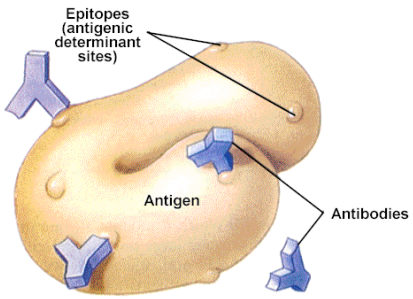
Chapter 16

Adaptive Immune Response

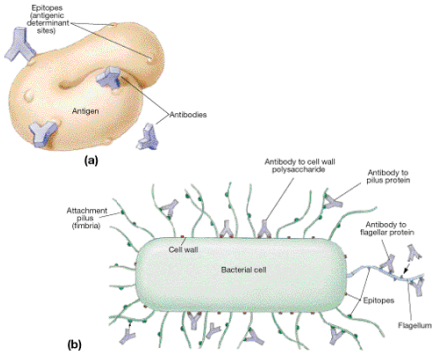
Acquired Specific Immunity

- Active immunity
  - Produced by the host
  - Natural--exposure to infection or free antigens.
  - Artificial--vaccination or transfusion.
- Passive immunity
  - Produced by a donor.
  - Natural--transplacental or in breast milk
  - Artificial--from serum or specific lymphocyte products.

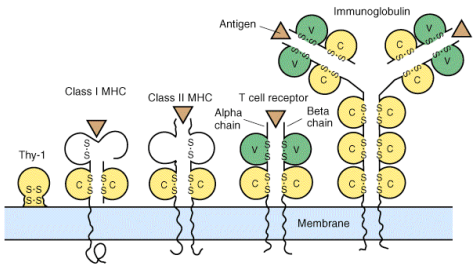
Antibodies bind to epitopes



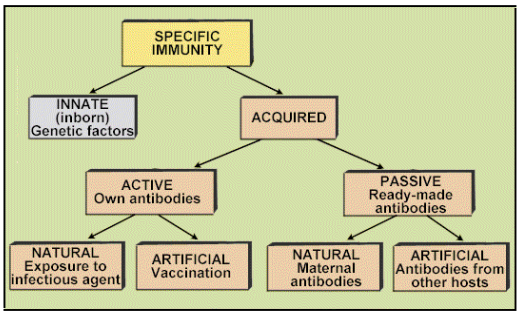
Flagella, pili, & cell walls may have several antigens



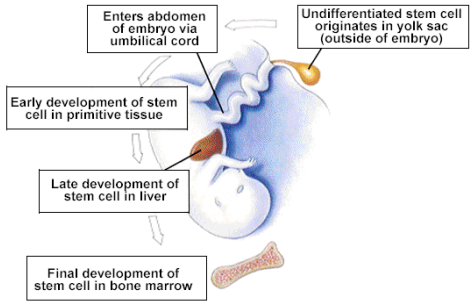
Antibodies and receptors



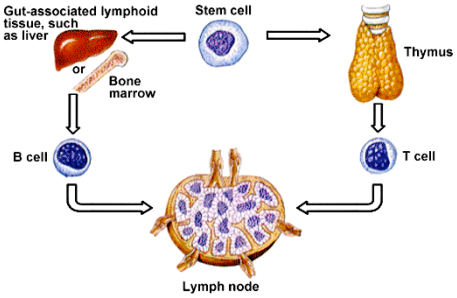
Immunity



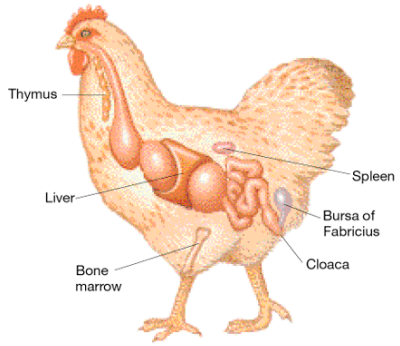
Embryonic stem cells reside in bone marrow



Stem cell can become T or B cells



The bursa of Fabricius



Percent B & T cell in tissues

LYMPHOID TISSUE	% B CELLS	% T CELLS
Peyer's patches and nodules in digestive tract	60	25
Spleen	45	45
Lymph nodes	20	70
Blood	25	75
Thymus	1	99

Two components

Humoral Immunity

Cellular Immunity

Humoral Immunity

- Found in blood serum and lymphoid organs.
- Defends host from pathogens outside of cells, bacteria, bacterial toxins, viruses in body fluids.
- Antibodies in serum comprise "humoral" component.

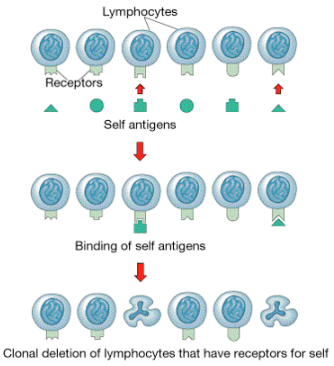
Cellular Immunity

- White blood cells in blood and lymphoid tissue.
- Defends host from bacteria, viruses within cells, fungi, protists, other parasites.
- Immune surveillance.

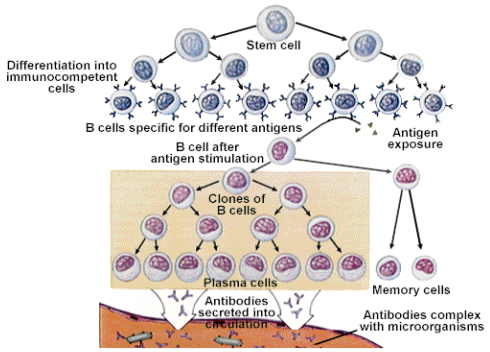
Properties of the immune response

- "self" verses "non-self"
  - "self" is normal host tissue
    - Cells are marked by major histocompatibility (MHC) proteins.
  - "non-self" is foreign substances
- Specific antigen-antibody response.
- Heterogeneity
  - many different kinds of antibodies
- immunologic memory
  - anamestic response (secondary or recall)

Clonal deletion (eliminates lymphocytes that recognize self)



Clonal selection process

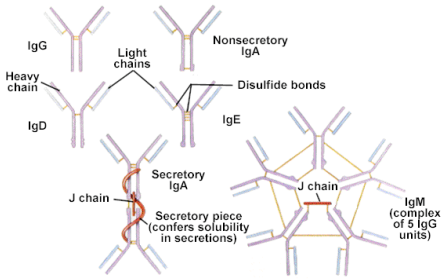


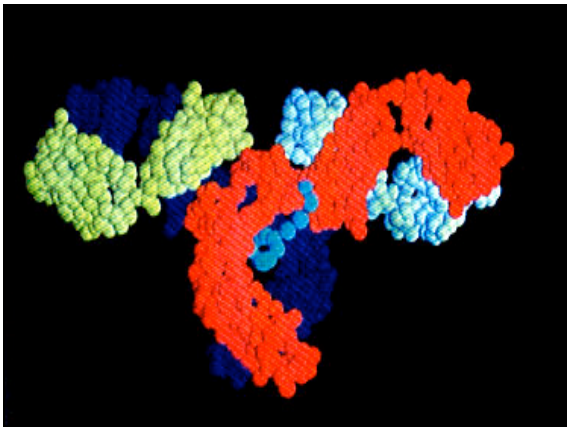
Antibody response: B cells

- Interleukins (IL) promote B cell growth and differentiation.
- B cells produce antibodies.

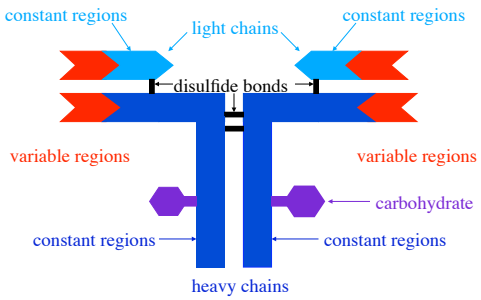
Antibody

- Immunoglobulin (Ig)
- Globular glycoprotein comprised of 2 "light" chains and 2 "heavy" chains.
- 5 kinds: IgM, IgG, IgA, IgD, IgE.
- 2 antigen-binding sites.

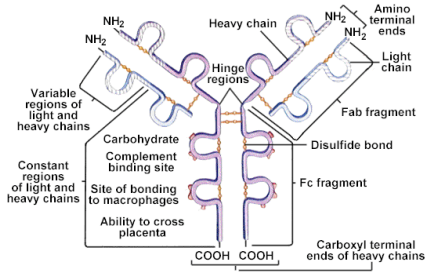




Basic Structure of an Antibody



Antibody



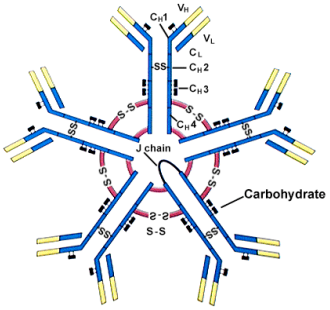
IgG

- Most common antibody (80% in serum).
- Major humoral defense protein.
  - Largest during the secondary response
- Fix complement, lyse bacteria, viruses, old cells.
- Transferred across placenta.
- Production follows formation of IgM.

IgM

- First immunoglobulin to be produced in response to antigen (primary)
- Short life span
- 5 units connected together
- Fix complement, lyse bacteria, viruses, old cells
- 5-10% serum

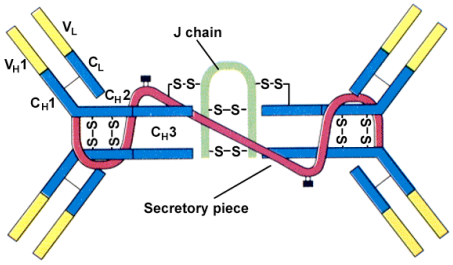
IgM



IgA

- Humoral immunity in mucous secretions (tears, saliva, semen, colostrum)
- Contains secretory piece
- Dimeric
- Neutralizes toxins, allergens, bacteria, viruses
- 10% in serum

IgA



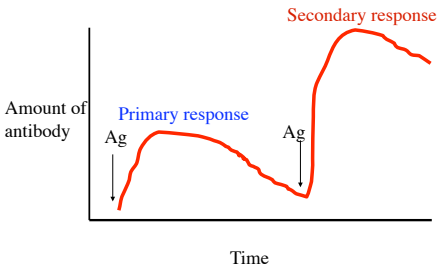
IgE

- Allergic antibody
- Attached to surface of mast cells (basophils)
  - causes the release of histamines
- 0.005% in serum

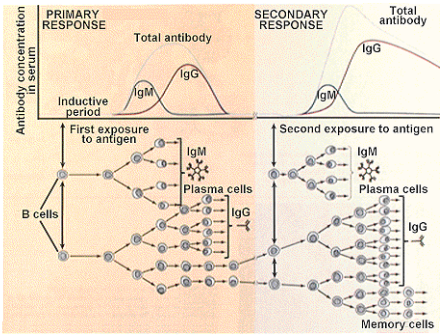
IgD

- Function is not well known.
- Associated with unactivated B cells.
- Perhaps a cell receptor.
- 0.2% in serum

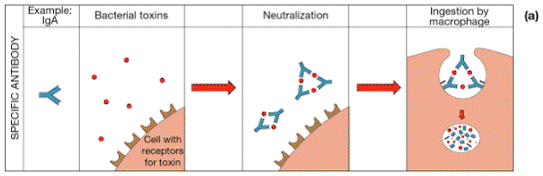
Antibody production



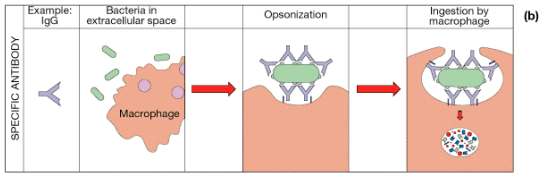
Antibody responses



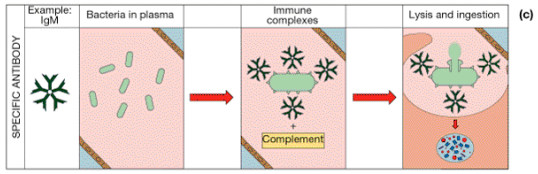
IgA, IgM, & IgG mediated neutralization of toxins



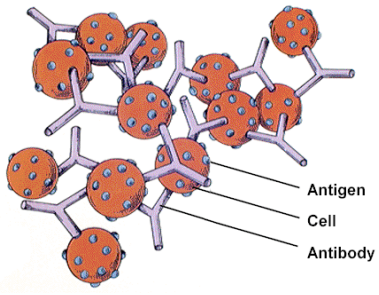
IgG & IgM - opsonization



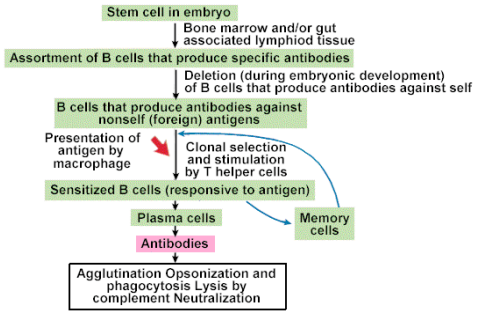
IgM & IgG formation of immune complexes



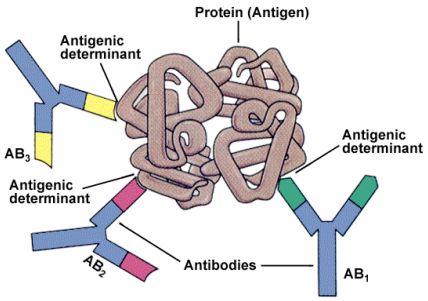
Immune complexes



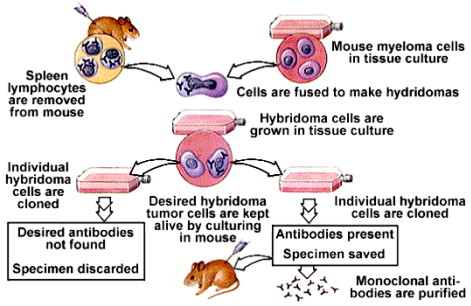
Summary of humoral immunity



Polyclonal antibodies



Monoclonal antibody production



Lymphocytes

- Mediators of both humoral and cellular immunity.
- T cells: thymus-derived.
- B cells: bone marrow-derived.
- Null cells: include natural killer (NK) cells and killer (K) cells.

Lymphocytes

CHARACTERISTIC	B CELLS	T CELLS
Site of production	Bursal-equivalent tissues	Thymus or under thymic hormones
Type of immunity	Humoral	Cell-mediated and assist humoral
Subpopulations	Plasma cells and memory cells	Cytotoxic, helper, suppressor, delayed hypersensitivity, and memory cells
Presence of surface antibodies	Yes	No
Presence of foreign surface antigens	No	No
Presence of receptors for antigens	Yes	Yes
Life span	Some long, most short	Long and short
Secretory product	Antibodies	Lymphokines
Distribution (% leukocytes)		
Peripheral blood	15-30	55-75
Lymph nodes	20	75
Bone marrow	75	10
Thymus	10	75

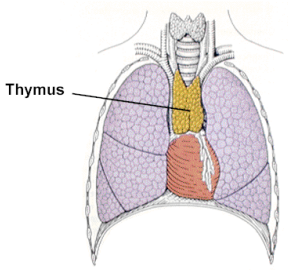
Antibody response: Macrophage

- Macrophage engulf foreign substance and process antigens.
- Macrophage present antigens to T and B lymphocytes.

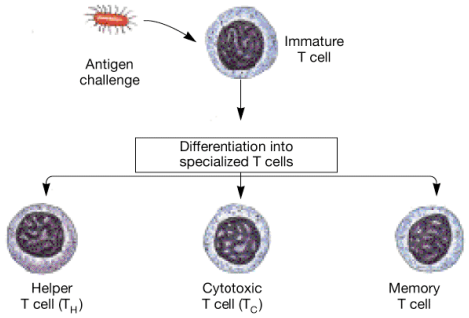
Antibody response: T cells

- Helper T cells produce interleukins.
  - they "help" the B cells.
- Suppressor T cells moderate/suppress the activity of the B cells.

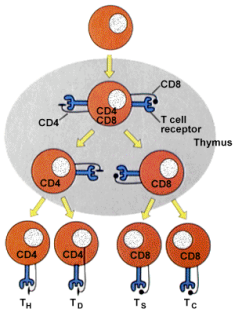
T-cells mature in the thymus



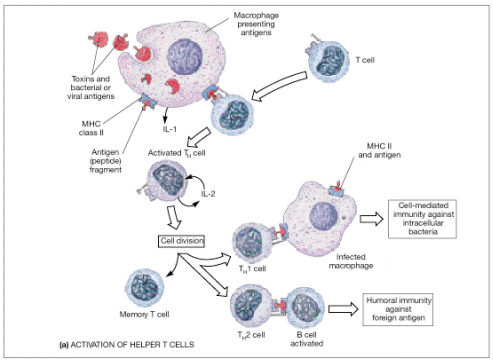
T-cell differentiation



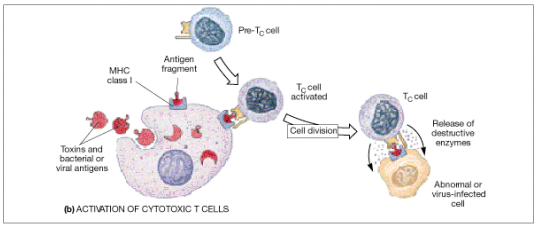
T-cell differentiation



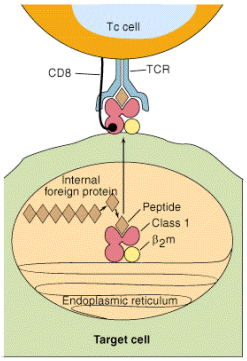
Activation of helper T-cells



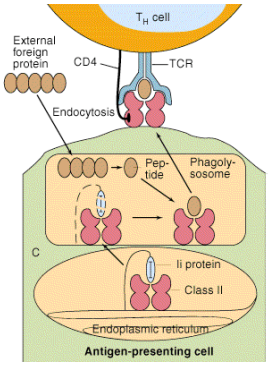
Activation of cytotoxic T-cells



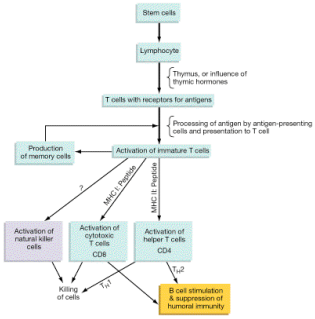
Cytotoxic T-cell targeting a cell



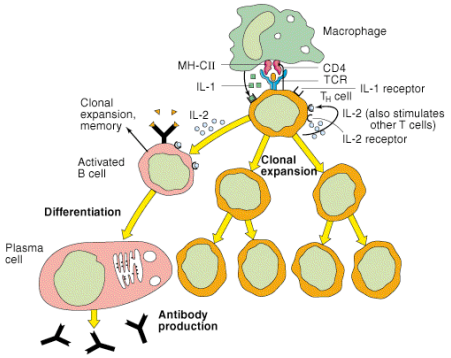
Antigen presenting cell (APC)



Summary of cell-mediated immunity



Summation



Antigens

- Foreign matter that triggers the immune response.
- Epitopes are small portions of an antigen that are recognized by antibody.

Hypersensitivity

- Extreme sensitivity to foreign antigens.
- Allergic responses.

Type I: Immediate/Anaphylactic

- Hay fever, insect stings, penicillin,
- Soluble antigens
- Acute phase ends within 20 minutes to a few hours.
- Symptoms: reddening and swelling, anaphylaxis.

Type I: Cellular response:

- IgE receptors are found on mast cells
- When antigen binds to bound IgE, granules are released
- Granules include histamines which cause vasodilation, leakage of serum into tissues, and smooth muscle contraction

Type II: Cytotoxic -- Complement-mediated

- Tranfussion, Rh disease, thrombocytopenia
- Requires complement-IgG/IgM complex
- Causes lysis of red blood cells if antigen is bound to rbc's
- Can lead to anaphylaxis when mast cells are activated.

Type III: Immune-Complex/Arthus

- Farmers lung, lupus, rheumatoid arthritis, rheumatic fever
- Associated with IgG/IgM and complement
- Response is similar to Type II
- Rash forms and may be renal failure

Type IV: Delayed/Cell-mediated

- Some drug allergies, poison ivy, poison oak, platics, cosmetics, tuberculin skin test
- Skin reaction over 24-72 hours: reddening, then diminishes
- T-cells migrate to area and release lymphokines, macrophage flood site, some host cells may be killed

Active immunization

- Toxoid
  - May require a booster
- Killed pathogen
- Live but attenuated pathogens
  - Usually life long immunity
- Vaccinations
  - DPT, poliomyelitis, MMR, Hib

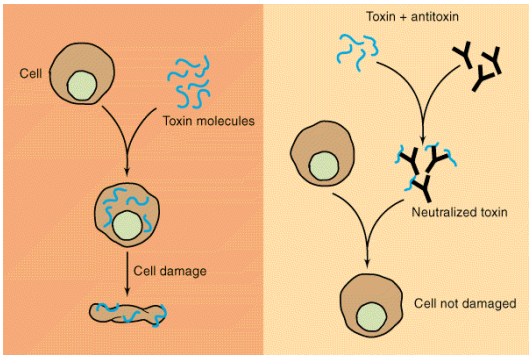
Immunizations

DISEASE	VACCINE	DOSAGE SCHEDULE
Diphtheria	Toxoid	2, 4, and 6 months, 1 1/2 and 4 to 6 years
Tetanus	Toxoid	Same as diphtheria, administered in DPT vaccine
Pertussis	Killed bacteria	Same as diphtheris, administered in DPT vaccine
Poliomyelitis	Live viruses Types I, II, and III	2, 4, and 6 months, 1 1/2 and 4 to 6 years
Haemophilus (HIB) infection	Polysaccharide-protein conjugate	2, 4, 6, and 15 months
Measles	Live virus	15 months, booster at school age, 11-12 years
Mumps	Live virus	15 months, 11-12 years
Rubella	Live virus	15 months, 11-12 years

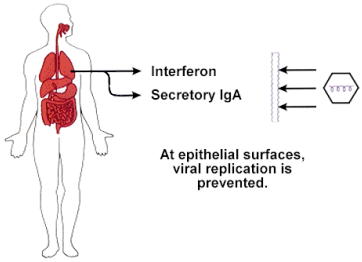
Passive immunization

- Immune serum globulin
  - Gamma globulin
    - Portion of the serum containing antibodies
- Hyperimmune serum
  - Gamma globulin from a person recovering from an illness
- Antitoxin
  - Antibodies against specific toxins

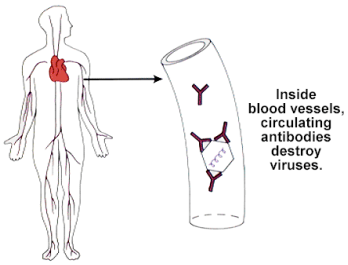
Passive immunization



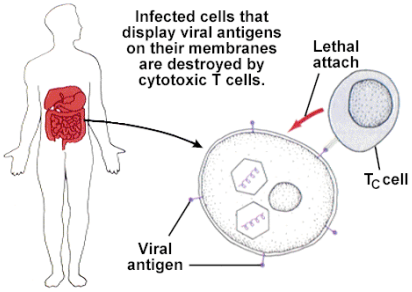
Viruses - IFN, IgA, & IgG



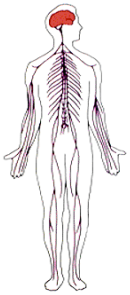
Viruses - IgM & IgG



Viruses - Tc cells and NK cells



Viruses - Host damage



Sometimes more damage results from immune response (killing of virally infected cells) than would have been caused by the virus alone.

↓

Immunopathology

Taxing the immune system