UNIT 22 - WORLD OF MICROBES

INTRODUCTION

- Microbiology (greek words: mikros -small, bios- life bearing, logy- study), is a branch of biology that deals with living organisms of microscopic size, which include bacteria, fungi, algae, protozoa and viruses.
- Microbes are found in habitats like terrestrial, aquatic, atmospheric or in living hosts.
- Some of them survive in extreme environments like hot springs, ice sheets, water bodies with high salt content and low oxygen, and in arid places with limited water availability.
- Some of the microorganisms are beneficial to us and they are used in the preparation of curd, bread, cheese, alcohol, vaccines and vitamins, while some others are harmful causing diseases to plants and animals including human being.
- This lesson will explore the beneficial and harmful effects of microbes in relation to welfare of human kind.

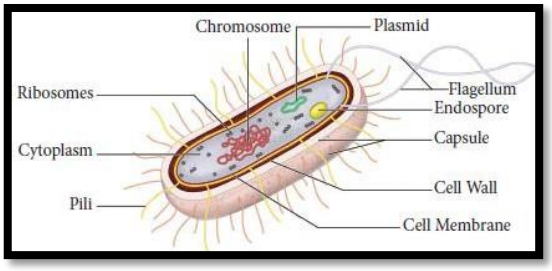
MICROBES AND THEIR TYPES

- Microorganisms differ from each other in size, morphology, habitat, metabolism and several other features.
- Microbes may be unicellular (Bacteria), multicellular (Fungi), acellular (not composed of cells-Virus). Types of microbes include bacteria, viruses, fungi, microscopic algae and protists.

BACTERIA

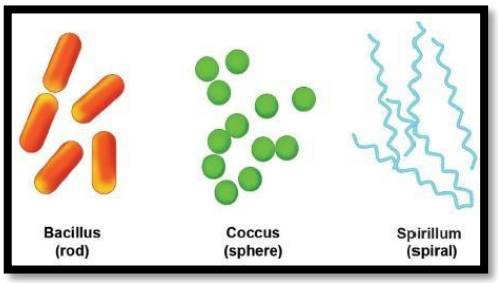
- Bacteria are microscopic, single celled prokaryotic organisms without nucleus and other cell organelles.
- Although majority of bacterial species exist as single celled forms, some appear to be filaments of loosely joined cells.
- The size varies from less than 1 to 10 µm in length and 0.2 to 1 µm micrometer in width. Bacteria may be motile or non-motile. Special structures called flagella are found on the cell surfaces for motility.

STRUCTURE OF A BACTERIAL CELL



a. SHAPES OF BACTERIA

- Based on the shapes, bacteria are grouped as:
- Spherical shaped bacteria called as cocci (or coccus for a single cell).
- Rod shaped bacteria called as bacilli (or bacillus for a single cell).
- Spiral shaped bacteria called as spirilla (or spirillum for single cell).



Shapes of bacteria

b. STRUCTURE OF A BACTERIAL CELL

- Bacterial cell has cell membrane, covered by strong rigid cell wall.
- In some bacteria, outside the cell wall there is an additional slimy protective layer called **capsule** made up of **polysaccharides**.
- The plasma membrane encloses the cytoplasm, **incipient nucleus** (nucleoid), ribosomes and DNA which serve as genetic material.
- Ribosomes are the site of protein synthesis.
- They lack membrane bound organelles. In addition to this, a small extra chromosomal circular DNA called **plasmid** is found in the cytoplasm

VIRUSES

- The term 'virus' in Latin means 'venom' or 'poisonous fluid'. Viruses are non-cellular, **self-replicating parasites**.
- They are made up of a **protein** that covers a central **nucleic** acid molecule, either RNA or DNA. The amount of protein varies from 60% to 95% and the rest is nucleic acid.
- Nucleic acid is either DNA (T4 bacteriophage) or RNA (Tobacco mosaic virus, TMV).
- A simple virus particle is often called a **virion**.
- They grow and multiply only in living cells.
- They are the smallest among the infective agents varying over a wide range from 18-400 nm (nanometre). They can live in plants, animals, human being and even bacteria.
- They can be easily transmitted from one host to another.

a. CHARACTERS OF VIRUSES

Viruses exhibit both living and non-living characters.

LIVING CHARACTERS OF VIRUSES

- They have the nucleic acid (DNA or RNA) i.e., the genetic material that can replicate.
- They can multiply in the living cells of the host.
- They can attack specific hosts.

NON-LIVING CHARACTERS OF VIRUSES

- Viruses remain as inert material outside their hosts.
- They are devoid of cell membrane and cell wall. Viruses are devoid of cellular organelles like ribosomes, mitochondria, etc
- They can be crystallised

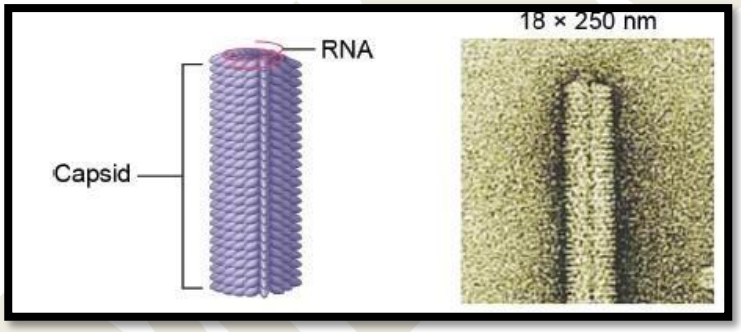
b. TYPES OF VIRUSES

Viruses are categorised as given below:

PLANT VIRUS:

- Virus that infect plants.

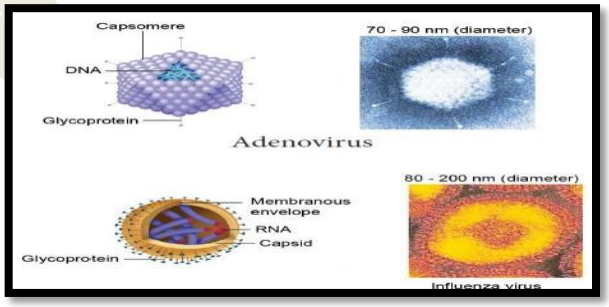
  eg. Tobacco mosaic virus, Cauliflower mosaic virus, Potato virus



Tobacco mosaic virus

ANIMAL VIRUS:

- Virus that infect animals.
- e.g. Adenovirus, Retrovirus(HIV), Influenza virus, Polio virus.



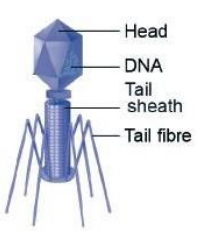
Influenza virus

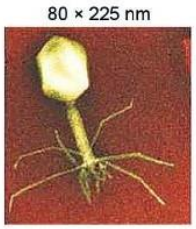
ANIMAL VIRUS

BACTERIOPHAGES:

Virus that infect bacterial cells.

eg. T4 bacteriophage.



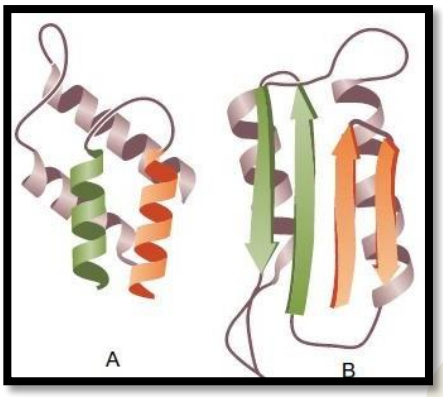


FUNGI

- They lack chlorophyll, hence depend on living or dead host for their nutritional needs.
- Fungi living on living hosts are called parasites, and those living on dead organic matter are called saprophytes.
- The body of the fungus is called **thallus**.
- Single celled yeast ranges from 1 to 5 µm in width.
- They are spherical in shape.
- Flagella are absent and hence they are non-motile.
- In the case of multicellular forms, thallus is called mycelium.
- **Mycelium** is a complex of several thin filaments called **hyphae** (singular: Hypha).
- Each hypha is 5 to 10 µm wide.
- They are tube like structures filled with protoplasm and cellular organelles.
- Cell wall is made up of cellulose or chitin.
- Cytoplasm contains small vacuoles filled with cell sap, nucleus, mitochondria, golgi body, ribosomes, and endoplasmic reticulum.
- Food material is stored in the form of glycogen or oil globules.
- They reproduce vegetatively (binary fission, budding and fragmentation), asexually (spore formation-conidia) and sexually (male and female gamatengium are called antheridium and oogonium).

PRIONS

- The term 'prion' was coined by Stanley B. Prusiner in 1982.
- Prions are **viral particles** which contain only proteins.
- They do not contain nucleic acid.
- They are infectious and smaller than viruses.
- Prions are found in neurons and are rod shaped.
- Prions induce changes in normal proteins. This results in the degeneration of nervous tissue.



Normal (A) and Abnormal (B) prion protein

APPLICATIONS OF MICROBES

Microorganisms contribute to human welfare in many ways.

In this section we will study about the diversified usefulness of microbes.

MICROBES IN AGRICULTURE

- Microbes play an important role in agriculture as biocontrol agents and biofertilizers.
- Microbes play a vital role in the cycling of elements like carbon, nitrogen, oxygen, sulphur and phosphorus.

MICROBES AS BIOFERTILIZERS:

- Microorganisms which enrich the soil with nutrients are called as biofertilizers.
- Bacteria, cyanobacteria and fungi are the main sources of biofertilizers.
- Nitrogen is one of the main source of plant nutrients.
- Atmospheric nitrogen has to be converted to available form of nitrogen.
- This is done by microbes either in free living conditions or by having symbiotic relationship with the plants.
- e.g. *Azotobacter*, *Nostoc* (free living), symbiotic microbes like *Rhizobium*, *Frankia*.

MICROBES AS BIOCONTROL AGENTS:

- Microorganisms used for controlling harmful or pathogenic organisms and pests of plants are called as biocontrol agents (Biopesticides).
- *Bacillus thuringiensis* (Bt) is a species of bacteria that produces a protein called as 'cry' protein.
- This protein is toxic to the insect larva and kills them.
- Spores of *B.thuringiensis* are available in sachets, which are dissolved in water and sprayed on plants infected with insect larva.

MICROBES IN INDUSTRIES

Microorganisms play an important role in the production of wide variety of valuable products for the welfare of human beings.

PRODUCTION OF FERMENTED BEVERAGES

- Beverages like wine are produced by fermentation of grape fruits by *Saccharomyces cerevisiae*.

CURING OF COFFEE BEANS,TEA LEAVES AND TOBACCO LEAVES

- Beans of coffee and cocoa, leaves of tea and tobacco are fermented by the bacteria *Bacillus megaterium*.
- This gives the special aroma.

PRODUCTION OF CURD:

Lactobacillus sp. converts milk to curd.

PRODUCTION OF ORGANIC ACIDS, ENZYMES AND VITAMINS:

- Oxalic acid, acetic acid and citric acid are produced by fungus *Aspergillus niger*.
- Enzymes like lipases, invertase, proteases, and glucose oxidase are derived from microbes.
- Yeasts are rich source of vitamin-B complex.

MICROBES IN MEDICINE ANTIBIOTICS:

- These are metabolic products of microorganisms, which in very low concentration are inhibitory or detrimental to other microbes.
- In 1929, Alexander Fleming produced the first antibiotic pencillin.
- In human beings antibiotics are used to control infectious diseases like cholera, diptheria, pneumonia, typhoid, etc.

Class of Microorganisms	Type of Microorganism	Antibiotic produced
Bacteria	*Streptomyces griseus*	Streptomycin
	Streptomyces erythreus	Erythromycin
	Bacillus subtilis	Bacitracin
Fungi	*Penicillium notatum*	Penicillin
	Cephalosporium acremonium	Cephalosporin

VACCINES

- These are prepared by killing or making the microbes inactive (attenuated).
- These inactive microbes are unable to cause
- World Health Day – 7th April
- World Malaria Day – 25th April
- World AIDS Day – 1st December
- World Anti -Tuberculosis Day – 24th March

MICROBES AND DISEASES

- Disease (dis = against; ease = comfort) can be defined as an impairment or malfunctioning of the normal state of the living organism that disturbs or modifies the performance of vital functions

of the body.

Disease can be categorized based on:

- The extent of occurrence (endemic, epidemic, pandemic or sporadic).
- Whether infectious or non-infectious.
- Types of pathogen – whether caused by bacterial, viral, fungal or protozoan infections.
- Transmitting agent – whether air borne, water borne or vector borne.

CLASSIFICATION OF DISEASE BASED ON OCCURENCE

Endemic:

- Disease which is found in a certain geographical area affecting a fewer number of people (low incidence).
- eg. Occurrence of goitre in Sub-Himalayan regions.

Epidemic:

- Disease which breaks out and affects large number of people in a particular geographical region and spreads at the same time.
- eg. Influenza.

Pandemic:

- Disease which is widely distributed on a global scale.
- eg. Acquired Immuno deficiency Syndrome (AIDS).

Sporadic:

- Disease which occur occasionally.
- eg. Malaria and Cholera.

MANIFESTATION OF DISEASE COMMUNICABILITY OF DISEASES

Infectious diseases are communicable diseases.

- They are caused by external factors like pathogenic organisms (bacteria, virus, vectors, parasites) invading the body and causing diseases.
- e.g. Influenza, Tuberculosis, Chickenpox, Cholera, Pneumonia, Malaria, etc

Non-infectious diseases are non-communicable diseases.

- They are caused by internal factors like malfunctioning of organs, genetic causes, hormonal imbalance and immune system defect.
- e.g. Diabetes, Coronary heart diseases, Obesity, Cancer, Goitre, etc

Point of entry and place of infection

- The disease causing microbes enter the body through different means.
- An infection develops when these pathogens enter the human body through contaminated air, water, food, soil, physical through contaminated air, water, food, soil, physical contact, sexual contact and through infected animals.
- They may be organ specific or tissue specific within our body where microbes reside.

Reservoir of infection

- Reservoir of infection refers to the specific environment in which the pathogens can thrive well and multiply without causing diseases.
- eg. Water, soil and animal population.

Incubation period

- The interval between infection and first appearance of the diseases is called incubation period.

It may vary from few hours to several days

Infection

Infection is the entry, development or multiplication of an infectious agent in the human body or animals.

Harmful Effects of Microbes

Pathogens cause disease in two ways. They are tissue damage and toxin secretion.

Tissue Damage:

- Many pathogens destroy the tissues or organs of the body causing morphological and functional damage.
- For example, bacterium of pulmonary tuberculosis damages the cells of the lungs, and virus causing hepatitis destroys liver tissue.

Toxin Secretion:

- Many pathogens secrete poisonous substances called toxins which cause tissue damage leading to diseases.