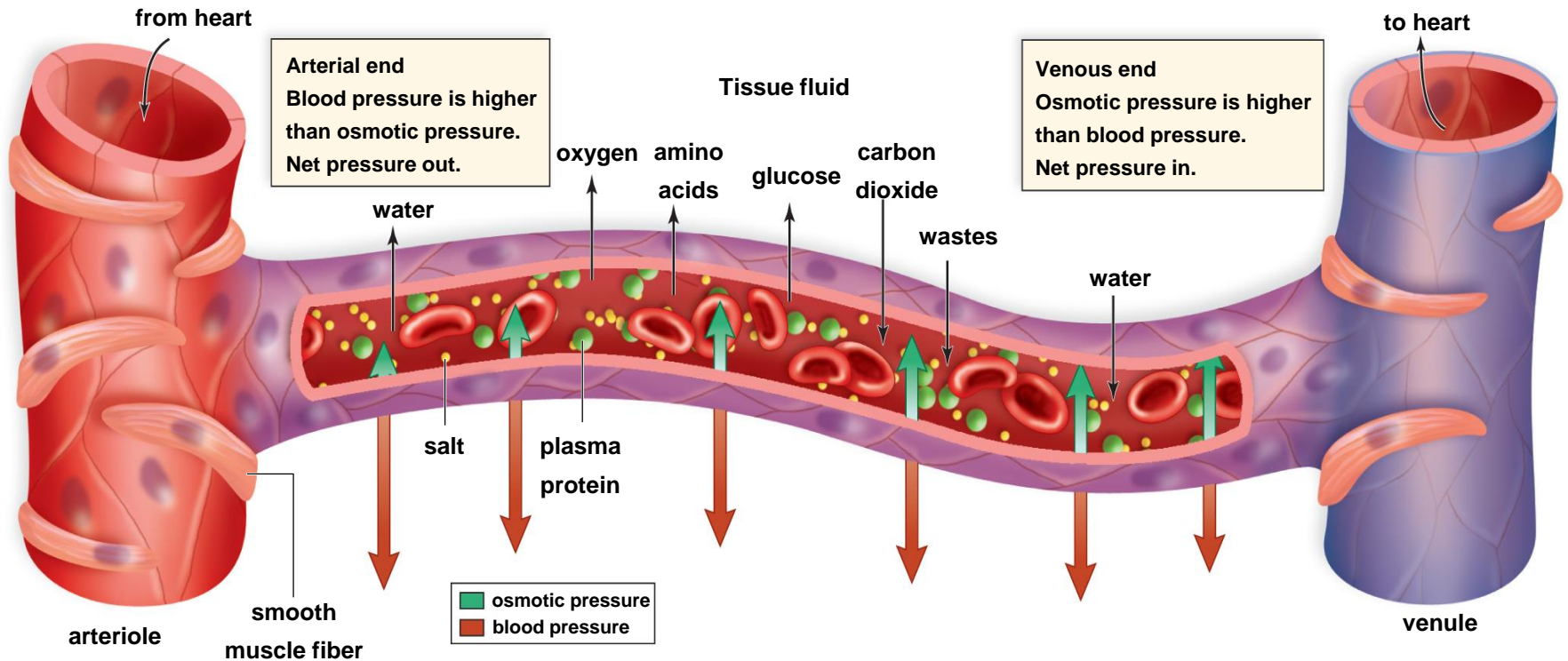
Chap 33: pp. 613-632



# The Lymphatic System

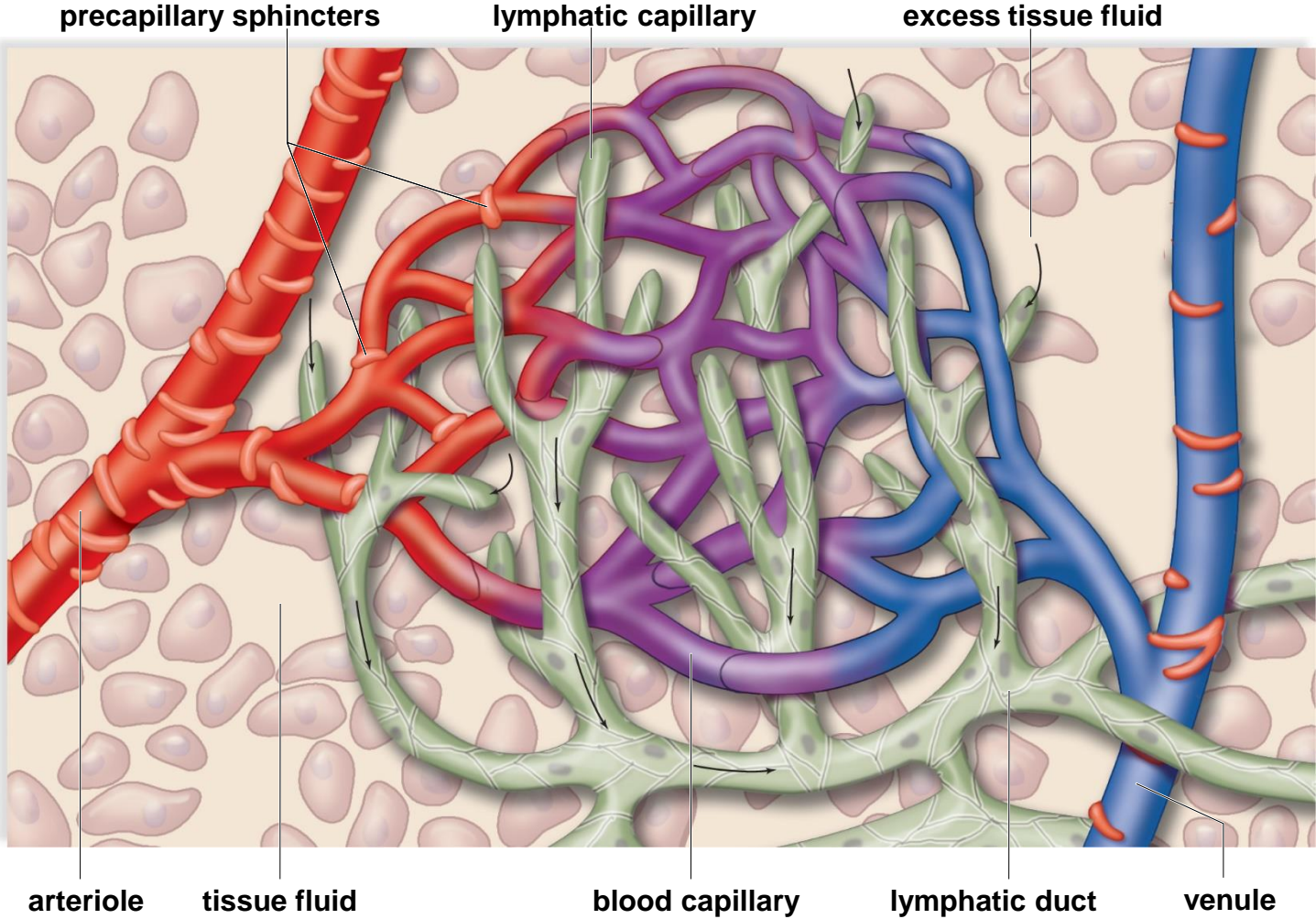
- Consists of lymphatic vessels and the lymphoid organs
  - Three main homeostatic functions:
    - Lymphatic capillaries take up and return excess fluid to the bloodstream
    - Lacteals receive lipoproteins and transport them to the bloodstream
    - Includes cells, tissues, and organs responsible for defending the body
- Lymphocytes resist infection and disease by responding to
  - Invading pathogens such as bacteria or viruses
  - Abnormal body cells such as cancer cells
  - 3 – Foreign proteins such as toxins

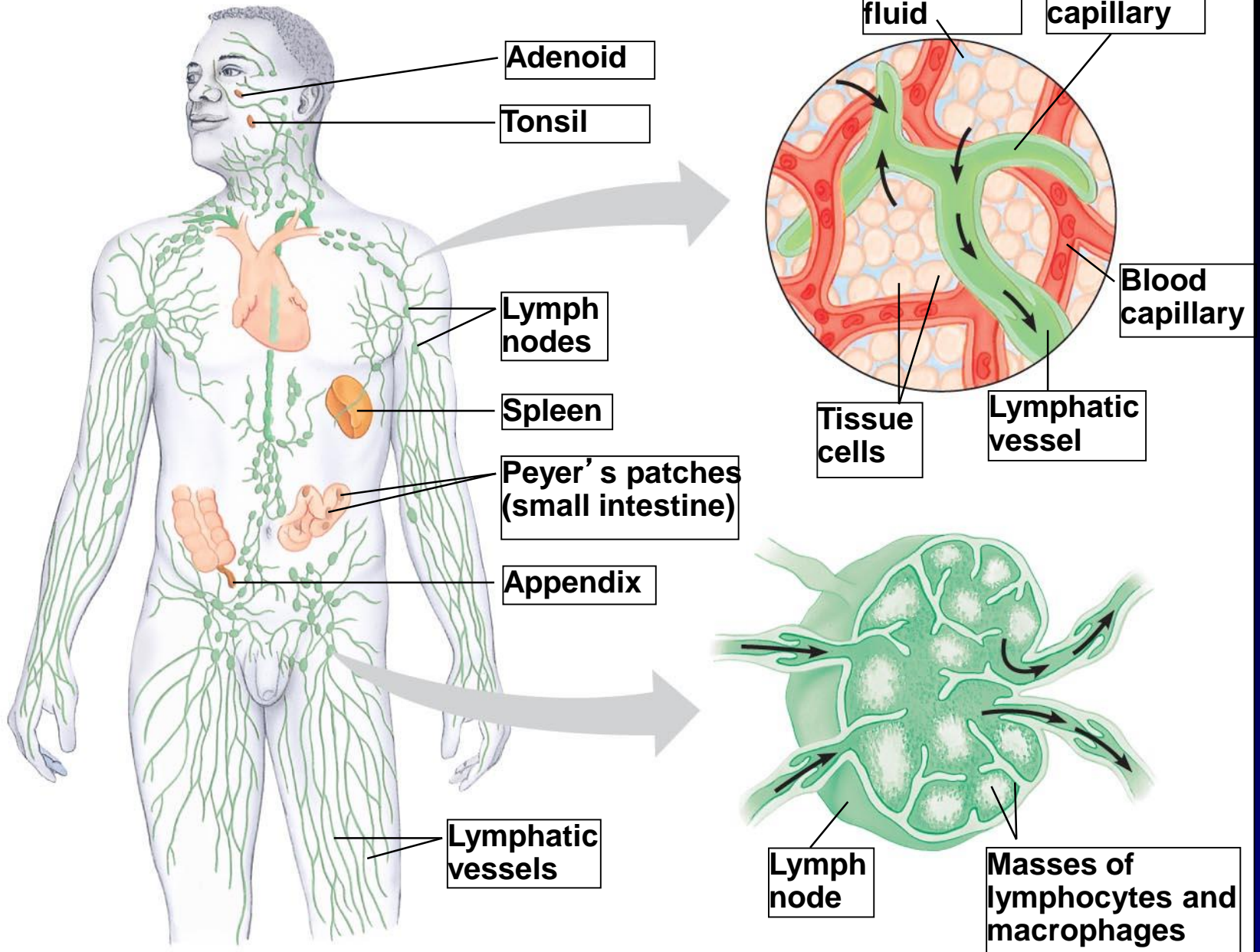
# Capillary Exchange





# Capillary Bed





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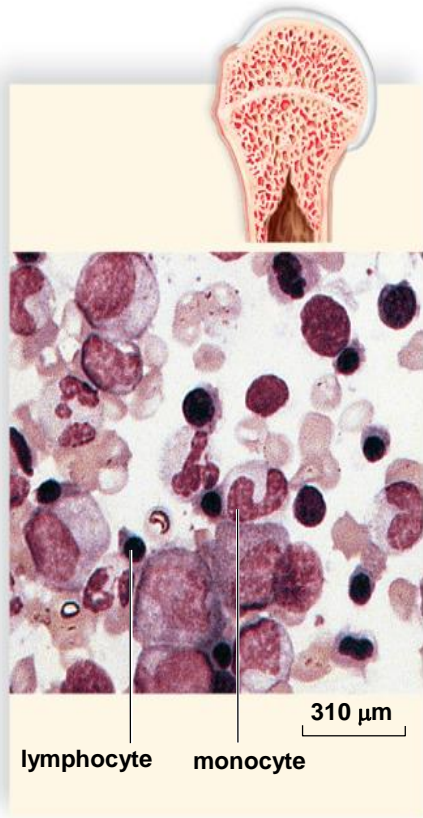
# The Lymphatic System

# Lymphatic System

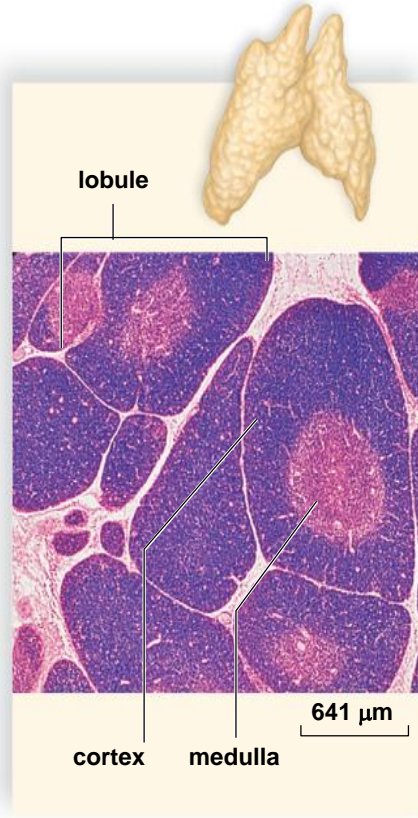
- One-way system that begins with lymphatic capillaries
  - Take up fluid that has been diffused from, and not reabsorbed by, blood capillaries
    - Edema - Localized swelling due to accumulation of tissue fluid
  - Lymph flows one way
    - From a capillary to ever-larger lymphatic vessels
    - Finally to a lymphatic duct, which enters a subclavian vein



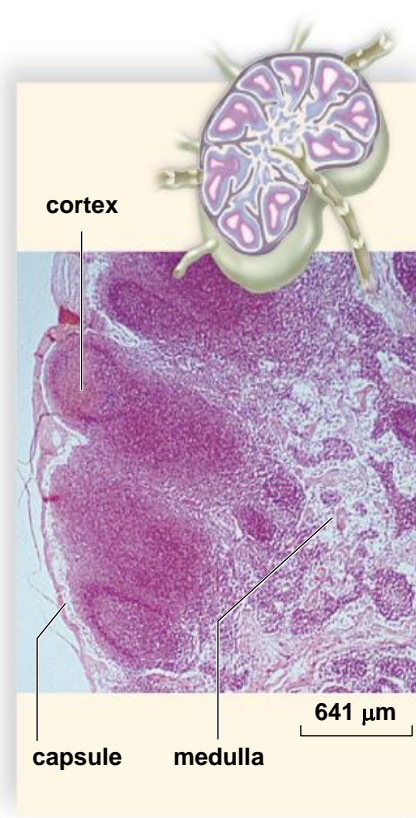
# The Lymphatic Organs



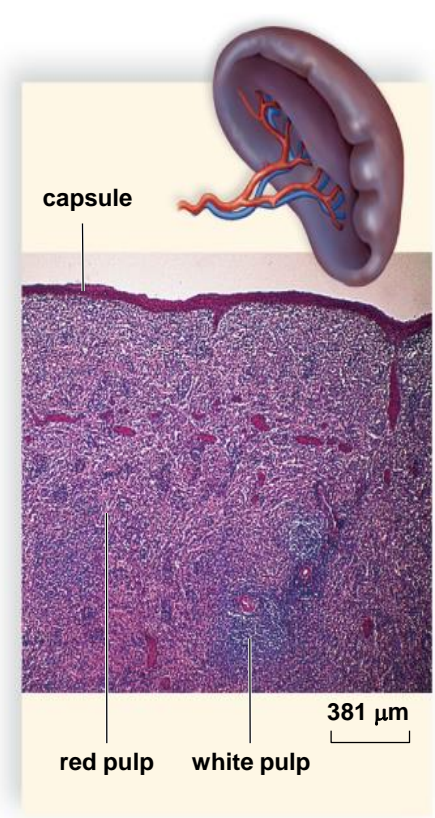
a. Red bone marrow



b. Thymus gland



c. Lymph node



d. Spleen

**C. Lymph Nodes** - Capsule surrounding two distinct regions, **cortex** and **medulla**



# Lymphoid Organs

- **Lymph Nodes** - Capsule surrounding two distinct regions, cortex and medulla
  - Lymphocytes congregate in cortex when fighting off a pathogen
  - Macrophages concentrated in medulla - cleanse lymph
  - Lymph nodes named for their location
- **Tonsils**
  - Patches of lymphatic tissue located around the pharynx
  - First to encounter pathogens that enter via the nose and mouth

# Lymphoid Organs

- **Thymus Gland**

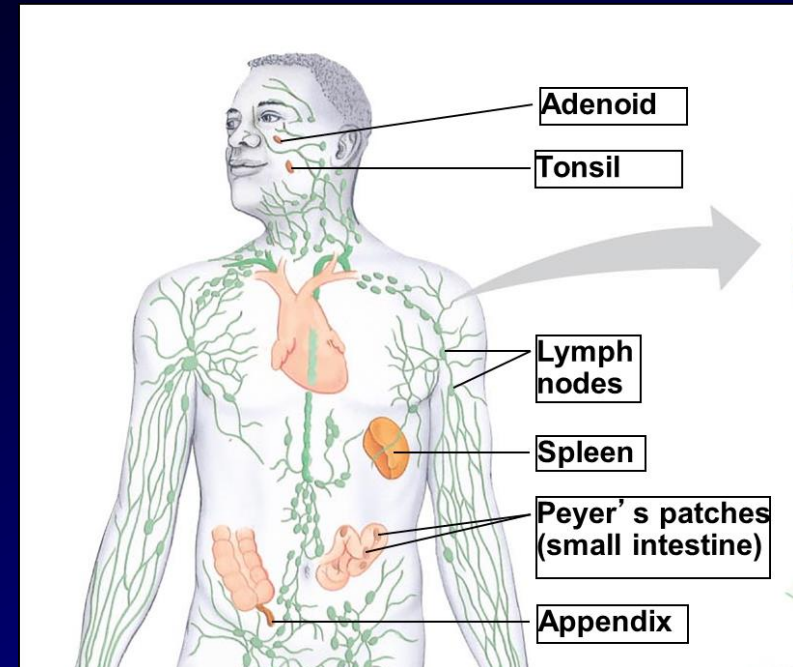
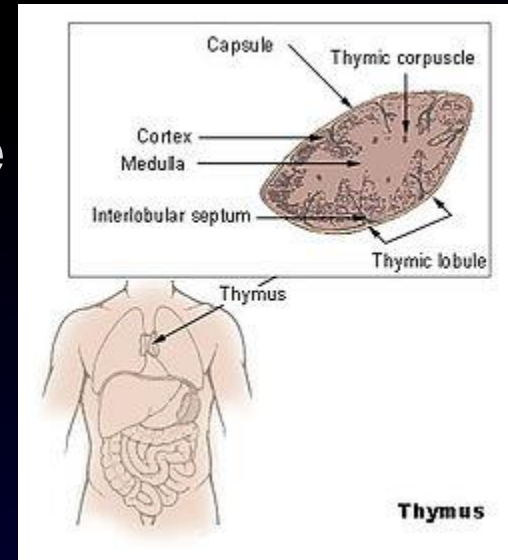
- Located along trachea behind the sternum in upper thoracic cavity
- Produces thymic hormones

- **Spleen**

- Located in upper left region of abdominal cavity just beneath diaphragm
- Cleanses blood

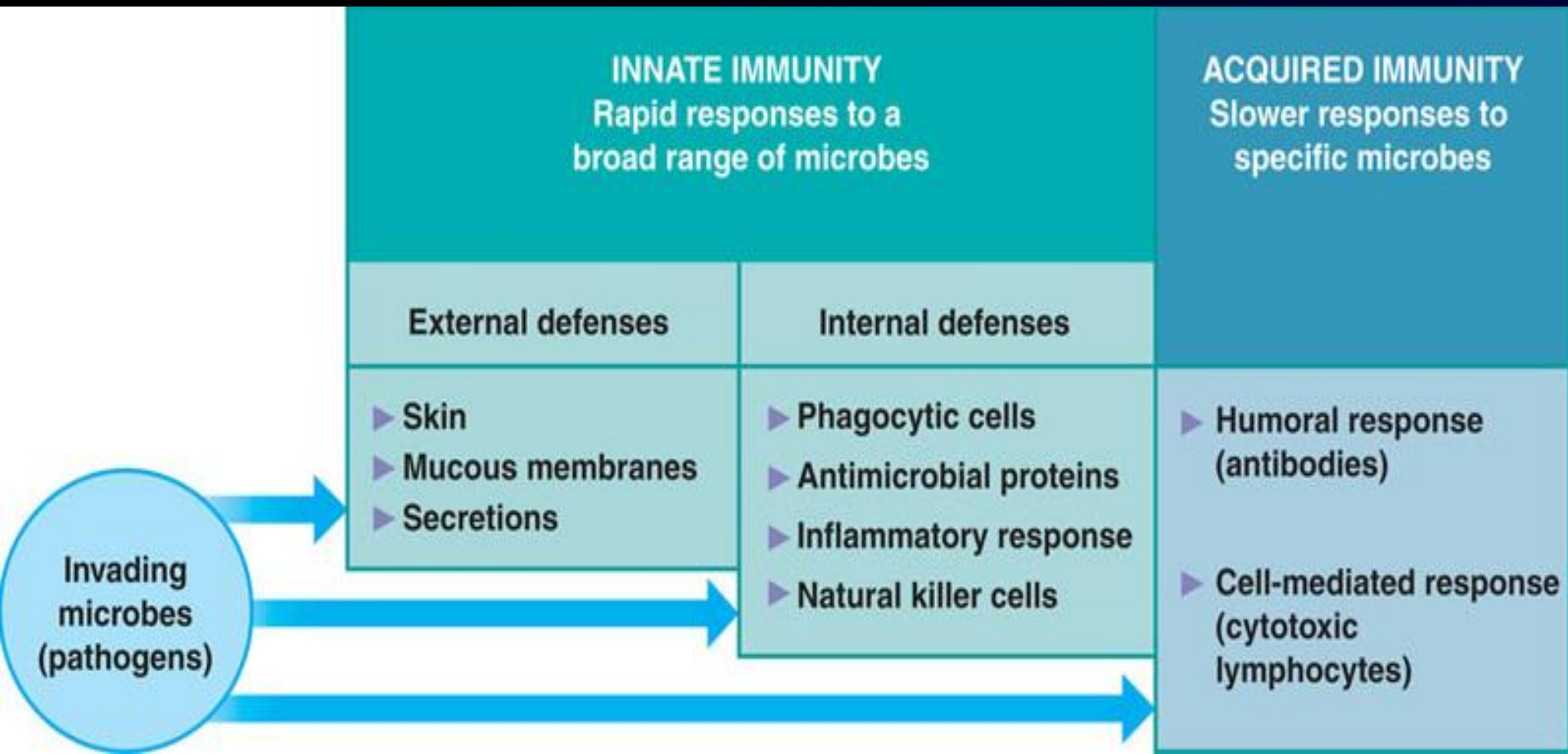
- **Red Bone Marrow**

- Origin for all types of blood cells
- Area of maturation for most white blood cells



# The Immune System

- ◆ An animal must defend itself from the many dangerous pathogens it may encounter
- ◆ Two major kinds of defense have evolved: innate immunity (non specific) and acquired immunity (specific)

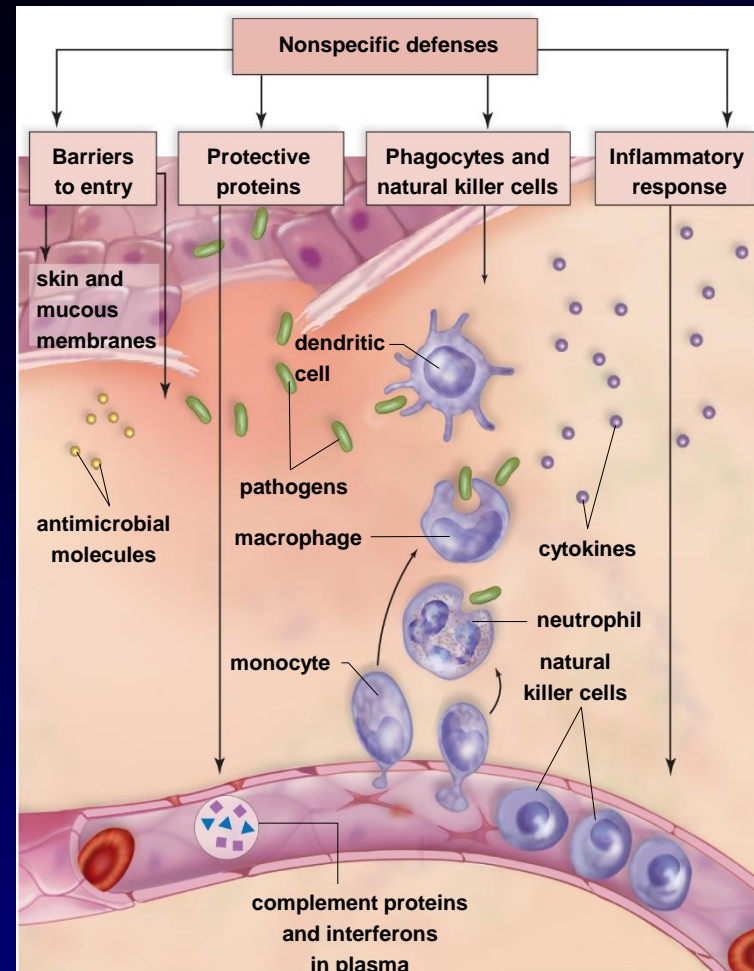




# Immune System

- **Nonspecific Defenses**
  - Do not distinguish one type of threat from another
  - broad, QUICK
  - Immunity begins with non specific defenses
  - 7 types:
    - Physical barriers
    - Inflammation
    - Complement system
    - Fever
    - Phagocytes
    - Immunological surveillance
    - Interferons (cytokines)

Overview of Nonspecific Defenses



# Nonspecific Defenses

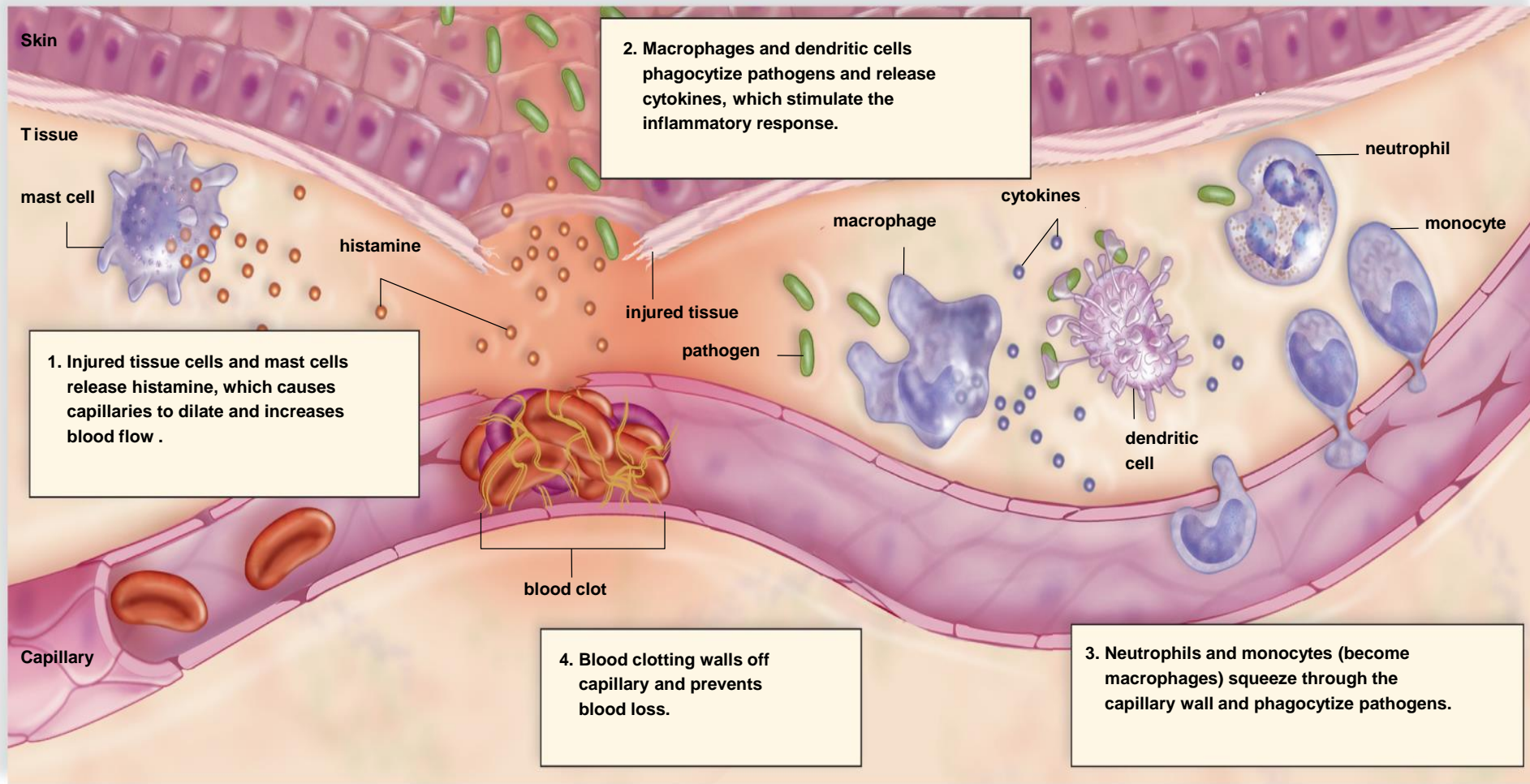
- **Physical barriers** serve as mechanical barriers
  - Includes hair, epithelia, secretions of integumentary and digestive systems
    - Mucous membranes lining respiratory, digestive, and urinary tracts

In the trachea, ciliated epithelial cells sweep mucus and any entrapped microbes upward, preventing microbes from entering the lungs





# Inflammatory Response





# Nonspecific Defenses

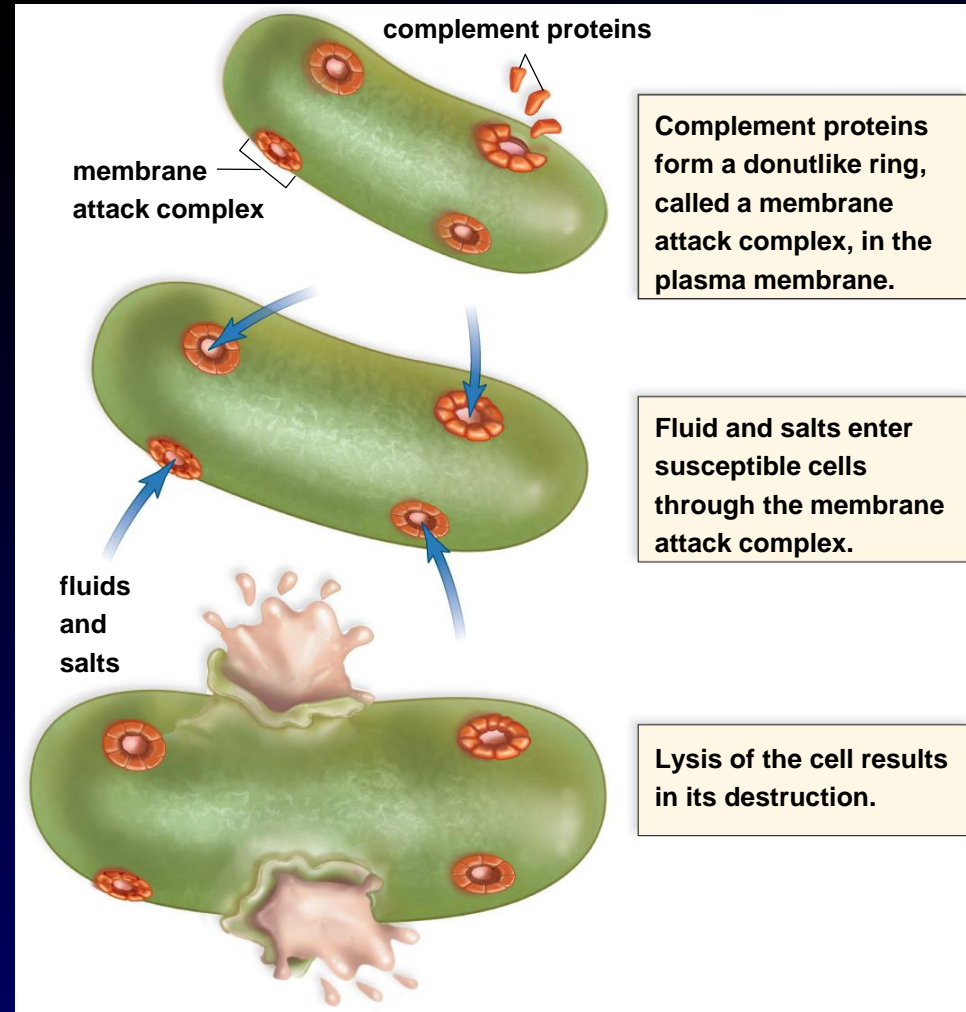
## • Complement System

– A collection of plasma proteins

- Activated when pathogens enter the body
- Complements certain immune responses

– Interferon binds to receptors of non-infected cells

- Causes them to prepare for possible attack
- Produce substances that interfere with viral replication



# Nonspecific Defenses

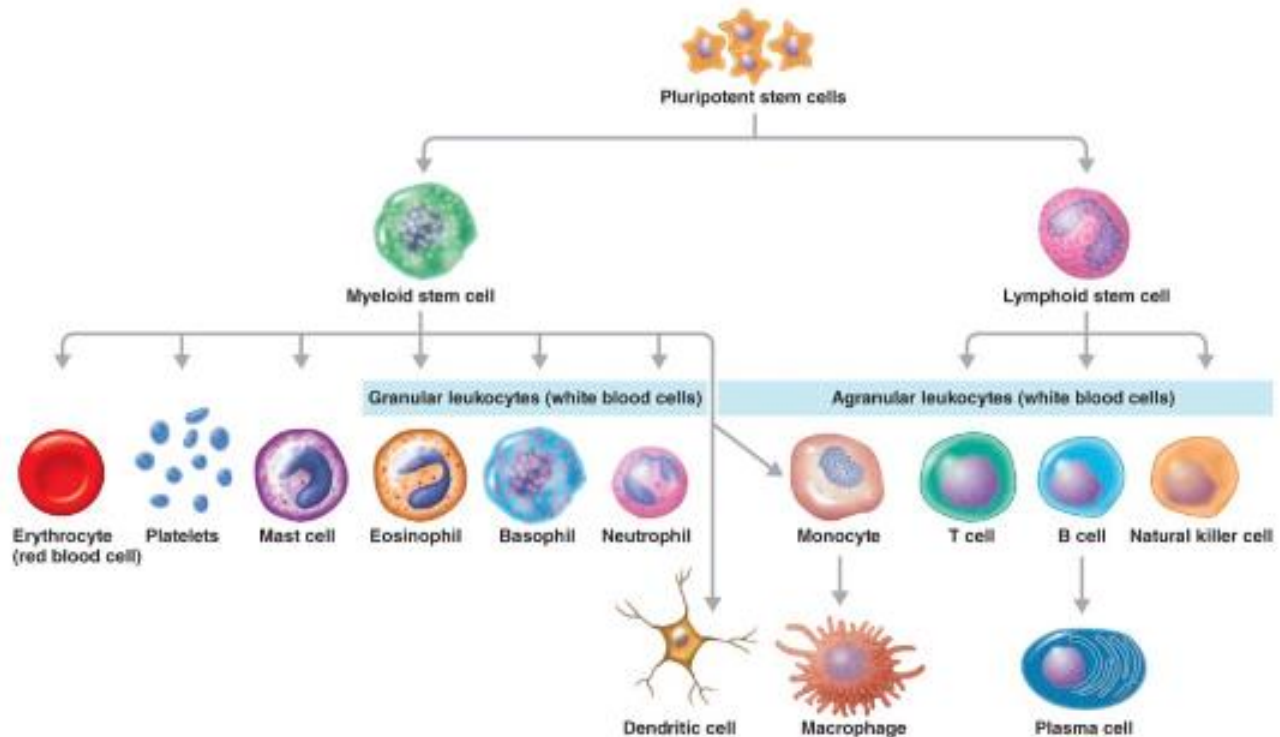
- **Fever**

- Maintenance of a body temperature above 37.2°C (99°F)
- Pyrogens reset the hypothalamic thermostat and raise body temperature.
  - Pathogens, toxins, antigen-antibody complexes can act as pyrogens
- In some instances, a fever may be beneficial.
  - Body's way of informing us that something is wrong.
  - It could be part of our first line of defense.
    - Can contribute an unfavorable environment for the invader.

# 8.3 Second Line of Defense: Innate Immune System

## Immune Cells

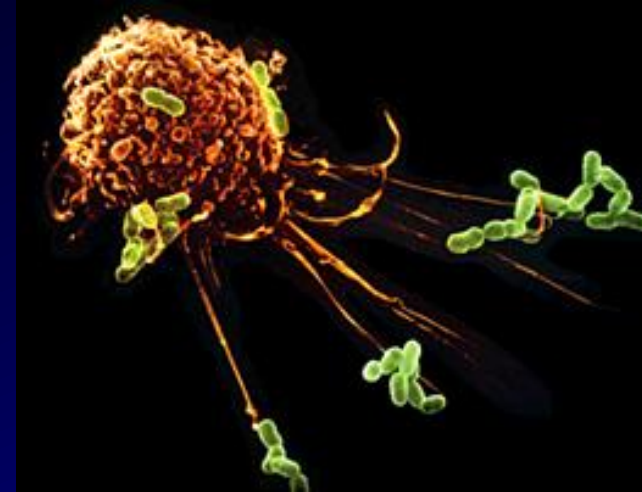
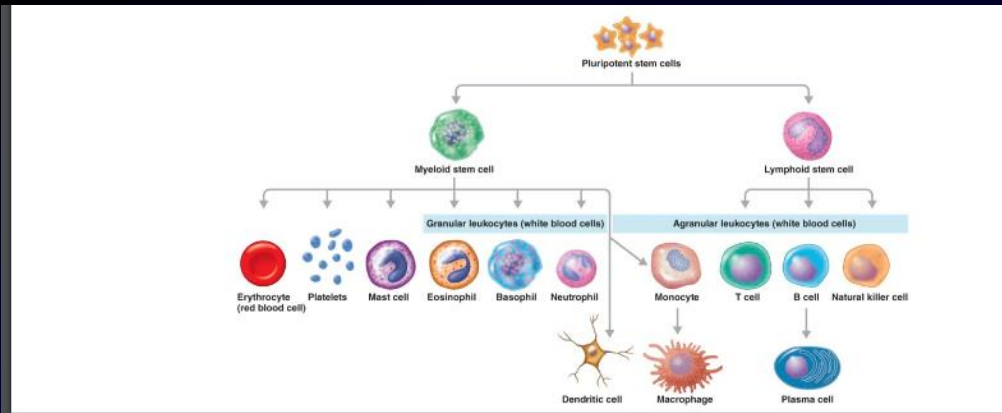
- Cells and cell fragments suspended in plasma
  - **Erythrocytes (red blood cells)**
  - **Leukocytes (white blood cells)**
  - **Platelets**
- Created in red bone marrow stem cells via **hematopoiesis**





# Nonspecific Defenses

- **Phagocytes and Natural Killer (NK) Cells**
  - Recognition of unusual surface proteins
  - Rotation of the Golgi toward the target cell and production of perforins
  - Release of perforins by exocytosis
  - Interaction of perforins causing cell lysis



- **Interferons (cytokines)**
  - Small proteins released by virally infected cells
  - Trigger the production of antiviral proteins

# Questions

The skin acts as a barrier to microbial invasion because

- A. the dead skin cells contain bacterial nutrients.
- B. the surface of the skin is covered with antibodies
- C. secretions from sweat glands and sebaceous glands inhibit bacterial growth.
- D. All of the above are true

Chronic smokers are more susceptible to illness than non-smokers. Which of the following effects of chronic exposure to cigarette smoke could account for this?

- A. Increased mucus production in the respiratory tract decreases flow of oxygen to the lungs.
- B. Toxins in cigarette smoke impair white blood cell function.
- C. Toxins such as nicotine cause paralysis of cilia in the respiratory tract.
- D. B and C

# Adaptive (or “acquired”) Immunity

- **Specific** for a certain invader! Takes at least 5-7 days.
- Two types:
  - Humoral Response – production of Antibodies (Ab) by B-lymphocytes
  - Cell-mediated - Cytotoxic T-lymphocytes (CTL’ s or killer T cells)
- **An antigen** is any foreign substance that stimulates the immune system to react
  - Lymphocytes capable of recognizing antigens
  - Have antigen receptors on plasma membrane
  - Protein’ s shape allow it to combine with a specific antigen



# Specific Defenses

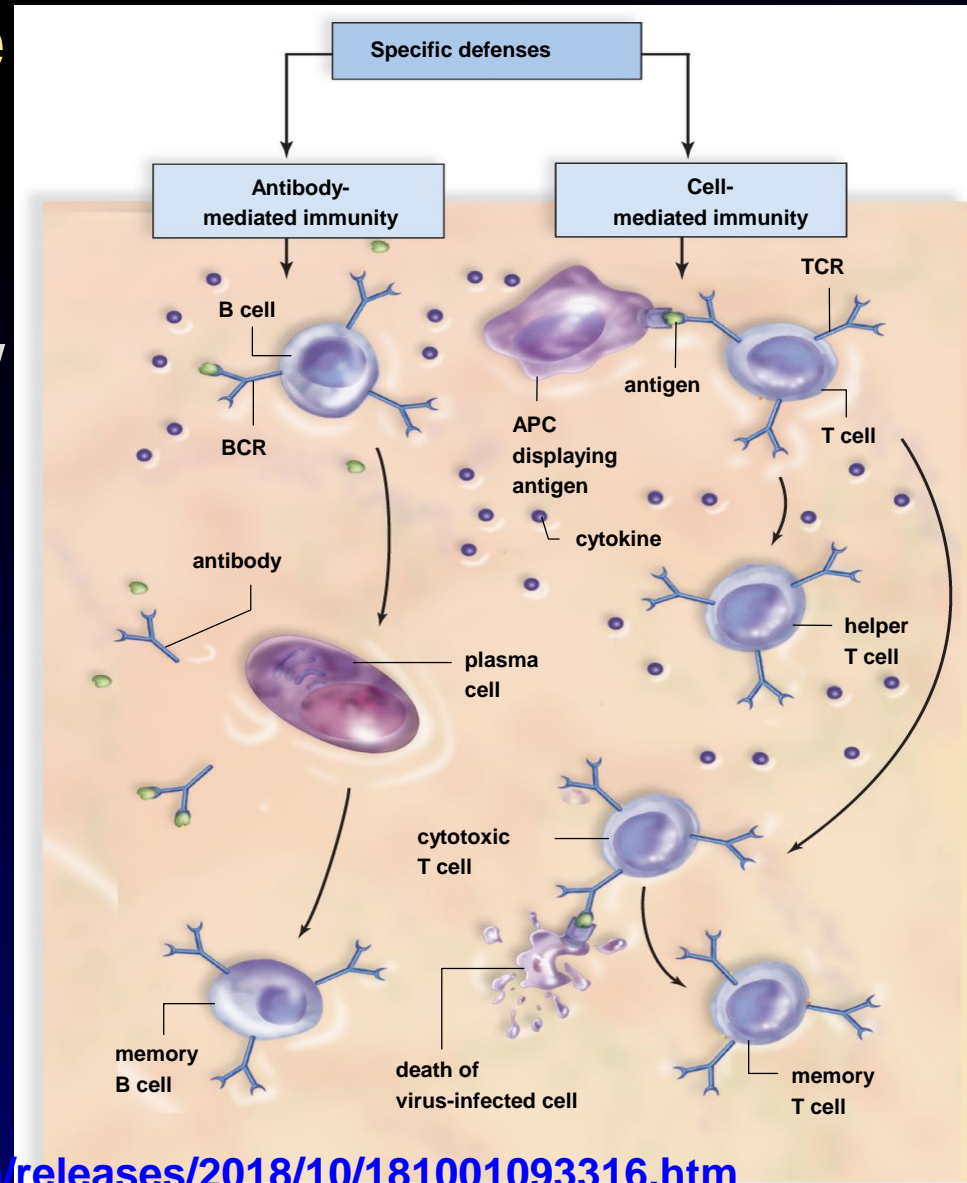
- Immunity primarily the result of

- B lymphocytes

- Mature in Bone Marrow
- B cells give rise to plasma cells
- Produce antibodies

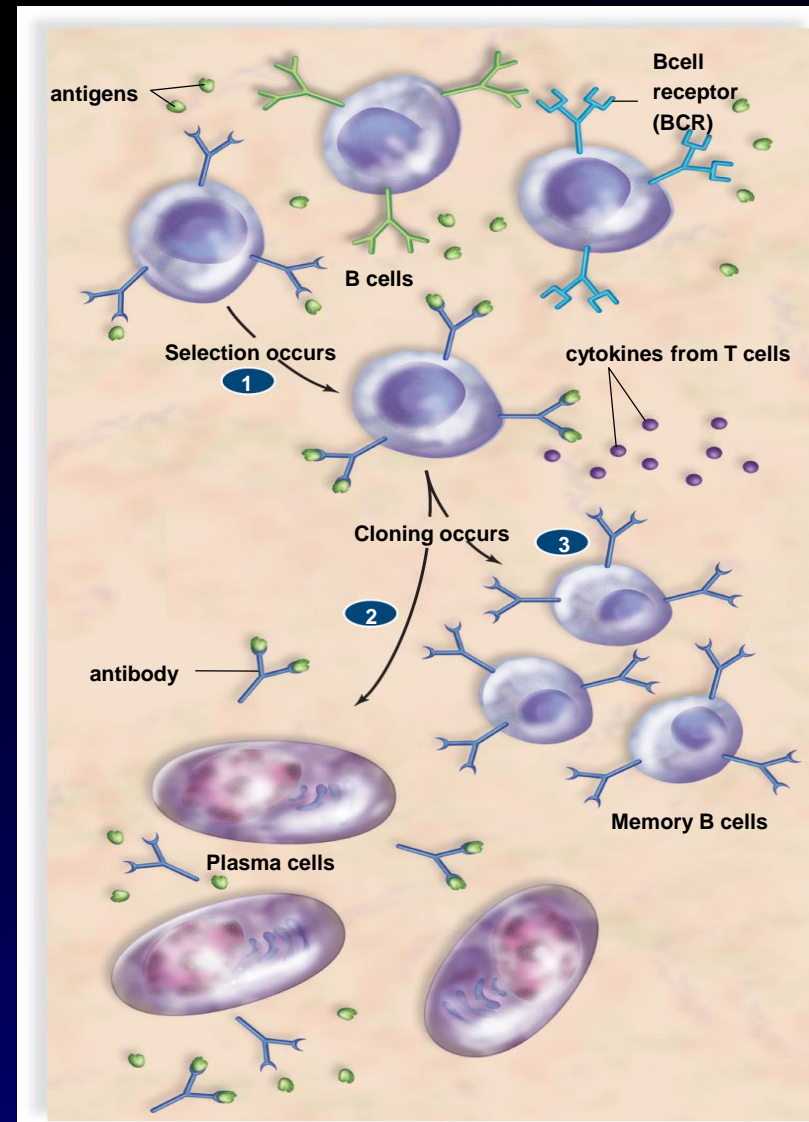
- T lymphocytes

- Mature in Thymus
- T cells directly attack cells that bear non-self proteins



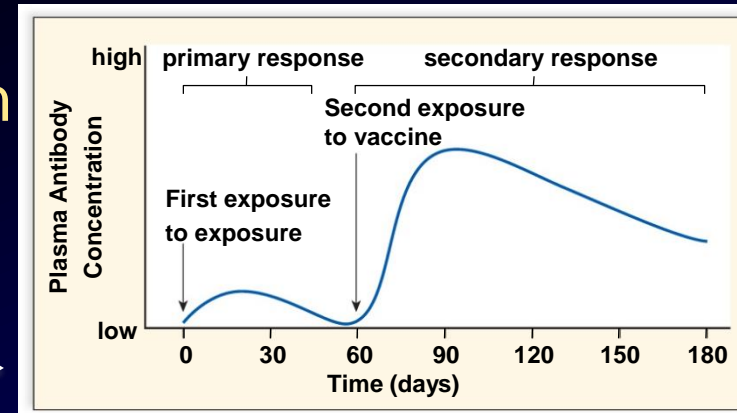
# Antibody-Mediated Immunity

- **Clonal selection theory:**
  - The antigen selects which lymphocyte will
    - Undergo clonal expansion, and
    - Produce more lymphocytes
  - If the same antigen enters the system again
    - Memory B cells quickly divide
    - Give rise to more lymphocytes capable of quickly producing adequate antibodies



# Forms of Immunity

- **Innate immunity**
  - Genetically determined
  - Present at birth
- **Acquired immunity**
  - Not present at birth
  - Achieved by exposure to antigen
    - **Active immunity**
      - **Immunizations/Vaccinations**
    - **Passive immunity**
      - Occurs when an individual is given prepared antibodies (immunoglobins) to combat a disease
      - Short-lived
      - Newborns often passively immune due to mother's blood



updated 10:40 PM EDT 09.11.14

## Ebola survivor donates blood to American

By Jen Christensen, CNN



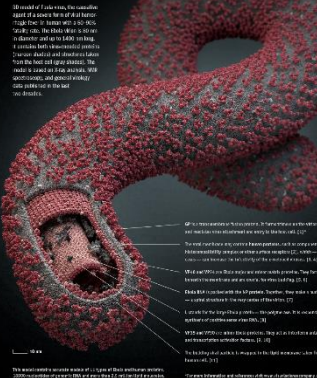
(CNN) - Dr. Rick Sacra and Dr. Kent Brantly were both infected with Ebola while working in Liberia with the aid organization Serving in Mission. Both were evacuated back to the United States for care.

But the two doctors also have another thing in common: They have the same blood type.

That little fact could be life-saving for Sacra. Brantly, who tested negative for the deadly virus after several weeks of treatment, recently flew to Nebraska where Sacra is in isolation and donated his blood.

Doctors treated Sacra with this plasma on at least two occasions. Doctors believe Brantly has antibodies that Sacra lacks, but his immune system needs to help him fight the deadly virus.

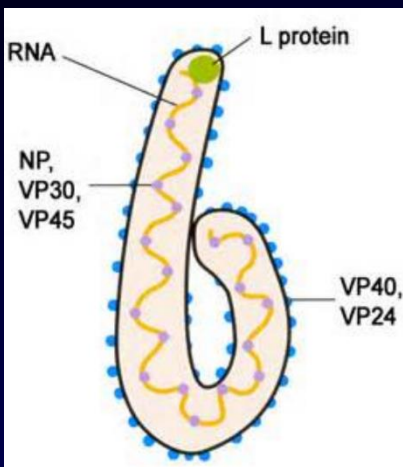
## The Ebola Virus



This illustration shows a single Ebola virus particle. The outer layer is a lipid bilayer envelope, which is studded with glycoprotein spikes. The inner core is a nucleocapsid, which consists of a single strand of RNA associated with nucleoproteins.

# Why would anyone want blood from an Ebola survivor?

EBOV carries a **negative-sense** RNA genome in virions that are cylindrical/tubular, and contain **viral envelope**, matrix, and nucleocapsid components. The overall cylinders are generally approx. 80 nm in diameter, and having a virally encoded glycoprotein (GP) projecting as 7-10 nm long spikes from its lipid bilayer surface.<sup>[6]</sup> The cylinders are of variable length, typically 800 nm, but sometimes up to 1000 nm long. The outer **viral envelope** of the virion is derived by budding from domains of host cell membrane into which the GP spikes have been inserted during their biosynthesis.<sup>[citation needed]</sup> Individual GP molecules appear with spacings of about 10 nm.<sup>[citation needed]</sup> Viral proteins VP40 and VP24 are located between



updated 10:48 AM EDT 09.19.14

## Ebola blood sold on black market

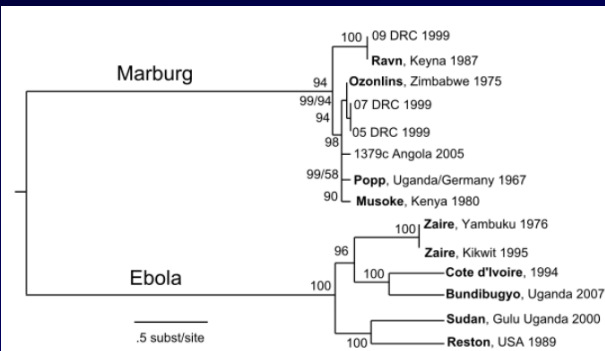
By Faith Karimi, CNN



(CNN) - As hospitals in nations hardest hit by Ebola struggle to keep up, desperate patients are turning to the black market to buy blood from survivors of the virus, the World Health Organization warned.

The deadliest Ebola outbreak in history has killed at least 2,400 people in Guinea, Liberia and Sierra Leone -- the countries most affected by the virus.

Blood from survivors, referred to as convalescent serum, is said to have antibodies that can fight the deadly virus. Though the treatment is unproven, it has provided some promise for those fighting a disease that's killing more than half of those it has infected.



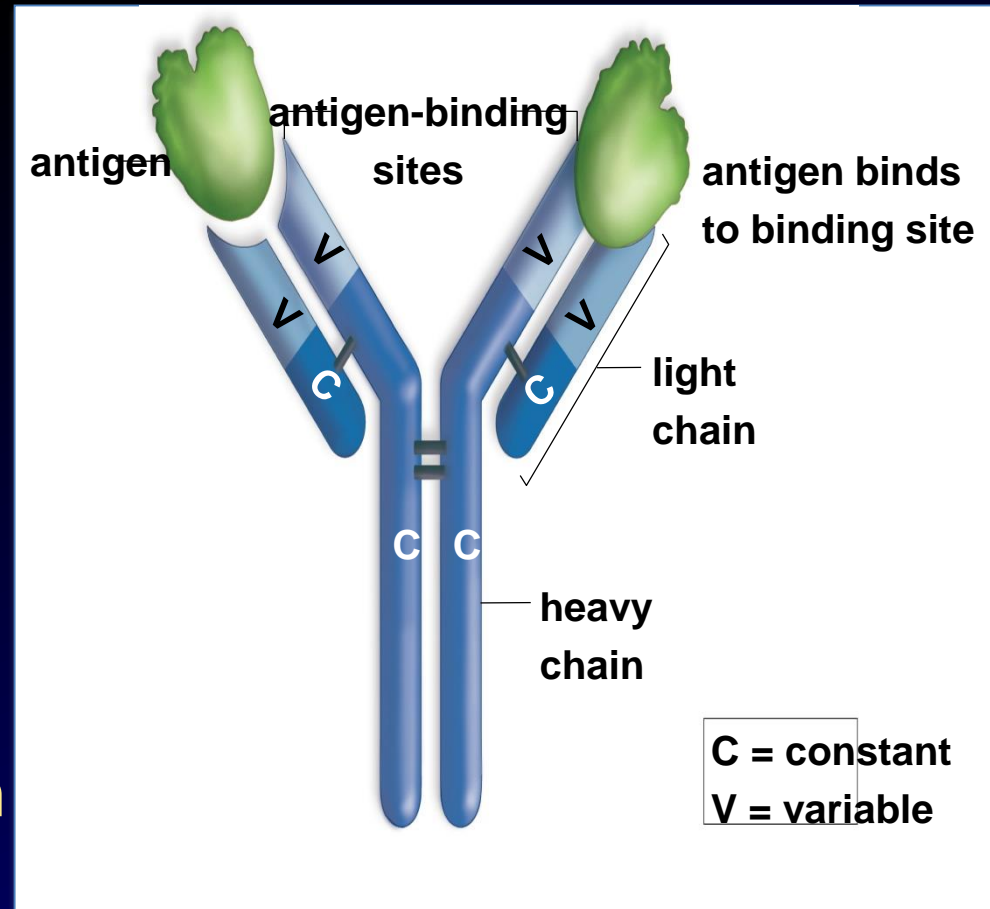
Phylogenetic tree comparing the Ebolavirus and Marburgvirus. Numbers indicate percent confidence of branches.

Wikipedia



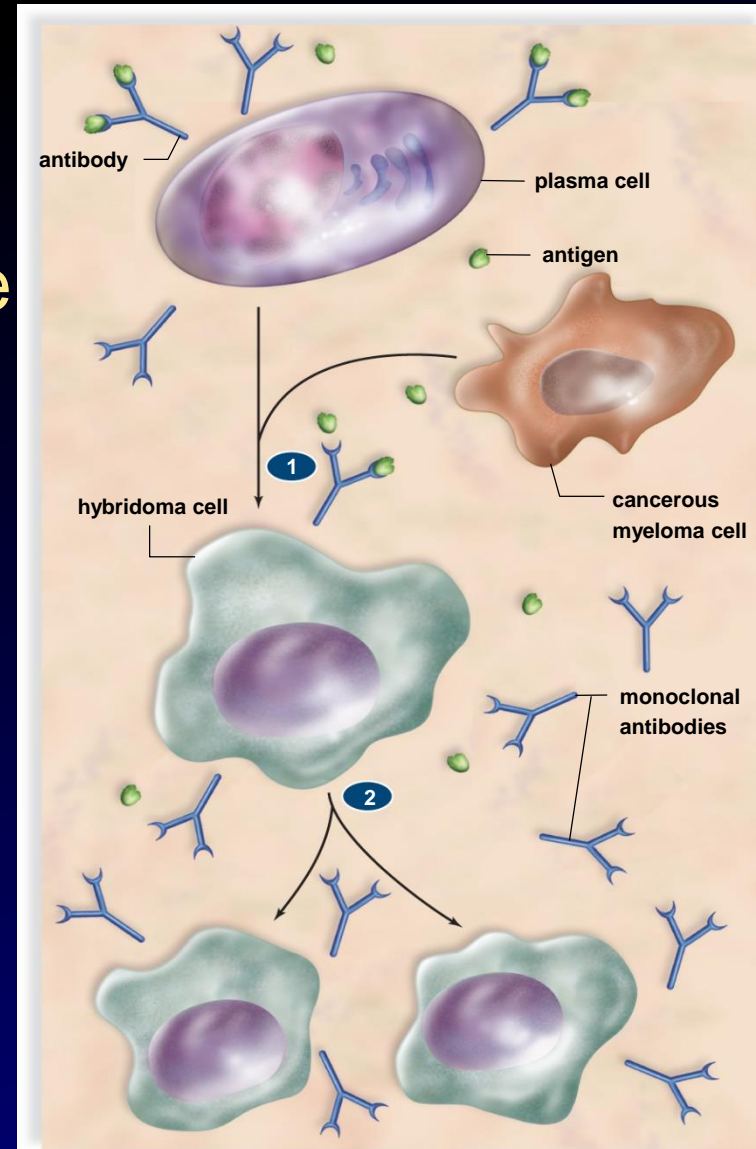
# Immunoglobulins = Antibodies

- IgG - Main antibody type in circulation
- IgM - Found in circulation, largest antibody
- IgA - Found in secretions
- IgD - Found on surface of immature B cells
- IgE - Found as antigen receptors on basophils in blood and on mast cells in tissue



# Monoclonal Antibodies

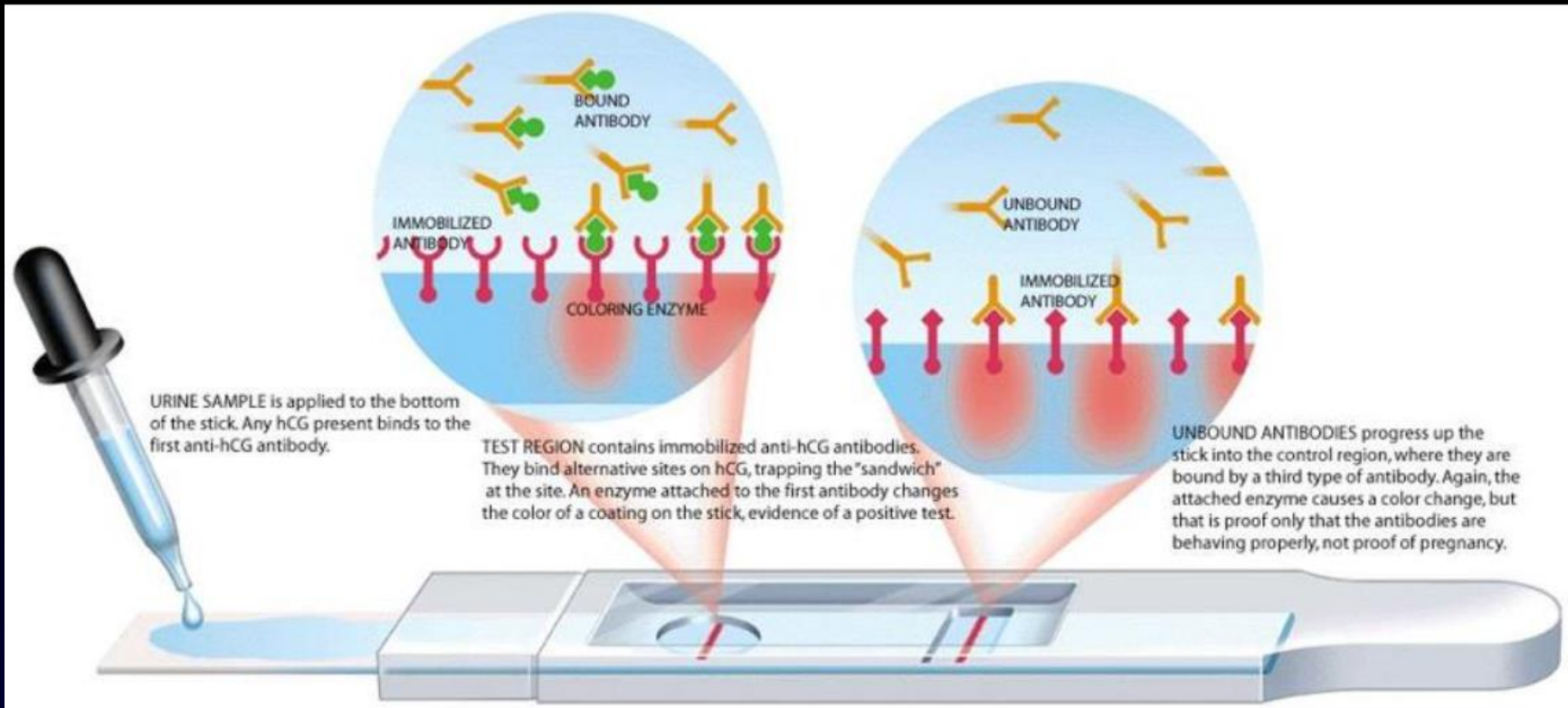
- Antibodies against a specific antigen
- All of them are the same type
- In vitro (outside the body in the laboratory) production of monoclonal antibodies
  - B cells are removed from an animal and exposed to a particular antigen
  - The resulting plasma cells are fused with myeloma cells
  - The fused cells are called hybridomas
    - The hybridomas secrete monoclonal antibody



# Monoclonal Antibodies

- Medical uses for Monoclonal Antibodies
  - To make quick and certain diagnoses of various conditions.
  - Used to signify pregnancy by detecting a particular hormone in the urine of a woman
  - Promise as potential drugs to help fight disease
    - RSV, a common virus that causes serious respiratory tract infections is now being successfully treated with a monoclonal antibody drug

# Pregnancy Test





# Questions

Foreign proteins that will bind to an antibody are called

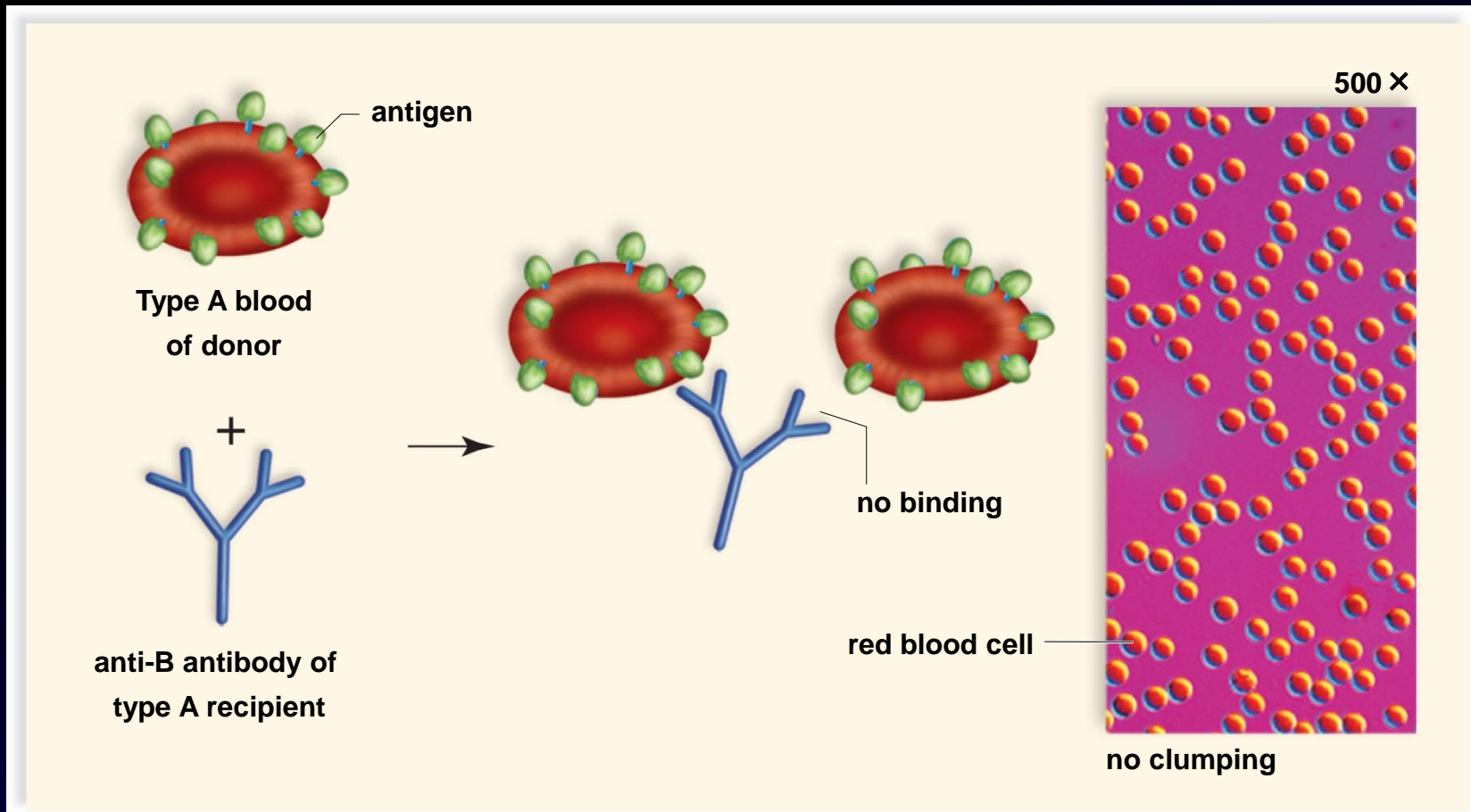
- A. histamines.
- B. immunoglobulins
- C. interferons.
- D. antigens

# Blood Type

- **Determined by the presence or absence of surface antigens (agglutinogens)**
  - Antigen A, B and Rh (D)
- **Antibodies in the plasma (agglutinins)**
- **Cross-reactions occur when antigens meet antibodies**

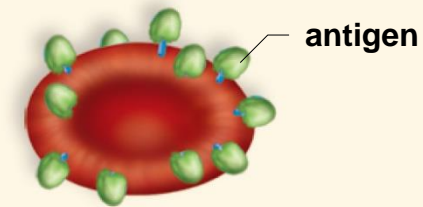
Blood Type	Antigen on Red Blood Cells	Antibody in Plasma
A	A	Anti-B
B	B	Anti-A
AB	A, B	None
O	None	Anti-A and anti-B

# No Agglutination



No agglutination

# Agglutination

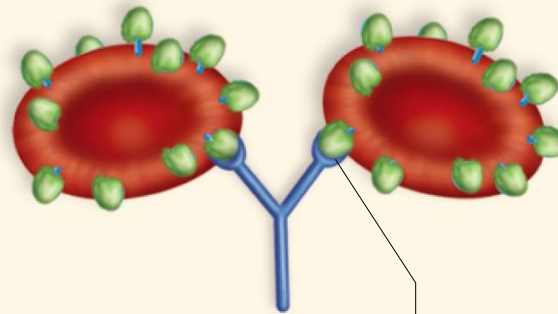


Type A blood of donor

+

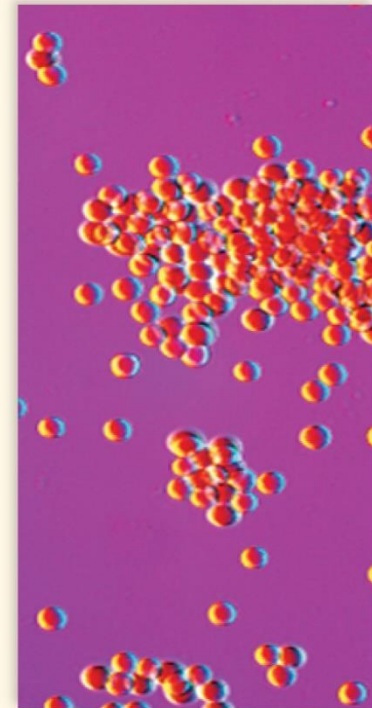


anti- A antibody of type B recipient



binding

500 ×



clumping

Agglutination



When Europeans first came to North America, one of the most disastrous interactions with native populations was the introduction of diseases like smallpox. Given what you know about the immune system, why did these diseases wreak so much more havoc in the Native American populations?

- A. They were genetically predisposed to be susceptible to smallpox.
- B. The Europeans had all been vaccinated against smallpox.
- C. Their immune systems had not evolved in the presence of this new microbe.
- D. Their immune systems were generally weaker than the Europeans.

# General Biology 1

BIO1201 RM 1021

## Syllabus & Textbook:

<https://openlab.citytech.cuny.edu/oer-biology/lecture-schedule/>

**Lecturer:** Michael Gotesman, PhD

**Email:** mgotesman@citytech.cuny.edu

**Office Hours:** Wednesday 11:30 - 12:30 PM

**Room:** A 302

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# Exam Schedule

~~Exam 1: 09/26/18 (Lectures 1-3)~~

~~Exam 2: 10/22/18 (Lectures 4-6)~~

Exam 3: 11/19/18 (Lectures 7-10)

Exam 4: 12/19/18 (Final: 11-15)

# T Cells

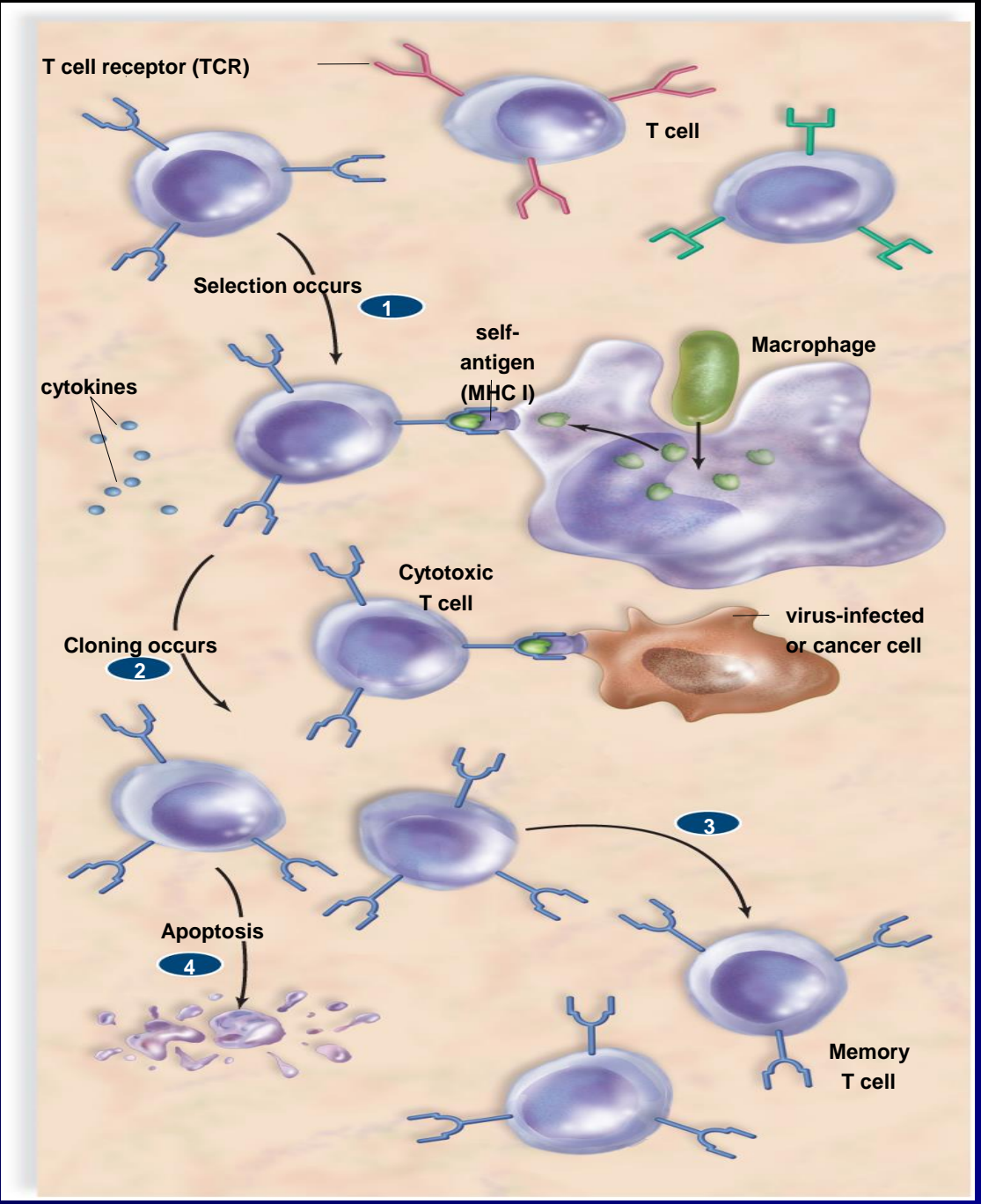
- Requirements for T cell antigen recognition:
  - Antigen must be presented by an antigen-presenting cell
  - Antigen is first linked to a major histocompatibility complex (MHC) protein in the plasma membrane
  - Cytokines - signaling chemicals that stimulate various immune cells



# Types of T Cells

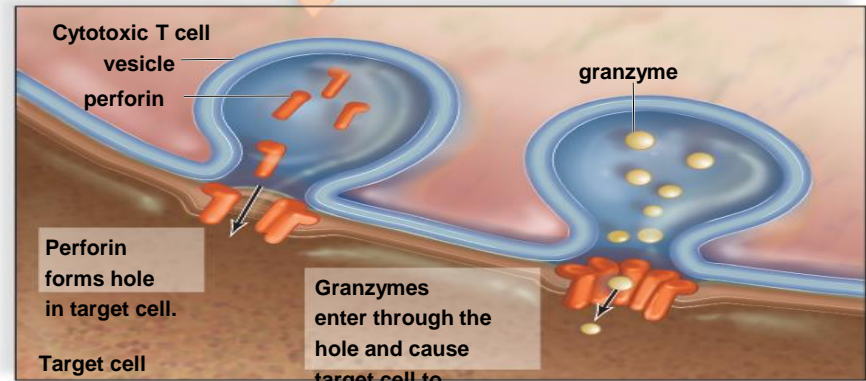
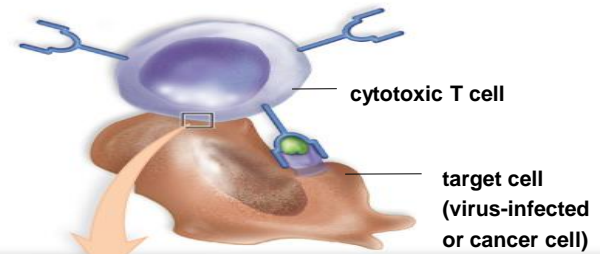
- **Cytotoxic T Cells**
  - Destroy antigen-bearing cells
  - Contain Perforins
- **Helper T Cells**
  - Activate other T cells and B cells
  - Regulate immunity by secreting cytokines
- **Suppressor T cells**
  - Inhibit the activation of T and B cells

# Clonal Selection Model as it Applies to T cells

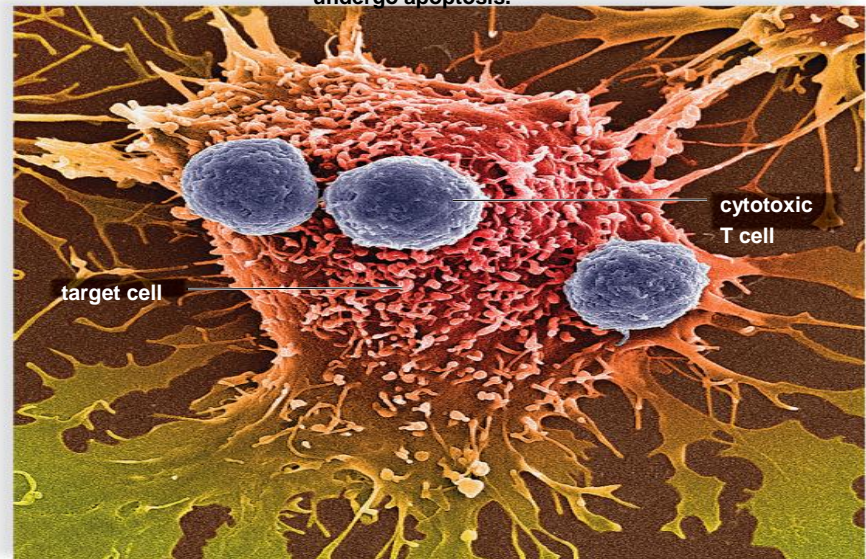


# Cell-mediated Immunity

<https://www.youtube.com/watch?v=jgJKaP0Sj5U>

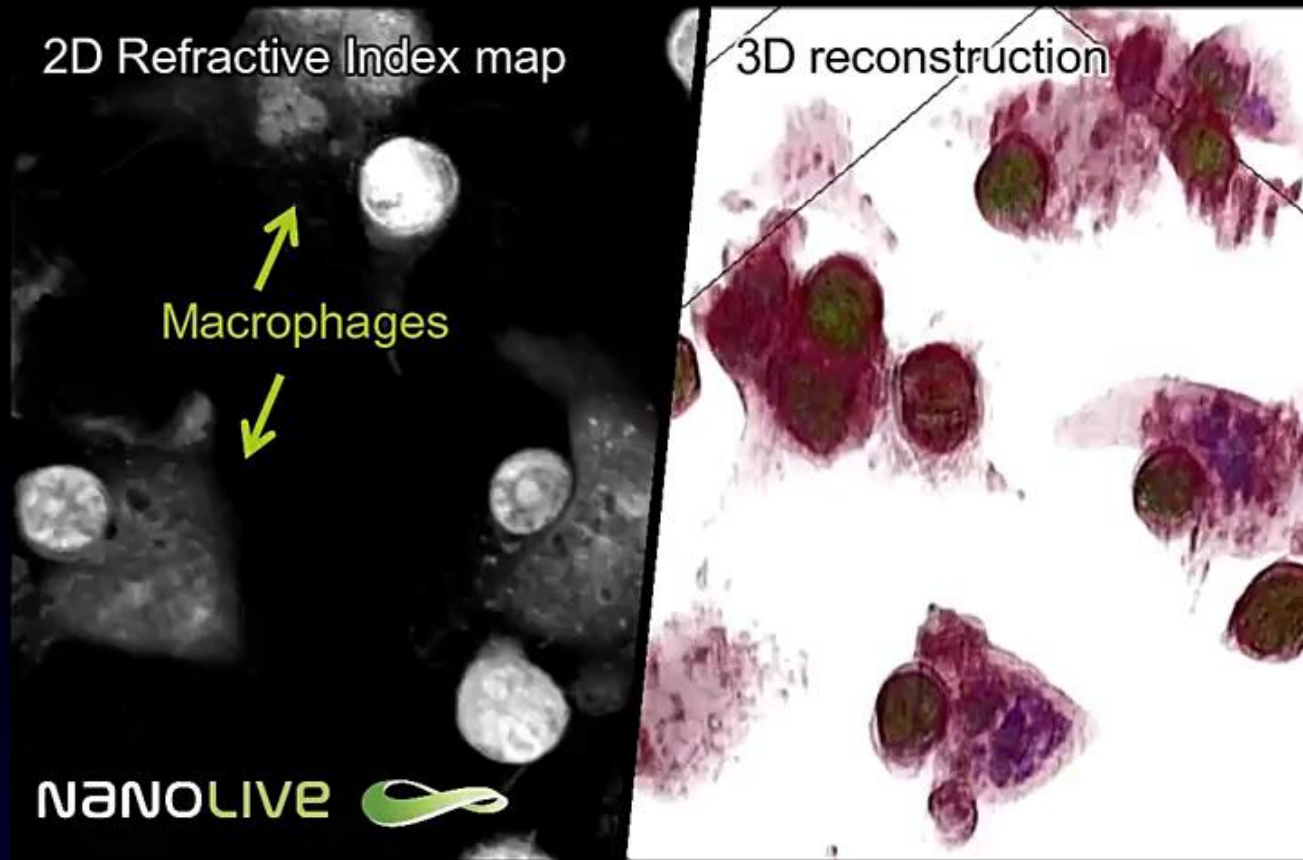


a.



b.

# THE PERFECT MURDER



T-cell mediated macrophage killing

[https://dms.licdn.com/playback/C4D05AQExbhf61IS0rw/e0bc59561587468498808e280f4ebc56/feedshare-mp4\\_3300-captions-thumbnails/1507940147251-drlcss?e=1542567600&v=beta&t=4y8vPG3IDBLkE-ZCeUohx3iHuH\\_AnZ6-xxtzK9th6MU](https://dms.licdn.com/playback/C4D05AQExbhf61IS0rw/e0bc59561587468498808e280f4ebc56/feedshare-mp4_3300-captions-thumbnails/1507940147251-drlcss?e=1542567600&v=beta&t=4y8vPG3IDBLkE-ZCeUohx3iHuH_AnZ6-xxtzK9th6MU)

<https://www.linkedin.com/in/alexjoneslivecellimaging/>

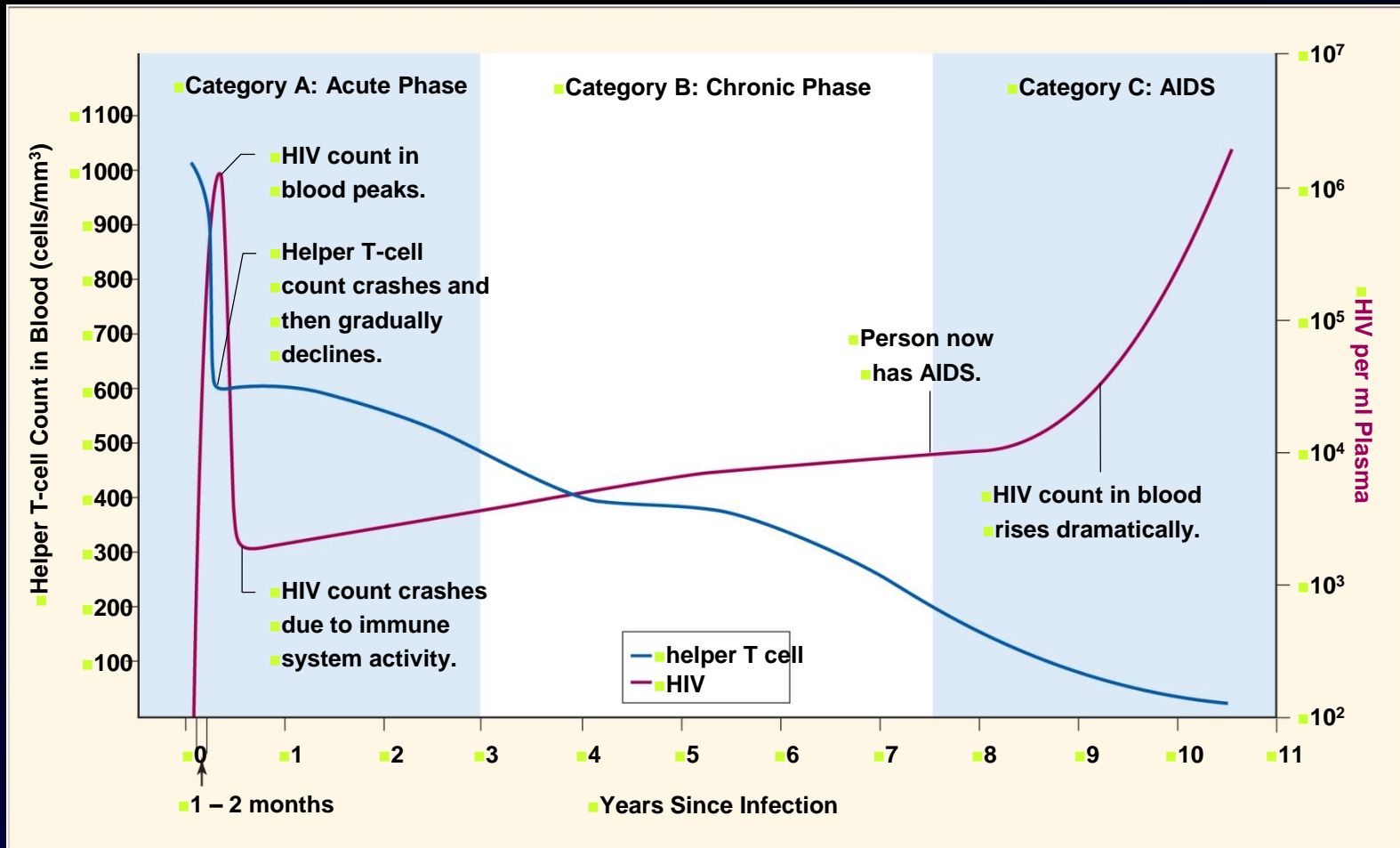


# HIV Infections

- The primary host for an HIV is a helper T cell
  - The host (helper T cell) produces viruses that go on to destroy more helper T cells
  - At first an individual is able to stay ahead of the virus by producing enough helper T cells
  - Gradually, HIV count rises and helper T cell count drops

<https://www.youtube.com/watch?v=U2h0ECyMWhE>

# Progression of HIV infection



# Cytokines and Immunity

- Cytokines
  - Signaling molecules produced by lymphocytes, monocytes, or other cells
  - Both interferon and interleukins have been used as immunotherapeutic drugs
  - Enhance the ability of the individual's T cells (and B cells) to fight cancer
    - [2018 Nobel Prize Jim Allison](#)

# Cytokines and Cancer Therapy

- Cytokine
  - Soluble protein that acts as a signaling molecule
  - Cytokines called interleukins are produced by white blood cells
    - Stimulate white blood cells
    - Interleukins might awaken the immune system and lead to the destruction of the cancer
  - Tumor necrosis factor (TNF) is a cytokine produced by macrophages
    - Cause the death of cancer cells

# Immunity Side Effects

- **Tissue Rejection**
  - Antibodies and cytotoxic T cells bring about destruction of foreign tissues in the body
  - Immune system is correctly distinguishing between self and nonself
- **Autoimmune Diseases**
  - Cytotoxic T cells or antibodies mistakenly attack the body's own cells



- In individuals with autoimmune diseases, the immune system loses tolerance for self and turns against certain molecules of the body

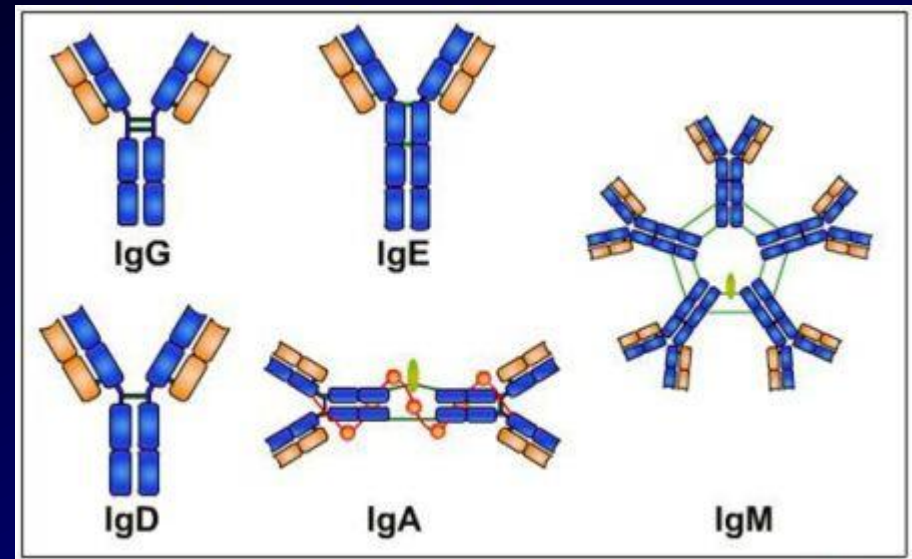
- Rheumatoid arthritis is an autoimmune disease leading to damage and inflammation of joints



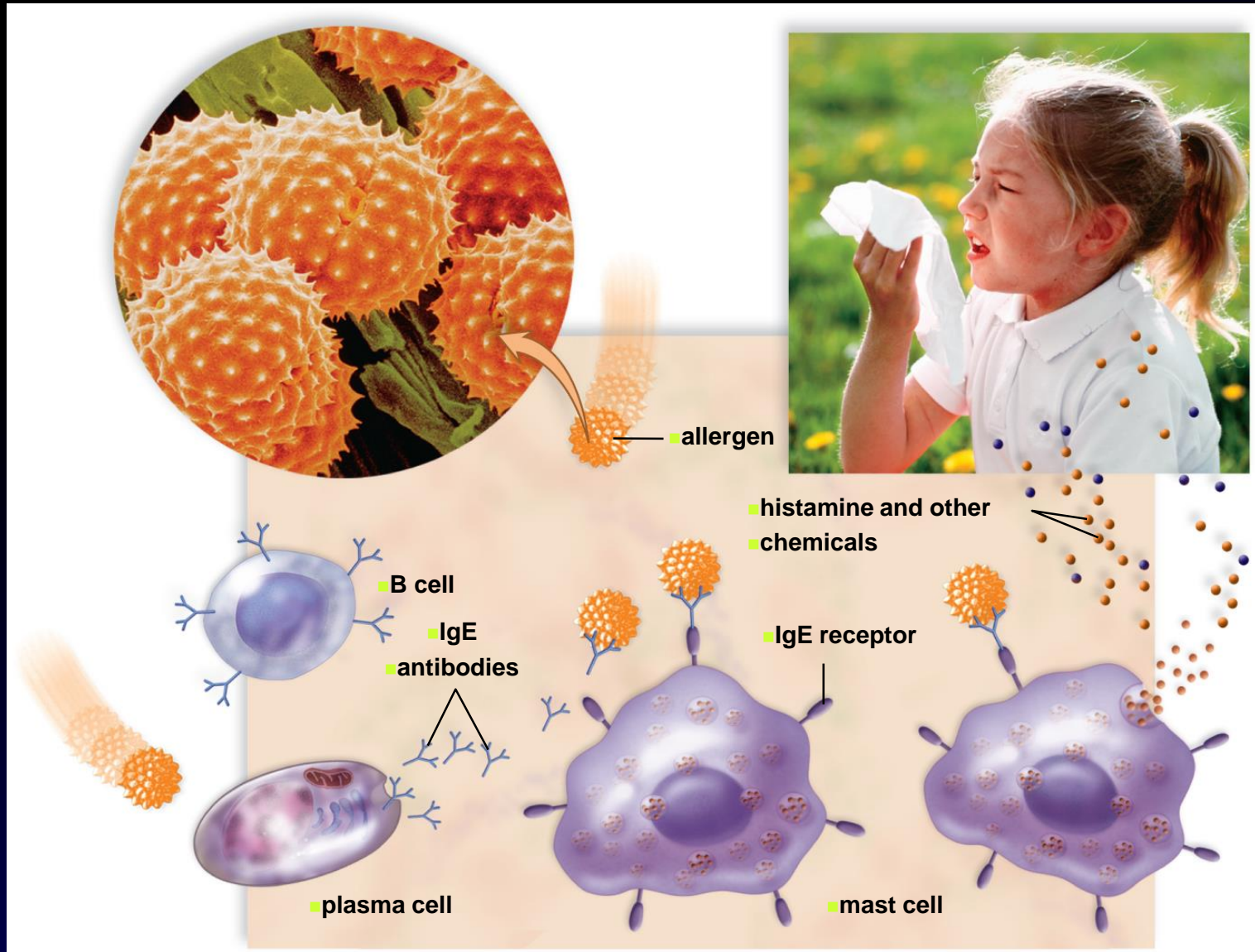
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# Immunity Side Effects

- Allergies
  - Hypersensitivities to substances that ordinarily would not harm the body
    - Immediate Response
      - IgE antibodies
    - Delayed Response
      - Memory T cells



# An Allergic Reaction



<https://play.kahoot.it/#/?quizId=46334691-150b-448a-9b97-198dcb052612>

<https://openlab.citytech.cuny.edu/oer-biology/lecture-schedule/>

**Quiz Time:**