

Although the vast majority of bacteria are harmless or beneficial, quite a few bacteria are pathogenic. Pathogenic bacteria are bacteria that cause bacterial infection. One of the bacterial diseases with highest disease burden is tuberculosis, caused by the bacterium *Mycobacterium tuberculosis*, which kills about 2 million people a year, mostly in sub-Saharan Africa. Pathogenic bacteria contribute to other globally important diseases, such as pneumonia, which can be caused by bacteria such as *Streptococcus* and *Pseudomonas*, and food borne illnesses, which can be caused by bacteria such as *Shigella*, *Campylobacter*, and *Salmonella*. Pathogenic bacteria also cause infections such as tetanus, typhoid fever, diphtheria, syphilis, and leprosy. Koch's postulates are criteria designed to establish a causal relationship between a causative microbe and a disease. Four criteria that were established by Robert Koch to identify the causative agent of a particular disease, these include:

1. The microorganism or other pathogen must be present in all cases of the disease
2. The pathogen can be isolated from the diseased host and grown in pure culture
3. The pathogen from the pure culture must cause the disease when inoculated into a healthy, susceptible laboratory animal
4. The pathogen must be reisolated from the new host and shown to be the same as the originally inoculated pathogen.

The changes to the host, manifested as a set of symptoms, may be due to the effect of microbial products such as toxins or the result of the host's immune reactions to the presence of the bacteria. Pain, fever, redness and swelling are common symptoms of bacterial disease.

A pathogen is a microorganism that is able to cause disease in a plant, animal or insect. Pathogenicity is the ability to produce disease in a host organism. Microbes express their pathogenicity by means of their virulence, a term which refers to the degree of pathogenicity of the microbe. Hence, the determinants of virulence of a pathogen are any of its genetic or biochemical or structural features that enable it to produce disease in a host. The relationship between a host and a pathogen is dynamic. The outcome of such a relationship depends on the virulence of the pathogen and the degree of resistance and susceptibility of the host, due to the effectiveness of the host defense mechanisms.

Two qualities of pathogenic microbes by which they cause disease to the host:

1. **Invasiveness** is the ability to invade tissues. It consists of colonization, production of extracellular substances which facilitate invasion and ability to bypass or overcome host defense mechanisms.
2. **Toxigenesis** is the ability to produce toxins. Bacteria may produce two types of toxins called exotoxins and endotoxins. Exotoxins are released from bacterial cells and may act at tissue sites removed from the site of bacterial growth. Endotoxins are cell-associated substance. The bacterial

toxins, both soluble and cell-associated, may be transported by blood and lymph and cause cytotoxic effects at tissue sites remote from the original point of invasion or growth.

The diseases can be caused by:

- • **Bacteria:-** These one-cell organisms are responsible for illnesses such as strep throat, urinary tract infections and tuberculosis.
- **Viruses:-** Even smaller than bacteria, viruses cause a multitude of diseases — ranging from the common cold to AIDS.
- **Fungi:-** Many skin diseases, such as ringworm and athlete's foot, are caused by fungi. Other types of fungi can infect your lungs or nervous system.
- **Parasites:-** Malaria is caused by a tiny parasite that is transmitted by a mosquito bite. Other parasites may be transmitted to humans from animal feces.

MICROBIAL PATHOGENICITY

Factors that Influence the degree of Pathogenicity and the Progression of Infection and Disease

- • **Host factors:** Age, sex, ethnicity, nutrition (diet), hormonal status; personal hygiene and immune status; Underlying disease or medical condition; Antibiotic or drug usage; Presence of foreign object (e.g., splinter, catheter, sutures, etc.); Innate differences between hosts
- **Microbial factors:** Bacterial virulence factors; Inoculum size (dosage)
- **External factors** (e.g., crowding; seasonal variations; hygiene, sanitation and public health; food processing, storage and preparation; etc.

To cause disease a pathogen must:

- • Gain access to the host.
- Adhere to host tissues.
- Penetrate or evade host defenses.
- Damage the host, either directly or accumulation of microbial wastes.

Progression of Infection and Disease

Entrance (Portal of entry).

- • **Mucous membrane:** - is most common route for most pathogens. The mucous membranes are respiratory tract, gastrointestinal tract, urinary/genital tracts and conjunctiva.
- **Skin (keratinized cutaneous membrane):-** Some pathogens infect hair follicles, sweat glands and colonize surface. But unless broken, skin is usually an impermeable barrier to microbes.
- **Parenteral route:** - penetrate skin, punctures, injections, bites, cuts, surgery and deposit organisms directly into deeper tissues.

The microbes must enter through preferred portal of entry in order to cause disease. But some can cause disease from many routes of entry

Colonization (Adherence; Adhesion; Attachment)

- • **Attachment/Adherence:** Close association of bacterial cells and host cells generally characterized by receptors and target sites.
- **Surface Receptors/Target Sites:** Receptor sites present on both hosts (Receptor) and bacterial surfaces (Adhesins).
- **Adhesins:** Bind Specific Host Receptors often involve fimbriae as structural cell component; Host cell receptors are often sugar moieties. The

lectins are adhesin specific for polysaccharide target receptor (sugar residues).

- **Fimbriae (plural):** Short hair-like protein (pilin) appendages extending outward from the surface of certain bacteria.

- **Pili (plural); Pilus (singular):** Short hair-like protein (pilin) appendages extending outward from the surface of certain bacteria and responsible for bacterial conjugation.

Biofilms: - are formed when microbes adhere to a surface which usually moist and contains organic matter. The microbe secretes glycocalyx allowing other microbes to adhere a large mass is formed. The biofilms are resistant to disinfectants and antibiotics.

Damage to Host Cells:-

The damages to the host cell can be direct or indirect. The direct damages are: -

- Tissue damage, cell components and metabolic by-products, toxins and enzymes.
- Organ necrosis: - Sum of morphological changes indicative of cell death and caused by the progressive degradative action of cellular components, metabolic by-products, enzymes and/or toxins.
- Metabolic Effects: Pathogenic organisms can affect any of the body systems with disruptions in metabolic processes.
- Indirect Damage: Damage to host from excessive or chronic immune response (immunopathogenesis).

Production of Toxins

Toxins are poisonous substance produced by microbes tend to cause widespread damage/disease in host may be necessary for virulence. There are two types of toxins produced by bacteria.

Exotoxins: - produced inside the bacteria and either secreted or released following microbe lysis and toxin genes are often found on plasmids or via lysogenic phages. The most exotoxins are enzymes and function to destroy certain host cell parts or inhibit particular metabolic functions or damage from toxin results in the particular signs or symptoms of a disease.

The named for the disease, type of cell attacked or organism that produces it e.g. tetanus toxin: causes tetanus (contraction) of muscle. Three types of exotoxins:

A-B toxins: - have two parts: A is the enzyme that disrupts some cell activity and B binds surface receptors to bring A into the host cell e.g. botulinum & tetanus toxin.

Membrane disrupting toxins: - cause lysis of the host cell by disrupting the plasma membrane e.g. leukocidins: make protein channels in phagocytic leukocytes e.g. hemolysins: make protein channels in RBCs (hemolysis: *Streptococcus pyogenes*).