Chapter 17
Specific Immune System

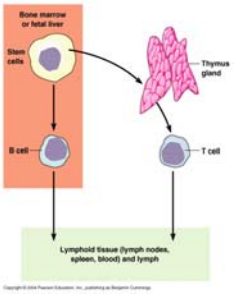
Specific Immune Response

- Innate (nonspecific) Defenses against any pathogen
- Immunity Specific antibody and lymphocyte response to an antigen
- Antigen (Ag) A substances that causes the body to produce specific antibodies or sensitized T cells
- Antibody (Ab) Proteins made in response to an antigen

General Characteristics

- Involves specialized WBC's known as lymphocytes
- Response is highly specific
- Response generates memory
- Can discriminate between self and non-self
- Antigen: substance that provokes response
- Antibody: Immune response product

Lymphocytes are responsible for the **specific** immune response



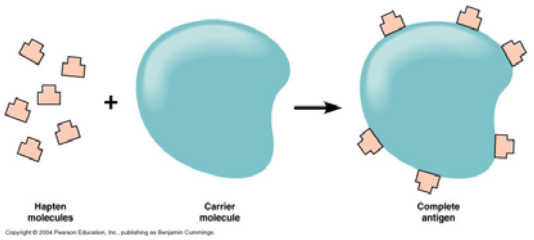
Types of Immunity

- Naturally acquired active immunity
  - Resulting from infection
- Naturally acquired passive immunity
  - Transplacental or via colostrum
- Artificially acquired active immunity
  - Injection of Ag (vaccination)
- Artificially acquired passive immunity
  - Injection of Ab/Immediate but short-lived

What promotes an immune response?

- Antigens
  - Usually proteins or polysaccharides
  - Foreign substance with MW of 10,000 daltons
  - Examples of antigens: bacterial capsules, cell walls, flagella, toxins of bacteria
  - Haptens: not large enough and needs a carrier molecule; Ab produced will react with hapten only

Some molecules are not recognized as antigens until bound to another



How are antigens recognized?

- Self markers also known as MHC markers
- MHC (major histocompatibility complex)
- MHC Class I-produced by all body cells
- MHC Class II-produced by B cells, T cells, and antigen presenting cells

How are antigens recognized?

- Self markers also known as MHC markers
- MHC (major histocompatibility complex)
- MHC Class I-produced by all body cells
- MHC Class II-produced by B cells, T cells, and antigen presenting cells

Antibody

- Immunoglobulin produced in response to an antigen; recognizes, binds to, and then neutralizes or destroys the antigen

5 classes of antibodies separated by electrophoresis

- IgM
- IgG
- IgA
- IgE
- IgD

Serum Proteins

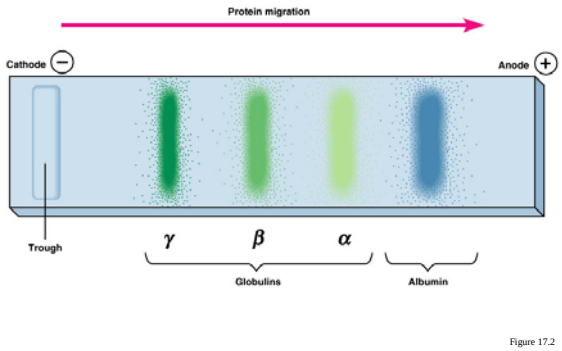


Figure 17.2

Antibody Structure

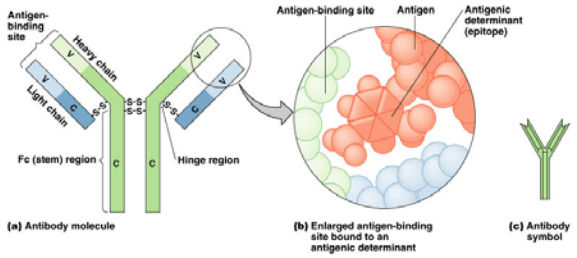


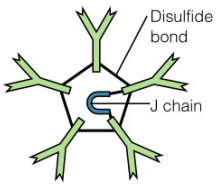
Figure 17.5a-c

IgG antibodies

- Monomer
- 80% of serum Abs
- Fix complement
- In blood, lymph,intestine
- Cross placenta
- Enhance phagocytosis; neutralize toxin/viruses; protects fetus & NB
- Half-life = 23 days

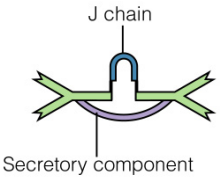
IgM antibodies

- Pentamer
- 5-10% of serum Ab
- Fix complement
- In blood, lymph, on B cells
- Agglutinates Ags; first Ab produced in response to infection
- Half-life = 5 days



IgA antibodies

- Dimer
- 10-15% of serum antibodies
- In secretions
- Mucosal protection
- Half-life = 6 days



IgD antibodies

- Monomer
- 0.2% of serum antibodies
- In blood, lymph, on B cells
- On B cells, initiate immune response
- Half-life = 3 days

IgE antibodies

- Monomer
- 0.002% of serum antibodies
- On mast cells and basophils, in blood
- Allergic reactions; lysis of parasitic worms
- Half-life = 2 days

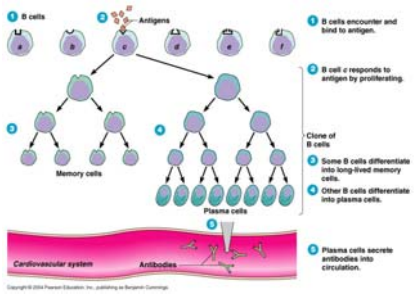
Clonal Selection

- Bone marrow gives rise to B cells.
- Mature B cells migrate to lymphoid organs.
- A mature B cells recognizes epitopes.

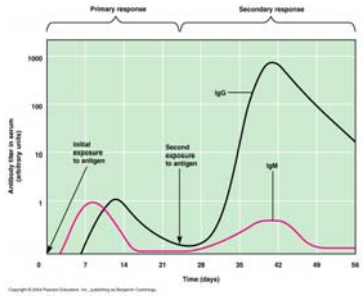
Self-tolerance

- Body doesn't make Ab against self
- Clonal deletion
  - The process of destroying B and T cells that react to self antigens

Clonal selection of B cells



Primary and secondary response to antigen



- Antibodies recognize and react with antigenic determinants or epitopes.

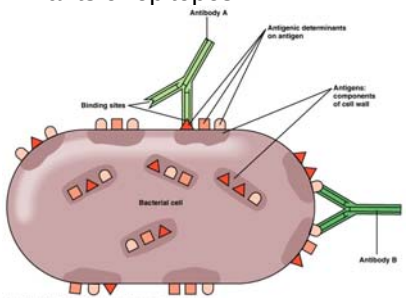
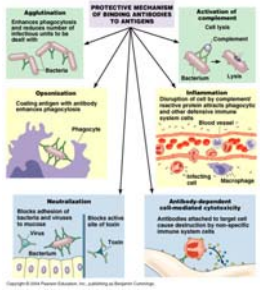


Figure 17.3

Antibody-Antigen Reactions

- Ab and Ag →Ab-Ag complex (tags foreign cells for removal)
- Ab does not harm Ag
- Ag rendered harmless by:
  - Agglutination
  - Neutralization
  - Opsonization
  - Ag dependent mediated cytotoxicity (trigger C')

What can happen when antibody binds antigen?



Monoclonal Antibodies

- Hybridomas are produced by fusing a cancer cell with an Ab-secreting plasma cells
- The hybridoma cell culture is immortal and produces monoclonal Abs (Mabs)
- Immunotoxins: Mabs conjugated with a toxin or radioisotope to target cancer cells
- Used to suppress T cells in transplant patient; treat specific illnesses (leukemia, Crohn's, RA)

Immune system cells communicate via cytokines

- Interleukins: between WBCs
  - Interleukin-1 Stimulates T_H cells
  - Interleukin-2 Activates T_H, B, T_C, and NK cells
  - Interleukin-12 Differentiation of CD4 cells
- γ-Interferon Increase activity of macrophages
- Chemokines Cause leukocytes to move to an infection/chemotaxis

Cell-Mediated Immunity

- Specialized lymphocytes, mostly T cells, respond to intracellular Ags
- After differentiating in the thymus, T cells migrate to lymphoid tissue
- T cells differentiate into effector T cells when stimulated by an Ag
- Some effector T cells become memory cells

Cell-Mediated Immunity

- Specialized lymphocytes, mostly T cells, respond to intracellular Ags
- After differentiating in the thymus, T cells migrate to lymphoid tissue
- T cells differentiate into effector T cells when stimulated by an Ag
- Some effector T cells become memory cells

Antigen Presenting Cells

- **Dendritic cell** and **macrophages** are **antigen-presenting cells**
- **APC ingests and processes Ag; displays fragment on surface with MHCII**
- **Activates T helper cells**

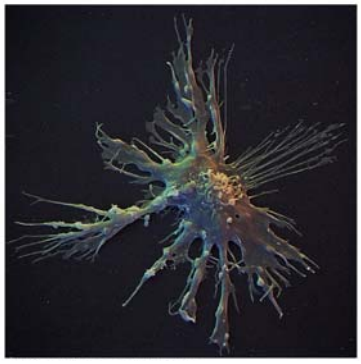


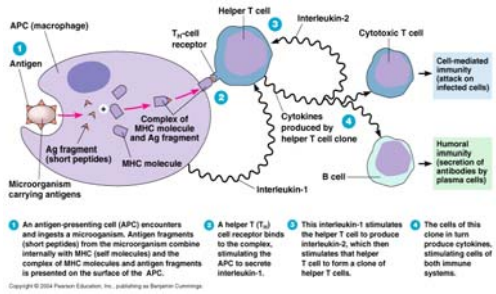
Figure 17.12

T Cells

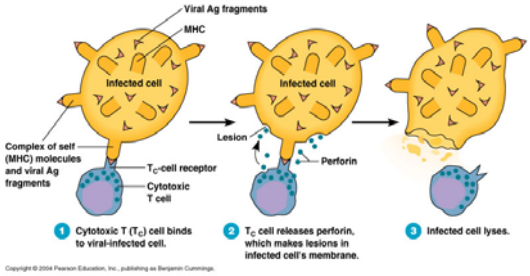
- Helper T Cells (CD4, T_H)
  - T_H1 Activate cells related to cell-mediated immunity
  - T_H2 Activate B cells to produce eosinophils, IgM, and IgE
- Cytotoxic T Cells (CD8, T_C)
  - Destroy target cells with perforin

- Delayed Hypersensitivity T Cells (T_D)
  - Associated with allergic reaction, transplant rejection, and tuberculin skin test
- Suppressor T cells (T_S)
  - Turn off immune response when Ag no longer present

Helper T cells help activate other immune cells



Cytotoxic T cells identify infected body cells



Nonspecific Cells

- Activated macrophages: Macrophages stimulated by ingesting Ag or cytokines
- Natural killer cells: Lymphs destroy virus or tumor

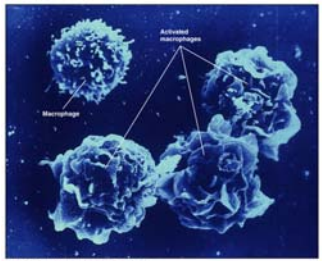
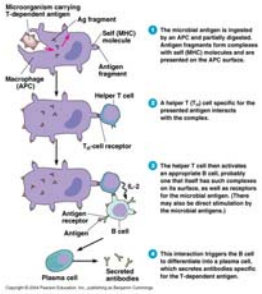
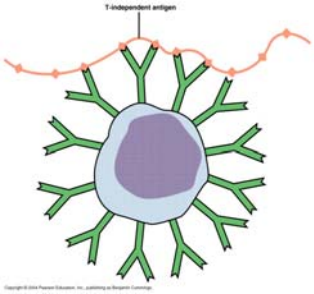


Figure 17.15

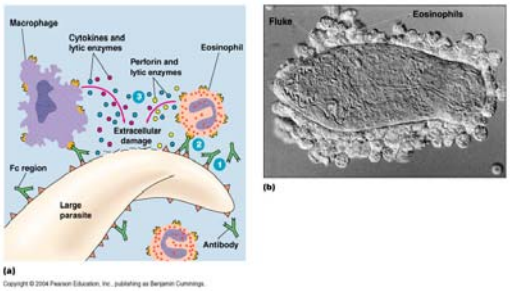
Helper T cells activate B cells



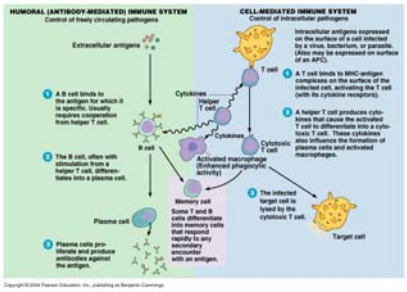
T independent antigens



Antibody dependent cell mediated cytotoxicity



Overview


HUMORAL (ANTIBODY-MEDIATED) IMMUNE SYSTEM
Control of freely circulating pathogens
CELL-MEDIATED IMMUNE SYSTEM
Control of intracellular pathogens
Extracellular antigens
Intracellular antigens expressed on the surface of a cell infected by a virus, bacterium, or parasite. (Also may be expressed on surface of an APC).
T cell
A T cell binds to MHC-antigen complexes on the surface of the infected cell, activating the T cell (with its cytokine receptors).
A B cell binds to the antigen for which it is specific. Usually requires cooperation from helper T cell.
Cytokines
Helper T cell
A helper T cell produces cytokines that cause the activated T cell to differentiate into a cytotoxic T cell. These cytokines also influence the formation of plasma cells and activated macrophages.
Cytokines
B cell
Cytotoxic T cell
The B cell, often with stimulation from a helper T cell, differentiates into a plasma cell.
Activated macrophage (Enhanced phagocytic activity)
Memory cell
The infected target cell is lysed by the cytotoxic T cell.
Target cell
Plasma cell
Some T and B cells differentiate into memory cells that respond rapidly to any secondary encounter with an antigen.
Plasma cells proliferate and produce antibodies against the antigen.