

Host-Microbe Relationships

Lecture# 5

Pharmaceutical Microbiology

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Host-Microbe Relationships

- **Pathogen** is a parasite capable of causing disease in a host.
- **Host:** is an organism that harbors another organism inside or near their body
- **Symbiosis is an association between two (or more) species.**
Meaning “living together,” the term *symbiosis* compasses a spectrum of relationships. These include *mutualism, commensalism, and parasitism*

Host-Microbe Relationships

- **Mutualism** : in **which both members of the association living together benefit from the relationship**
- E.g: large numbers of *Escherichia coli* live in the large intestine of humans. These bacteria release vitamin K, in turn, get a favorable environment in which to live and obtain nutrients.



Many of the bacteria on human skin are mutualistic.

Host-Microbe Relationships

- parasitism, in **which one organism, the parasite, benefits from the relationship, whereas the other organism, the host, is harmed by it.**
- bacteria, viruses, protozoa, fungi, and helminths are parasites.
- Parasites exert harmful effects on **human host ranging from slight harm to death**



Host-Microbe Relationships

- **Commensalism: one benefits from the relationship, the other neither benefited nor harmed.**
- For example, many microorganisms live on our skin surfaces and utilize metabolic products secreted from skin without causing any harm.



- **Antagonism: both species harm each other without either benefiting**

For example, normal flora interfere with the growth of some pathogens by competing for nutrients that the pathogen needs, or they produce substances in which the pathogen cannot grow

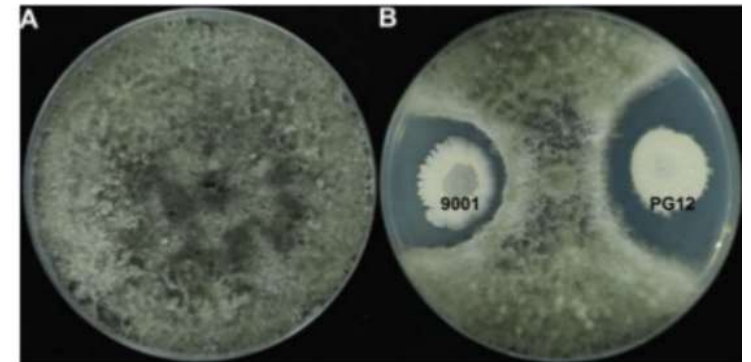


Table 14.1 The Spectrum of Symbiotic Association

Relationship	Effect on Species A	Effect on Species B
Mutualism	+	+
Parasitism	+	-
Commensalism	+	0
Antagonism	-	-

Contamination, Infection & Disease

- **Contamination means that the microorganisms are present.**
- **Infection : multiplication of any parasitic organism within or on the host's body. (Sometimes the term infestation is used to refer to the presence of larger parasites, such as worms or in the body.)**
- **Disease is a disturbance in the state of health wherein the body cannot carry out all its normal functions.**

When an infection causes disease, the effects of the disease range from mild to severe , either reversible or irreversible

Pathogenicity & Virulence

- **Pathogenicity is the capacity to produce** disease

An organism's pathogenicity depends on:

1. Its ability to invade a host
 2. Number of infectious organisms that enter the body.
 3. multiply in the host.
 4. avoid being destroyed by host defence mechanisms.
- **Virulence refers to the intensity of the disease produced by pathogens**, and it varies among different microbial species
 - For example *Bacillus cereus* causes mild gastroenteritis, whereas the rabies virus causes neurological damage that is nearly always fatal

Pathogenicity & Virulence

- The virulence of a pathogen can be decreased by

Attenuation: the weakening of the disease-producing ability of the pathogen.

- Attenuation can be achieved by:

1.Repeated **subculturing**

2.Transposal of virulence: transferring the pathogen from its normal host to new different species, then repeat the passage through many individuals of the new host, the pathogen will adapt to the new host & will lose its virulence to its original host. (used to prepare mumps & measles vaccines)

Normal (Indigenous) Microflora

- An adult human body harbors 10^{14} (100 trillion) prokaryotic and eukaryotic microorganisms on the skin surface, on mucous membranes, and in the passageways of the digestive, respiratory, and reproductive systems.
- Normal microflora (*normal microbiota*): microorganisms that live in or on the body **without causing any harm, it is divided into:**
 - **Resident microflora: always present in or on the body.** Present in areas which are accessible & where conditions are suitable for growth (moist, warm, availability of nutrients).
 - **Transient microflora are microorganisms that can** be present under certain conditions in any of the locations where resident microflora are found.

Normal Microflora (Microbiota)

- resident and transient microflora are usually harmless but can cause disease under certain conditions. These organisms are called **opportunists**
- Conditions that create opportunities for such organisms include:
 1. *Failure of the Host's Normal Defenses*
 2. *Introduction of the Organisms into Unusual Body Sites*
 3. *Disturbances in the Normal Microflora.*

Classification of Diseases

- **Communicable infectious (contagious diseases):** infectious diseases can be spread from one host to another

E.g : Rubella(red measles) and rubella are highly communicable.

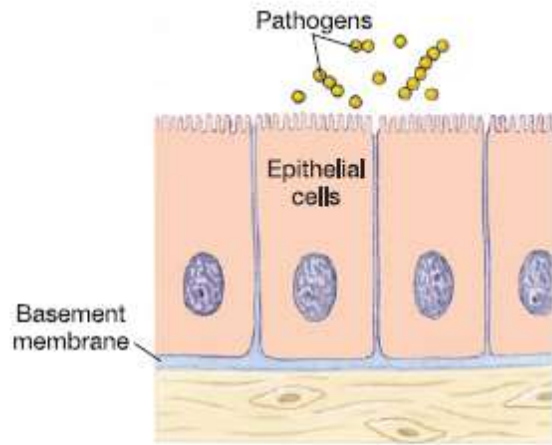
- **Noncommunicable infectious diseases are not spread** from one host to another

E.g:

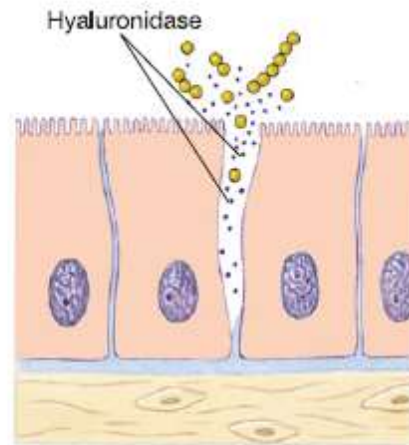
- Ingestion of food poisoned by bacterial **toxin, e.g. enterotoxin (Staph.)**
- Infection by organisms in the **environment ,e.g. Tetanus**

How Bacteria Cause Disease

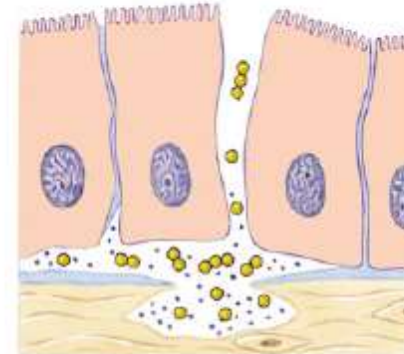
- **Virulence factors:** are structures or physiologic characters of a pathogen that increase its ability to cause infection & disease; such as:
 - **Adhesions:** help the bacterium to adhere & colonize the host.
 - **Enzymes:**
 1. Hyaluronidase (*Streptococci*)
 2. Coagulase (*Staphylococcus aureus*): *clots blood & protect bacteria from immune system*
 3. Streptokinase (*Streptococci*): *dissolves blood clot & aid bacterial spreading and invasion*
 - **Toxins:**
 1. Exotoxins: mostly proteins or polypeptides secreted by the bacteria into host tissues
 2. Endotoxins: part of the cell wall of **G-ve bacteria (LPS)** which are released **into the body when bacteria die**



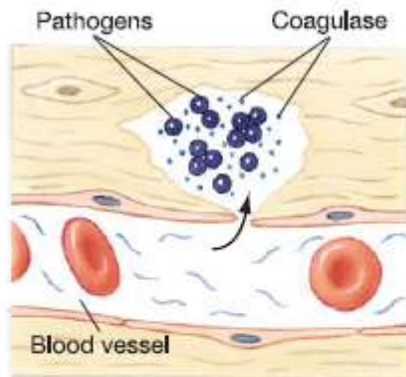
(a) 1. Invasive pathogens reach epithelial surface.



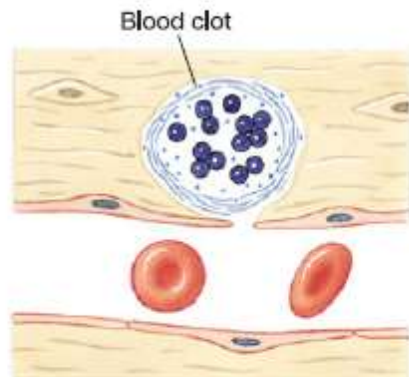
2. Pathogens produce hyaluronidase.



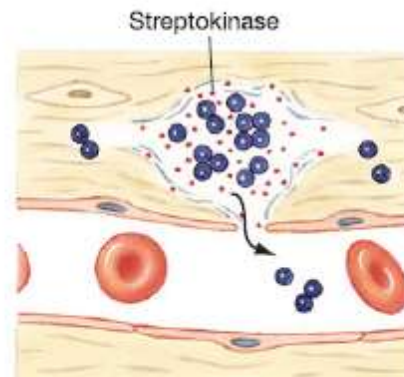
3. Pathogens invade deeper tissues.



(b) 1. Pathogens produce coagulase.



2. Blood clot forms around pathogens.



3. Pathogens produce streptokinase, dissolving clot and releasing bacteria.

Enzymatic virulence factors help bacteria invade tissues and evade host defenses. (a) Hyaluronidase dissolves the “cement” that holds together the cells that line the intestinal tract. Bacteria that produce hyaluronidase can then invade deeper cells within the intestinal tissues. (b) Coagulase triggers blood plasma clotting, allowing bacteria protection from immune defenses. Streptokinase dissolves blood clots. Bacteria trapped within a clot can free themselves and spread the infection by producing streptokinase.

Stages of an Infectious Disease

- **The Incubation Period is the** time between infection and the appearance of signs and symptoms.

It ranges from few days (cholera) to months (hepatitis) or years (AIDS)! Patient is contagious in this stage.

- **The Prodromal Phase is a short period during** which nonspecific, often mild, symptoms such as malaise and headache sometimes appear. infected individuals are contagious.

- **The Invasive Phase is the period during which the individual** experiences the typical signs and symptoms of the disease. During this phase, the time when the signs and symptoms reach their greatest intensity is known as the **acme**. **During the acme, pathogens** invade and damage tissues.

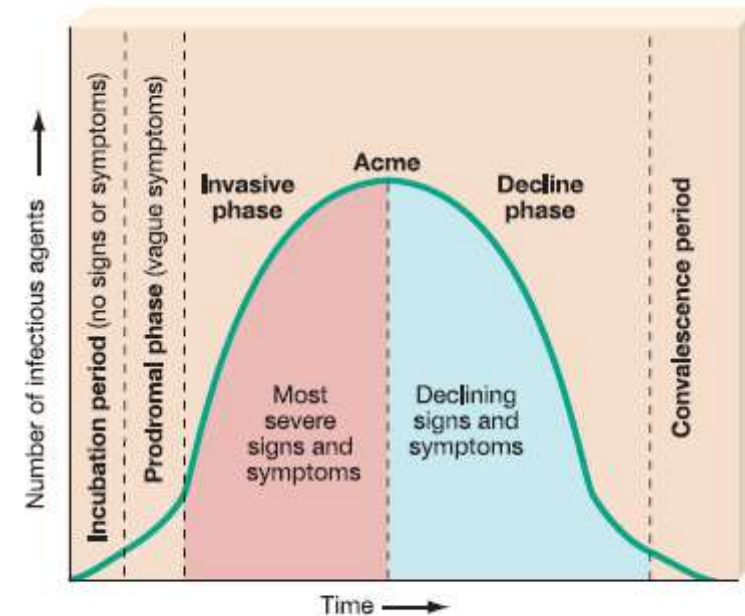


FIGURE 14.9 Stages in the course of an infectious disease.

Stages of an Infectious Disease

- The **Decline Phase** is the period of illness during **which host defenses** and the effects of treatment finally overcome the pathogen.
- **Convalescence period:** recovery phase. Symptoms disappear, body heals & regain strength. persons recovering from the disease can **still transmit pathogens to others**

However, Effects remaining after the disease has ended are called **sequelae** e.g: **Permanent heart or kidney damage can be due to streptococcal infections**

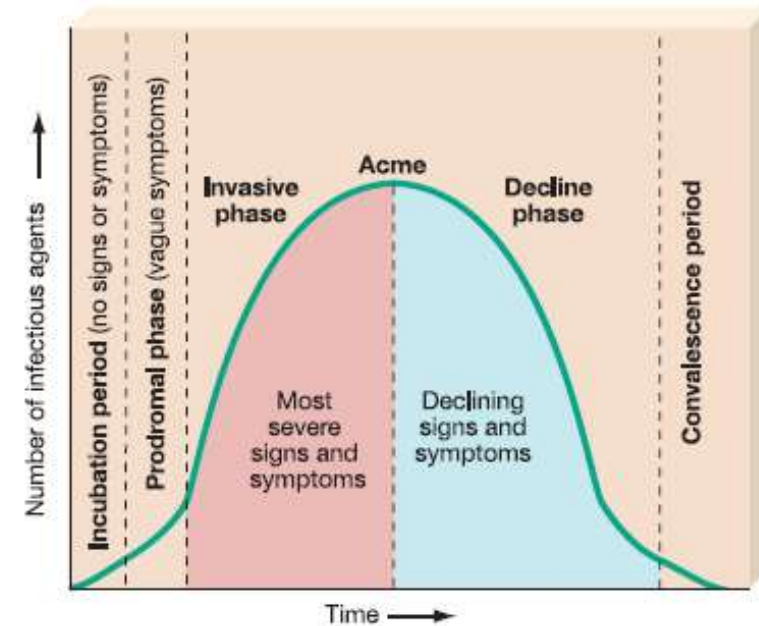


FIGURE 14.9 Stages in the course of an infectious disease.

Important Terms

Table 14.8 Terms Used to Describe Infections

Term	Characteristic of Infection
Acute disease	Disease in which symptoms develop rapidly and that runs its course quickly
Chronic disease	Disease in which symptoms develop slowly and disease is slow to disappear
Subacute disease	Disease with symptoms intermediate between acute and chronic
Latent disease	Disease in which symptoms appear and/or reappear long after infection
Local infection	Infection confined to a small region of the body, such as a boil or bladder infection
Focal infection	Infection in a confined region from which pathogens travel to other regions of the body, such as an abscessed tooth or infected sinuses
Systemic infection	Infection in which the pathogen is spread throughout the body, often by traveling through blood or lymph
Septicemia	Presence and multiplication of pathogens in blood
Bacteremia	Presence but not multiplication of bacteria in blood
Viremia	Presence but not multiplication of viruses in blood
Toxemia	Presence of toxins in blood
Sapremia	Presence of metabolic products of saprophytes in blood
Primary infection	Infection in a previously healthy person
Secondary infection	Infection that immediately follows a primary infection
Superinfection	Secondary infection that is usually caused by an agent resistant to the treatment for the primary infection
Mixed infection	Infection caused by two or more pathogens
Inapparent infection	Infection that fails to produce full set of signs and symptoms