The Lymphatic System
Lymphatic System

Three main functions
- Fluid balance
- _______________ - from digestive tract
- Defense

Lymphatic vessels
- Form a __________ system
- Begins with ____________________________
  - Tiny, closed-ended vessels
  - Take up ______________________________
- Vessels merge and then enter one of two ducts:
  - Thoracic duct
  - Right lymphatic duct
- Vessels have ______ and movement of lymph depends ____________________________
- Edema is __________ caused by ____________________________
Organs, Tissues, and Cells of the Immune System

- Primary Lymphatic Organs

  - Red Bone Marrow
    - Site of ________________________________
    - In an adult, ___________________________ is found in:
      - Sternum
      - Vertebrae
      - Ribs
      - Skull
      - Part of the pelvic girdle
      - Proximal heads of the humerus and femur
    - Lymphocytes differentiate ____________________________
  
  - B lymphocytes mature in ____________________________
  - T lymphocytes mature in ____________________________
Thymus Gland

- In the ________________
- ________ in children and ________ as a person ages
- Critical to ________________
- Lobules are filled ________________
- Produces ________________
  • Aids in ________________
  • May have other functions in ________________
a. Neutrophil
40–70%
Phagocytizes primarily bacteria

b. Eosinophil
1–4%
Phagocytizes and destroys antigen-antibody complexes and parasitic organisms

c. Basophil
0–1%
Releases histamine and other chemicals when stimulated

d. Lymphocyte
20–45%
B type produces antibodies in blood and lymph; T type kills virus-containing cells and cancer cells

e. Monocyte
4–8%
Becomes macrophage—phagocytizes bacteria and viruses
Secondary lymphatic organs

0 Places where

0 **Spleen**
- Largest
- Blood entering the spleen is _______
  - Lymphocytes and macrophages react to _______
  - Macrophages engulf _______ and _______
- Consists of two types of tissue:
  - White pulp – _______
  - Red pulp – surrounds _______ and is involved in _______
Lymph nodes

- **Small structures**
  - passing through the sinus is
  - T lymphocytes

- **Lymphatic nodules**
  - Concentrations of
  - Tonsils
  - Peyer patches
  - Appendix
Nonspecific Defenses

Barriers to entry

- Physical
  - ____________________________
  - ____________________________

- Chemical
  - Lysozyme in ______________________________
  - pH of ____________________________
  - ____________________________
Signs of inflammatory reactions

- Four signs:
  - 1. ______ - excess _______ flows into the area causing skin to be ______ & _______
  - 2. Heat- inhibits ________
  - 3. Swelling- capillary permeability causes ________
  - 4. Pain- _______ puts on ________
  - 5. ______ & _______

wall off the area
Nonspecific and Specific Defenses

- **Natural killer cells**
  - Kill virus-_________________________________
  - Large, granular______________________________
  - No __________ and no ______________________

- **Protective proteins**
  - Complement
    - Composed of _________________________________
    - Activated when ______________________________
    - Amplify____________________________________
    - Bind to the surface of __________, ensuring that they ______________
    - Form a membrane attack complex that __________
in the _______ and ____________ of bacteria
  - Interferon
    - Produced by _______________________________________________________________________
    - Produce substances that _______________________________________________________________
Specific Defenses-

- Lymphocytes have

  - **B lymphocytes**
    - Mature in ________________________________
    - Give rise to ________________________________

  - **T lymphocytes**
    - Mature in ________________________________
    - Directly _______ cells that have nonself proteins or ________________________________
When B cells encounter an _antigen_ they are activated to _Plasma cells - Clones; Most mature Plasma cells; Some become Memory B cells_.

- Clones
- Most mature Plasma cells
- Some become Memory B cells
  - Make _antibody_ possible
### Function of Antibodies

<table>
<thead>
<tr>
<th>Classes</th>
<th>Presence</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>IgG</td>
<td>Main antibody type in circulation; crosses the placenta from mother to fetus</td>
<td>Binds to pathogens, activates complement proteins, and enhances phagocytosis</td>
</tr>
<tr>
<td>IgM</td>
<td>Antibody type found in circulation; largest antibody; first antibody formed by a newborn; first antibody formed with any new infection</td>
<td>Activates complement proteins; clumps cells</td>
</tr>
<tr>
<td>IgA</td>
<td>Main antibody type in secretions such as saliva and milk</td>
<td>Prevents pathogens from attaching to epithelial cells in digestive and respiratory tract</td>
</tr>
<tr>
<td>IgD</td>
<td>Antibody type found on surface of immature B cells</td>
<td>Presence signifies readiness of B cell</td>
</tr>
<tr>
<td>IgE</td>
<td>Antibody type found as antigen receptors on basophils in blood and on mast cells in tissues</td>
<td>Responsible for immediate allergic response and protection against certain parasitic infections</td>
</tr>
</tbody>
</table>
T Cells and Cell-Mediated Immunity

• __________________________ must be presented to T cells by an __________________________

• T cell compares __________________________ and the __________________________
  
  - Activated T cell and all daughter cells can __________________________
  
  - Will __________________________ carrying __________________________

• Activated T cells produce __________________________ that stimulate various __________________________
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a. Cytotoxic T cell
- Vesicle
- Perforin
- Digesting enzyme

b. Perforin forms hole in target cell.

c. Digesting enzymes enter through the hole and cause target cell to undergo apoptosis.

d. Scanning electron micrograph

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Active immunity - can develop naturally

Immunization

- Involves ______________________________________
- After the 1st exposure, a ___________________occurs
- A second exposure (“booster”) produces a
  ____________________________________________
- Depends on the presence of __________________
- Usually ____________________
Passive immunity

Occurs when an __________________________ (immunoglobulins)

• Is __________________________

• Can be used in the event of an unexpected exposure __________________________
Hypersensitivity Reactions

Allergies

- (allergens)
  - IgE-Mediated Allergic Response *Immediate allergic response*
    - Caused by ______________________________
    - When an allergen attaches to the IgE antibodies, ______________________________
      - ______________________________ occurs when the ______________________________ has entered the blood stream
  - T-Cell Mediated Allergic Response
    - Initiated by ______________________________ at the site of ______________________________
    - Regulated by ______________________________
Tissue rejections

- Transplanted tissue is recognized as __________________________
- Cytotoxic T cells cause __________________________
- Can be controlled by:
  - Selecting organs that have the same type of __________________________
  - Administering __________________________
Autoimmune diseases

- **Cytotoxic T cells or antibodies**
  
  
  
- **Cause**
  
  Examples:
  - Myasthenia gravis
  - Multiple sclerosis
  - Systemic lupus erythematosus
  - Rheumatoid arthritis

No cures, but
Immune deficiency

- Can be acquired or __________________________
  __________________________
  __________________________
  Can be acquired or __________________________
  Without treatment, __________________________
  __________________________
Effects of Aging

- Aging people become more susceptible _______.
- Thymus gland _______ and number of T cells _______.
- B cells sometimes do not _______.
- Incidence of _______ is decreased _______.
- _______ is decreased.
Homeostasis

- The lymphatic system helps the following:
  - The digestive system______________________________
  - The cardiovascular system________________________
  - The immune system______________________________

- Nonspecific immune responses are dependent on:
  - __________________________
  - __________________________ of the ____________________ tract, the ____________________ tract, the _________ and _________ systems

- Specific defenses are dependent____________________

- There is a strong connection between the _________, ____________________, and ____________
  ____________________