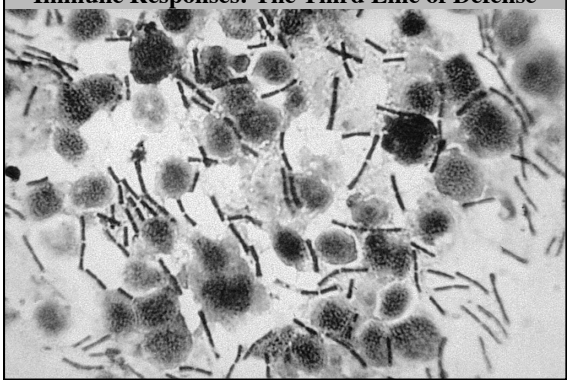
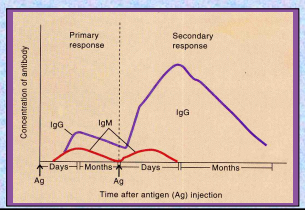
Immune Responses: The Third Line of Defense



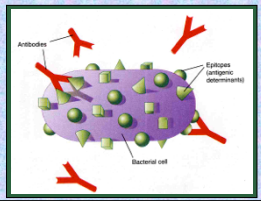
Immune Response (Handout Fig 16.9)

- Immune responses (adaptive immunity) occur if inflammation has failed to eliminate pathogens.
- Characteristics:
  - Specific: Immunity to one pathogen doesn't control other pathogens.
  - Delayed: Usually 7-10 days (initial exposure, primary response). Subsequent encounters, 1-2 days (secondary response).
  - Memory established: Secondary response rapid, infection seldom causes disease.



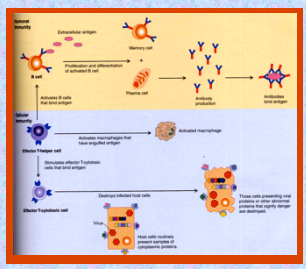
Antigens and Epitopes (Handout Fig 16.3)

- Antigen: Molecule that induces immune response.
  - Large molecules (>10,000 daltons) that are foreign. Body recognizes antigens as "not self".
  - Proteins and polysaccharides induce strong responses (sufficient diversity). Lipids and nucleic acids induce weak response (little diversity).
- Each pathogen has multiple antigens. Pathogen products (like toxins) also act as antigens.
- Epitope: Part of antigen with which antibody reacts. Epitopes are ~10 subunits (amino acids or monosaccharides) within antigen or 3-dimensional shape of a portion of the antigen.



Arms of the Immune Response (Handout Fig 16.1)

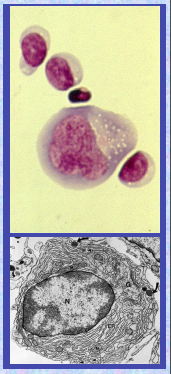
- Two types of immune responses:
  - Humoral Response: Antibody production. Effective against extracellular pathogens or molecules released from pathogens.
  - Cell-Mediated Immunity: Destruction of intracellular pathogens. Antigen presenting cells (APC, like tissue macrophage) participate.



Cells of the Immune Response: Lymphocytes

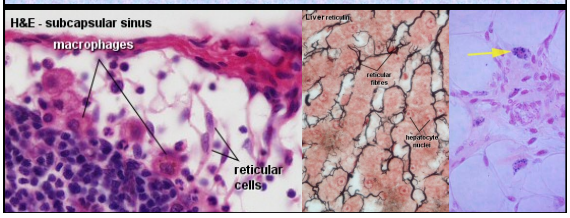
- Lymphocytes: ~35% of white blood cells. Usually lack granules, incapable of phagocytosis, minor role in inflammation.
- 3 Types (identified by surface components):

1. B Cells: have immunoglobulin (antibody) receptors. After antigen contact, differentiate to produce antibody (some become memory cells).
2. T Cells: antigen receptors (T-cell receptor). Cannot be directly activated by antigen. Antigen must be "presented" by APC. After activation, T-cells differentiate to T-helper cells, cytotoxic T cells, or memory cells.
3. NK (natural killer) Cells: contain lysosomes but granule contents different from phagocyte granules.
   - Recognize:
   1. Cells with foreign antigen on surface (host cells that are "different").
      - Initiate apoptosis (programmed cell death) of cells with intracellular pathogen.
   2. Large cells (too large for phagocytes) coated with antibody.
      - Release granule contents into/onto surface of target cells causing direct lysis.



Accessory Cells: Antigen Presenting Cells

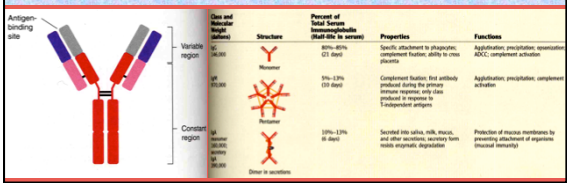
- Accessory cells: not pathogen specific. Necessary for strong immune response and for cytokine production necessary to direct "appropriate" response (B-cell (antibody) for extracellular pathogen, T-cell (cytotoxic) for intracellular pathogen).
- Antigen Presenting Cells: Phagocytic cells (tissue macrophage, dendritic or reticular cells, monocytes) that engulf pathogens, degrade them, and "display" antigens from pathogens in configuration recognized by T-cells.



Humoral Immunity: Antibody Types (Handout Table 16.1)

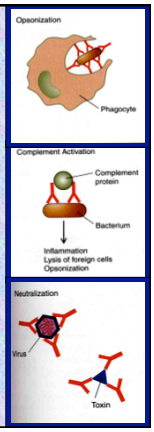
- Basic Antibody Structure: Y-shaped protein (4 different polypeptide chains linked by disulfide bonds). Each antibody has 2 sites for binding antigens.
- Different types of antibody (important in immunity):

1. IgG: Single antibody. Most abundant. Can cross placenta.
2. IgM: 5 identical antibody molecules joined by Fc portion (stem, constant region). First antibody produced.
3. IgA: 2 identical antibody molecules joined by Fc portion. Called secretory IgA because secreted across mucous membranes (prevents adherence of pathogens).



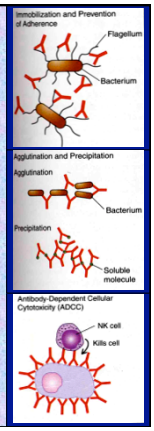
Antibody Actions Against Pathogens (Handout Fig 16.5)

- Antibodies: effective against extracellular pathogens and pathogen products.
  1. Opsonization: Antibody binds to pathogen, Fc portion binds Fc receptor on phagocytes. Increases interaction between pathogen and phagocyte to allow phagocytosis.
  2. Complement Activation: Antibody bound to pathogen activates complement cascade. Pathogen destroyed by MAC.
  3. Neutralization: Antibody binds to pathogen (particularly virus) at sites used for adherence or to part of toxin responsible for targeting a cell. Pathogen or toxin cannot bind target cell, "neutralized".



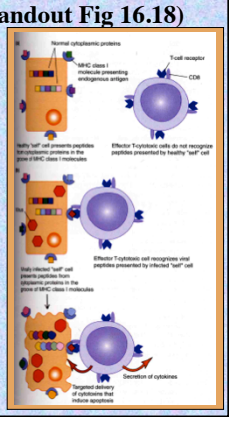
Antibody Actions Against Pathogens (cont., Handout Fig 16.5)

4. Immobilization: Antibody against flagella prevents movement of bacteria.
5. Agglutination and Precipitation: Antibody connects pathogens using 2 antigen binding sites (agglutination) allowing phagocytosis of numerous pathogens simultaneously. Cross-linking of pathogen products like a toxin causes the product to become insoluble (precipitation).
6. Antibody-Dependent Cell Cytotoxicity (ADCC): Cells too large for phagocytes or cells with intracellular pathogens (that show antigen on cell surface) become coated with antibody. NK cells bind to antibody-coated cell and release granule contents. Large cells killed directly. Apoptosis induced in infected cells.



Cell Mediated Immunity (Handout Fig 16.18)

- Cell mediated immunity: designed to kill intracellular pathogens.
- When cell is infected with intracellular pathogen, normal cell markers are disrupted. Some pathogen antigens displayed.
- Cytotoxic T cells: bind to cells displaying pathogen antigens and release cytotoxins that cause apoptosis. Pathogens stay inside dead cell until phagocytized by macrophage. Killed.
- T-helper cells: produce cytokines that direct immune response (make sure response occurring is the one necessary to control the pathogen), initiate antibody production, and activate macrophages (enhance their ability to kill pathogens).



Immune Response Localization

- B cells: stay in lymph nodes. Produce antibodies. Antibodies released into lymph or blood. Circulate through body. Sites of pathogen invasion (inflammation) have increased leakage of fluid so increased antibody.
- Cytotoxic T cells: after activation, return to circulation and migrate to sites of inflammation. Carry out activities at infection site.
- T-helper cells: remain in lymph tissues. Activate B-cells and cytotoxic T-cells.