

Ch 14 Notes – Lymphatic System

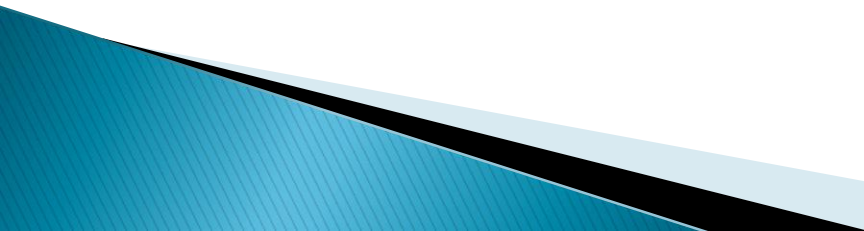
“If you’re not with us, then you’re against us”

Three Parts

- ▶ Lymphatic vessels – pick up excess tissue fluid that have escaped from cardiovascular system and transport it back into blood
 - If fluid is not returned, then a build up occurs in tissues called edema
- ▶ Lymph nodes and organs – house phagocytic cells and lymphocytes that aid in body's defense and resistance to disease

Lymphatic Vessels

- ▶ Lymph = clear water
- ▶ **Function:** carries fluid back to blood so blood can have a sufficient amount of volume
- ▶ **Structure:**
 - One-way system – towards heart and returns to venous system
 - Moves lymph by action of smooth muscles and pressure changes caused from breathing

- ▶ Lymph capillaries spider-web between tissue cells and blood capillaries
 - ▶ **Cell debris, bacteria, and viruses can easily enter the lymph capillaries but not blood capillaries**
 - ▶ Bacteria and viruses can use vessels as a transport system to other areas of the body
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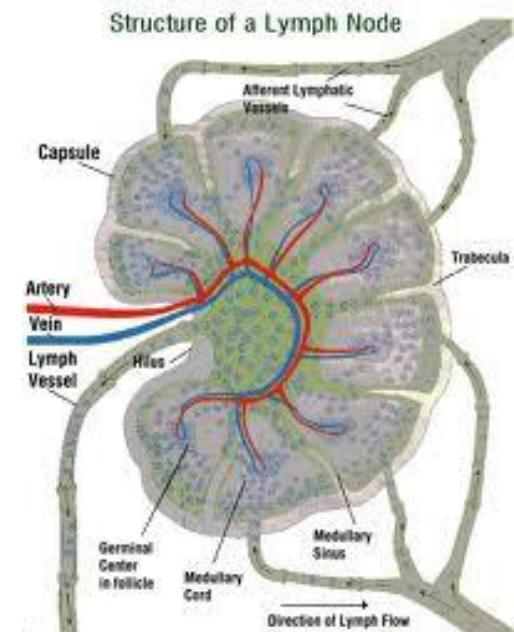
Lymph Nodes

- ▶ **Function:** help protect the body by removing foreign material from lymph (immune response)
- ▶ **Location:** large clusters found within the connective tissue of the inguinal, axillary, and cervical regions
- ▶ **Nodes contain several chambers that hold the macrophages and lymphocytes**
 - Macrophages – engulf and destroy bacteria, viruses, and other foreign substances
 - Lymphocytes – type of white blood cell that responds to foreign substances



Lymph Nodes

- ▶ Lymph gets filtered through thousands of lymph nodes before reaching the heart
- ▶ Swollen lymph nodes are the result of trapped lymph during acute infections
- ▶ Nodes can become secondary cancer sites if they get too large a number of the infectious cells



Types of White Blood Cells

▶ Granulocytes

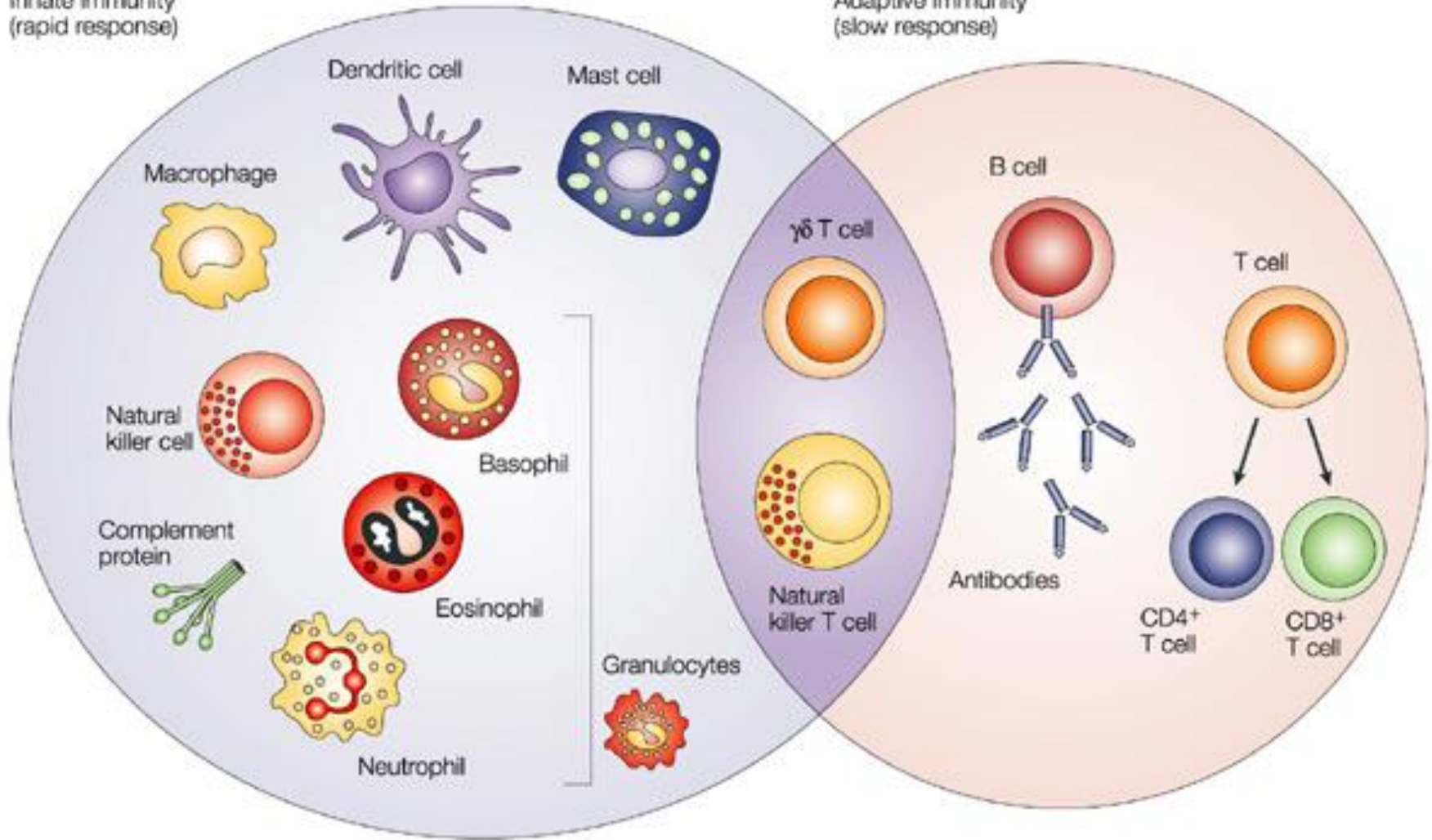
- Neutrophils
- Basophils
- Eosinophils

▶ Agranulocytes

- Monocytes – become macrophages and perform phagocytosis
- Lymphocytes – specific immune response cells (B and T)

Innate immunity
(rapid response)

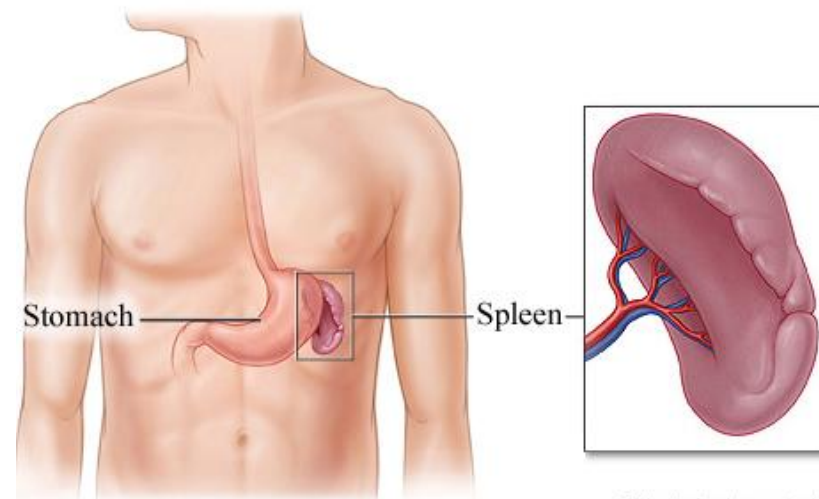
Adaptive immunity
(slow response)



Lymph Organs

Spleen – blood-rich organ that filters blood

- ▶ Destroys worn out red blood cells and returns pieces to liver
- ▶ Stores platelets and is a blood reservoir
 - Fetus – spleen makes red blood cells
 - Adult – makes lymphocytes



Lymph Organs

- ▶ **Thymus** – found overlying the heart
- ▶ Produces hormones (Thymosin) that program lymphocytes (T cells) to carry out protective roles in body

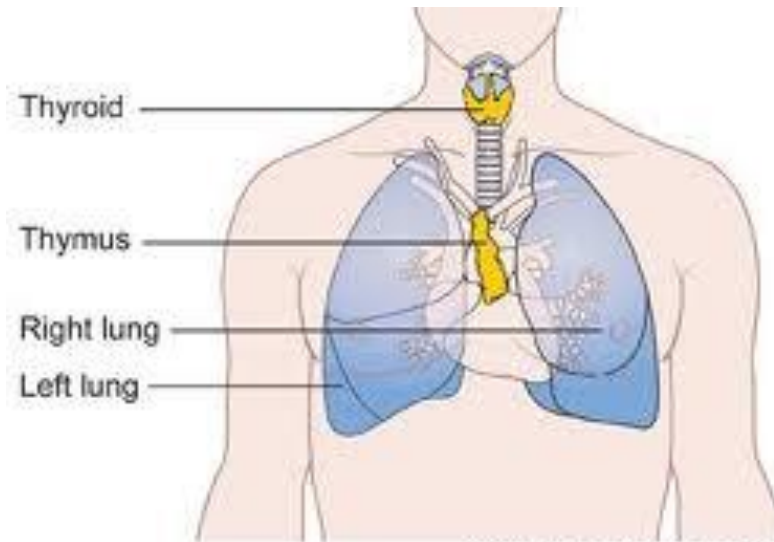


Diagram showing the position of the thymus gland
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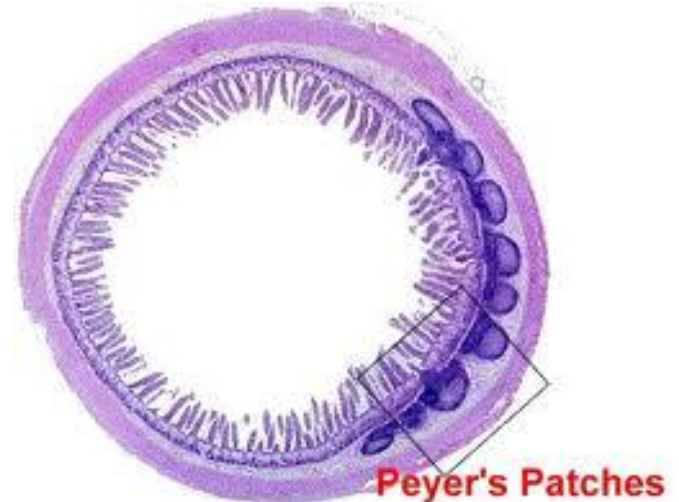
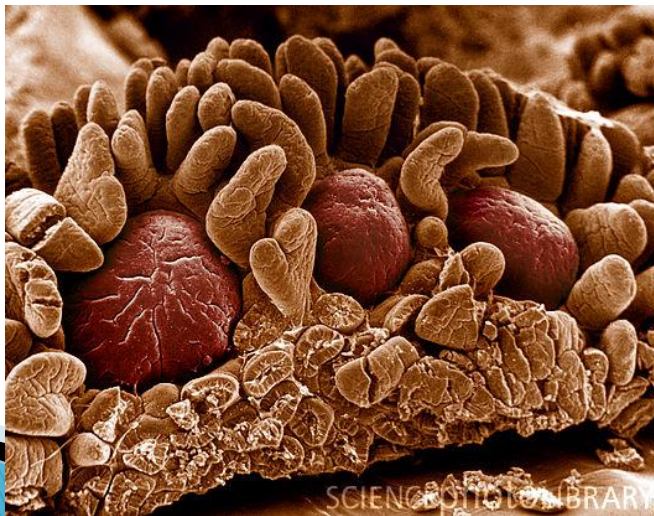
Lymph Organs

- ▶ **Tonsils** – small masses of lymphatic tissue around the pharynx
- ▶ Protects respiratory system by trapping and removing bacteria and other foreign substances before they can enter the throat




Lymph Organs

- ▶ **Peyer's Patches** – found in walls of intestines
- ▶ Protects digestive system from bacteria, viruses, and other harmful substances



Nonspecific Defense System –

responds immediately to protect body from all foreign substances

- ▶ Mechanical barriers that cover body surfaces and cells and chemicals that initially act to protect the body against pathogens
 - ▶ Pathogens = harmful or disease causing microorganisms
 - ▶ Prevents entry and spread of microorganisms throughout the body
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Surface Membrane Barriers

- ▶ Skin and mucous membranes are the body's first line of defense
 - How? Skin secretes acidic substances, stomach mucosa is acidic, saliva can kill bacteria, sticky mucous in digestive tract can trap microorganisms
- ▶ When surface barrier is broken other nonspecific responses occur

Inflammatory response – body's second line of defense

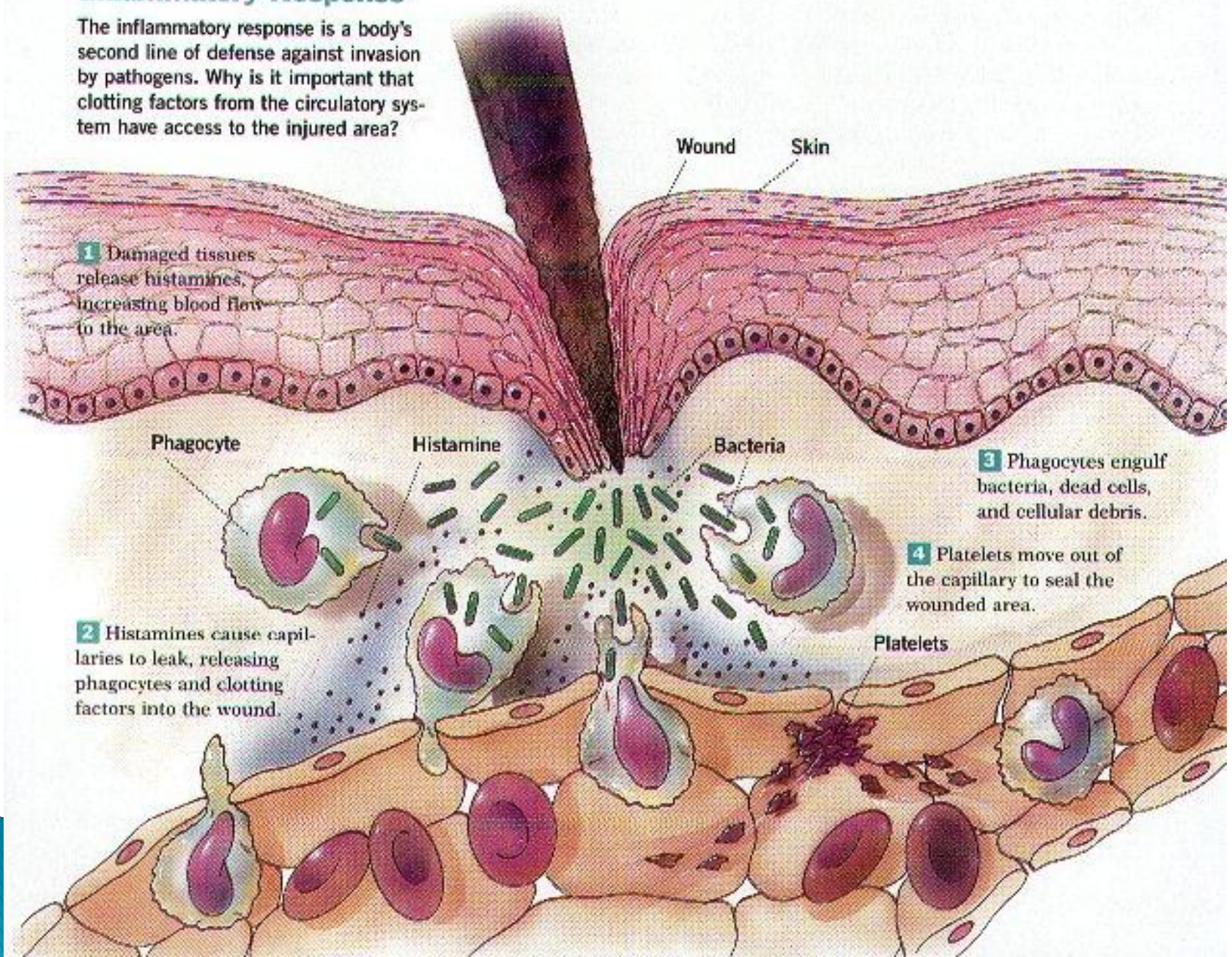
- ▶ Triggered whenever body tissues are injured
- ▶ Signs and Symptoms = redness, heat, swelling, and pain
- ▶ STEPS: Injury → release of chemicals from injury site → blood vessels dilate → activates pain receptors → attract phagocytes and white blood cells to area → clotting protein come in to block off injured area

Inflammatory Response

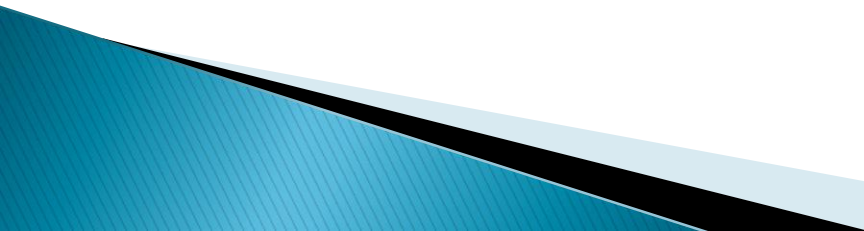
- ▶ Prevents spread of damaging agents, disposes cell debris and pathogens, and sets stage for repair
 - ▶ Hour after = neutrophils enter area from capillaries and break down any damaged cells or pathogens
 - ▶ Macrophages then enter and do the final disposal of cell debris
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Steps of the Inflammatory Response

The inflammatory response is a body's second line of defense against invasion by pathogens. Why is it important that clotting factors from the circulatory system have access to the injured area?



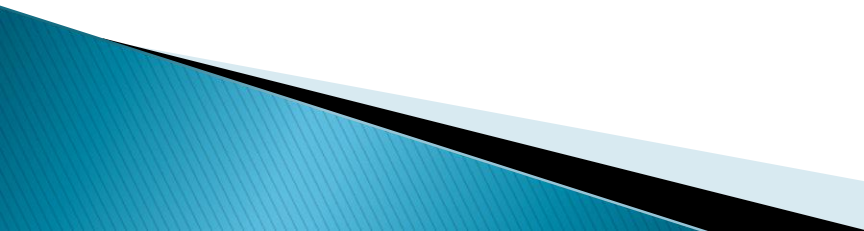
Cells

- ▶ Phagocytes (Macrophage) – engulfs foreign substance and breaks it down
 - ▶ Natural killer (NK) cells – found in blood and lymph and can kill cancer cells and virus-infected cells; can act against any foreign cell
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Antimicrobial Molecules

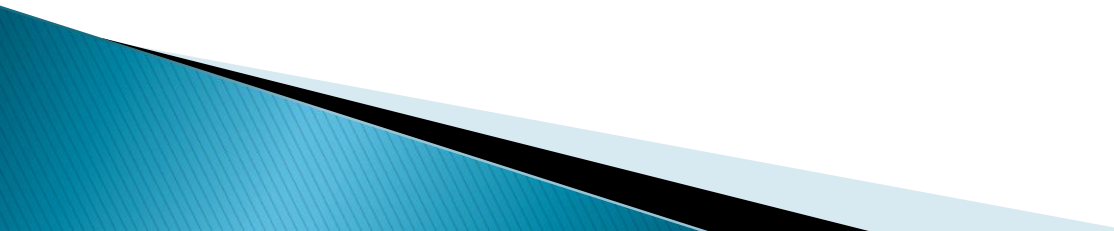
- ▶ Complement – proteins that attach to and break apart foreign cells, which amplifies the inflammatory response
- ▶ Interferon – proteins released by virus–infected cells that protect uninfected cells from viral takeover
 - [Interferon Video](#)

Fever


- ▶ Abnormally high body temperature inhibits multiplication of bacteria and enhances repair processes
 - ▶ Systemic response triggered by pyrogens (chemicals secreted by white blood cells and macrophages that have been exposed to foreign cells)
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Specific Defense System – Immune system

- ▶ Attacks very specific foreign substances – either direct cell attack or by releasing chemicals or antibodies – and acts to destroy or inactivate them
 - Includes variety of molecules and trillions of immune cells that live in lymphatic tissue
- ▶ Protects us from most bacteria, viruses, transplanted organs or grafts, and cells that have turned against us (cancer cells)
- ▶ **Immunity** = highly specific resistance to disease
- ▶ Must first encounter a substance (antigen) before it can protect the body against it

- ▶ Immune Response – reaction to a threat that starts the inflammatory response and attacks specific antigens
 - Body will attack anything that is recognized has not being part of the body
 - ▶ Immunology – study of immunity
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3 General Characteristics of Immune Response

- ▶ Antigen specific – acts on particular pathogens
 - ▶ Systemic – not restricted to infection site
 - ▶ Has “memory” – recognizes and has even stronger attacks on previously encountered pathogens
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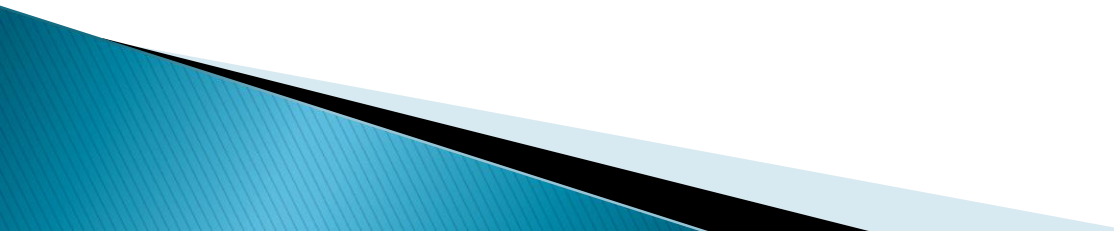
Types of Immunity

- ▶ Humoral immunity – antibody–mediated
 - Provided by antibodies present in body’s fluids
- ▶ Cellular immunity – cell–mediated
 - When lymphocytes (living cells) defend the body
- ▶ **Antigens** = any substance capable of exciting our immune system and provoking an immune response


Lymphocytes

- ▶ Formed in red bone marrow
 - **B cells** – produce antibodies and oversee humoral immunity
 - **T cells** – nonantibody-producing lymphocytes that make up cell mediated immunity
 - Mature in thymus
- ▶ Our genes, not antigens, determines what specific foreign substances our immune system will recognize and resist

Macrophages

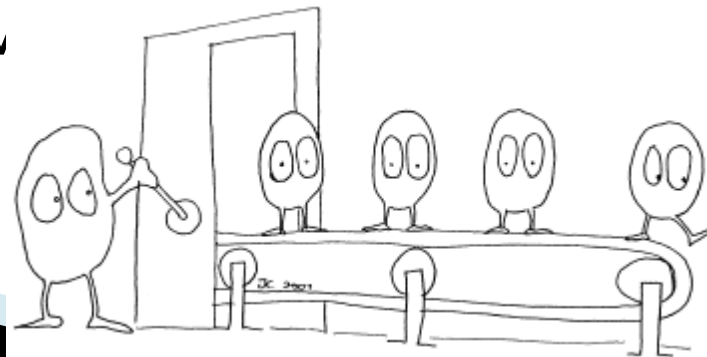
- ▶ Do not respond to specific antigens, but helps lymphocytes
 - ▶ Engulf pathogens and break them down
 - ▶ Leave parts of antigens on the surface so T cells can recognize the “bad guys”
 - ▶ Tend to stay in lymphatic organs where as lymphocytes circulate
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Humoral (Antibody-Mediated) Immune Response

- ▶ B lymphocytes are activated when it binds to an antigen
 - ▶ Clonal selection – B lymphocytes are selected out of the billions and begin to grow and multiple rapidly
 - ▶ Cloned lymphocytes with the antibodies they release are the primary humoral response to antigens
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Humoral (Antibody-Mediated) Immune Response

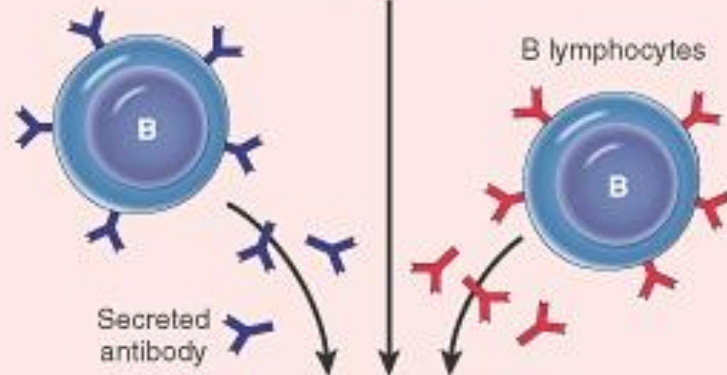
- ▶ B cells turn into plasma cells (rapid multiplication) or memory cells (long lived and can respond to antigen later)
- ▶ Blood antibody levels rise and then decline
- ▶ Secondary responses to the same antigen are with memory cells – faster, more prolonged, and more effective



HUMORAL IMMUNITY



Extracellular microbes
(e.g., bacteria)



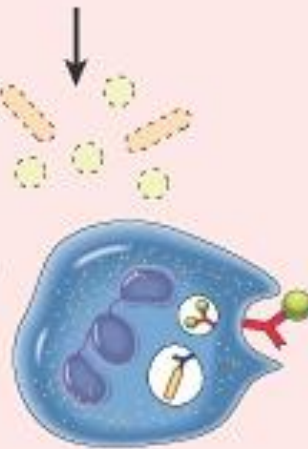
Secreted antibody



Neutralization

Lysis (complement)

Phagocytosis
(PMN, macrophage)



Active and Passive Humoral Immunity

- ▶ **Active Immunity** – B cells encounter antigens and produce antibodies
 - Naturally acquired – during infections
 - Artificially acquired – receive vaccines
 - Vaccines spare us from most signs and symptoms and can stimulate antibodies to fight off antigen
- ▶ **Passive Immunity** – getting antibodies from another immune human or animal donor
 - Naturally acquired – antibodies from mother during fetal development
 - Artificially acquired – received from immune serum

Antibodies

- ▶ Part of blood proteins – soluble
- ▶ Each type only binds to one antigen

- ▶ Structure:
 - long and short chains of amino acids that form a Y shape
 - All antibodies have a region that is the same and a region that allows them to bind to a specific antigen

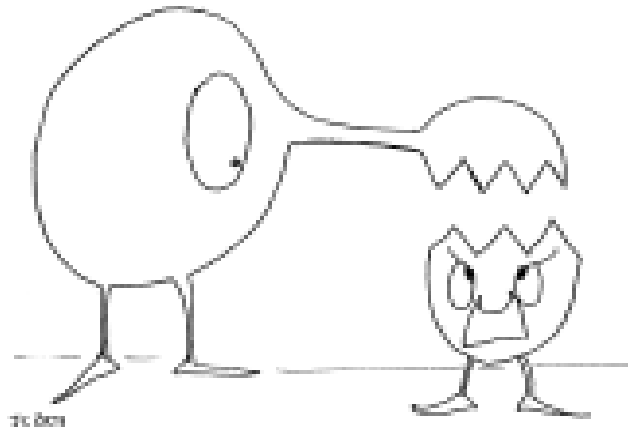
- ▶ Classes:
 - 5 major classes – each has a different location and role in the body

Function of Antibodies

- ▶ Inactivate antigens by:
 - **complement fixation** – proteins bind to foreign cell and causing it to break apart
 - **neutralization** – block harmful effects of toxins released from bacteria or virus
 - **agglutination** – antibodies can bind to more than one antigen at a time and they can clump foreign cells together; used in blood typing
 - **precipitation** – antigen–antibody complexes are so large that they settle out of solution; this makes it easier for phagocytes to engulf and destroy antigens

Cellular (Cell-Mediated) Immune Response

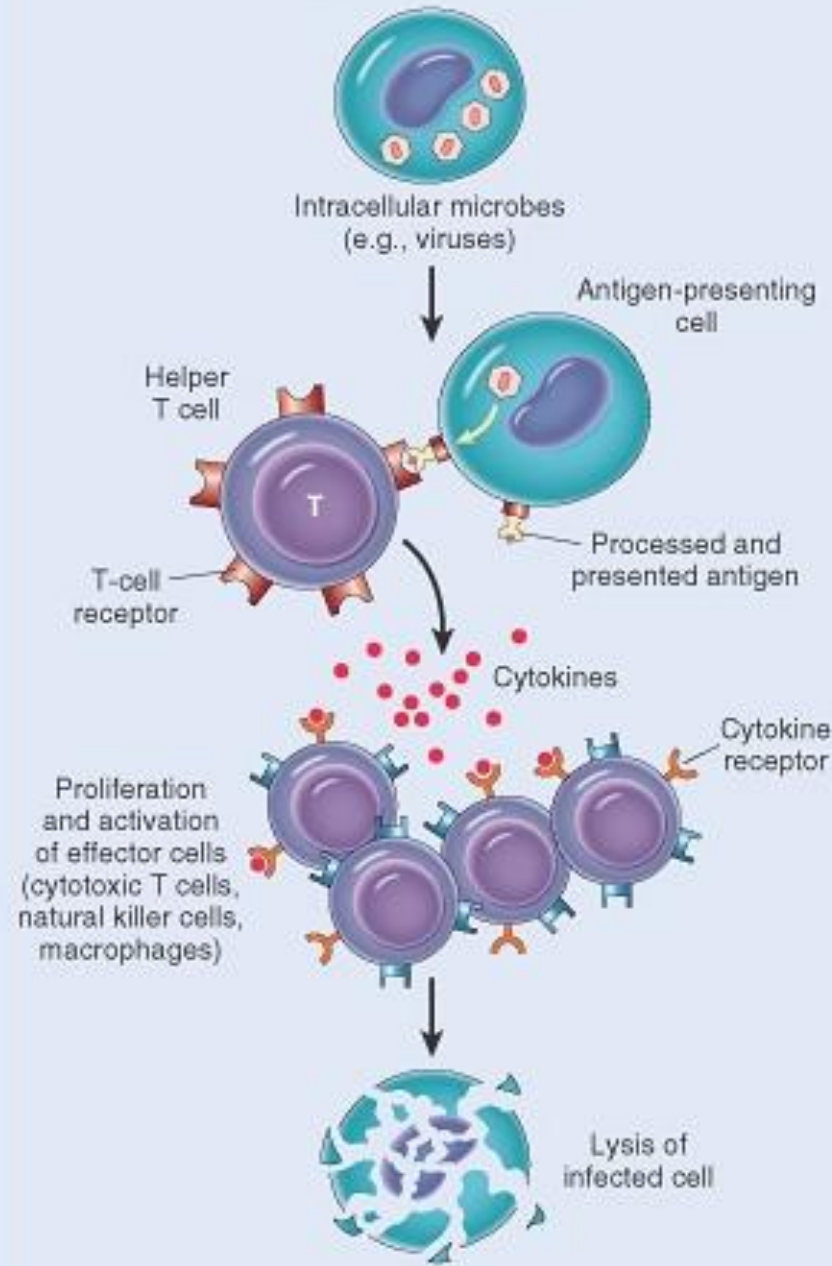
- ▶ T cells are activated to form clones (just like B cells) when the macrophage present broken down parts of antigens and T cells can recognize it as “non-self”
- ▶ T cells cannot bind to free antigens



Cellular (Cell-Mediated) Immune Response

- ▶ Classes:
 - Cytotoxic (killer) T cells – kill virus infected, cancer, or foreign graft cells
 - Helper T cells – directors of immune system; recruit other cells to fight infections
 - Suppressor T cells – slows activity of T and B cells; vital for stopping immune response
 - Delayed hypersensitivity T cells – allergies and long-term inflammation
 - Memory cells – remain behind to be activated again if antigen returns

CELLULAR IMMUNITY



Website Links

- ▶ [Lymphatic Videos](#) on notes website
 - ▶ [Clonal Selection](#)
 - ▶ [Flu Virus](#)
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