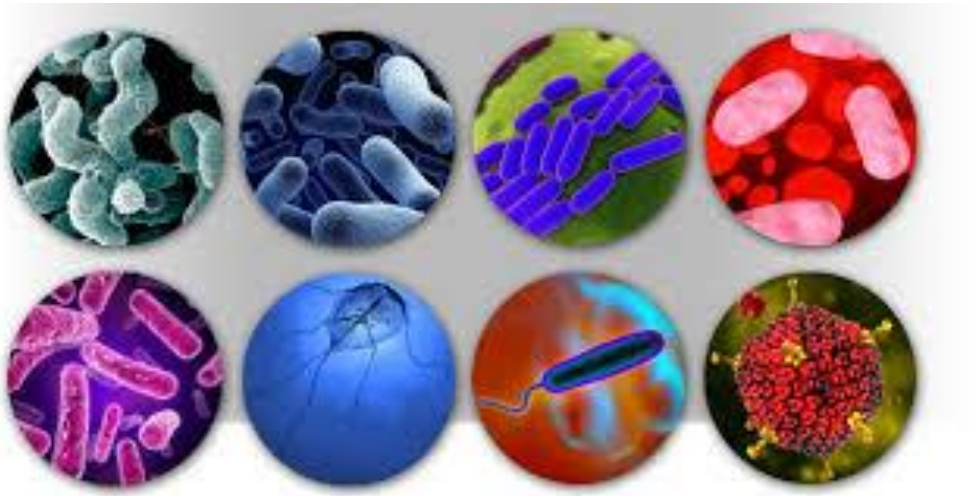
Third stage/ Medical microbiology

Introduction to microbiology



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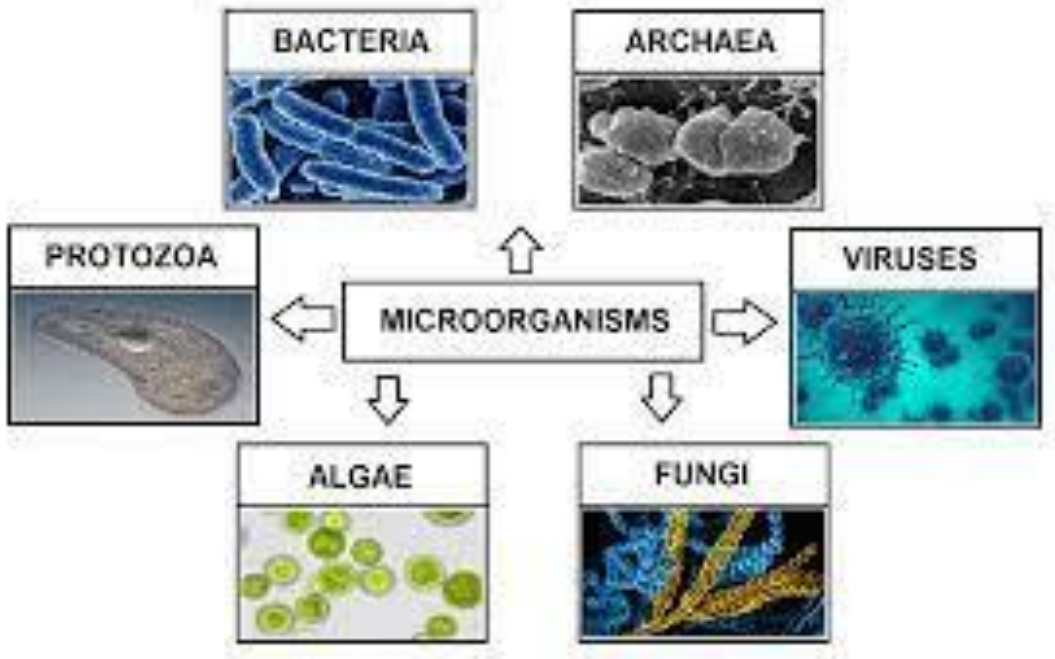
Summery

- Give an outline about microbiology and the definition of microbiology.
- Mention some points about the history of microbiology.
- Explain some of the medically important terms in microbiology science.

Microbiology is the study of microorganisms, which is a large and diverse group of microscopic organisms that exist as single cells or cell clusters.

These microorganisims include:-

- Viruses
- Bacteria
- Fungi
- Algae
- Protozoa's



The history of microbiology divided into

- Discovery Era
- Transition Era
- Golden Era
- Modern Era

DISCOVERY ERA: “Spontaneous generation” Aristotle (384-322) and others believed that living organisms could develop from non-living materials.

In 13th century, Rogen Bacon described that the disease caused by a minute “seed” or “germ”.

TRANSITION ERA: Francesco Redi (1626 - 1697) He showed that maggots would not arise from decaying meat, when it is covered.

GOLDEN ERA: Louis Pasteur (1822-1895) (Father of microbiology) was a French chemist, biologist and microbiologist. He linked disease to germs and discovered the existence of germs for the first time in the 1860s.

He invented the processes of pasteurization, fermentation and the development of effective vaccines (rabies and anthrax).

MODERN ERA: In this era, great scientists made a number of discoveries such as Diphtheria antitoxin, Phagocytosis, Penicillin, Structure DNA, Genetic code, Genetic regulation of organ development and cell death.

What are pathogens?

A **pathogen** is an infectious agent (“germ”) that causes disease or illness in a host.

The host is the organism in which a parasite or pathogen does damage.

Non-Pathogenic microorganisms are incapable of causing disease. i.e., harmless to other organisms

- They mostly live in the environment as saprophytes. Some of them are autotrophs
- Around 99% of bacteria are nonpathogenic.
- They are useful to man as they are involved in manufacturing foods such as butter, cheese, alcohol, lactic acid, Probiotics and fermented products

Some **non-pathogenic bacteria** live on the surface of animals as normal flora.

They are **commensals**, but, these bacteria can become **opportunistic** pathogens when they invade the tissues.

For example, *E. coli* are non-pathogenic bacteria that live in the gastrointestinal tract and can trigger an immune response under certain circumstances

Pathogenicity

- Is the ability of a microbe to be harmful to health and to cause disease.

- Pathogenicity depends on both microbial and host species.

- Particular microbial species is pathogenic for a specific host species only, for another species it may be non-pathogenic.

- This host species is susceptible to the relevant microbial species, to a different microbial species it can be resistant.

OPPORTUNISTIC PATHOGEN

- An infectious microorganism that is normally a commensal or does not harm its host but can cause disease when the host's resistance is low.

OPPORTUNISTIC INFECTION

- An opportunistic infection is an infection caused by pathogens, particularly opportunistic pathogens.

Infection

- Is the invasion of a host bodily tissues by disease-causing organisms,

- Infections are caused by microorganisms such as viruses, prions, bacteria,

and larger organisms like parasites and fungi.

- Infection is a medical term that refers to the invasion and multiplication of

microorganisms, such as bacteria, viruses, fungi, or parasites, within the body.

Adherence (cohesion, attachment)

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

Invasion

- The process whereby bacteria, parasites, fungi, and viruses enter host cells or tissue and spread in the body.

Toxigenicity

- The ability of a micro-organism to produce a toxin that contributes to the development of disease. Toxins can be produced by various organisms, including bacteria, fungi, and plants. They can have a wide range of effects on the body, depending on the type of toxin and the route of exposure.

Virulence

- The quantitative ability of an agent to cause disease
- Virulence **involves** adherence, invasion and toxigenicity.
- Virulence is measured by the number of organisms required to cause disease.

Carrier

- In microbiology, a carrier state refers to a condition in which an individual harbors and can potentially transmit a microorganism, such as a bacterium or virus, without showing symptoms of the associated disease.

- This means that the person is infected with the microorganism but remains asymptomatic.

- In carrier states, the microorganism can continue to replicate and potentially be shed from the carrier's body, making them a potential source of infection to others.

-Carriers may be temporary or chronic, and the reasons for not developing symptoms can vary, including factors like a strong immune response that keeps the pathogen in check, genetic factors, or variations in the strain of the microorganism.

Molecular biology

- Is the study of biology at a molecular level.

- The field overlaps with other areas of biology and chemistry, particularly genetics and biochemistry.

- Molecular biology is understanding the interactions between the various systems of a cell, including the interactions between DNA, RNA, protein and biosynthesis as well as learning how these interactions are regulated.

Bacterial genetics

- Genetics is the study of genes including :-
- The structure of genetic materials
- What information is stored in the genes
- How the genes are expressed and how the genetic information is transferred.
- Genetics is also the study of heredity and variation.

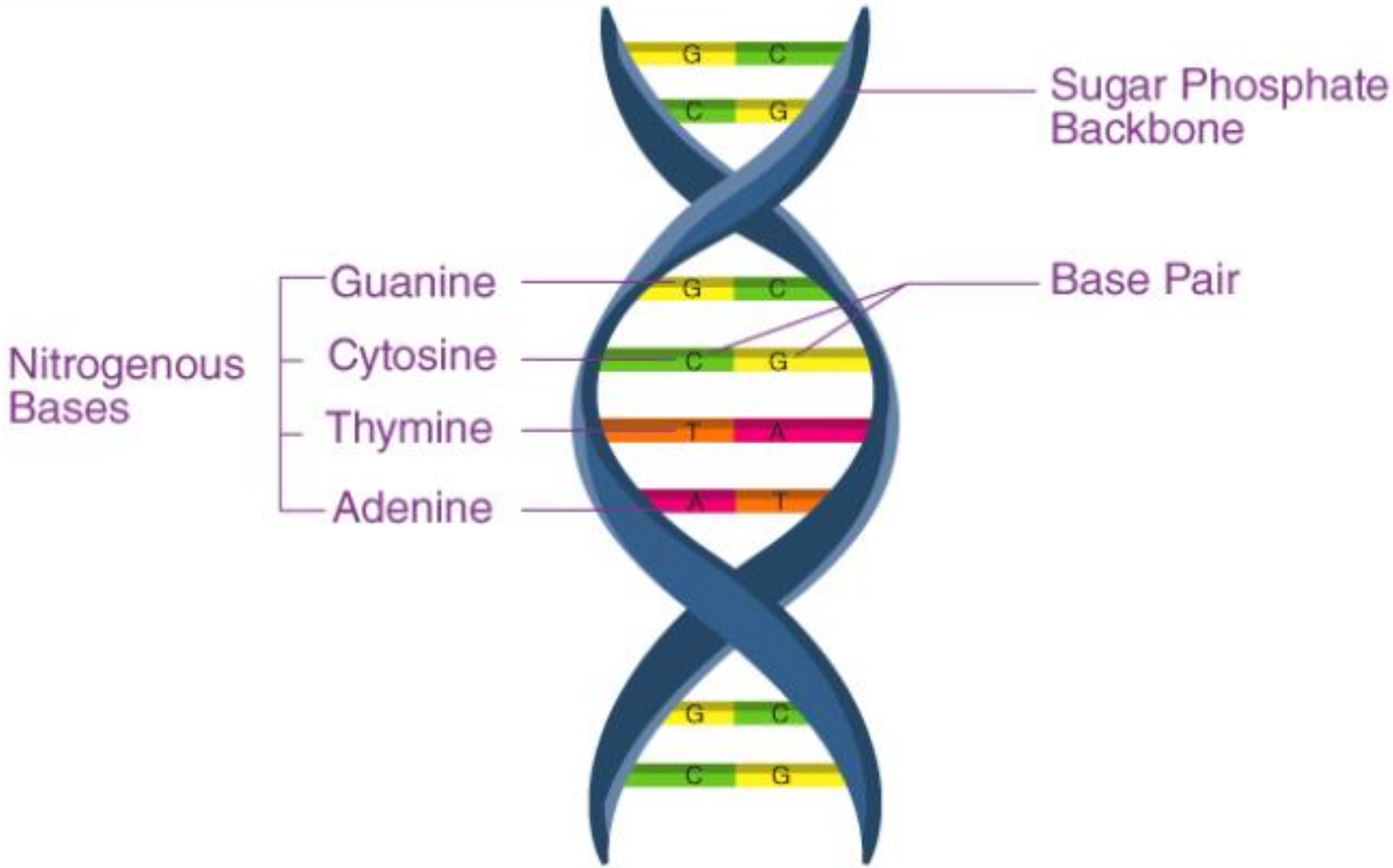
- Bacterial genetics, is the branch of genetics that focuses on the study of the genetic material and processes within bacteria.

DNA Structure

- The DNA structure can be thought of as a twisted ladder. This structure is described as a double-helix, It is a nucleic acid, and all nucleic acids are made up of nucleotides.
- The DNA molecule is composed of units called nucleotides, and each nucleotide is composed of three different components such as sugar, phosphate groups and nitrogen bases.

- The basic building blocks of DNA are nucleotides, which are composed of a sugar group, a phosphate group, and a nitrogen base. The sugar and phosphate groups link the nucleotides together to form each strand of DNA. Adenine (A), Thymine (T), Guanine (G) and Cytosine (C) are four types of nitrogen bases.

DNA STRUCTURE



DNA Diagram representing the DNA Structure

- Bacteria typically have a single circular chromosome, although some may have plasmids (small, extrachromosomal pieces of DNA).

Topics related to bacterial genetics:

- The bacterial genome: contains all the genetic information necessary for the bacterium to function, grow, and reproduce.

- Gene Structure: Bacterial genes are composed of DNA and are organized into operons. Operons are groups of genes that are transcribed together and often involved in related functions. The genes in an operon are controlled by a single promoter region and are transcribed as a single mRNA molecule.

- Replication: Bacterial DNA replication is a highly coordinated process. The process involves enzymes such as DNA polymerase and helicase.

Bactreia chromosome contain a double stranded molecules of DNA arranged in circular form.

Mutation: Bacterial genomes can undergo mutations, which are changes in the DNA sequence. Mutations can be spontaneous or induced by external factors like radiation or chemicals. They are a driving force behind bacterial evolution.

Horizontal Gene Transfer: Bacteria can exchange genetic material. This allows them to acquire new genes from other bacteria, which can lead to rapid adaptation to changing environments.

Vertical Gene Transfer: refers to the passage of a part of gene from mother to daughter cells during division.

Plasmids: Plasmids are small, circular pieces of DNA that can replicate independently of the bacterial chromosome. They often carry genes that confer selective advantages to the bacteria, such as antibiotic resistance genes.

Antibiotic Resistance: Understanding bacterial genetics is crucial for addressing the problem of antibiotic resistance. Bacteria can acquire resistance genes through horizontal gene transfer, making infections more challenging to treat.

Thank you