The Lymphatic System and Immunity

Unit 9

Lymphatic System Functions

- Consists of networks of lymph vessels that pick up excess tissue fluid, cleanse it, and return it to the circulatory system
- Picks up fats that have been absorbed by the digestive system
- Fights disease and infections

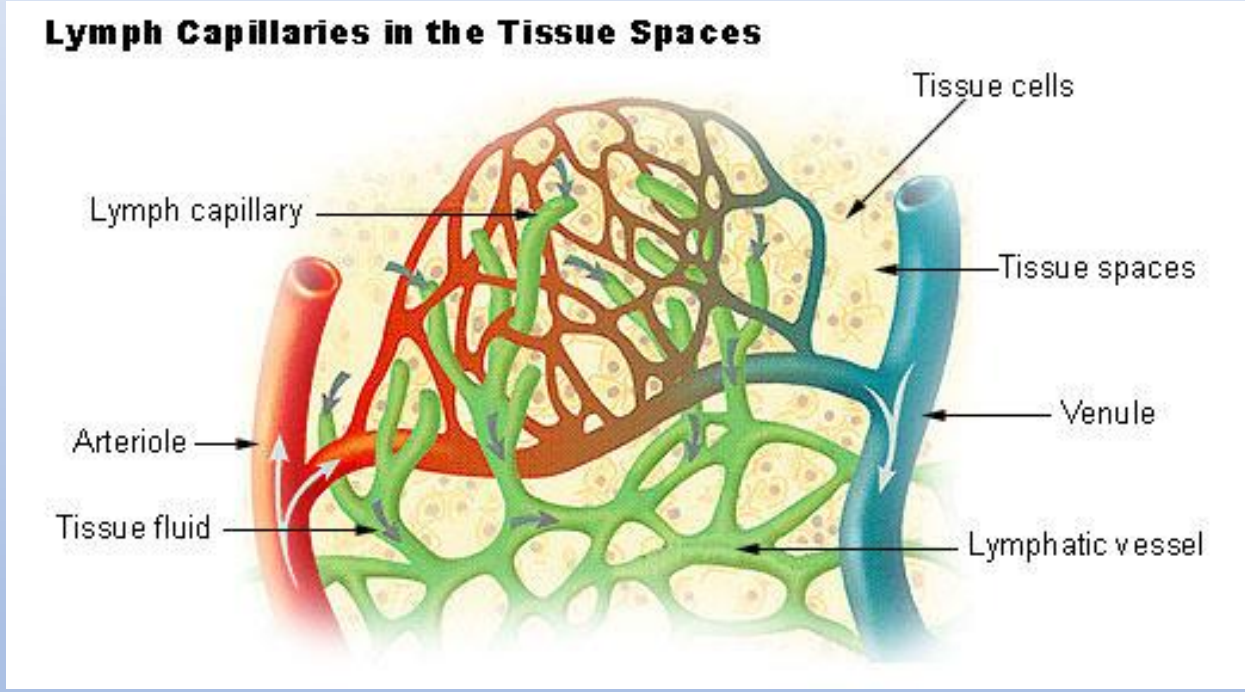
Organs of the Lymphatic System

- Lymph Nodes
- Lymphatic vessels
- Spleen
- Thymus gland
- Tonsils

Lymphatic Vessels

- **Lymph**
  - The fluid inside the lymphatic vessel
- **Lacteals**
  - Lymph vessels located around the small intestines
  - Pick up absorbed fats for transport

Lymphatic Vessels



Lymphatic Vessels

- Form an extensive network of ducts throughout the entire body
- Vessels are not in a closed loop
- Severe as one way-pipes conducting lymph from the tissues toward the thoracic cavity
- Vessels begin as very small lymphatic capillaries in the tissues

Lymphatic Vessels

- Excessive tissue fluid enters these capillaries to begin the trip back to the circulatory system
- Capillaries merge into larger lymphatic vessels
- Very low-pressure system
- Vessels have valves along their length to ensure lymph can only move toward the thoracic cavities
- Vessels drain into the right lymphatic duct or thoracic duct.

Lymphatic Nodes

- Small organs composed of lymphatic tissue located along the route of lymphatic vessels
- Referred to as lymph glands
- House lymphocytes and antibodies
- Work to remove pathogens and cell debris as lymph passes through them on its way back to the thoracic cavity

Sites for lymph nodes

Name	Location	Function
Axillary	Armpits	Drain arms and shoulder region; cancer cells from breasts may be present
Cervical	Neck	Drain head and neck; may be enlarged during upper respiratory infections
Inguinal	Groin	Drain legs and lower pelvis
Mediastinal	Chest	Drain chest cavity

Tonsils

- Collections of lymphatic tissue located on each side of the throat or pharynx
- Not a vital organ and can be removed if they become a continuous site of infection
- 3 sets of tonsils
  - Palatine
  - Pharyngeal
  - lingual

Spleen

- Located in the upper left quadrant of the abdomen
- Consists of lymphatic tissue that is highly infiltrated with blood vessels
- Blood vessels spread out into slow-moving blood sinuses
- Not a vital organ and can be removed due to injury or disease (a person's susceptibility to a blood stream infection may be increased)
- Main function
  - Filters out and destroys old red blood cells, recycles the iron, and also stores some of the blood supply for the body

Thymus Gland

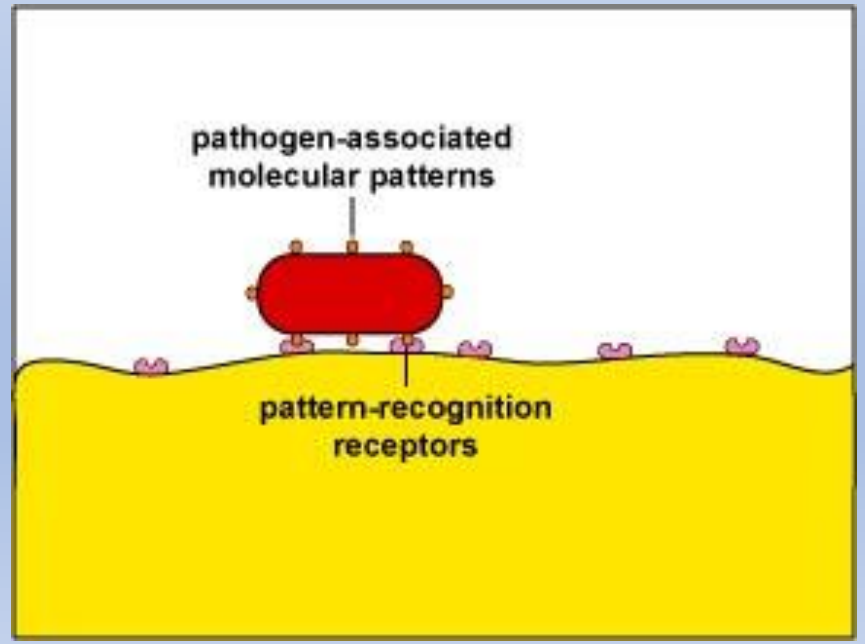
- Located in the upper portion of the mediastinum
- Essential for proper development of the immune system
- Assists the body with the immune function and the development of antibodies
- Hormone thymosin changes lymphocytes to T lymphocytes

What is immunity?

- Organisms ability to resist and combat infection

PAMPs

- Pathogen Associated molecular patterns
- Nonself cues
- Any molecule that is recognized by the body as nonself
- Type of antigen
- Body responds in one of 2 ways



Innate Immunity

- Immediate response/ What we are born with
  - Skin, Mucous, Phagocytes, Antimicrobial Proteins, Attack Cells
- Detects a fixed set of receptors for PAMPs (1,000)
- WBCs will be released
  - Engulf & Protect
  - Produce Antibodies

Adaptive or Acquired Immunity

- When the body experiences a threat stronger than what innate can handle
- Has to be introduced and recognized by the body before the body attacks it
- Slow to act
  - Specific
  - Systemic
  - Memory

Types of Leukocytes

- **Neutrophils**- Perform phagocytosis while circulating in the blood
- **Macrophages-** Migrate through tissues and tissue fluid
- **Dendrites-**Alert adaptive immune system
- **Eosinophils-** Kill parasites
- **Basophils-** Secrete chemical mediators in inflammation and allergic reactions
- **Monocytes-** Phagocytosis mature macrophages in tissues

Types of Leukocytes

- **B cells-** make antibodies
- **T cells-** play a specific response in adaptive immune systems
- **Cytotoxic T cells-** kill infected or cancerous cells
- **Natural Killer Cells-** kill cancerous body cells that are undetectable by cytotoxic cells

Surface Barriers

- Prevent microorganisms from invading the internal environment
- **Normal Flora-** microorganisms that live on human surfaces including tubes of digestive and respiratory tracts
- We provide them with a stable environment and they deter more dangerous species from colonizing
- Only helpful on body surfaces and if they get in the tissue they cause disease
  - Acne, pneumonia, ulcers, colitis, whooping cough, meningitis, cancer

Innate Response Video

- https://www.youtube.com/watch?v=GIJK3dwCWCw

Innate

- This immunity is always there
- Its rapid
- Creates time for the specific immunity to occur
- Keeps an invading pathogen from establishing a population in body tissues or fluids

What happens after an antigen is detected inside the body tissues or fluids?

- Antigen triggers complement activation
    - **Complement-** proteins that recognize and bind to antibodies clustered on a surface cell
- Activated complement recruits phagocytic leukocytes, coats pathogens in the affected area, and triggers lysis of foreign cells
- Phagocytic leukocytes release cytokines and antimicrobial molecules after engulfing antigen-bearing particles such as complement-coated microorganism
    - **Cytokines**- allows cells to coordinate activities during immune responses

Complement activation & cytokines release

- Trigger inflammation and fever
- **Inflammation**
- occurs when leukocytes release prostaglandins and histamines at a site of tissue damage or infection
- Increase blood flow and attracts more leukocytes to the site
- Lasts until macrophages produce compounds that suppress inflammation and promote tissue repair

Complement activation & cytokines release

- **Fever**
- Cytokines stimulate brain cells to make and release prostaglandins which act on the hypothalamus to raise the body's internal temperature
- Fever enhances the immune defenses while slowing down pathogen growth

Acquired or Adaptive Immunity

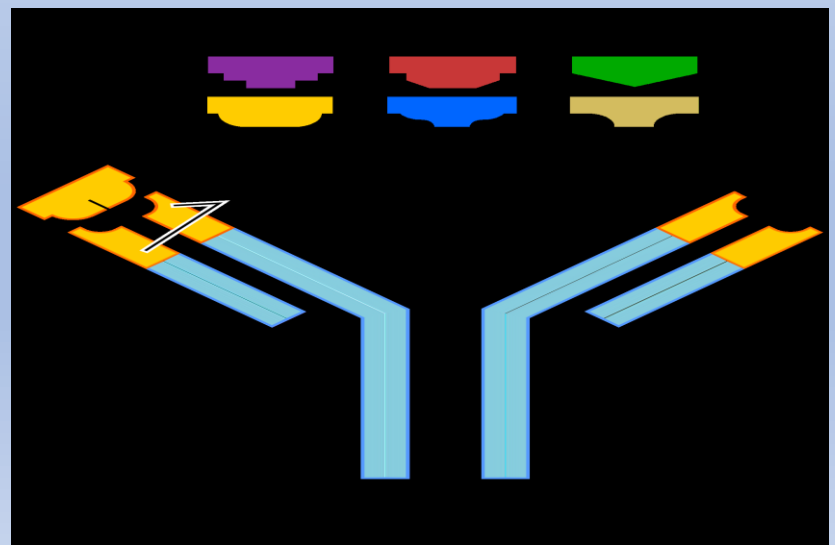
- Video
- https://www.youtube.com/watch?v=2DFN4IBZ3rI

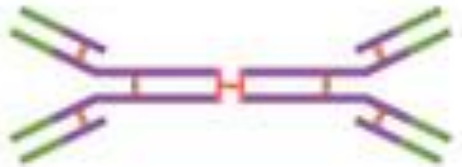
Adaptive

- Introduced and recognize as a threat before it attacks
- Slow to act
- Never forgets the specific pathogens
- Systemic- fight throughout whole body at once
- Humoral Immunity & Cellular Defenses

Antibodies

- Antigen receptors
- Y shaped proteins made and secreted by B cells
- Circulate in the blood
- Do not kill pathogens directly
- Activate complements and help facilitate phagocytosis

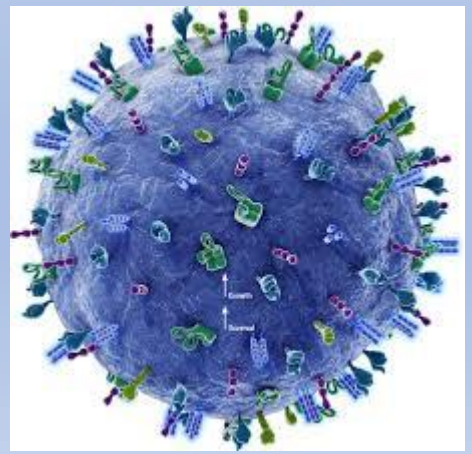


Name	Properties	Structure
IgA	Found in mucous, saliva, tears, and breast milk. Protects against pathogens.	
IgD	Part of the B cell receptor. Activates basophils and mast cells.	
IgE	Protects against parasitic worms. Responsible for allergic reactions.	
IgG	Secreted by plasma cells in the blood. Able to cross the placenta into the fetus.	
IgM	May be attached to the surface of a B cell or secreted into the blood. Responsible for early stages of immunity.	

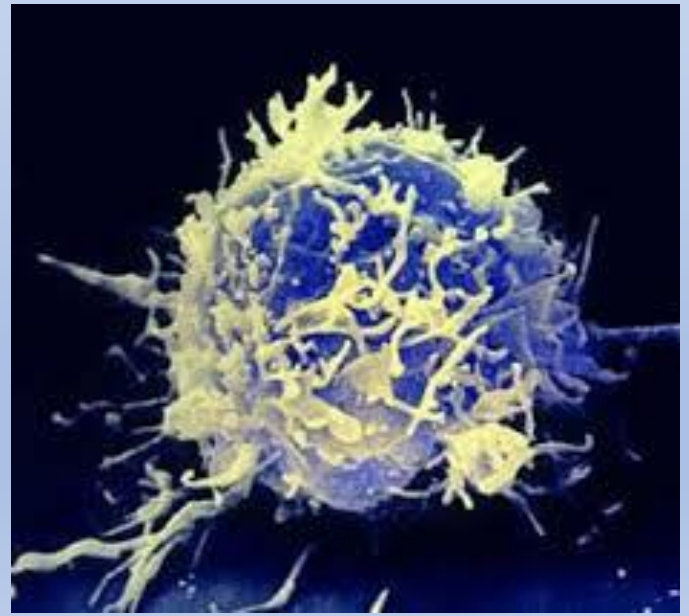
Humoral Immunity

- Dispatches antibodies (proteins)
- Made by special white blood cells
- **Antigen-** invader from outside world
- Large signaling molecules not formally found that act as flags to get your immune system working

- B cell- located in bone marrow
- Mature into bone marrow and as it matures it develops the ability to recognize how to bind to particular antigen self tolerance
- Displays 10,000 special protein receptors are membrane bound antibodies
- Colonize in lymph nodes and blood and lymph
- Naïve and untested and wont be truly active until they meet their task

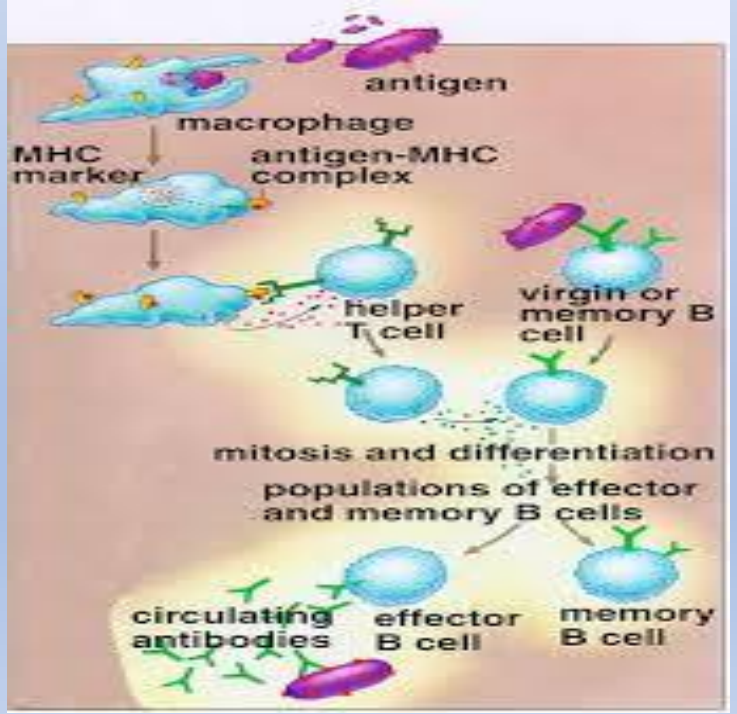


- Your t cells have special antigen receptors called T cell receptors or TCR
- TCR recognize antigens as nonself & another part recognizes as self called MHC markers



Antibody Mediated Response

- B cells produce antibodies that bind to an antigen in blood or interstitial fluid
- Antibody binding can prevent a pathogen from entering body cells, neutralize a toxin, and facilitate the elimination of both from the body
- Not as effective against pathogens in the cell



Antigen Mediated Response Steps- Page 654

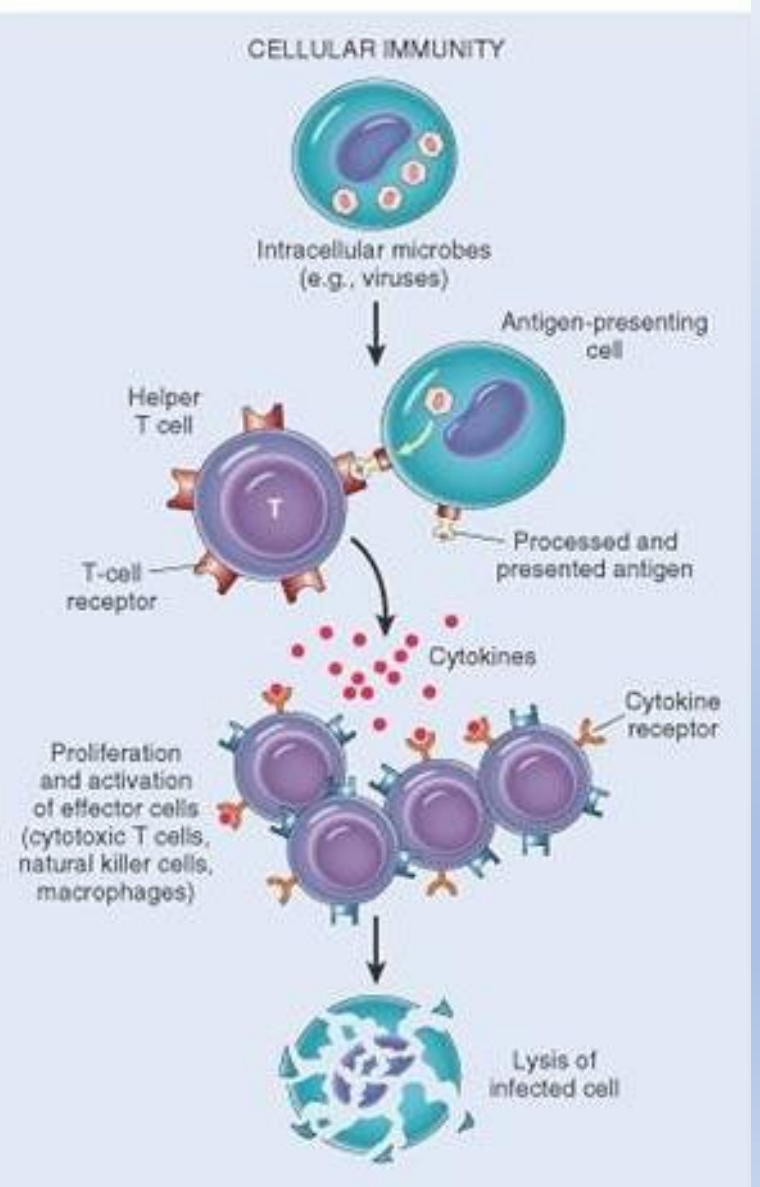
- B cells bind to bacteria and the complement on the bacteria triggers the B cell to engulf it. The fragments of bacteria are bound to a MHC marker and become displayed on the surface
- A dendritic cell engulfs the same bacteria and its fragments will do the same
- TCR’s on a t cell recognize the MHC complex on the dendritic cell. They interact and the Tcells divide by mitosis. The descendants mature as memory cells

Antigen Mediated Response Steps

- TCR on effector cells recognize and bind to the antigen MHC complexes on B cell and binding will cause the Tcell to release cytokines
- Cytokines make B cells and go through mitosis and become memory B cells and effector B cells
- Effector B cells make antibodies which will recognize the same antigen as original B. The new antibodies circulate throughout the body and bind to the remaining bacteria

Cell- Mediated Immune Response

- Cytotoxic T Cells & NK cells that form kill infected body cells or those that have been altered by cancer
- Doesn’t involve antibodies



Video

- https://www.youtube.com/watch?v=rd2cf5hValM

Cell- Mediated Immune Response Steps

- 1. A dendritic cell engulfs and digests a virus infected cell. Bits bind to the MHC markers and the complexes become displayed at the dendritic cells surface. It migrates to a lymph node
- 2. Receptors on the naïve cytotoxic T cell bind to antigen MHC complexes and the interaction will activate the cytotoxic T cell
- 3. Receptors on a naïve helper T cell bind to antigen- MHC complexes displayed by the dendritic cell and the interaction activates the helper T cell.

Cell- Mediated Immune Response Steps

- 4. The activated helper T cell divides again and its descendants mature as effector and memory cells each with T cell receptors that recognize the same antigen
- The effector cells secrete Cytokines