

## IV. Principles of Medical Microbiology (Session 6)

### A. Principles of Infectious Disease

1. Colonization, Normal Flora and The Host-Parasite Relationship
2. Symbiotic Relationships
  - a. A definition of symbiosis: *Staphylococcus epidermidis* (Skin)
  - b. Examples of symbiosis:
    - 1) Mutualism: *E. coli* (G.I. tract)
    - 2) Commensalism: *Enterococcus faecalis* (Throat)
    - 3) Parasitism:
      - Opportunists: *Pneumocystis carinii* (Fungus),  
*Candida albicans* (Yeast), *Pseudomonas aeruginosa*
      - Facultative Parasites: *Clostridium* sp. (Soil),
      - Obligate Parasites: All viruses, *Chlamydia* sp.
3. Pathogenicity and Virulence
  - a. Pathogenicity: *Staphylococcus aureus* vs. *Nitrosomonas* sp.
  - b. Virulence:
    - Human Immunodeficiency Virus (HIV) vs. Rhinovirus
    - Influenza A vs. Influenza B vs. Influenza C Viruses
    - Staph. aureus* vs. *Staph. Epidermidis*
4. Miscellaneous:
  - Parasitism, Evolution and Reduced Virulence
  - Attenuation and Reduced Virulence
  - Koch's Postulates and Molecular Postulates

### B. The Host Parasite Relationship: Mechanisms of Pathogenicity and The Infectious Process

#### 1. Bacteria

##### Step 1: Entrance:

- Oral (*Salmonella* sp.)
- Respiratory (Influenza virus)
- Dermal (Dermatophytes)
- Parenteral (HIV)
- Mucous membranes (*Neisseria gonorrhoeae*)

##### Step 2: Adherence:

- N. gonorrhoeae* - epithelium of urethra
- Hemorrhagic viruses - endothelium of blood vessels
- Rhinoviruses - epithelium of URT
- Note: Anti-phagocytic capsules (*Strep. pneumoniae*)

##### Step 3: Colonization (including multiplication & avoiding immune clearance):

- Extracellular (*Shigella dysenteriae*)
- Intracellular (*Chlamydia* sp.)
- Facultative intracellular (*Histoplasma capsulatum*)

##### Step 4: Tissue damage:

- Due to Invasiveness (*Treponema pallidum*)
  - Types of Invasive Factors: (Hyaluronidase, collagenase, etc)
- Due to toxins:
  - Toxigenic infections (*Corynebacterium diphtheriae*)
  - Intoxications (Staph food poisoning)
    - Endotoxins (Lipid A of LPS of many Gram (-) bacteria)
    - Exotoxins (neuroexotoxins of *Cl. Botulinum* & *Cl. tetani*)
- Due to adverse immune response

#### 2. Effects of Viral Replication

- a. Acute viral diseases: Rapidly cytocidal virus infections (e.g. Polio, Influenza)
- b. Persistent viral diseases:
  - Chronic virus infections (e.g. Hepatitis B and C)
  - Latent infections (e.g. Herpes simplex I and II)
  - Transformation and cancer (e.g. Retroviruses)
  - Slow virus infections ( e.g. HIV)

## C. Epidemiology

1. Reservoirs of disease: Where the m.o.'s are
  - a. Humans: *Salmonella typhi* (Note: Carriers)
  - b. Animals: Rabies and Yellow Fever Virus (Monkeys, etc)
  - c. Non-living: *Vibrio cholera* (Water)
  - d. Nosocomial: *Staph. aureus* (Antibiotic resistant) , *Ps. aeruginosa*, *E. coli* (Toxigenic)
  
2. Transmission of disease: How the m.o.'s get to you
  - a. Contact:
    - Direct: HIV
    - Droplets or saliva: Influenza Virus
    - Fomites: Dermatophytes (Ringworm) and combs; *S. aureus* and towels
  - b. Vectors:
    - Direct injection: WEE and (mosquitoes); RMSF (Ticks)
    - Indirect: *Salmonella* sp.(Houseflies)
  - c. Vehicles:
    - Food: Staph and Salmonella
    - Water: Cholera
    - Air: Coccidiomycosis
  
3. Disease Categories
  - a. Re: Contraction: Infectious (Tetanus) vs. Contagious (Leprosy)
  - b. Re: Chronology: Acute (Influenza) vs. Chronic (Hepatitis) vs. Latent (Herpes)
  - c. Re: Distribution: Endemic (Rhinovirus) vs. Epidemic (Influenza) vs. Pandemic (HIV)
  - d. Re: Incidence: Morbidity vs. Mortality (Rhinovirus vs. HIV)
  - e. Re: Extent: Local vs systemic (*Staph. aureus* & *E. coli*)
  - f. Re: Agent: Primary vs secondary (Influenza A vs *Strep. pneumoniae*)
  - g. Re: Clinical: Detectable vs subclinical
  
4. Roles of Epidemiologists: Who do you trust?

## D. The Host Parasite Relationship: Mechanisms of Immunity

1. Basic Functions:
  - a. Defense
  - b. Homeostasis
  - c. Surveillance
2. Types of Immunity
  - a. Humoral: Transferred by substances
  - b. Cellular: Transferred by cells
  - c. Innate or non-specific immunity
    - First line: Physical and chemical barriers
    - Second line: Biological Barriers
  - d. Adaptive or specific acquired immunity:
    - Recognition
    - Specificity
    - Memory
3. Organization of the Immune System
  - a. Cells: B&T Lymphocytes, Natural killers (NK's), Macrophages, Neutrophils (PMN's), APC's
  - b. Tissues:
    - Primary: Bone marrow, Thymus
    - Secondary: Diffuse lymphoid tissue, Lymph nodes, Spleen
  - c. Substances: Enzymes, Interferons, Complement, Antibody, Lymphokines
4. Mechanisms of Innate Immunity
  - a. Phagocytosis
  - b. Inflammation
  - c. Soluble substances
5. Mechanisms of Specific ("Antigen Driven") Immunity
  - a. Clonal Selection:
  - b. Types:
    - Humoral - via B-cells
    - Cellular - via T-cells
  - c. The Nature of Antigens
    - Properties: Foreignness: Size, Chemistry, Complexity
    - Antigens and Antigenic determinants
  - d. Specific, Humoral Immunity: Antibodies
    - Definition and Chemistry
    - Classes: IgG IgM IgA IgE IgD
    - Functions
  - e. Specific, Cellular Immunity: T-cells
    - Function and Properties
    - Cells: T-Helper (TH), T-Killer (TK), Natural killer (NK)
    - Functions
6. Applied Immunology
  - a. Beneficial Immune Reactions
    - 1) Immunization
      - Purpose and types of vaccines
  - b. Immunologic based tests
  - c. Harmful immune reactions
    - 1) Hypersensitivity reactions
      - Type I-Immediate: ITH
      - Type II-Cytotoxic
      - Type III-Immune Complex
      - Type IV-Delayed: DTH
    - 2) Autoimmune disease
      - Type II-Cytotoxic
      - Type III-Immune complex
      - Type IV-Delayed
    - 3) Transplant rejection
  - d. Immunotherapy
  - e. Reduced Immunologic Reactions
    - 1) Immunosuppression
    - 2) Immunodeficiency
    - 3) Cancer of immune system

- E. Antimicrobial Chemotherapy
  - 1. Historical Background
  - 2. Introduction: Basic Terminology
    - a. Antibiotics: Penicillin
    - b. Synthetic antibiotics: Sulfa's, Isoniazid
    - c. Semi-synthetic antibiotics: Amoxicillin
  - 3. Properties of Antimicrobial Agents
    - a. Selective toxicity: Therapeutic Index = Toxic dose / Therapeutic dose
    - b. Spectrum of activity: Broad vs Narrow vs Very Narrow
    - c. Activity: -Static vs -Cidal
  - 4. Adverse Reactions
    - a. Toxicity or side effects: Dose related vs genetic relatedness
    - b. Development of allergies
    - c. Disruption of normal flora
    - d. Development of resistance
  - 5. Characteristics of an Ideal Antibiotic
  - 6. General Mechanisms of Action of Antibacterial Antibiotics
    - a. Inhibition of cell wall synthesis: Penicillins, Cephalosporins
    - b. Inhibition of protein synthesis: Erythromycin, Tetracyclines, etc
    - c. Inhibition of cell membranes: Nystatin, Polymixin, Amphotericin B
    - d. Inhibition of metabolism: Sulfa's
    - e. Inhibition of nucleic acids: Rifampin
  - 7. General Mechanisms of Action of Antiviral Drugs
    - Amantadine, Acyclovir, AZT, protease inhibitors
  - 8. General Mechanisms of Action of Antifungal Drugs
    - Amphotericin B, nystatin, Azoles,
  - 9. General Mechanisms of Action of Antiprotozoal Drugs