The Nature of Host Defenses

There are at Least Three Lines of Defense Against Microbial Invasion

- 1st line of defense – Non-Specific Barriers
  - intact skin
  - mucous membranes & their secretions
- 2nd line of defense - Non-Specific
  - phagocytic white blood cells
  - inflammation -complement
  - fever -interferon
- 3rd line of defense - Specific
  - B & T lymphocytes
  - antibodies

Physical or Anatomical Barriers

- Cornification of outermost layer of skin
- Flushing effect of sweat glands
- Rapid replacement of damaged cells
- Mucous impedes attachment & entry of bacteria
- Blinking & tear production
- Nasal hair traps larger particles

Chemical Defenses

- Sebaceous secretions
- Lysozyme in tears
- High lactic acid & electrolyte concentration in sweat
- Skin’s acidic pH
- Hydrochloric acid in stomach
- Digestive juices and bile of intestines
- Semen contains antimicrobial agents
- Vagina has acidic pH

Genetic Defenses

- Some pathogens have great specificity
- Some genetic differences exist in susceptibility
A Healthy Immune System is Responsible for
- Surveillance of the body
- Recognition of foreign material
- Destruction of entities deemed to be foreign

Immune System Definitions
- White blood cells (leukocytes) – have an innate ability to recognize and distinguish foreign material
- Non-self – foreign material
- Self – normal cells of the body
- Pathogen-associated patterns (PAMPs) – molecules shared by microorganisms
- Pathogen recognition receptors (PRRs) – receptors on WBCs for PAMPs

The Immune System
- A large, complex, and diffuse network of cells and fluids that penetrate into every organ and tissue
- The four major subdivisions of immune system:
  1. Reticuloendothelial system (RES)
  2. Extracellular fluid (ECF)
  3. Bloodstream
  4. Lymphatic system

Reticuloendothelial System (RES)
- Network of connective tissue fibers that interconnects other cells and meshes with the connective tissue network surrounding organs
- Inhabited by phagocytic cells – mononuclear phagocyte system – macrophages ready to attack and ingest microbes that passed the first line of defense
White Blood Cells (Leukocytes) are the Body's Immune Cells

Leukocytes
- Neutrophils - 55-80% - lobed nuclei with lavender granules; phagocytes
- Eosinophils - 1-3% - orange granules & blobed nucleus; destroy eucaryotic pathogens
- Basophils, mast cells - 0.5%; constricted nuclei, dark blue granules; release chemical mediators

Leukocytes - Continued
- Lymphocytes - 20-35% - large nucleus; B & T cells involved in the specific immune response
- Monocytes, macrophages - 3-7% - large nucleus; phagocytic

Lymphatic System
- Provides an auxiliary route for return of extracellular fluid to the circulatory system
- Acts as a drain-off system for the inflammatory response
- Renders surveillance, recognition, and protection against foreign material

Lymphatic Vessels
- Lymphatic capillaries permeate all parts of the body except the CNS
- Thin walls easily permeated by extracellular fluid which is then moved by contraction of skeletal muscles
- Functions to return lymph to circulation; flow is one-direction - toward the heart - eventually returning to blood stream
**Lymphatic Fluid**
- Lymph is a plasmalike liquid carried by lymphatic circulation
- Formed when blood components move out of blood vessels into extracellular spaces
- Made up of water, dissolved salts, 2-5% proteins
- Transports white blood cells, fats, cellular debris & infectious agents

**Lymph Nodes**
- Small, encapsulated, bean-shaped organs stationed along lymphatic channels & large blood vessels of the thoracic and abdominal cavities
- Contain populations of T and B lymphocytes in sinuses
- Act as sites for encounters with microbes leading to specific immune responses

**Actions of the Second Line of Defense**
- Recognition
- Inflammation
- Phagocytosis
- Interferon
- Complement

**Recognition**
- Protein receptors within cell membrane of macrophages, called Toll-like receptors
- Detect foreign molecules and signal the macrophage to produce chemicals which:
  - stimulate an inflammatory response (nonspecific)
  - promote the activity of B and T cells (specific)
Inflammation – a Generalized Response to Tissue Injury

Stages of Inflammation

- Blood vessels constrict, then dilate in response to chemical mediators and cytokines
- Edema swells tissues, helping prevent spread of infection
- WBC's, microbes, debris and fluid collect to form pus
- Pyrogens (endogenous or exogenous) may induce fever
- Macrophages and neutrophils engage in phagocytosis

Activities of Phagocytes

- To survey tissue compartments & discover microbes, particulate matter & dead or injured cells
- To invade and eliminate these materials
- To extract immunogenic information from foreign matter

Characteristics of Leukocytes

- Diapedesis – migration of cells out of blood vessels into the tissues
- Chemotaxis – migration in response to specific chemicals at the site of injury or infection
Fever: Another Non-Specific Response

- Elevated body temperature in response to a chemical mediator
- Inhibits temperature-sensitive microorganisms
- Impedes bacterial nutrition
- Stimulates immune reactions

Interferon

- Small proteins produced by specific cells
  - Alpha interferon - lymphocytes & macrophages
  - Beta interferon - fibroblasts & epithelial cells
  - Gamma interferon - T cells
- Produced in response to viruses, RNA, immune products, and various antigens
- Bind to cell surfaces and induce expression of antiviral proteins
- Inhibit expression of cancer genes

Complement

- Consists of 26 blood proteins that work in concert to destroy bacteria, fungi and enveloped viruses
- Complement proteins are activated by cleavage
- Classical pathway
- Alternative pathway
**Complement Pathways**

- Classical pathway – activated by the presence of antibody bound to microorganism
- Alternative pathway – begins when complement proteins bind to normal cell wall and surface components of microorganisms

**Complement Uses a Cascade System**

One component activates another which activates another, and so on