

Al-Anbar University

College of Sciences

Biology department



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Lecture title: Pathogenesis Of Bacterial infection

Subject teacher

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PATHOGENESIS OF BACTERIAL INFECTION

The pathogenesis of bacterial infection includes initiation of the infectious process and the mechanisms that lead to the development of signs and symptoms of disease.

Humans and animals have abundant normal microbiota that usually do not produce disease but achieve a balance that ensures the survival, growth, and propagation of both the bacteria and the host. Some bacteria that are important causes of disease are cultured commonly with the normal flora (eg, *Streptococcus pneumoniae*, *Staphylococcus aureus*). Sometimes bacteria that are clearly pathogens (eg, *Salmonella* serotype Typhi) are present, but infection remains latent or subclinical, and the host is a “carrier” of the bacteria.

Glossary

Adherence (adhesion, attachment): The process by which bacteria stick to the surfaces of host cells. After bacteria have entered the body, adherence is a major initial step in the infection process. The terms *adherence*, *adhesion*, and *attachment* are often used interchangeably.

Carrier: A person or animal with asymptomatic infection that can be transmitted to another susceptible person or animal.

Infection: Multiplication of an infectious agent within the body. Multiplication of the bacteria that are part of the normal flora of the gastrointestinal tract, skin, and so on is generally not considered an infection; on the other hand, multiplication of pathogenic bacteria (eg, *Salmonella* species)-even if the person is asymptomatic-is deemed an infection.

Invasion: The process whereby bacteria, animal parasites, fungi, and viruses enter host cells or tissues and spread in the body.

Microbiota: Microbial flora harbored by normal, healthy individuals.

Nonpathogen: A microorganism that does not cause disease; may be part of the normal microbiota.

Opportunistic pathogen: An agent capable of causing disease only when the host's resistance is impaired (ie, when the patient is "immunocompromised").

Pathogen: A microorganism capable of causing disease.

Pathogenicity: The ability of an infectious agent to cause disease. (See also virulence).

Superantigens: Protein toxins that activate the immune system by binding to major histocompatibility complex (MHC) molecules and T-cell receptors

(TCR) and stimulate large numbers of T cells to produce massive quantities of cytokines.

Toxigenicity: The ability of a microorganism to produce a toxin that contributes to the development of disease.

Virulence: The quantitative ability of an agent to cause disease. Virulent agents cause disease when introduced into the host in small numbers. Virulence involves adherence, persistence, invasion, and toxigenicity.

TRANSMISSION OF INFECTION

Bacteria can adapt to a variety of environments that include external sources such as soil, water and organic matter or internal milieu as found within insect vectors, animals and humans, where they normally reside and subsist. In doing so, the bacteria ensure their survival and enhance the possibility of transmission. By producing a symptomatic infection or mild disease rather than death of the host, microorganisms that normally live in people enhance the possibility of transmission from one person to another.

Some bacteria that commonly cause disease in humans exist primarily in animals and incidentally infect humans. For example, *Salmonella* and *Campylobacter* species typically infect animals and are transmitted in food products to humans. Other bacteria produce infection of humans that is inadvertent, a mistake in the normal life cycle of the

organism; the organisms have not adapted to humans, and the disease they produce may be severe. For example, *Yersinia pestis* (plague) has a well-established life cycle in rodents and rodent fleas, and transmission by the fleas to humans is inadvertent; *Bacillus anthracis* (anthrax) lives in the environment, occasionally infects animals, and is transmitted to humans by products such as raw hair from infected animals. The *Clostridium* species are ubiquitous in the environment and are transmitted to humans by ingestion (eg, *C. perfringens* gastroenteritis and *C. botulinum* [botulism]) or when wounds are contaminated by soil (eg, *C. perfringens* [gas gangrene] and *C. tetani* [tetanus]).

Both *Bacillus anthracis* and the *Clostridium* species elaborate spores to protect the organisms' nucleic acid from harsh environmental factors such as ultraviolet light, desiccation, chemical detergents, and pH extremes. These spores ensure survival in external environments including foods ingested by humans. After being ingested or inoculated, the spores germinate into the vegetative, metabolically active form of the pathogen.

The clinical manifestations of diseases (eg, diarrhea, cough, genital discharge) produced by microorganisms often promote transmission of the agents. Examples of clinical syndromes and how they enhance transmission of the causative bacteria are as follows:

Vibrio cholerae can cause voluminous diarrhea, which may contaminate salt and fresh water; drinking water or seafood such as oysters and crabs may be contaminated; ingestion of contaminated water or seafood can produce infection and disease. Similarly, contamination of food products with sewage containing *Escherichia coli* that caused diarrhea results in transmission of the bacteria. *Mycobacterium tuberculosis* (tuberculosis) naturally

infects only humans; it produces respiratory disease with cough and production of aerosols, resulting in transmission of the bacteria from one person to another.

Many bacteria are transmitted from one person to another on hands. A person with *Staphylococcus aureus* carriage in the anterior nares may rub his nose, pick up the staphylococci on the hands, and spread the bacteria to other parts of the body or to another person, where infection results. Many opportunistic pathogens that cause nosocomial infections are transmitted from one patient to another on the hands of hospital personnel. Handwashing is thus an important component of infection control.

The most frequent **portals of entry of pathogenic bacteria** into the body are the sites where mucous membranes meet with the skin, which are the respiratory (upper and lower airways), gastrointestinal (primarily mouth), genital, and urinary tracts. Abnormal areas of mucous membranes and skin (eg, cuts, burns, and other injuries) are also frequent sites of entry. Normal skin and mucous membranes provide the primary defense against infection. To cause disease, pathogens must overcome these barriers.

THE INFECTIOUS PROCESS

In the body, most bacteria that cause disease do so first by **attaching or adhering** to **host cells**, usually epithelial cells. After the bacteria have established a primary site of infection, they **multiply and spread** directly through tissues or via the lymphatic system to the bloodstream. This infection (**bacteremia**) can be transient or persistent.

Bacteremia allows bacteria to spread widely in the body and permits them to reach tissues particularly suitable for their multiplication.

Pneumococcal pneumonia is an example of the infectious process. *Streptococcus pneumoniae* can be cultured from the nasopharynx of 5-40% of healthy people. Occasionally, pneumococci from the nasopharynx are aspirated into the lungs; aspiration occurs most commonly in debilitated people and in settings such as coma when normal gag and cough reflexes are diminished. Infection develops in the terminal air spaces of the lungs in persons who do not have protective antibodies against that particular pneumococcal capsular polysaccharide type. Multiplication of the pneumococci and resultant inflammation lead to pneumonia. The pneumococci enter the lymphatics of the lung and move to the bloodstream. Between 10% and 20% of persons with pneumococcal pneumonia have bacteremia at the time the diagnosis of pneumonia is made. When bacteremia occurs, the pneumococci can spread to secondary sites of infection (eg, cerebrospinal fluid, heart valves, and joint spaces). The major complications of pneumococcal pneumonia are meningitis, septic arthritis, and rarely endocarditis.

The infectious process in **cholera** involves ingestion of *Vibrio cholerae*, chemotactic attraction of the bacteria to the gut epithelium, motility of the bacteria by a single polar flagellum, and penetration of the mucous layer on the intestinal surface. The *V. cholerae* adherence to the epithelial cell surface is mediated by pili and possibly other adhesins. Production of cholera toxin results in flow of chloride and water into the lumen of the gut, causing diarrhea and electrolyte imbalance.

References:

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