

Chapter 19 Host-Microbe Interactions

Microbial Relationships

✓ Symbiosis

Symbiosis is:

- the close association of one species with another species.

- Mutualism
- Commensalism
- Antagonism
- Competition
- Parasitism
- Predation

Mutualism

Mutualism is:

- the interaction of two species for their mutual benefit.
- Bacteria and the synthesis of vitamins K and B

Commensalism

The interaction of two microorganisms in which one microorganism benefits, but the other is unaffected.

One organism utilizes a substrate and forms a product that can be used by another organism.

Flora living on our skin

Antagonism

The inhibition of one microbial species by another.

- Production of antibiotics
- Production of toxins
- Production of enzymes that degrade the cell walls of other organisms.

Competition

The struggle between organisms for nutrients and space.

- Often associated with several harmful associations, such as, predation and parasitism.

Parasitism

One organism (the parasite) lives on or in another organism (the host).

- Parasitic fungi include: *Penicillium*, *Rhizoctonia*, and *Trichoderma*.

Predation

The interaction in which one organism (the predator) feeds on and digests the other organism (the prey).

Infection and infestation

✓ Infection

- Multiplication of any parasitic organism within the host's body.

✓ Infestation

- often used with macroscopic organisms.

Steps of infection

- Enter the host
 - Portal of entry
- Attachment
 - Adhesins
 - End of pili or fimbriae
 - Can be very specific to cell type and pathogen
- Metabolize and multiply in host tissue (colonize)
- Resist host defenses
- Damage the host
 - Toxins or other molecules

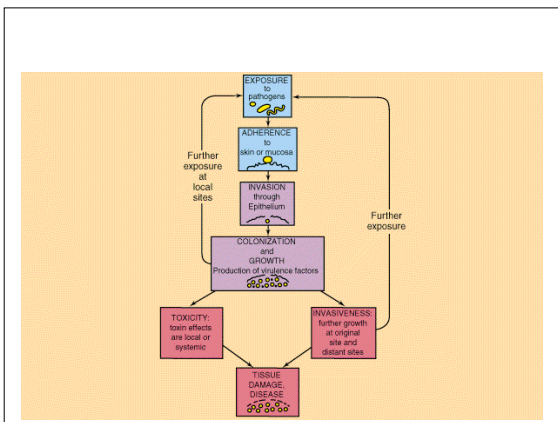
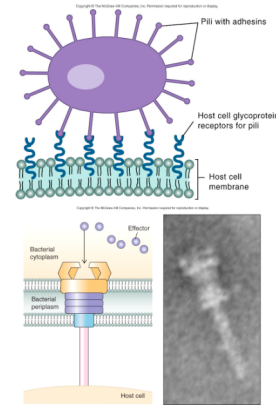
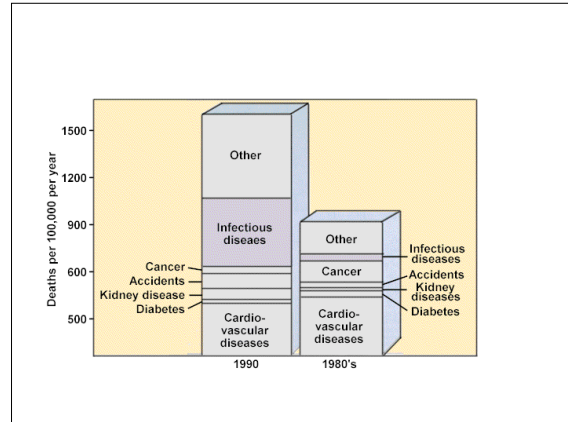


Table 19.1 Terms Used in the Study of Infectious Diseases

Term	Definition
Bacteremia	Bacteria circulating in the bloodstream
Colonization	Establishment and growth of a microorganism on a body surface
Disease	Noticeable impairment of body function
Immunocompromised	A host with weaknesses or defects in the innate or adaptive defenses
Inapparent infection	Infection with no obvious symptoms
Infectious disease	Disease caused by an infecting microorganism or virus
Latent infection	Infection in which the infectious agent is present but not active
Opportunistic pathogens	Organisms that cause disease only when introduced into an unusual location or into an immunocompromised host
Parasite	An organism that benefits at the expense of another organism, the host
Pathogen	Any disease-causing microorganism or virus
Pathogenic	Disease-causing
Primary infection	Infection in a previously healthy person
Secondary infection	An additional infection that occurs as a result of a primary infection and that occurs during or immediately following the primary infection
Septicemia	Acute illness caused by infectious agents or their products circulating in the bloodstream
Systemic infection	Widespread infection through blood or lymph
Toxemia	Toxin circulating in the bloodstream
Viremia	Viruses circulating in the bloodstream
Virulence determinants	Attributes of a microorganism or virus that promote pathogenicity

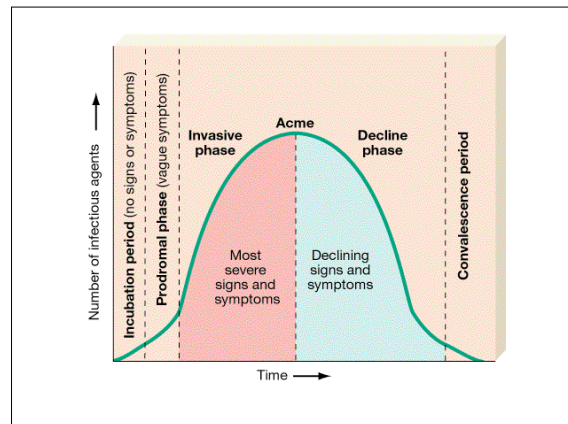
Signs, Symptoms, Syndromes

- ✓ Signs - observed by examination
 - Swelling, redness, rashes, coughing, pus formation, runny nose, fever, vomiting, diarrhea.
- ✓ Symptoms - felt by the patient
 - Pain, shortness of breath, nausea, sore throat, headache, malaise.
- ✓ Syndrome
 - Combination of signs and symptoms.



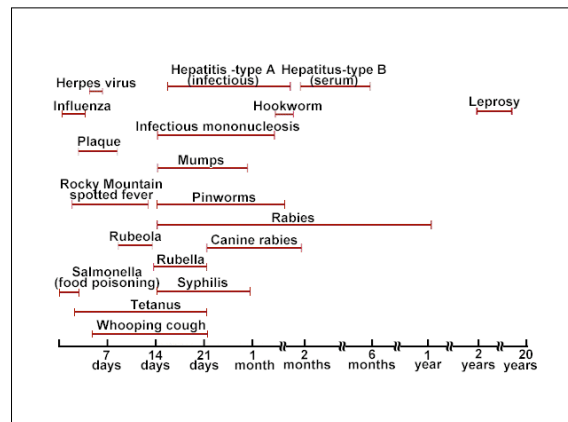
Stages of an Infectious Disease

- ✓ Incubation
- ✓ Prodromal
- ✓ Invasive
- ✓ Acme
- ✓ Decline
- ✓ Convalescence



Incubation Phase

- ✓ No signs or symptoms.
- ✓ No tissue damage



Prodromal Phase

- ✓ Local redness and swelling, headaches, general aches and pains
- ✓ Release of toxins has started to cause tissue damage

Invasive Phase

- ✓ Cough, sore throat, fever, swollen lymph nodes, rashes, nasal congestion, specific pains, nausea, vomiting, diarrhea
- ✓ Result of toxins, and stimulation of vomiting and diarrhea

Acme phase

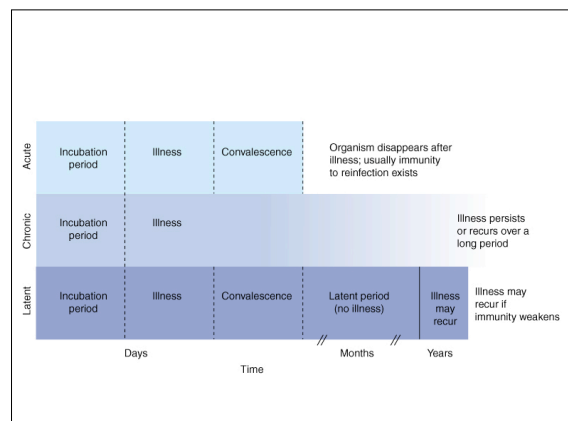
- ✓ All signs and symptoms are at peak intensity

Decline Phase

- ✓ Signs and symptoms subside
- ✓ Host defense mechanisms are contributing to overcoming of infection

Convalescence Phase

- ✓ Regaining of strength
- ✓ Tissue repair continues; no signs or symptoms



Pathogenicity

- ✓ The capability of an organism to cause a disease or to establish an infection.
 - Characteristics of the organism.
 - Ability of host to resist infection.
 - **Primary pathogens**
 - ⇒ infect healthy individuals
 - **Opportunistic pathogens**
 - ⇒ Normally part of our normal flora
 - **Virulence**
 - ⇒ The degree of the ability of a pathogen to cause a disease

Table 19.2b Exotoxins Produced by Various Primary Pathogens

Toxins	Name of Disease; Name of Toxin	Characteristics of the Disease	Mechanism	Page Reference
MEMBRANE-DAMAGING TOXINS (cytotoxins) —Disrupts plasma membranes.				
<i>Clostridium perfringens</i>	Gas gangrene; α -toxin	Extensive tissue damage	Removes the polar head group on the phospholipids in the membrane, destabilizing its integrity	p. 701
<i>Staphylococcus aureus</i>	Wound and other infections; leukocidin	Accumulation of pus	Inserts into membranes, forming pores that allow fluids to enter.	p. 693
<i>Streptococcus pyogenes</i>	Pharyngitis and other infections; streptolysin O	Accumulation of pus	Inserts into membranes, forming pores that allow fluids to enter.	p. 565
SUPERANTIGENS —Overrides the specificity of the T-cell response.				
<i>Staphylococcus aureus</i> (certain strains)	Foodborne intoxication; staphylococcal enterotoxins	Nausea and vomiting	How the ingested toxins lead to the characteristic symptoms of foodborne intoxication is not understood.	p. 812
<i>Staphylococcus aureus</i> (certain strains)	Staphylococcal toxic shock; toxic shock syndrome toxin (TSST)	Fever, vomiting, diarrhea, muscle aches, rash, low blood pressure	Systemic toxic effects due to the resulting massive release of cytokines.	p. 641
<i>Streptococcus pyogenes</i> (certain strains)	Streptococcal toxic shock; streptococcal pyogenic exotoxins (SPE)	Fever, vomiting, diarrhea, muscle aches, rash, low blood pressure.	Systemic toxic effects due to the resulting massive release of cytokines.	p. 566
OTHER TOXIC PROTEINS				
<i>Staphylococcus aureus</i>	Scalded-skin syndrome; exfoliatin	Separation of the outer layer of skin	Thought to break ester bonds that hold the layers of skin together.	p. 538
Various organisms	Various diseases; proteases, lipases, and other hydrolases	Tissue damage	Degrades proteins, lipids, and other compounds that make up tissues.	

Virulence factors

- ✓ Virulence factors are properties of the organism that enhance its pathogenicity.
- ✓ Help the pathogen cause the disease or aid in the infection process.
 - Toxins
 - Extracellular enzymes
 - Cellular factors

Toxins

- ✓ Toxins have a damaging effect on cells and tissues of the host.
 - Exotoxins are secreted into environment surrounding the pathogen.
 - Endotoxins are part of the cell.

Exotoxins

- ✓ Proteins.
- ✓ Produced by either Gram positive or Gram negative bacteria.
- ✓ Highly specific effect on host.
- ✓ Can be destroyed by heat or chemically.
- ✓ Form toxoids.
- ✓ Stimulate the production of antitoxins.

Endotoxins

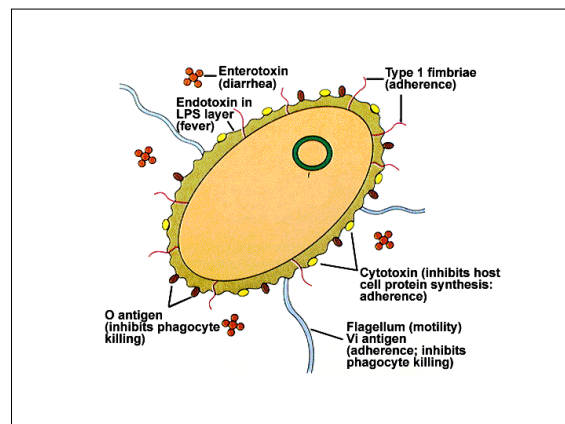
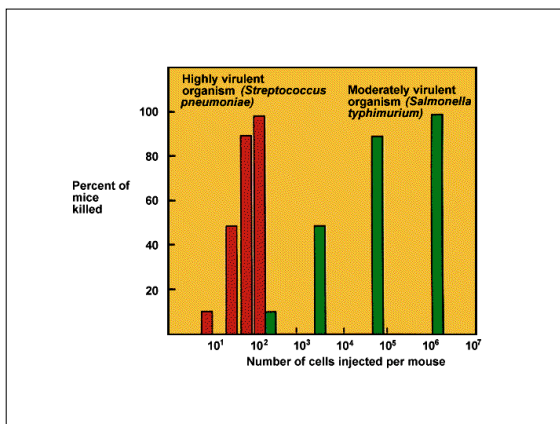
- ✓ Usually endotoxins are components of the outer membrane.
- ✓ Gram negative bacteria only.
- ✓ Polysaccharides.
- ✓ Very heat-stable
- ✓ Do not produce toxoids.
- ✓ Often associated with fever and shock.

Extracellular enzymes

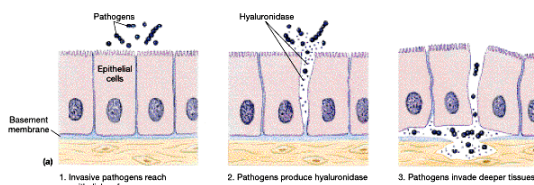
- ✓ Role in the infection process, particularly *invasiveness*.
- Penetration with hyaluronidase.
- Lecithinase lyses tissue cells.
- Coagulase transforms fibrinogen into fibrin.
- Hemolysins lyse red blood cells.

Cellular factors

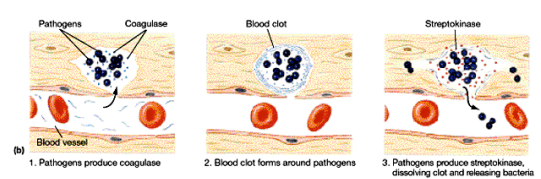
- ✓ Capsules prevent phagocytosis by white blood cells.
- ✓ Pili aid in adherence to host cell surfaces.



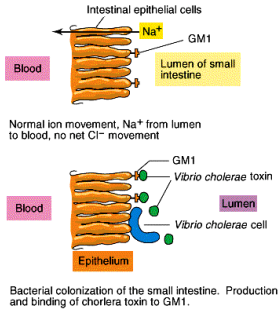
Enzyme virulence factors



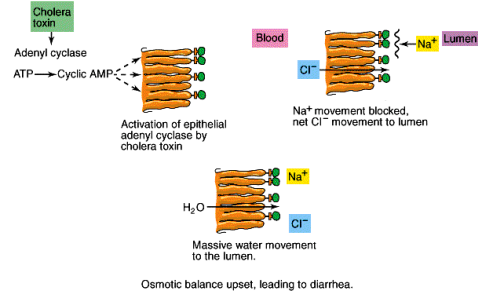
Enzyme virulence factors



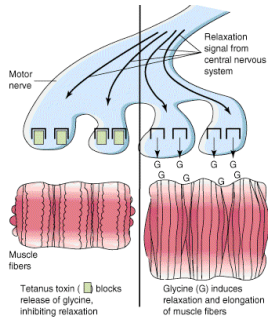
Cholera toxin



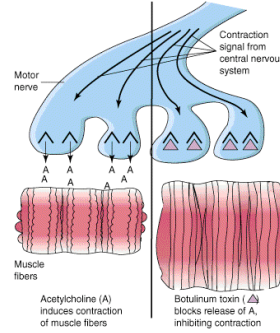
Cholera toxin (cont.)



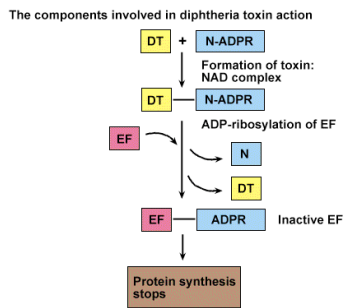
Tetanus toxin



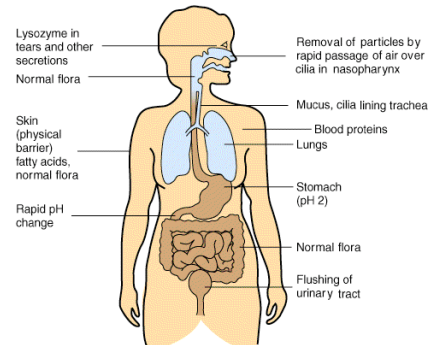
Botulism



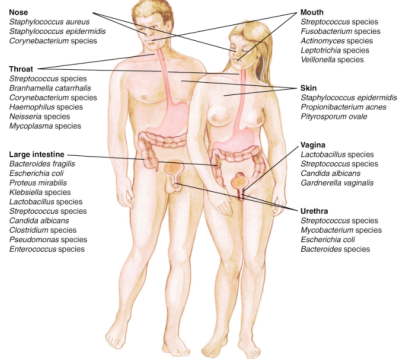
Diphtheria



Factors that prevent infection



Normal Flora



Protective role

- ✓ Prevent pathogens from attaching
- ✓ Consume available nutrients
- ✓ Produce toxic compounds that inhibit other microbes
- ✓ Prime the immune system

Dynamic nature

- ✓ Composition of normal flora changes due to
 - Hormonal changes
 - Type of food consumed
 - Antibiotics