M6 - Pathogenesis & Host Defense

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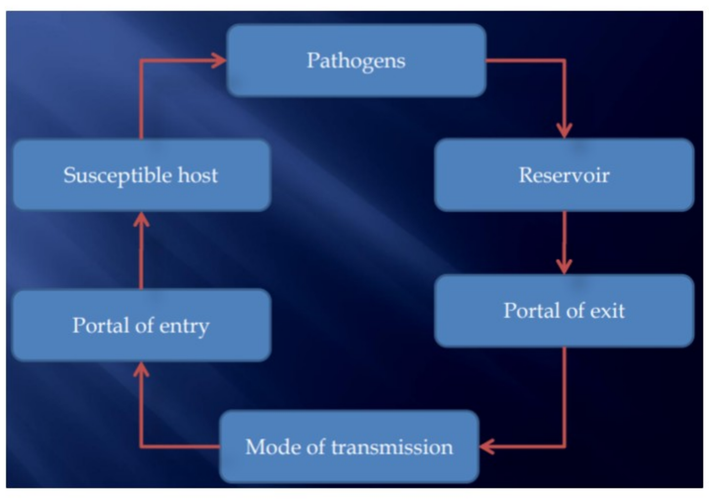
Learning Objectives For Pathogenesis

1. Study the spread of the infection: reservoirs, transmission of disease, and exit
2. Microbial pathogenesis: entry into the host, penetrate host defense and damage the host
3. Understand nonspecific host defense, specific host defense, and antibody-mediated immunity vs. cell-mediated immunity

The Infection Chain

Pathogen	★ Rapid identification of organisms
Reservoir	★ Health surveillance ★ Environmental sanitation ★ Disinfection/sterilization
Portal of exit	★ Hand hygiene ★ Control of excretions and secretion ★ Trash and waste disposal
Mode of transmission	★ Hand hygiene ★ Sterilization ★ Standard precautions ★ Airflow control ★ Food handling ★ Isolation ★ Pest control
Portal of entry	★ Aseptic technique ★ Catheter care ★ Wound care
Susceptible host	★ Treatment of underlying diseases ★ Recognition of high-risk patients



The Iceberg Concept of Infectious disease

Severity and Duration of a Disease

Disease Type	Develop Time	Duration	Example
Acute	Rapidly	Short	Influenza, Hepatitis A
Chronic	Slowly	Long	Tuberculosis, Hepatitis B, HIV
Latent	Inactive	Can be reactivated	Herpes Simplex Virus

Development of Disease

Stage of Disease	Description
Period of incubation	Between: Infection ~ First sign of symptoms
Illness	Exhibits symptoms
Decline	Symptoms subside
Convalescence	Regains strength → a state of health

Predisposing Factors

Gender / Genetic	Climate	Age	Fatigue	Stress	Nutrition

Extent of the Infection

- Local infection (Relative Small Area of Body)
- Systemic infection (Toxins are spread throughout the body via the circulatory system)
- Factors → more susceptible to disease.

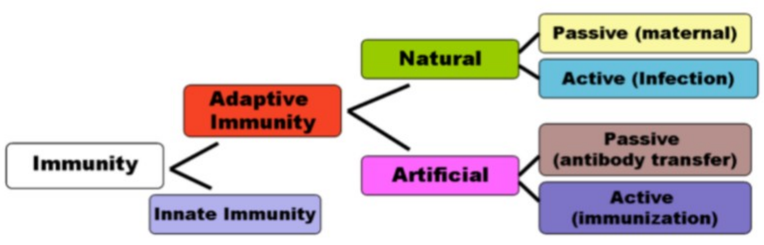
Damage Mechanism

Mechanism	Description
Direct damage to the tissue	Specific tissue-degrading enzymes Example: Collagenases - degrade collagen [Connective tissue]
Endotoxins	Part of Lipopolysaccharide - Release when cell dies → Activate cytokines production → Causing **Septic shock** Therapy: ***anti-endotoxin*** or ***anti-TNF antibodies***
Exotoxins - Cytotoxins	★ Cytotoxins: inhibits protein synthesis E.g.: **Diphtheria Toxin** from *Corynebacterium diphtheria*
Exotoxins - Neurotoxins	★ Neurotoxins: interfere with nerve impulse - **Lockjaw** [Muscle Contraction] E.g.: **Tetanus Toxin** from *Clostridium tetani*
Exotoxins - Enterotoxins	★ Enterotoxins: Affect epithelia cell lining @ GI tract E.g.: **Vibrio enterotoxin** from *Vibrio cholera*

Learning Objectives For Host Defense Mechanism

- Understand nonspecific vs. specific host defense.
- Understand antibody-mediated immunity vs. cell-mediated immunity.

Introduction to Immunity

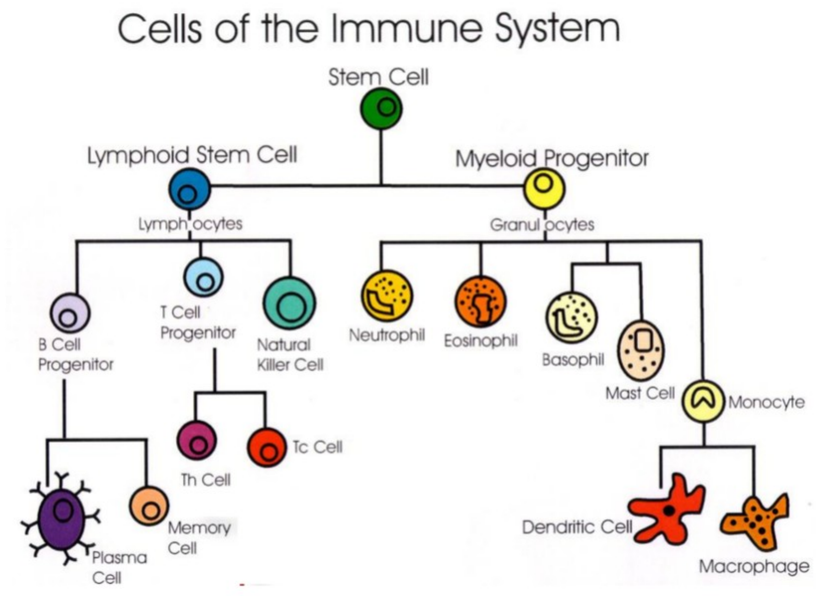


Resistance of organism to infection, disease, or other unwanted biological invasion

Remarks of the Immune Systems

- Phagocytic Cells: Macrophages, Neutrophils, Dendritic cells
- Mast cells: produce Histamine & Prostaglandin → Vasodilation & ↑ permeability of blood vessels
- Interferons:

Function	★ Induce uninfected cells to produce antiviral proteins ★ Modulate immune response
Innate Immunity	IFN-α & IFN-β
Acquired Immune Response	IFN-γ



Non-specific defense

Barriers	★ Physical barriers ★ Chemical barriers ★ Biological barriers
Innate Immunity	★ inflammatory response ★ fever ★ complement system ★ interferon ★ phagocytosis ★ natural killer cells ★ natural resistance

Introduction to Barriers of Non-Specific Defense

Name of Barriers	Description	Type of Barriers
Intact skin	Against the penetration of microorganism	Physical Barriers
Saliva	Washes microorganisms from teeth and gums	Physical Barriers
Mucus	Traps microorganisms @ RR and GI tracts	Physical Barriers
Ciliate	**Moves the mucus up**	Physical Barriers
Sebum from sebaceous glands [Skin]	Production of fatty acid that helps protect the skin	Chemical Barriers
Lysozyme @ tears & saliva	Breaks down bacterial cell walls	Chemical Barriers
Hydrolytic enzymes in saliva Acid in stomach Degradative enzymes in small intestine	Break down and degrade microorganisms	Chemical Barriers
Normal flora	Prevent colonization & Infection	Biological Barriers

Innate Immunity

Type of Innate Immunity	Inflammation	Fever
Cause	Cell damage	Interleukin-1 → hypothalamus
Symptoms	Redness, pain, heat, and swelling	Abnormal High Body Temperatures
Response	Vasodilation and ↑ permeability of blood vessels → Caused by histamine & prostaglandin from mast cells	/
Benefits	Phagocytic cells squeeze through endothelial linings → Phagocytosis → Facilitate tissue repairing	No consistent benefits
Related Systems	Complement system (>20 Different Proteins → Attacks surfaces of pathogens)	CNS

Specific host dense

- Adaptive immune immunity
  - Cell-mediated response - [T-Cell] T for *thymus*
  - Humoral response - [B-Cell] B for *bone marrow*

▼ **Humoral response - Extracellular**

- Production and Circulation of antibodies
  Taget: Extracellular pathogens & Circulating toxins.
- Primary Infection:
  B Cells → Plasma Cell → Release Antibodies
- Secondary Infection:
  Long-living Memory Cell → Multiply → Plasma Cell
- Antibodies from B cells → **Bind to pathogens**
  → **Mark them for destruction by Immune Cells**

▼ **Cell-mediated response - Intracellular**

- Activation of T cells - Recognize and Attack infected cells
  Target: Intracellular pathogens, Cancer cells
- Cytokines from T cells → **Coordinate the immune response**

	Helper T cells (CD4+)	Cytotoxic T cells (CD8+)	Memory T
Responsibility	modulate T and B cell	Release **Lesion & Perforin** → Destroy target cells	secondary immunity

▼ **Remarks:**

- Difference between Natural killer cells (Innate) & T-Cells (Adaptive)

	T-Cells	Natural Killer (NK) Cells A minor type of T Cells
Origin	Mature in the thymus gland	Originate from the bone marrow
Function	Recognize specific antigens → directly attack and kill those cells Release cytokines to regulate the immune response	Missing-self Process. Part of the innate immune system. Killing abnormal cells Antibody-mediated cytotoxicity
Specificity	High degree of specificity.	Recognize based on lack of certain surface markers
Activation	Require antigen presentation become activated - By antigen-presenting cells (APCs) - Example: Dendritic & Macrophages	kill without the need for antigen presentation.
Memory	Memory T Cell	Do not exhibit memory response.

▼ Working Mechanism of T-Cells

- APCs present antigen and pass Interleukin-1 (prevent fever) → Th.
- Th. help to clone the cytokines to the B-cell & T-cell → Killing abnormal cell.