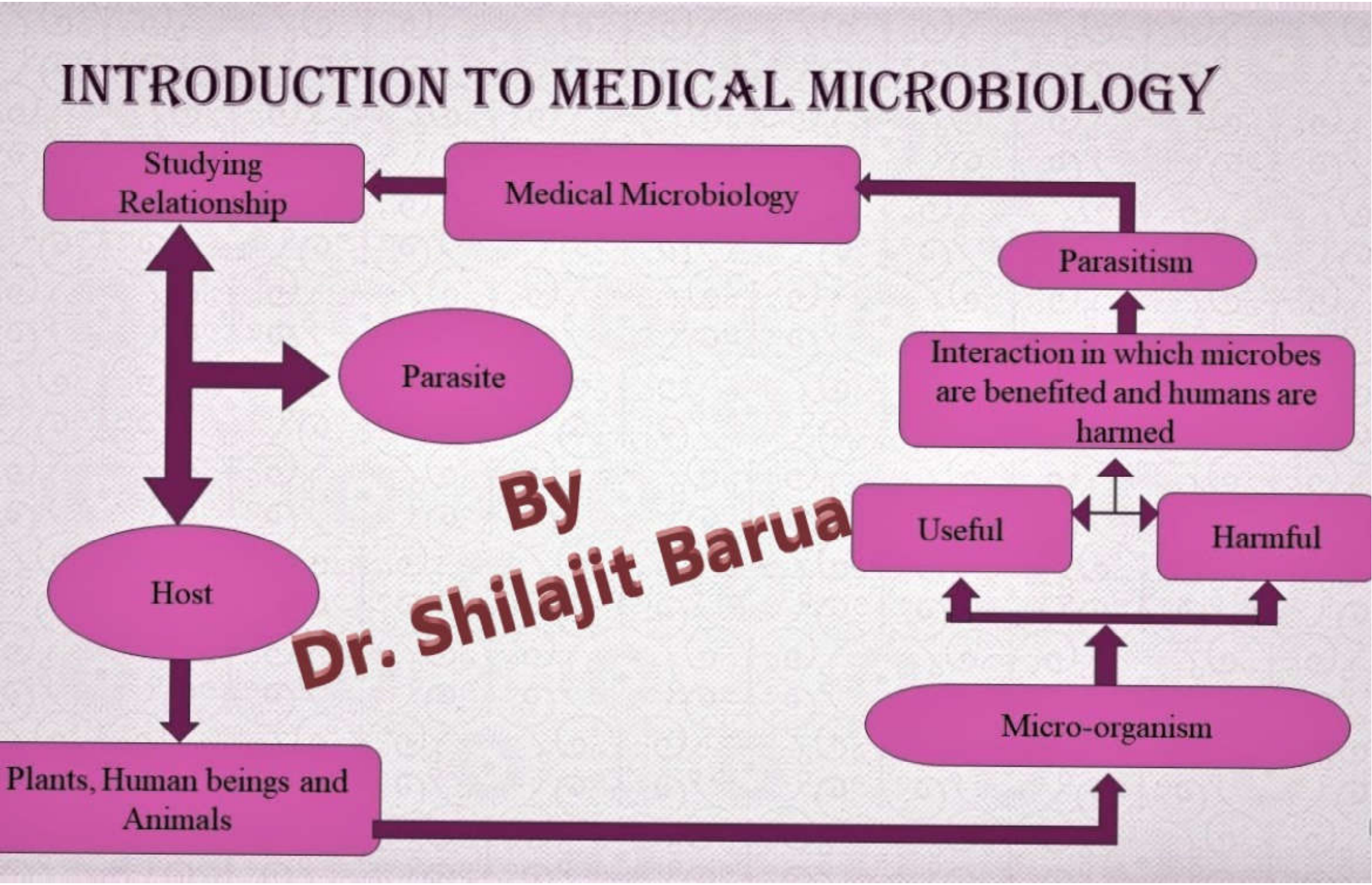

INTRODUCTION TO MEDICAL MICROBIOLOGY
Studying Relationship
Medical Microbiology
Parasitism
Parasite
Interaction in which microbes are benefited and humans are harmed
By
Dr. Shilajit Barua
Useful
Harmful
Host
Micro-organism
Plants, Human beings and Animals

Pathogenesis of bacterial Infections

Initiation of the infectious process and the mechanisms that lead to the development of signs and symptoms of disease.

Objectives

- Define Pathogenesis ,Carrier ,infection.....
- Koch's postulate , Molecular Koch's pas.
- To understand the characteristic of pathogenic bacteria
- To know the infectious process .
- Regulation of virulence factor

Bacterial Infection

A BACTERIAL INFECTION IS THE INVASION OF BODY TISSUES BY DISEASE-CAUSING BACTERIA, THEIR MULTIPLICATION AND THE REACTION OF BODY TISSUES TO THESE MICROORGANISMS AND THE TOXINS THAT THEY PRODUCE.

- **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 normal flora of the gastrointestinal tract, skin, etc, is generally not considered an infection;
  - 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.
- **Nonpathogen:** A microorganism that does not cause disease; may be part of the normal flora.
- **Opportunistic pathogen:** An agent capable of causing disease only when the host's resistance is impaired (ie, when the patient is "immunocompromised").

- **Pathogenicity:** The ability of an infectious agent to cause disease.
- **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, invasion, and toxigenicity.

Identifying Bacteria that Cause Disease

- In 1884, Robert Koch proposed a series of postulates that have been applied broadly to link many specific bacterial species with particular diseases. **Koch's postulates**

- The microorganism should be found in all cases of the disease in question, and its distribution in the body should be in accordance with the lesions observed
- The microorganism should be grown in pure culture in vitro (or outside the body of the host) for several generations

- When such a pure culture is inoculated into susceptible animal species, the typical disease must result.
- The microorganism must again be isolated from the lesions of such experimentally produced disease.

- *Treponema pallidum* (syphilis) , *Mycobacterium leprae* (leprosy) cannot be grown in vitro; there are animal models of infection with these agents.
- *Neisseria gonorrhoeae* (gonorrhea), there is no animal model of infection, the bacteria cultured in vitro; experimental infection in humans has been produced, which substitutes for an animal model.
- pathogenicity in an in vitro model of infection rather than in an animal model.

  For example, some forms of *E coli*-induced diarrhea have been defined by the interaction of the *E coli* with host cells in culture.

- Modern-day microbial genetics has opened new frontiers to study pathogenic bacteria and differentiate them from nonpathogens.
- Molecular cloning has allowed investigators to isolate and modify specific virulence genes and study them with models of infection.
- The ability to study genes associated with virulence has led to a proposed form of **molecular Koch's postulates**

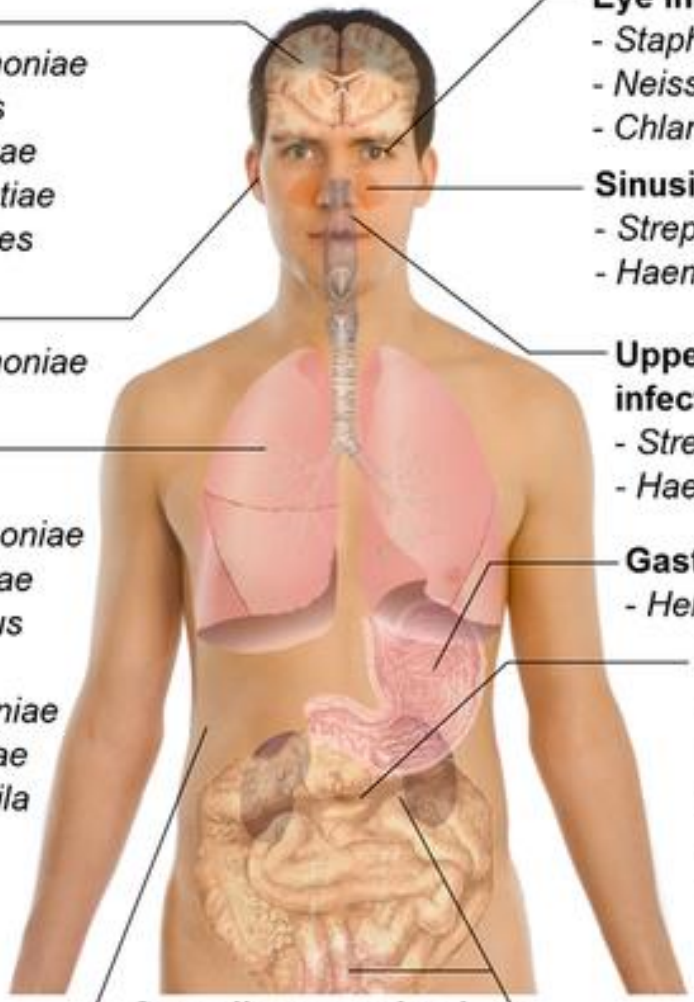
Molecular Koch's Postulates

- The phenotype or property under investigation should be significantly associated with pathogenic strains of a species and not with nonpathogenic strains.
- Specific inactivation of the gene or genes associated with the suspected virulence trait should lead to a measurable decrease in pathogenicity or virulence

- Reversion or replacement of the mutated gene with the wild-type gene should lead to restoration of pathogenicity or virulence

Overview of

Bacterial infections



Bacterial meningitis
- *Streptococcus pneumoniae*
- *Neisseria meningitidis*
- *Haemophilus influenzae*
- *Streptococcus agalactiae*
- *Listeria monocytogenes*

Otitis media
- *Streptococcus pneumoniae*

Pneumonia
Community-acquired:
- *Streptococcus pneumoniae*
- *Haemophilus influenzae*
- *Staphylococcus aureus*

Atypical:
- *Mycoplasma pneumoniae*
- *Chlamydia pneumoniae*
- *Legionella pneumophila*

Tuberculosis
- *Mycobacterium tuberculosis*

Skin infections
- *Staphylococcus aureus*
- *Streptococcus pyogenes*
- *Pseudomonas aeruginosa*

Sexually transmitted diseases
- *Chlamydia trachomatis*
- *Neisseria gonorrhoeae*
- *Treponema pallidum*
- *Ureaplasma urealyticum*
- *Haemophilus ducreyi*

Eye infections
- *Staphylococcus aureus*
- *Neisseria gonorrhoeae*
- *Chlamydia trachomatis*

Sinusitis
- *Streptococcus pneumoniae*
- *Haemophilus influenzae*

Upper respiratory tract infection
- *Streptococcus pyogenes*
- *Haemophilus influenzae*

Gastritis
- *Helicobacter pylori*

Food poisoning
- *Campylobacter jejuni*
- *Salmonella*
- *Shigella*
- *Clostridium*
- *Staphylococcus aureus*
- *Escherichia coli*

Urinary tract infections
- *Escherichia coli*
- *Other Enterobacteriaceae*
- *Staphylococcus saprophyticus*
- *Pseudomonas aeruginosa*

Characteristics of pathogenic bacteria

- Transmissibility,
- Adherence to host cells,
- Invasion of host cells and tissues,
- Toxigenicity,
- Ability to evade the host's immune system

Portals of entry of pathogenic bacteria

- the sites where mucous membranes meet with the skin:
  - 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.
- respiratory (upper and lower airways),
- gastrointestinal (primarily mouth),
- genital, urinary tracts.
- To cause disease, pathogens must overcome these barriers

Transmission of Infection

- *Salmonella* and *Campylobacter* species typically infect animals and are transmitted in food products to humans.
- *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 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]).

The clinical manifestations of diseases

- Diarrhea, cough, genital discharge produced by microorganisms often promote transmission of the agents
- *Vibrio cholerae* , 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.
- Contamination of food products with sewage containing *E coli* that cause diarrhea results in transmission of the bacteria.
- *Mycobacterium tuberculosis* (tuberculosis) naturally infects only humans; it produces respiratory disease with cough and production of aerosols,

- Many bacteria are transmitted from one person to another on hands.
- A person with *S 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.
- Hand washing is thus an important component of infection control.

Adherence (adhesion, attachment):

- The process by which bacteria stick to the surfaces of host cells.
- Once bacteria have entered the body, adherence is a major initial step in the infection process.
- The terms adherence, adhesion, and attachment

The Infectious Process

- attach or adhere to host cells, usually epithelial cells
- multiply and spread directly through tissues or via the lymphatic system to the bloodstream; Pneumococcal pneumonia
- The infectious process in cholera involves ingestion of *Vibrio cholerae*

Genomics and Bacterial Pathogenicity

- organisms are clonal

Mobile Genetic Elements

- A primary mechanism for exchange of genetic information between bacteria is transfer of extra chromosomal mobile genetic elements: plasmids or phages.

- *Yersinia pestis* produces a series of virulence plasmid-encoded proteins.
- Antiphagocytic fraction 1 capsular protein:
- expressed maximally at 35–37 °C, the host temperature, and minimally at 20–28 °C, the flea temperature at which antiphagocytic activity is not needed.

Pathogenicity Islands

- Large groups of genes that are associated with pathogenicity and are located on the bacterial chromosome are termed pathogenicity islands (PAIs).
- They are large organized groups of genes, usually 10 to 200 kilobases in size

They have one or more virulence genes. They are present in the genome of pathogenic members but absent in the nonpathogenic members. They typically have a different guanine plus cytosine (G+C) content than the rest of the bacterial genome; they are often found with parts of the genome associated with mobile genetic elements they often have genetic instability

Regulation of Bacterial Virulence Factors

- Environmental signals often control the expression of the virulence genes.
- Common signals include :
  - temperature,
  - iron availability,
  - osmolality,
  - growth phase,
  - pH, and specific ions (eg, Ca^{2+}) or nutrient factors.

- The gene for diphtheria toxin from *Corynebacterium diphtheriae* is carried on temperate bacteriophages.
- Toxin is produced only by strains lysogenized by the phages. Toxin production is greatly enhanced when *C diphtheriae* is grown in a medium with low iron.

- The virulence factors of *Vibrio cholerae* are regulated on multiple levels and by many environmental factors.
- Expression of the cholera toxin is higher at pH 6.0 than at pH 8.5 and higher also at 30 °C than at 37 °C. Osmolality and amino acid composition also are important. As many as 20 other genes of *V cholerae* are similarly regulated

- Expression of virulence genes of *Bordetella pertussis* is enhanced when the bacteria are grown at 37 °C and suppressed when they are grown at lower temperatures or in the presence of high concentrations of magnesium sulfate or nicotinic acid.

- Motility of bacteria enables them to spread and multiply in their environmental niches or in patients.
- *Yersinia enterocolitica* and *Listeria monocytogenes* are common in the environment where motility is important to them.
- *Y enterocolitica* is motile when grown at 25 °C but not when grown at 37 °C.
- *Listeria* is motile when grown at 25 °C and not motile or minimally motile when grown at 37 °C.

Thank you