Introduction

- The prefix “path” refers to disease.

Pathogenicity means the ability to cause disease.

Pathogenesis refers to the steps or mechanisms involved in the development of a disease.
Infection Versus Infectious Disease

• An *infectious disease* is a disease caused by a microbe, and the microbes that cause infectious diseases are collectively referred to as *pathogens*.

• *Infection* is commonly used as a synonym for infectious disease (e.g., an ear infection is an infectious disease of the ear).

• Microbiologists reserve the word *infection* to mean *colonization by a pathogen*; the pathogen may or may not go on to cause disease.

• A person can be infected with a pathogen, but *not* have an infectious disease.

Why Infection Does Not Always Occur

• The microbe may land at an anatomic site where it is unable to multiply.

• Many pathogens must attach to specific receptor sites before they are able to multiply and cause damage.

• Antibacterial factors may be present at the site where the pathogen lands.

• Indigenous microflora of that site may inhibit growth of the foreign microbe (i.e., microbial antagonism).

• The indigenous microflora may produce antibacterial factors (i.e., bacteriocins) that destroy the pathogen.

• The individual’s nutritional and overall health status often influences the outcome of the pathogen-host encounter.

• The person may be immune to that particular pathogen.

• Phagocytes present in the blood may destroy the pathogen.
Four Periods or Phases in the Course of an Infectious Disease

- The incubation period
- The prodromal period
- The period of illness
- The convalescent period

Localized Versus Systemic Infections

- Localized Infections
  - Once an infectious process is initiated, the disease may remain localized or it may spread; examples of localized infections are pimples, boils, and abscesses.

- Systemic Infections
  - When the infection spreads throughout the body it is said to have become a systemic or generalized infection; an example is miliary tuberculosis caused by *Mycobacterium tuberculosis.*
**Acute, Subacute, and Chronic Diseases**

- An *acute disease* is one that has a rapid onset, and is usually followed by a relatively rapid recovery; examples are measles, mumps, and influenza.

- A *chronic disease* has a slow onset and lasts a long time; examples are tuberculosis, leprosy, and syphilis.

- A *subacute disease* is one that comes on more suddenly than a chronic disease, but less suddenly than an acute disease; an example would be bacterial endocarditis.

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**Symptoms of a Disease Versus Signs of a Disease**

- A *symptom of a disease* is defined as some evidence of a disease that is experienced by the patient; something that is subjective; for example, aches or pains, ringing in the ears, blurred vision, nausea, dizziness, etc.
  - There are *symptomatic* and *asymptomatic diseases*. In a symptomatic disease, the patient is experiencing symptoms. In an asymptomatic disease, the patient is not experiencing any symptoms.

- A *sign of a disease* is defined as some type of objective evidence of a disease; for example, *elevated blood pressure*, *abnormal heart sounds*, *abnormal pulse rate*, *abnormal laboratory results*, etc.
Latent Infections

- Latent infections are infectious diseases that go from being symptomatic to asymptomatic, and then, later, go back to being symptomatic.
  - Examples include syphilis and herpes virus infections such as cold sores, genital herpes, and shingles.

Primary Versus Secondary Infections

- One infectious disease may commonly follow another; in such cases, the first disease is referred to as a primary infection and the second disease is referred to as a secondary infection.
  - Example: serious cases of bacterial pneumonia frequently follow mild viral respiratory infections.
- During the primary infection, the virus causes damage to the ciliated epithelial cells of the respiratory tract; these cells are then unable to clear opportunistic bacterial pathogens from the respiratory tract, leading to the secondary infection (pneumonia).
A common sequence of steps in the pathogenesis of infectious diseases is:

1. Entry of the pathogen into the body.
2. Attachment of the pathogen to some tissue(s) within the body.
3. Multiplication of the pathogen.
4. Invasion or spread of the pathogen.
5. Evasion of host defenses.
6. Damage to host tissue(s).

**Virulence**

- The term "virulent" is sometimes used as a synonym for pathogenic.
- There may be virulent (pathogenic) strains and avirulent (nonpathogenic) strains of a particular species.
  - Virulent strains are capable of causing disease; avirulent strains are not.
  - For example, toxigenic (toxin-producing) strains of *Corynebacterium diphtheriae* can cause diphtheria, but nontoxigenic strains of *C. diphtheriae* cannot. Thus, the toxigenic strains are virulent, but the nontoxigenic strains are not.
Virulence, cont.

- Sometimes, the term virulence is used to express the measure or degree of pathogenicity.
  - Example: It only takes 10 *Shigella* cells to cause shigellosis, but it takes between 100 and 1,000 *Salmonella* cells to cause salmonellosis. Thus, *Shigella* is more virulent than *Salmonella*.
  - Example: Some strains of *Streptococcus pyogenes* (e.g., the “flesh-eating” strains) are more virulent than other strains of *S. pyogenes*.
  - Example: Some strains of *S. aureus* produce toxic shock syndrome, but other strains of *S. aureus* do not. Those that do are considered more virulent.

Virulence Factors

- **Virulence factors** are attributes that enable pathogens to attach, escape destruction, and cause disease.
- Virulence factors are phenotypic characteristics that are dictated by the organism’s genotype. Examples:
  - *Adhesins* (ligands) - special molecules on the surface of pathogens – are considered to be virulence factors because they enable pathogens to recognize and bind to particular host cell receptors.
  - Pili (bacterial fimbriae) are considered to be virulence factors because they enable bacteria to attach to surfaces, such as tissues within the human body.
Adhesins and Receptors

Examples of Virulence Factors
Obligate Intracellular Pathogens

- Pathogens that must live within host cells in order to survive and multiply are referred to as obligate intracellular pathogens (examples: *Rickettsia* and *Chlamydia* spp.).
  - *Intraleukocytic pathogens* (e.g., *Ehrlichia* spp. and *Anaplasma phagocytophilum*) live within white blood cells, causing diseases known as ehrlichiosis and anaplasmosis.
  - *Plasmodium* spp. (which cause malaria) and *Babesia* spp. (which cause babesiosis) are examples of *intraerythrocytic pathogens*; they live within red blood cells.

Facultative Intracellular Pathogens

- *Facultative intracellular pathogens* are capable of both an intracellular and extracellular existence.
- Intracellular Survival Mechanisms
  - Possess a cell wall composition that resists digestion (e.g., *Mycobacterium tuberculosis*)
  - Fusion of lysosomes with phagosomes is prevented
  - Production of phospholipases that destroy the phagosome membrane, thereby preventing lysosome-phagosome fusion
  - Other unknown mechanisms
Capsules and Flagella

- Capsules and flagella are considered to be virulence factors.
- Examples of encapsulated bacteria: *Streptococcus pneumoniae*, *Klebsiella pneumoniae*, *Haemophilus influenzae* and *Neisseria meningitidis*.
- Flagella are virulence factors because they enable flagellated bacteria to invade aqueous areas of the body; may also help the bacterium to escape phagocytosis.

Exoenzymes

- The major mechanisms by which pathogens cause disease are the exoenzymes or toxins that they produce.
- Exoenzymes released by bacteria include:
  - Necrotizing enzymes: Coagulase
  - Kinases: Hyaluronidase
  - Collagenase: Hemolysins
  - Lecithinase
Toxins

- Toxins are poisonous substances released by various pathogens. There are 2 general types:
  - Endotoxins
    - Part of the cell wall structure of Gram-negative bacteria
    - Can cause serious, adverse physiologic effects such as fever and shock
  - Exotoxins
    - Poisonous proteins secreted by a variety of pathogens
    - Examples: neurotoxins, enterotoxins, exfoliative toxin, erythrogenic toxin, and leukocidins

Mechanisms by Which Pathogens Escape Immune Responses

- Antigenic Variation
  - Some pathogens evade the immune system by changing their surface antigens – antigenic variation; examples, Neisseria gonorrhoeae and Borrelia recurrentis.
- Camouflage and Molecular Mimicry
  - Some organisms conceal their foreign nature by coating themselves with host proteins – like camouflage (e.g., adult schistosomes).
- Destruction of Antibodies
  - Some pathogens produce IgA protease, an enzyme that destroys some of the host’s antibodies; example, Haemophilus influenzae.