Chapter 21: The Immune System

Immunity = resistance to disease.
Innate vs. adaptive forms; they work together.
Fight pathogens: disease-causing agents.

I. Innate Defenses

(A) Surface Barriers: skin and mucous membranes.

Low pH.
Stomach acid and protein digestion.
Saliva & tears with lysozyme.
Sticky mucous.

(B) Internal Defenses

-1- Phagocytes: Macrophages, neutrophils.
Combine phagosomes with lysosomes.
Adherence facilitated by opsonization.
Additional enzymes released by respiratory burst.

-2- Natural Killer (NK) Cells:
Effective against cancer and virus-infected cells.
Cause apoptosis (similar to lysis).
Enhance inflammation.

-3- Inflammation: Cardinal signs = redness, heat, swelling, pain.
Mast cells release histamine.
Other chemicals released by more WBCs, e.g.
Prostaglandins; leukotrienes; complement.

Hyperemia, edema.
Phagocytes mobilized.

Leukocytosis: increased number of WBCs.
Margination: adhere to capillary walls.
Diapedesis: squeeze through walls into interstitial space.
Chemotaxis: chemical attraction.

Pus accumulates, when contained forms abscess.
-4- Antimicrobial Proteins

a. Interferons = anti-viral.

b. Complement = more than twenty proteins. Enhance inflammation; Lyse pathogens with MAC (membrane attack complex).

Activated by classical and alternative pathways. Classical pathway involves antibodies, opsonization (coats “bad” cells for recognition).

-5- Fever: triggered by pyrogens.

II. Adaptive Defenses

Specific; Systemic; with memory.


(A)Antigens = molecules acting as markers.

Haptens are incomplete antigens. Combine with body proteins for response, Involved in allergies.

Antigenic determinants are the immunogenic (cause the reaction) portion of the antigen.

MHC Proteins are genetically unique. Display peptides on cell surface.

(B)Cells

-1- Lymphocytes

Their development involves immunocompetence and self-tolerance. Done in thymus (T) and bone marrow (B).

Display antigen receptors (antibodies on B Cells).

Naïve until encounter matching antigen and become mobilized.
Somatic recombination of thousands of genes $\rightarrow$
Millions of combinations.

**-2- Antigen Presenting Cells = APCs**
Dendritic Cells (Langerhans);  Macrophages;  B Cells.

(C) **Humoral Immunity**

-1- **Clonal Selection & Differentiation of B Cells**
following encounter with matching antigen.

Most produce **plasma cells**,  
Secrete antibodies 200/ sec.

Few are memory cells.

-2- **Immunological Memory**

Primary response with lag period.  
Secondary response much faster.

-3- **Active** (memory cells formed) **vs. Passive**
  **Natural vs. Artificial forms.**

Vaccines are active, artificial.  
Breast milk is natural, passive.  
Gamma globulin injections artificial and passive.

-4- **Antibodies** = immunoglobulins.  "Gamma Globulins" in blood.

Basic Structure is four polypeptide chains,  
Two heavy and two light.

Each with variable (V) and constant (C) region.  
Antigen binding site created from V regions.
C regions unique to antibody classes-
- **IgA** in secretions
- **IgD** = B Cell receptors
- **IgG** in plasma
- **IgE** in blood, involved in allergies.

Functions: inactivate foreign antigens by neutralization;
agglutinization;
or precipitation,
followed by phagocytosis.
Activates complement, leading to lysis.

Monoclonal antibodies used for pregnancy testing, diagnosing STDs & cancer, other diseases. Can treat blood cancers.

**(D) Cell-Mediated Immunity**

More effective with intracellular pathogens.

1- Clonal Selection & Differentiation of T Cells

Double recognition – foreign antigen and MHC Protein.

**MHC I** on all nucleated cells – displays endogenous antigens.

**MHC II** only on APCs - display exogenous antigens.

Antigen binding, then co-stimulation,
Leads to clonal selection.

Variety of cytokines = chemical messengers.
-2- Specific T Cells

   a. **Helper Ts** activate T & B Cells, macrophages.

   b. **Cytotoxic Ts** directly attack and kill cells.

   Lethal hits with perforins and granzymes, cause apoptosis.

   Do immune surveillance with NK Cells.

   c. **Regulatory T Cells** = suppressors.

-3- Organ Transplants

Match blood types, MHC proteins.
Immunosuppression after surgery.

(E) **Homeostatic Imbalances**

-1- **Immunodeficiencies:** SCIDS (innate);

AIDS. Retrovirus infects Helper Ts (few other Ts). Opportunistic infections: 
*Pneumocytis* pneumonia; Thrush; Kaposi Sarcoma…..

HIV survives in body fluids, mostly blood and others with WBCs (semen, breast milk).

-2- **Autoimmune:** MS (multiple sclerosis); myasthenia gravis; Graves Disease; Type I Diabetes; Lupus; rheumatoid arthritis.

-3- **Hyper sensitivities:**

Allergies
Most are immediate, Type I, some are delayed.