Prokaryotic cells are the cells that do not have a true nucleus and membrane-bound organelles.
"Prokaryotic cells are single-celled microorganisms known to be the earliest on earth. Prokaryotes include Bacteria and Archaea. The photosynthetic prokaryotes include cyanobacteria that perform photosynthesis. A prokaryotic cell consists of a single membrane and therefore, all the reactions occur within the cytoplasm.

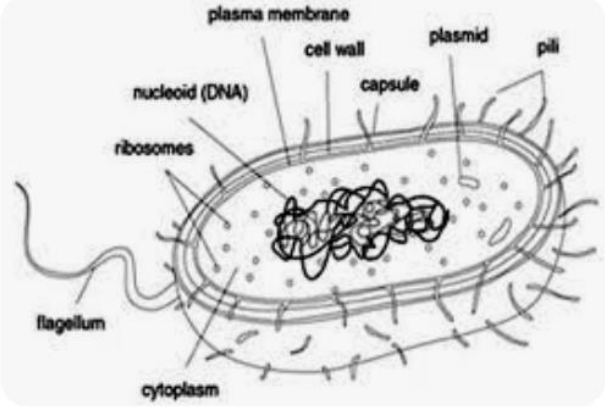
Characteristics of Prokaryotic Cell

1. They lack a nuclear membrane.
2. Cell organelles like Mitochondria, Golgi bodies, chloroplast, and lysosomes are absent. The genetic material is present on a single chromosome.
3. The histone proteins, the important constituents of eukaryotic chromosomes, are lacking in them. The cell wall is made up of carbohydrates and amino acids.
4. The plasma membrane acts as the mitochondrial membrane carrying respiratory enzymes.
5. They divide asexually by binary fission. The sexual mode of reproduction involves conjugation

Prokaryotic Cell Structure

A prokaryotic cell does not have a nuclear membrane. However, the genetic material is present in a region in the cytoplasm known as the nucleoid. They may be spherical, rod-shaped, or spiral. A prokaryotic cell structure is as follows:

1. **Capsule**– It is an outer protective covering found in the bacterial cells, in addition to the cell wall. It helps in moisture retention, protects the cell when engulfed, and helps in the attachment of cells to nutrients and surfaces.
2. **Cell Wall**– It is the outermost layer of the cell which gives shape to the cell.
3. **Cytoplasm**– The cytoplasm is mainly composed of enzymes, salts, cell organelles and is a gel-like component.
4. **Cell Membrane**– This layer surrounds the cytoplasm and regulates the entry and exit of substances in the cells.
5. **Pili**– These are hair-like outgrowths that attach to the surface of other bacterial cells.
6. **Flagella**– These are long structures in the form of a whip, that help in the locomotion of a cell.
7. **Ribosomes**– These are involved in protein synthesis.
8. **Plasmids**– Plasmids are non-chromosomal DNA structures. These are not involved in reproduction.
9. **Nucleoid Region**– It is the region in the cytoplasm where the genetic material is present.
10. **Plasma Membrane-** It is an outer protective covering of phospholipid molecules which separates the cell from the surrounding environment.
11. **Cytoplasm-** It is a jelly-like substance present inside the cell. All the cell organelles are suspended in it.
12. **DNA-** It is the genetic material of the cell. All the prokaryotes possess a circular DNA. It directs what proteins the cell creates. It also regulates the actions of the cell.
13. **Ribosomes-** Protein synthesis occurs here.



Structure of prokaryotic cell

"Eukaryotic cells are the cells that contain a membrane bound nucleus and organelles

Characteristics of Eukaryotic Cells

1. Eukaryotic cells have the nucleus enclosed within the nuclear membrane.The cell has mitochondria.
2. Flagella and cilia are the locomotory organs in a eukaryotic cell.
3. A cell wall is the outermost layer of the eukaryotic cells.
4. The cells divide by a process called mitosis.
5. The eukaryotic cells contain a cytoskeletal structure.
6. The nucleus contains a single, linear DNA, which carries all the genetic information.

Structure of Eukaryotic cell:- ." Eukaryotic cells have a nucleus enclosed within the nuclear membrane and form large and complex organisms. Protozoa, fungi, plants, and animals all have eukaryotic cells. They are classified under the kingdom Eukaryota.

1. **Plasma Membrane:-**The plasma membrane separates the cell from the outside environment.It comprises specific embedded proteins, which help in the exchange of substances in and out of the cell.

2. **Cell Wall:-**A cell wall is a rigid structure present outside the plant cell. It is, however, absent in animal cells.It provides shape to the cell and helps in cell-to-cell interaction. It is a protective layer that protects the cell from any injury or pathogen attacks. It is composed of cellulose, hemicellulose, pectins, proteins, etc.

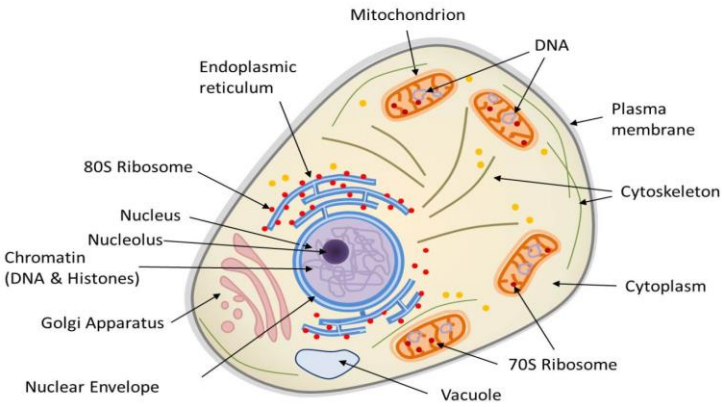
3. **Cytoskeleton:-**The cytoskeleton is present inside the cytoplasm, which consists of microfilaments, microtubules, and fibres to provide perfect shape to the cell, anchor the organelles, and stimulate the cell movement.

4. **Endoplasmic Reticulum:-**It is a network of small, tubular structures that divides the cell surface into two parts: luminal and extraluminal. Endoplasmic is of two types:

5. Rough Endoplasmic Reticulum contains ribosomes. And Smooth Endoplasmic Reticulum that lacks ribosomes and is therefore smooth.

6. **Nucleus: -**The nucleoplasm enclosed within the nucleus contains DNA and proteins.The nuclear envelop consists of two layers- the outer membrane and the inner membrane. Both the membranes are permeable to ions, molecules, and RNA material. Ribosome production also takes place inside the nucleus.
7. **Golgi Apparatus: -**It is made up of flat disc-shaped structures called cisternae. It is absent in red blood cells of humans and sieve cells of plants. They are arranged parallel and concentrically near the nucleus. It is an important site for the formation of glycoproteins and glycolipids.
8. **Ribosomes: -**These are the main site for protein synthesis and are composed of proteins and ribonucleic acids.
9. **Mitochondria: -**These are also known as "powerhouse of cells" because they produce energy.It consists of an outer membrane and an inner membrane. The inner membrane is divided into folds called cristae.They help in the regulation of cell metabolism.
10. **Lysosomes: -**They are known as "suicidal bags" because they possess hydrolytic enzymes to digest protein, lipids, carbohydrates, and nucleic acids.
11. **Plastids: -**These are double-membraned structures and are found only in **plant cells**. These are of three types:

- **Chloroplast** that contains chlorophyll and is involved in photosynthesis.
- **Chromoplast** that contains a pigment called carotene that provides the plants yellow, red, or orange colours.
- **Leucoplasts** that are colourless and store oil, fats, carbohydrates, or proteins



Structure of Eukaryotic cell

Examples of Eukaryotic Cells:-Eukaryotic cells are exclusively found in plants, animals, fungi, protozoa, and other complex organism

<u>Classification based on morphology</u>

1. Coccus (Pl. cocci): The spherical unicellular bacteria are called cocci which may be arranged in chains or in groups. They are comparatively resistant than other forms. They may be found in pairs called as diplococcus, or in chain called as strepto coccus or in clusters called staphylococcus.

2. Bacillus (Pl. Bacilli): They are unicellular rod like cells which may be long and narrow. Their size ranges from 1.5 u width to 10 u in length. Like cocci, they may occur single (called microbacillus) or in pairs known as diplobacillus, or in chains Lactobacillus of rods called as streptobacillus. The common rod shaped bacteria are - (in milk and curd), Clostridium (in soil), Bacillus subtilis etc.

3. Vibrio (Pl. Vibrios) are rod shaped bacteria which are little bit curved at one end to give a comma shape. They are small within 10 μ diameter. E.g. Vibrio comma.

4. Spirillum (Pl. spirilla) they are rod shaped forms which become coiled like a spring with more than one turn of helix. They are motile with cork screw motion. Their size varies 10-50 μ in length and 0.3 to 0.5 μ in breadth. E.g. Spirillum undulum, S. volutans.

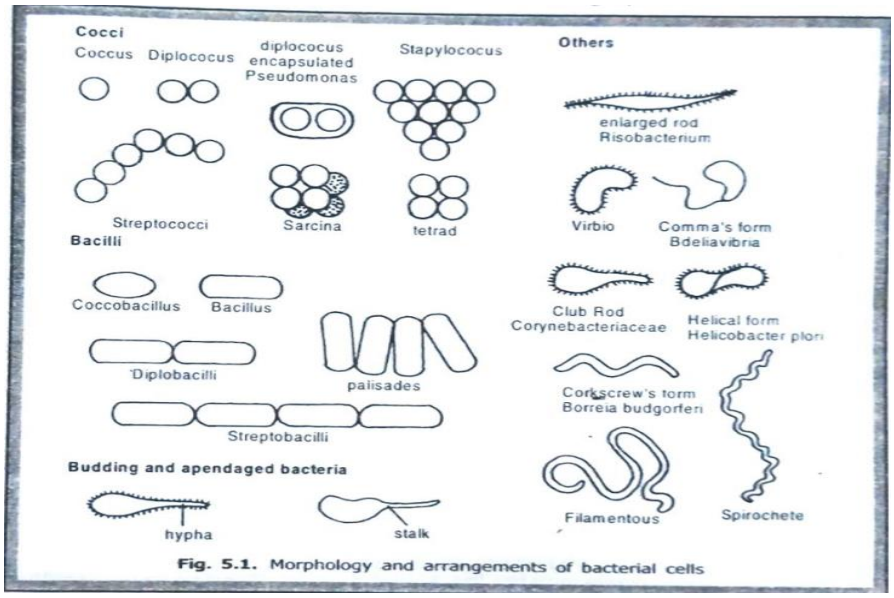
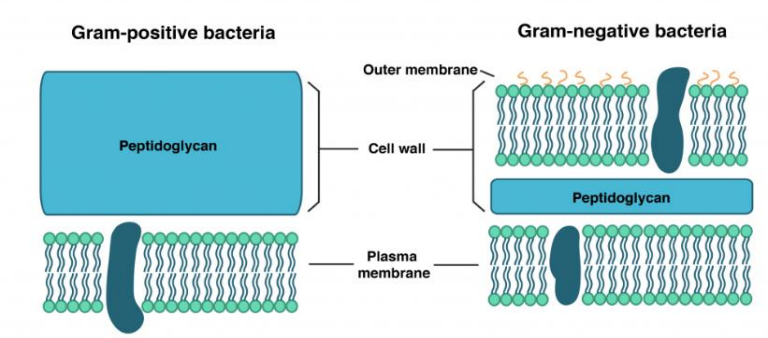


Fig. 5.1. Morphology and arrangements of bacterial cells

Classification based cell wall composition, bacteria are classified into two major group

1.Gram positive bacteria: -The cell walls of gram-positive bacteria are composed predominantly of peptidoglycan. Peptidoglycan can represent up to 90% of the cell wall, with layer after layer forming around the cell membrane. Gram positive cell wall is **teichoic acid**, a glycopolymer, which is embedded within the peptidoglycan layers. Teichoic acid is believed to play several important roles for the cell, such as generation of the net negative charge of the cell, which is essential for development of a proton motive force. Teichoic acid contributes to the overall rigidity of the cell wall, which is important for the maintenance of the cell shape, particularly in rod-shaped organisms. teichoic acids participate in cell division, by interacting with the peptidoglycan biosynthesis machinery. It constitutes about 50% of dry weight of cell wall. It is the major surface antigen of gram-positive bacteria.

2.Gram negative bacteria: -The cell walls of gram-negative bacteria are more complex than that of gram-positive bacteria, with more ingredients overall. They do contain peptidoglycan as well, although only a couple of layers, representing 5-10% of the total cell wall. What is most notable about the gram-negative cell wall is the presence of a plasma membrane located outside of the peptidoglycan layers, known as the **outer membrane**. This makes up the bulk of the gram-negative cell wall. The outer membrane is composed of a lipid bilayer, very similar in composition to the cell membrane with polar heads, fatty acid tails, and integral proteins. It differs from the cell membrane by the presence of large molecules known as **lipopolysaccharide (LPS)**, which are anchored into the outer membrane and project from the cell into the environment.



Classification based on nutrition: -Nutrition is substances used in biosynthesis and energy production and therefore are required for all living things. Bacteria, like all living cells, require energy and nutrients to build proteins and structural membranes and drive biochemical processes. Bacteria require sources of carbon, nitrogen, phosphorous, iron and a large number of other molecules. Carbon, nitrogen, and water are used in the highest quantities. The nutritional requirements for bacteria can be grouped according to the carbon source and the energy source.

Bacteria are prokaryotic organisms that require nutrients and energy for their growth and development like other living organisms. They require carbon, hydrogen, oxygen, nitrogen, metals and water for their biochemical processes. On the basis of their energy source and the carbon, bacteria are divided into two major classes: autotrophs and heterotrophs.

1)Autotrophs: -Organisms that obtain carbon from carbon dioxide and use light energy or inorganic chemical compounds to produce complex organic compounds are known as autotrophs. These are bacteria that can synthesise their own food from inorganic compounds.

Autotrophic bacteria are further classified into two:

a) Photoautotroph: -Photoautotrophic bacteria use CO_2 as their carbon source to convert it into carbohydrates in the presence of sunlight. These bacteria have bacteriochlorophyll and bacterioviridin pigments in their photosystems. Example: cyanobacteria, purple sulphur bacteria and green sulphur bacteria.

b) Chemoautotroph:-Chemoautotrophs are organisms that use inorganic sources to synthesise organic compounds in the absence of light. These bacteria lack any pigments and carry out only the dark phase of photosynthesis. Example: sulphur bacteria that oxidise elemental sulphur to gain energy, *Hydromonas* (hydrogen bacteria) that convert hydrogen into water, iron bacteria that obtain energy by oxidising dissolved ferrous oxides, methanogens and nitrifying bacteria.

2)Heterotrophs:-Heterotrophs are organisms that cannot make their own food but instead obtain nutrition from other organic sources that may be living or dead. Heterotrophs can be divided into two:

a)Photoheterotrophs:-Photoheterotrophic bacteria are those that use light as their source of energy but cannot use carbon dioxide as the carbon source. Instead they obtain nutrition from organic compounds found in the environment such as alcohols, carbohydrates and fatty acids. Examples: purple non-sulphur bacteria, heliobacteria and green non-sulphur bacteria.

b)Chemoheterotrophs:-Chemoheterotrophs are organisms that derive their energy as well as their carbon source from organic compounds such as carbohydrates and lipids. Example: saprophytic bacteria

Classification based on Respiration

1**. Aerobic Respiration: -**The organic food substances such as sugars are oxidized into CO_2 and H_2O by using molecular oxygen. Here the food substance acts as an electron donor and the oxygen acts as an electron acceptor. Anaerobic respiration in bacteria is very similar to that in higher plants. The overall reaction of aerobic respiration is given below

$$C_6H_{12}0_6 \text{ ----}\rightarrow 6CO_2 + 6H_2O + D686 \text{ Kcal}$$

The glucose is broken into 2 molecules of pyruvic acid by glycolysis. The pyruvic acid molecules are oxidized into CO, and H,O by Krebs's cycle. During these two series of reactions. NADH, molecules are generated. The electron transport systems present in the plasma membrane oxidize the NADH, into NADH and release energy. This energy is stored in the form of ATP molecules. Aerobic bacteria grow on the surface of the culture media.

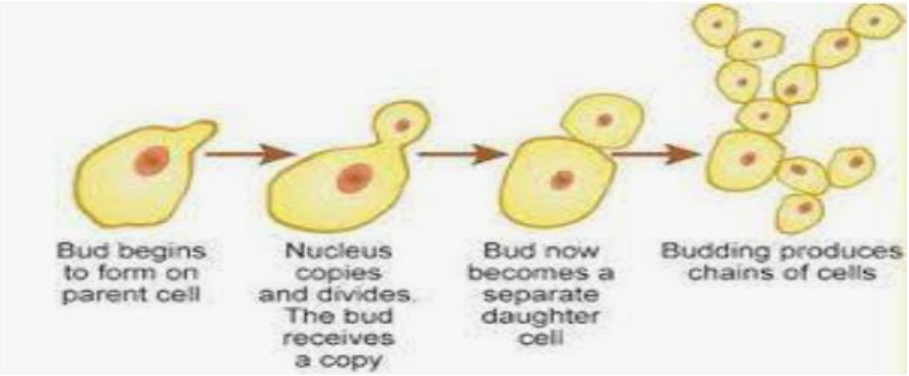
2. **Anaerobic Respiration:-**The generation of energy from organic food substances using electron acceptors other than free oxygen is called anaerobic respiration. Here NO, SO^2, CO_2, S^o and Fe^3 are used as the final electron acceptor in the electron transport chain.The glucose is broken into two molecules of pyruvic acid by glycolysis. The pyruvic and undergoes fermentation and forms ethyl alcohol and CO_2 or lactic acid. It consumes NADH The NADH, produced in the glycolysis passes through the electron transport chain that relea energy. At the final step the electron goes to any one of the above said electron acceptors. For example, in Desulfuromonas, elemental sulfur S^o accepts the electron and becomes HS Pseudomonas and Bacillus use Fe^{3+} as electron acceptor and hence Fe^{3+} becomes Fe^{2+} A large amount of energy is wasted in the form of heat during anaerobic respiration. Further it is an incomplete respiration that makes little ATPs. Anaerobic microbes form colonies at the bottom of the culture media.

3. Facultative Anaerobes:-Some bacteria do aerobic respiration when free oxygen is present and proceed anaerobic respiration when there is no oxygen. Such bacteria are called facultative anaerobes. Eg Methanogens and Desulfovibrio. They are growing well in the middle of the culture media. Their electron transport system is best suited for aerobic and anaerobic respirations.

REPRODUCTION IN BACTERIA: -Reproduction in bacteria or multiplication of cell numbers in bacteria occurs mainly by vegetative reproduction and asexual method. There is no sexual reproduction in bacteria due to lack of sex organs or gamete formation.

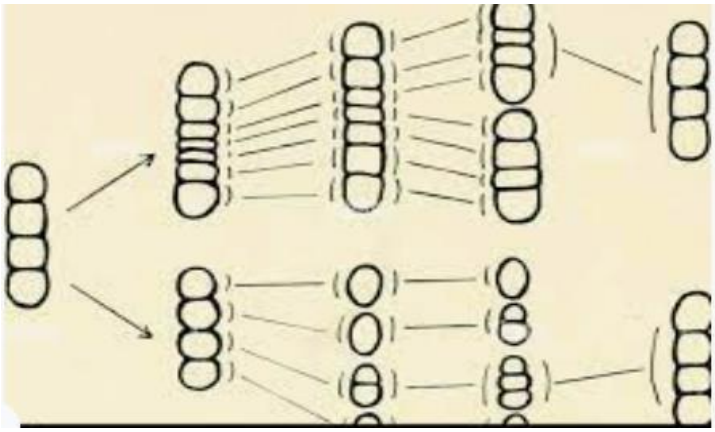
(A) Vegetative Methods of Reproduction: -**It occurs by three methods Budding, Fragmentation and Binary Fission.**

(**a) Budding** : Budding occurs by formation of a protuberance called bud at one end of the cell. Genome replication occurs and a copy of the genome enters into the bud. The bud then enlarges and finally gets separated from the parent cell to give rise to a daughter independent bacterial cell.



(b) Fragmentation : During unfavourable conditions bacterial protoplasm undergoes compartmentalization forming minute bodies called gonidia. Each gonidium grows to a new bacterium under favorable conditions.

Prior to this, the genome has under gone several replications so as to be included one in each gonidium. The parent body divides into several fragments and each fragment develops into a new organism



(c) Binary Fission: It is the most common method of reproduction in all bacteria

1. The bacterium before binary fission is when the DNA is tightly coiled.
2. The DNA of the bacterium has uncoiled and replicated.
3. The DNA is pulled to the separate poles of the bacterium as it increases in size to prepare for splitting.
4. The growth of a new cell wall begins to separate the bacterium.
5. The new cell wall fully develops, resulting in the complete split of the bacterium.
6. The new daughter cells have tightly coiled DNA rods, ribosomes, and plasmids, these are brand new organisms. (ii) Before binary fission the cell constituents get doubled. (iii) The entire event occurs in a proper sequence - first DNA replication, then DNA partitioning and lastly cross wall formation. (iv) First the bacterial chromosome gets attached to the cell membrane and replicates into two.(v) As the cell enlarges, the daughter DNAs still attached to the wall get separated by a simple pinching off process.(vi) A cross wall is then formed. First the transverse plasma membrane is laid down followed by the centripetal growth of the cell wall which splits the plasma membrane into two halves.(vii) The binary fission occurs when the environmental condition is favorable and it takes nearly 20-30 minutes to form two cells. This is the generation time. (viii) Due to binary fission the single bacterial cell grows in a geometric progression and a big colony is seen in the culture plate in a short time

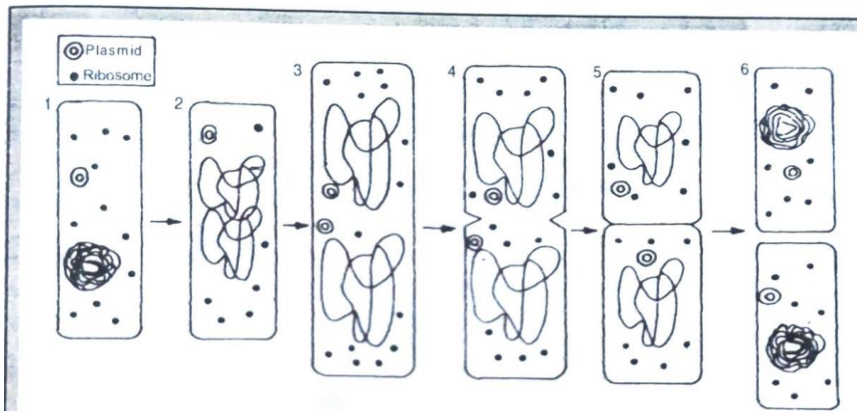


Diagram of Binary fission

d) **Endospore formation**:-Some bacteria are able to produce spores called endospores. Generally, spore producing bacteria are rod shaped and species of Clostridium and Bacillus form endospores under unfavourable circumstances. Only one endospore is formed in one cell.

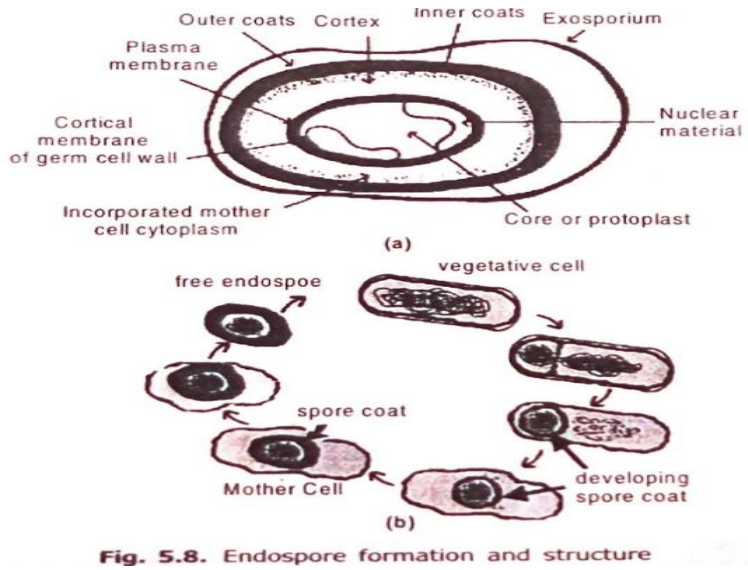


Fig. 5.8. Endospore formation and structure

i) During the process, a part of the protoplast becomes concentrated around the (ii) A hard resistant wall is secreted around it. (iii) The rest of the bacterial cell degenerates.

(iv) Each endospore is either spherical, cylindrical or ellipsoidal in shape. (v) The endospore has a complex structure.(vi) The outer layer is thin, delicate and called exosporium. It is followed by the spor coat. Inner to spore coat the cortex contains concentric rings of wall. Below th cortex, the core cell wall is present surrounding the cell membrane and the protoplasm (vii) Endospore contains especially dipicolinic acid (DPA) which in association with calcium ions make the endospore heat resistant.(viii) Under favourable conditions, the endospore germinates by imbibing water, activating the cytoplasm and synthesizing metabolites and then due to swelling bursting or wall occurs giving rise to the new vegetative cell

Sexual method of reproduction(genetic recombination in bacteria):-

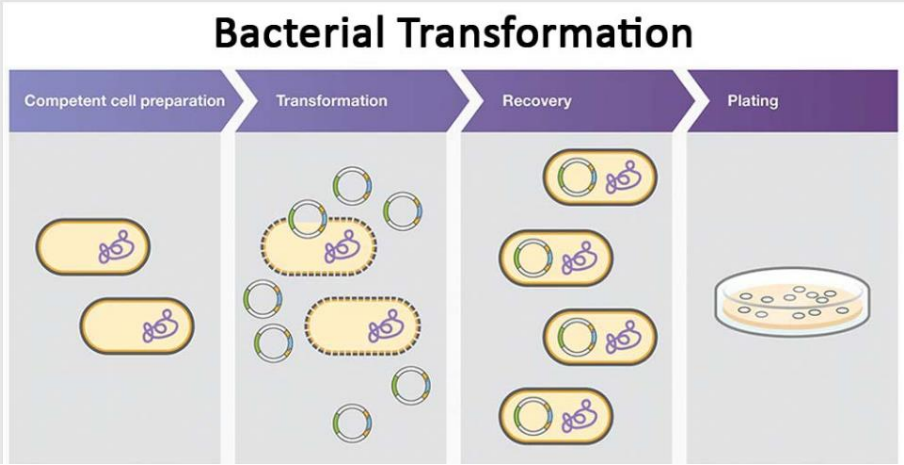
Recombination is the arrangement and reshuffling of genes resulting in the new genotypes. Bacterial recombination is brought about by the transfer of genetic materials from one bacterium to another. The bacterium which denotes the genetic material is called donar and the bacterium is called recipients. It occurs by 3 methods

1)Transformation:- Bacterial transformation is the transfer of free DNA released from a donor bacterium into the extracellular environment that results in assimilation and usually an expression of the newly acquired trait in a recipient bacterium. Bacterial transformation is based on the natural ability of bacteria to release DNA which is then taken up by another competent bacterium.

The success of transformation depends on the competence of the host cell. Competence is the ability of a cell to incorporate naked DNA in the process of transformation. Organisms that are naturally transformable spontaneously release their DNA in the late stationary phase

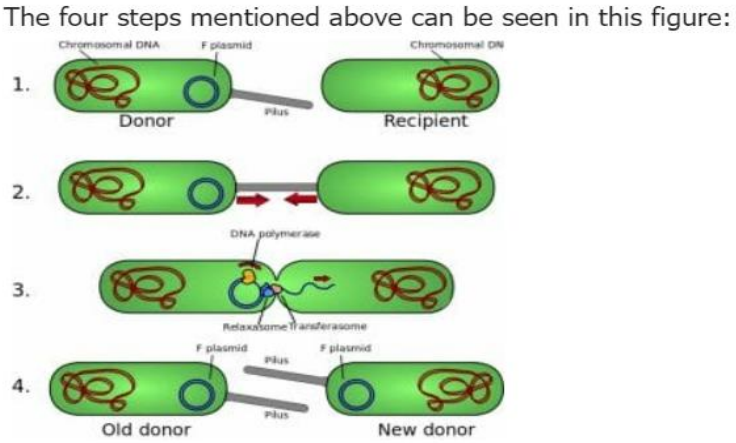
This process doesn't require a living donor cell and only requires free DNA in the environment. The recipient that successfully propagates the new DNA is called the transformant. During extreme environmental conditions, some bacterial genera spontaneously release DNA from the cells into the environment free to be taken up by the competent cells. The competent cells also respond to the changes in the environment and control the level of gene acquisition through a natural transformation process. Transformation is adopted as the most common method of gene transfer as it is the best way for the transfer of artificially altered DNA into recipient cells. The process of transformation can transfer DNA regions of one to tens of kilobase.Several bacteria, including *Escherichia coli*, can be artificially treated in the laboratory to increase their

transformability by chemicals, such as calcium, or by applying a strong electric field.



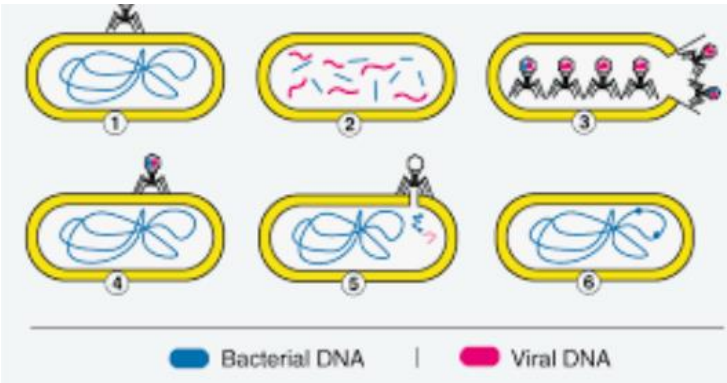
2)Conjugation:-Conjugation is the transfer of a plasmid or other self-transmissible DNA element and sometimes chromosomal DNA from a donor cell to a recipient cell via direct contact usually mediated by a conjugation pilus or sex pilus. Recipients of the DNA transferred by conjugation are called transconjugants. The process of conjugation can transfer DNA regions of hundreds to thousands of kilobases and has the broadest host range for DNA transfer among the methods for bacterial exchange.Conjugation occurs in and between many species of bacteria, including Gram-negative as well as Gram-positive bacteria. The process of bacterial conjugation is based on the principle that the plasmid or any other genetic material is transferred from the donor cell to the recipient cell through close physical contact. Of all the conjugative plasmids, the F (fertility) plasmid of *E. coli* was the first discovered and is one of the best-studied. The F plasmid is present in one or two copies per cell and is very large (about 100 kilobases). *E. coli* harbouring the F plasmid are referred to as donor (F^+ or male) cells and E. coli lacking the F plasmid are referred to as recipient (F^- or female) cells. Only donor cells are capable of transferring the F plasmid to recipient cells.For transfer of the F plasmid from donor to recipient, intimate contact between cells, resulting in mating-pair formation, is required.

The transfer of genetic material is then brought by membrane fusion of the two cells by the action of different enzymes.Following the membrane fusion, the replication of donor DNA occurs and is transferred into the recipient cell.



3)Transduction: - The transfer of genetic material from one bacterium to another through bacteriophage is called transduction. Here the bacteriophage infects a bacterium and multiplies within it. During this process, the new phages pick up certain genes from the bacterial genome. After lysis of the bacterium the new phages infect another bacterium. During this process, the host gene picked up the phage is injected into the bacterium.

Therefore, the bacterium shows a some characters of the old host of the phage virus. Transduction is a method of gene transfer in bacteria from donor to recipient using bacteriophage. In transduction at first bacteriophage infects donor bacteria and then carries some part of donor genome with it. When this bacteriophage infects new bacterial cell, it transfer that DNA in to recipient cell. The phages involved in transduction are all temperate, that is, those which either lyse the cell at once or remain in the host cell without killing it. They can multiply inside the bacterial cell and finally cause lysis of the host cell. A bacterium which harbours temperate phages is said to be lysogenic.



Viruses are infectious agents that replicate inside the body of a host. virus, Microscopic, simple infectious agent that can multiply only in living cells of animals, plants, or bacteria.Viruses are much smaller than bacteria and consist of a single- or double-stranded nucleic acid (DNA or RNA) surrounded by a protein shell called a capsid; some viruses also have an outer envelope composed of lipids and proteins.

Properties of Viruses:-

1. They are non-cellular organisms, which is enclosed in a protective envelope.
2. The presence of spikes helps in attaching the viruses to the host cell.
3. These viruses do not grow, neither respire nor metabolize, but they reproduce.
4. They are surrounded by a protein coat – capsid and have a nucleic acid core comprising DNA or RNA.
5. They are considered both as living and non-living things. These viruses are inactive when they are present outside of host cells, but become active within host cells. These viruses cause several infections and reproduce within the host cell by using the enzymes and raw materials

Structure of Viruses: -Viruses are tiny and smaller in its size, ranging between 30-50 nm. Viruses do not contain cells and usually lack a cell wall but are surrounded by a protective protein coating called the capsid.

1)Capsid - The capsid is the protein shell that encloses the nucleic acid; with its enclosed nucleic acid, it is called the nucleocapsid. This shell is composed of protein organized in subunits known as capsomers. They are closely associated with the nucleic acid. It can be seen as a genetic element and is characterized by the combined evolution of the virus and the host. They contain either RNA or DNA as the genetic material. The capsid has three functions: 1) it protects the nucleic acid from digestion by enzymes, 2) contains special sites on its surface that allow the virion to attach to a host cell, and 3) provides proteins that enable the virion to penetrate the host cell membrane and, The capsid is composed of smaller protein components referred to as **capsomers**.

3. Envelope:Some virus contains envelope that surrounds nucleocapsid. The virus without envelope is called naked virus.The envelope is a bilayer of lipoprotein and glycoprotein.
The envelope is acquired by the progeny virus from host cell during virus release by budding process.In some virus the glycoprotein projects out in the form of spike called peplomere. Some of the peplomers or

glycoprotein spike such as Haemaglutinin and Neuraminidase which are involved in binding of virus to host cell.

4.Enzymes:Some virus contains enzymes which play central role during infection process. Eg. Some bacteriophage contains an enzyme lysozyme, which makes small hole in bacterial cell that allows viral nucleic acid to get in.Some virus contains their own nucleic acid polymerase which transcribe the viral genome into mRNA during replication process. Eg. Retro virus are RNA virus that replicates inside host cell as DNA intermediate. These virus possess an RNA dependent DNA polymerase called reverse transcriptase.

5.Genome:Virus contains either DNA or RNA as genetic material but not both. Virus which contains DNA as genetic material are called DNA virus and those containing RNA are called RNA virus.

Classification of Viruses

Viruses can be classified primarily on their phenotypic characteristics, core content, chemical composition, capsid structure, size, shape, modes of replication and other viral genome structures.

Classification based on the presence of nucleic acid

1)DNA virus:-The virus, having DNA as its genetic material. There are two different types of DNA virusSingle-stranded (ss) DNA virus: e.g. Picornaviruses, Parvovirus, etc.

Double-stranded (ds) DNA virus: e.g. Adenovirus, Herpes virus, etc.

2)RNA virus:-The virus, having RNA as its genetic material. There are two different types of RNA virus.Double-stranded (ds) RNA virus: e.g. Reovirus, etc.

Single-stranded (ss) RNA virus. It is further classified into two Positive sense RNA (+RNA) and negative sense RNA (-RNA). Poliovirus, Hepatitis A, Rabies virus, Influenza virus are examples of single-stranded RNA virus

Classification based on the structure or symmetry

Viruses come in different shapes, from basic helical and icosahedral shapes to more intricate ones. The classification based on different shapes and symmetry of viruses are as follows:

1. Complex virus. E.g Poxvirus
2. Radial symmetry virus. E.g.Bacteriophage
3. Cubical or icosahedral symmetry shaped virus. E.g. Reovirus, Picornavirus
4. Rod or Spiral shaped or helical symmetry virus. E.g. Paramyxovirus, orthomyxovirus

Classification based on the replication properties and site of replication

1. Replication within the cytoplasm of the host cell.
   E.g. All RNA viruses except the Influenza virus.
2. Replication within the nucleus and the cytoplasm of the host cell.
   E.g. Influenza virus, Poxvirus, etc.
3. Replication within the nucleus of the host cell.
   All DNA viruses except Pox virus.
4. Replication of the virus through the double-stranded DNA intermediate.
   E.g. All DNA viruses, Retrovirus and some tumour causing RNA virus.

5. Replication of the virus through a single-stranded RNA intermediate.
   E.g. All RNA viruses except Reovirus and tumour-causing RNA viruses.

Classification based on the host range:-Based on the type of host, there are four different types of viruses:

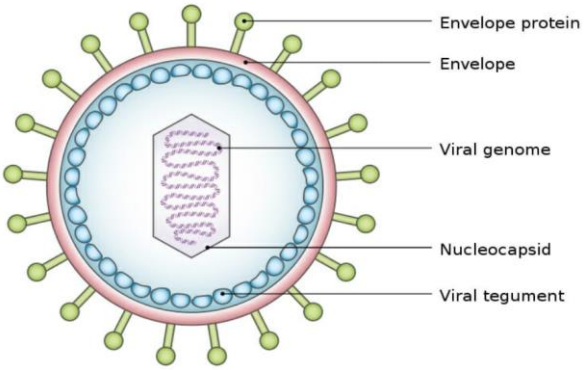
Animal viruses:-These viruses infect by invading the cells of animals, including humans. Prominent examples of animal viruses include the influenza virus, mumps virus, rabies virus, poliovirus, Herpes virus, etc.

Plant viruses:-These viruses infect plants by invading the **plant cells.** Replication of plant viruses is obligate and does not happen without a host. Well-known examples of plant virus include the potato virus, tobacco mosaic virus (TMV), beet yellow virus, and turnip yellow virus, cauliflower mosaic virus, etc.

Bacteriophage:-The virus which infects bacterial cells is known as bacteriophage. There are many varieties of bacteriophages, such as DNA virus, MV-11, RNA virus, λ page, etc.

Classification based on the mode of transmission

1. Airborne infections – Transmission of the virus through the air into the respiratory tract. E.g. Swine flu, and Rhinovirus.
2. Fecal oral route – Transmission of the virus through the contaminated water or food.
   E.g. Hepatitis A virus, Poliovirus, Rotavirus.
3. Sexually transmitted diseases – Transmission of the virus through sexual contacts with the infected person.
   E.g. Retrovirus, human papillomavirus, etc.
4. Transfusion-transmitted infections- Transmission of the virus through the blood transfusion.E.g. Hepatitis B virus, Human Immunodeficiency Virus, etc.
5. Zoonoses -Transmission of the virus through the biting of infected animals, birds, and insects to human. E.g. Rabies virus, Alpha virus, Flavivirus, Ebola virus, etc.



Structure of virus

Virus Replication Cycle:-The replication cycle of viruses can vary from virus to virus, there is a general pattern that can be described, consisting of five steps:

1)Attachment – the virion attaches to the correct host cell. This is the first step in virus infection in which interaction of virion with a specific receptor site on the surface of host cell occurs.The receptors sites are

normal cell surface components of host cell such as protein, polysaccharides or lipoprotein-polysaccharide complex to which virus attach.

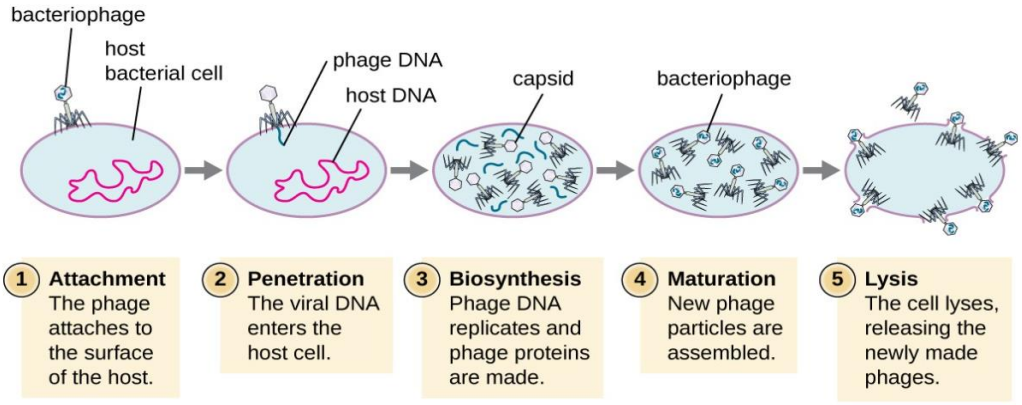
For eg. HIV binds to CD4 cell receptor of T-lymphocytes

2)Penetration or Viral Entry – the virus or viral nucleic acid gains entrance into the cell. After binding of virus, virus is taken up inside the cell which is referred as penetration or engulfment. The entry of virus into host cell may involves, Transfer of only genome across cytoplasmic membrane. Transport of entire virus across cytoplasmic membrane by endocytosis. Fusion of viral envelope with cytoplasmic membrane of host cell

3)Synthesis – the viral proteins and nucleic acid copies are manufactured by the cells' machinery. In most virus, only part of nucleic acid is initially transcribed into mRNA.
The early mRNA codes for early proteins (enzymes) required for nucleic acid replication

After nucleic acid replication, many copy of progeny nucleic acids formed. Late mRNA is transcribed from progeny genome

4) Assembly:- When critical number of various viral components have been synthesized, they assembled into mature virus. The assembly occurs in nucleus or cytoplasm of host cell depending upon types of virus.DNA virus assembled in nucleus except Poxvirus and RNA viruses assembled in cytoplasm except Influenza virus and Reo virus.

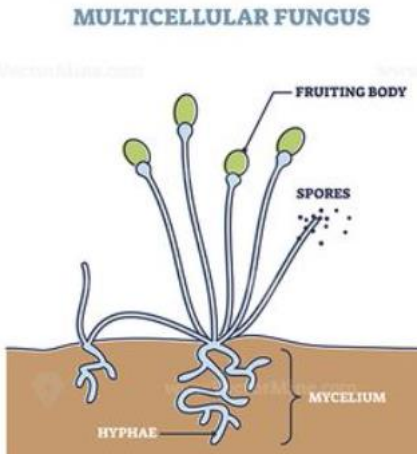


Fungi are eukaryotic organisms that include microorganisms such as yeasts, moulds and mushrooms. These organisms are classified under kingdom fungi.The organisms found in Kingdom fungi contain a cell wall and are omnipresent. They are classified as heterotrophs among the living organisms.

Characteristics of Fungi

1. Fungi are eukaryotic, non-vascular, non-motile and heterotrophic organisms.
2. They may be unicellular or filamentous.
3. They reproduce by means of spores.
4. Fungi exhibit the phenomenon of alternation of generation.
5. Fungi lack chlorophyll and hence cannot perform photosynthesis.
6. Fungi store their food in the form of starch.
7. Biosynthesis of chitin occurs in fungi.
8. The nuclei of the fungi are very small.
9. The fungi have no embryonic stage. They develop from the spores.
10. The mode of reproduction is sexual or asexual

1) **Hyphae:-**Fungi grow as thread-like filaments, The filaments are called **hyphae** (singular, hypha). Each hypha consists of one or more cells surrounded by a tubular cell wall. A mass of hyphae make up the body of a fungus, which is called a **mycelium** (plural, mycelia).
2) Spores are the main reproductive units for fungi and are usually single cells. They may be produced either directly by asexual methods or indirectly by sexual reproduction. Spores are commonly formed by the fragmentation of the mycelium or within specialized structures.
3) The sporangium is a vital structure in the reproduction of fungi and bryophytes. In most cases, they appear as a sac or a capsule. They are involved in the **production of spores through mitosis**
4) This fruiting body, known as the **sporocarp**, is a multicellular structure on which spore-producing structures form. The fruiting body is part of the sexual phase of a fungal life cycle.
5) The cell wall is a characteristic structure of fungi and is composed mainly of glucans, chitin and glycoproteins. The fungal cell wall is an essential structure with great plasticity that is vital to maintaining cellular integrity and viability. The cell wall plays an important role in different biological functions such as controlling cellular permeability and protecting the cell from osmotic and mechanical stress.
6) Protoplast, which divides into other cell parts such as the cell membrane, cell organelles, cytoplasm, and nuclei



Structure of Fungi