Body Defenses

• NONSPECIFIC
• 1\textsuperscript{st}-External body membranes
  – Skin and mucosa
• 2\textsuperscript{nd}-Phagocytes & antimicrobial proteins
  – Inflammation-hallmark & most important mechanism

• SPECIFIC
• 3\textsuperscript{rd}-Immune system
  – Particular foreign substances are attacked
Nonspecific Defenses

• Species Resistance
  – Uniqueness

• Mechanical Barriers
  – Skin
  – Mucous membranes

• Chemical Barriers
  – Enzymes, etc. in body fluids
    • pH of skin = 3-5
    • Gastric juice
    • Lysozyme in tears
  – Interferons
Nonspecific Defenses

• Inflammation
  – Prevents spread to nearby tissues
  – Disposes of cell debris and Pathogens
  – Sets stage for repair processes

  – Histamine, Bradykinin, Prostaglandins, Lymphokines all enhance inflammation.
Nonspecific Defenses

• Phagocytosis
  – Neutrophils-die in the battle
    • Produce defensins
  – Macrophages-survive several battles
    • Respiratory burst

• Natural Killer Cells (NKs)
  – Secrete chemicals against cell wall
  – Enhance inflammatory response
1. Neutrophils enter blood from bone marrow
2. Margination (pavementing)
3. Diapedesis
4. Positive chemotaxis

Inflammatory chemicals diffusing away from the inflamed site act as chemotactic agents.
Complement System

Activation of complement proteins

- Opsonization-enhancing phagocytosis of antigens
- Altering the molecular structure of viruses
- Chemotaxis-attracting macrophages and neutrophils
- Lysis-rupturing membranes of foreign cells
- Clumping of antigen-bearing agents

Presence of antibodies combined with antigens
**Host Cell 1**
Infected by virus; makes interferon; is killed by virus

**Host Cell 2**
Entered by interferon from cell 1; interferon induces changes that protect it
Nonspecific Defenses

• Fever
  – Regulated by the hypothalamus
  – Difficult for bacteria to repair cell walls
  – Stimulates WBC activity
**B-Cell and T-Cell Origin**

1. Stem cells in red bone marrow give rise to undifferentiated lymphocytes.
2. Undifferentiated lymphocytes enter blood.
3. Some lymphocytes are processed in thymus gland to become T cells.
4. Other lymphocytes are processed in bone marrow to become B cells.
5. T cells and B cells are transported to lymphatic organs by blood.

Blood vessel

Undifferentiated lymphocyte

Red bone marrow

Thymus gland

Fetal bone marrow

T cell

Lymph node

B cell
Lymphocyte Functions

• Cell-mediated immunity (CMI)
  – Cell to cell contact
    • Respond to processed protein fragments
    • T cells release cytokines

• Antibody-mediated immunity (AMI)
  – B cells differentiate into plasma cells
  – Secrete antibodies (immunoglobulins)
1. Antigen adheres to APC
2. APC forms pseudopods that eventually engulf the particle
3. Phagocytic vesicle containing antigen (phagosome)
4. Antigen in fused vesicle (phagolysosome) is partially degraded and peptide portions of it are displayed on the APC’s surface coupled to a cell-surface self (MHC) protein
5. Indigestible and residual material is removed by exocytosis
Antibody Formation

- Antigen
- Receptor-antigen combination
- Activated B cell
- Proliferation
- Released antibodies
- Plasma cell (antibody-secreting cell)
- Memory cell (dormant cell)
- Endoplasmic reticulum
- Plasma cell (antibody-secreting cell)
- Memory cell (dormant cell)
Acquired Immunity

Naturally acquired
- Active: Infection; contact with pathogen
- Passive: Antibodies pass from mother to fetus via placenta; or to infant in her milk

Artificially acquired
- Active: Vaccine; dead or attenuated pathogens
- Passive: Injection of immune serum (gamma globulin)
Antibody Structure

Key:
- **Disulfide bond**
- **Carbohydrate side chain**

(a) Antibody molecule
Antibody Types

- IgG—most abundant antibody in plasma
- IgA—exocrine gland secretions
- IgM—released during primary response
- IgD—important in B cell activation
- IgE—associated with allergic reactions
Monoclonal Antibodies

- Produced by descendants of a single cell
- Fusion of tumor cells and B lymphocytes
- Hybridomas
- Uses
  - Diagnose pregnancy
  - Diagnose some sexually transmitted diseases
  - Diagnose types of cancer
Immunodeficiencies
Acquired Immunodeficiencies

• Hodgkin’s Disease
  – Cancer of the lymph nodes
    • Symptoms = fatigue, fever, night sweats

• AIDS
  – Human Immunodeficiency Virus (HIV)
  – Destroys Helper T-cells
Common AIDS-Related Conditions

(1) Persistant lymphadenopathy
(2) Fever
(3) Nausea and vomiting
(4) Fatigue
(5) Night sweats
(6) Headaches
(7) Persistent diarrhea
(8) Dementia
(9) Cancers
(10) Opportunistic infections
Autoimmune Diseases

- Multiple sclerosis
- Myasthenia gravis
- Grave’s disease
- Type I (juvenile) diabetes mellitus
- Systemic lupus erythematosus
- Glomerulonephritis
- Rheumatoid arthritis
Immediate—Reaction Allergy

1. Initial contact with allergen
   - Allergen
   - B cell
   - Allergic reaction
   - Histamine and other chemicals

2. Plasma cell
   - Released IgE antibodies
   - IgE receptor

3. Mast cell

4. Subsequent contact with allergen
   - Granule
   - Allergen

5.
Transplantation and Tissue Rejection

Isograft—identical twin
Autograft—from your own body
Allograft—same species
Zenograft—from different species

Ex. Pig kidneys (54) & heart valves (74)

Immunosuppressive drugs are necessary
Immune System

- Stress—depresses the immune system
  - Macrophages become sluggish
  - High levels of endorphins
  - High levels of cortisol & epinephrine
  - Growth hormone depressed
  - Short term memory fade
  - Cancer & autoimmune diseases