I. Introduction

A) General

1) Lymphatic System performs 2 basic functions:

   (a) 
   
   (b) 

2) Organs of the Lymphatic System
   (a) lymphatic vessels
   (b) lymph nodes
   (c) spleen
   (d) thymus
   (e) tonsils
   (f) peyers patches

B) Lymphatic Vessels

1) Blood Capillaries

   (a) fluid leaves arterial end of capillary due to hydrostatic pressure and osmotic pressure

   (b) fluid returns to venous end of capillary due to hydrostatic pressure and osmotic pressure

   (c) interstitial fluid:

   (d) edema: excel fluid within body tissues

2) Lymphatic capillaries

   (a) blind ended
   (b) endothelial cell overlap forming valves
   (c) high pressure forces cells open/close

   (d) lymph:
(e) lymph moves through lymphatic vessels

1) milking action of skeletal muscles
2) breathing/changes in thoracic cavity volume

(f) lymph returned to blood via

C) (Slide 5) **Lymph Nodes**

1) (vary) large clusters (1000s nodes)
   (a) size and shape
   (b) buried in CT

2) lymph typically passes through several nodes before entering blood
3) As lymph passes through node, interacts with
   (a) 
   (b) 

D) (Slide 6) **Spleen**

1) location: abdominal cavity, left

2) structure:
   (a) red pulp
   (b) white pulp

3) function:
   (a) 
   (b) 
   (c) 
   (d) 

4) hemorrhage: liver and spleen contract and empty blood into blood vessels to increase blood volume
(a) agranulocytes
   (1) lack cytoplasmic granules

E) (Slide 7) **Thymus**

1) organ of the endocrine and lymphatic systems
2) highest activity youth
3) thymosins (hormone) mature T-lymphocytes (T-cells)

F) **Tonsils**

1) ring pharynx within mucosa
2) trap/remove debris

G) **Peyers patches**

1) walls of intestines
2) macrophages (phagocytize bacteria)

II. (Slide 8) **Body Defenses/Immunity—Immune System**

A) **Immune response:** all defense mechanisms that target any threat

**Note:** nonspecific and specific defense mechanisms work together!

B) (Slide 9) **Antigen**

1) __

2) __

3) Mainly large/complex (foreign) molecules
   (a) protein
   (b) large carbohydrates/polysaccharides
   (c) nucleic acids
   (d) some lipids

4) __
   (a) bacteria (endotoxin or cell wall components)
   (b) fungi
   (c) viruses (protein coat)

5) __
   (a) tumor/cancer cells
   (b) transplanted organ/grafts
C) (Slide 10) **Nonspecific Immunity (innate)**

1) General Characteristics:

(a) 

(b) 

(c) 

2) Includes

(a) skin
(b) mucous membranes
(c) cells
(d) proteins
(e) inflammation

3) (Slide 11) **1st Line of Defense: Skin and Mucous Membranes**

(a) **unbroken**—physical barrier  
(b) **acidic secretions** are antibacterial  
   (1) skin-sebum (pH 3-5)  
   (2) stomach-HCl (pH 2)  
   (3) vagina  
(c) **mucus**: traps (respiratory, digestive, urinary and reproductive system)  
(d) **cilia**: move mucus with trapped pathogens across surface  
(e) **lysozyme**: antibacterial enzyme  
   saliva and lacrimal fluid (tears)  
(f) **hairs**: filter  
   *broken: shaving, brushing teeth, etc.*

4) (Slide 12) **2nd Line of Defense—Internal nonspecific Defense Mechanisms include cells and proteins!**

(a) phagocytes  
(b) natural killer cells  
(c) inflammation  
(d) complement (antibacterial protein)  
(e) interferon (antiviral protein)  
(f) fever

5) (Slide 13) **Phagocytes**

(a) located in virtually all body organs/tissues  
(b) engulf pathogen within vacuole and fuse with lysosome resulting indigestion of contents  
(c) includes:  
   (1) 
   (2) 

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![Diagram of immune response](image-url)

\[1\] Microbe adheres to phagocyte  
\[2\] Phagocyte engulfs the particle  
\[3\] Phagocytic vesicle is fused with a lysosome  
\[4\] Microbe in fused vesicle is killed and digested by lysosomal enzymes within the phagolysosome  
\[5\] Indigestible and residual material is removed by exocytosis
6) (Slide 14) **Natural Killer cells**
   (a) unique group lymphocytes
   
   (b) __
   
   (c) **Perforin**: protein that forms holes in target cell’s membrane and allows fluid to rush in resulting in osmotic lysis

7) (Slide 15) **Inflammation**:

   (a) triggered by tissue damage
      (1) ex: physical, heat, viral, bacterial
      (2) release **histamine** and **kinins**

   (b) **4 Hallmark or Cardinal Signs**
      
      (1) __
      
      (2) __
      
      (3) __
      
      (4) __

   (c) (Slide 16) Histamine and kinins cause
      (1) blood vessels dilate/increase flow
         (a) heat
         (b) redness
      (2) blood vessels become leaky/capillary permeability
         (a) edema
      (3) activate pain receptors
      (4) attract phagocytes and other WBCS (chemotaxis)

(d) (Slide 17) **Purpose of Inflammatory response**

   (1) prevents
   
   (2) disposes
   
   (3) sets stage for repair
      
      (a) heat increases metabolism/activity
      (b) fibrin mesh provides scaffold for repair

8) (Slide 18) **Antimicrobial Protein: Complement**

   (a) 20+ (inactive) plasma proteins
   (b) ‘fixed’/activated—attach to antigen
   (c) kills by MAC attack (membrane attack complex) forms protein donut in pathogen membrane causing death by osmotic lysis
9) (Slide 19) **Antiviral Proteins: Interferon**
   (a) **viruses:** obligate intracellular molecular parasites
      (1) (basic) nucleic acid core and protein coat
      (2) requires cells machinery (ribosomes), monomers and ATP to build more viral particles
   (b) **virally infected body cells produce interferon when infected**
      (1) secreted to extracellular environment
      (2) bind receptors on neighboring body cells
      (3) signals them to begin synthesizing antiviral proteins to prevent viral replication

10) (Slide 20) **Fever**
   (a) __________
   (b) hypothalamus (control center)
      (1) resets body temperature in response to
      (2) secreted by WBCs and macrophages
      (3) rate group (antigen) attached to the surface of red blood cells
   (c) Higher body temperature affects normal body protein function—moderate/mild fever
      (1) optimal for WBC activity
      (2) liver and spleen take up Iron and Zinc (decreases bacteria’s ability to multiply)

III. (Slide 21) **Specific Defense: 3rd Line of Defense**

A) **Specific Defense**
   1) **General Characteristics**
      (a) single target
      (b) involves entire body
      (c) provides recognition to mount stronger response to a second encounter with same antigen

   2) **2 types of Immune Response**
      (a) antibody-mediated immunity
      (b) cell-mediated immunity

B) (Slide 22) **Cells of the Lymphatic System**

   1) **B-lymphocytes or B-cells**
      (a) produced in red bone marrow
      (b) mature in red bone marrow
      (c) cell membrane receptors recognize a specific antigen
      (d) function:

   2) **T-lymphocytes or T-cells**
      (a) produced in red bone marrow
      (b) mature in thymus gland
      (c) cell membrane receptors recognize a specific antigen
      (d) function:
C) **Antibody-Mediated Immunity**

1) carried out by B-cells

2) specific antigen activates a B-cell to divide

3) produces two populations of cells:
   (a) **plasma cells**: secrete antibodies (same as receptor) into blood
   (b) **Memory cells**: reside in lymphatic organs and wait till encounter same pathogen (antigen) again

4) **Clonal Selection Theory**: specific antigen selects which lymphocyte will undergo mitosis and produce antibodies

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**Diagram:**

- **Primary Response** (initial encounter with antigen)
- **Secondary Response** (can be years later)
- Diagram showing the process of clonal selection and the production of plasma and memory cells.

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**Graph:**

- **Primary response** shows a gradual increase in antibody concentration.
- **Secondary response** shows a sharp increase in antibody concentration after antigen injection.

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D) **Antibodies:**

1) **Proteins**
   (a) soluble protein (plasma)
   (b) secreted by activated B-cells
   (c) identical to B-cell receptor
   (d) antigen-binding site (specific to a particular antigen)

2) **Functions:**
   (a) **neutralize antigen**
      (1) prevent colonization
      (2) block toxin activity
   (b) **agglutination**
      (1) more easily phagocytized
      (2) immobilizes pathogens

3) **Types (Immunoglobulin)**
   (a) **IgG**
      (1) most common
      (2) crosses placenta
   (b) **IgM**
      (1) largest
      (2) agglutination
   (c) **IgA**
      (1) milk, saliva, mucous
      (2) prevents attachment
   (d) **IgD**
      (1) important B-cell activation
   (e) **IgE**
      (1) allergy/allergic reactions
      (2) inflammation reactions
      (3) parasitic worms
E) Cell-Mediated Immunity

1) T-cell receptor specific for antigen bound to body marker

2) activation: antigen-body marker presented by macrophage
   
   (a) results in clonal expansion
      (1) plasma cells
      (2) memory cells

3) T-cells
   
   (a) T-cytotoxic cells
      (1) kill virally infected body cells
      (2) kill cancer cells
      (3) perforin
   
   (b) T-helper cells
      (1) enhance response/recruit other immune cells

F) Induced Immunity

1) Active Immunity:
   
   (a) characteristics
      (1) produce antibodies in response to antigen
      (2) takes time to develop
      (3) has memory/generally long-lived/permanent
   
   (b) natural active immunity: develop after exposure (sick)
   
   (c) artificial active immunity: develop after exposure but with decreased symptoms
      
      vaccine: substance contains antigen without the pathogen

2) Passive Immunity
   
   (a) characteristics
      (1) antibodies injected (NOT produced)
      (2) effect is immediate/short-lived
      (3) NO memory
   
   (b) natural passive immunity: mom’s antibodies cross placenta and in breast milk
   
   (c) artificial passive immunity: injection of antibodies that bind antigen stimulating phagocytosis and complement