Virus (Latin = poison)

The use of the word goes back to many hundreds of years, long before any one really knew what a virus was.

- In 1770, a virus disease 'leaf roll' of potato was observed for the first time in England & In 1785 (in) from Germany.
- TMV was recognized by Sxlieten in Holland in 1887.
- Adolph Mayer, a Dutch investigator working with TMV in Holland was first to point out in 1886 that it was transmissible & infectious.
- Iwanowski, a Russian investigator (1892), demonstrated that TMV would pass through a bacteria proof filter & thereby he distinguished this type of infectious agency from bacteria & from fungi
- This work was confirmed by Beizerink in 1898, who showed further that tobacco mosaic virus will diffuse through an agar agar layer suggested that it was a 'contagium vivum fluidum'

1898. Loeffler & Frosch were the first to show virus of animal origin to be filterable when they demonstrated that the foot & mouth disease of (sugarcane) cattle was incited by an entity which passed through bacteria proof filter.

- Sirah disease of sugarcane (Java, 1882)

- Mosaic disease of Sugarcane |→ yellow stripe disease (Java, 1890)
- Mosaic of Tomato (Observed in England, studied in America, 1887)

- In 1886 Mayer discovered tobacco mosaic in north Europe

- Iwanowsky (1892) discovered the first virus & thought it to be the small bacterium causing tobacco mosaic.

- In 1901, Takami of Japan, transmitted the dwarf or stunt disease of paddy by an insect *Nephotettix apicalis*, and it was known for the first time that viruses could be transmitted by insects.

- For the first time in 1935, W. M. Stanley isolated the 'Tobacco Mosaic Virus' in paracrystalline form.

- Bawden & Pirie (1938) isolated a fully crystalline viruses of the tomato bushy stunt virus.

- The word virus, before their discovery was applied to any poisonous substance came to be used for all kinds of infection agents.

- As research progressed further, it was found that certain agents were so fine that they could pass through specially designed filters which did not allow even bacteria & other known microorganisms to pass through.
- invisible to the most powerful microscopes of conventional type.
- It was the invention of electron microscope in recent years that has enabled these tiniest of organisms to be identified and photographed.

(light microscope - 2000 X
Electron microscope - 10,000 magnification
2,00,000 photographical enlargement)

- Virus (Definition)

Viruses are ultramicroscopic, very simple, acellular, intracellular, disease causing entities.

- Chemically viruses consist of nucleoproteins - a combination of nucleic acid & protein essential constituents of living matter.
- The more complex viruses contain some fats in addition.

Twort & D'herille (1915-17) used the term virion or virion (Lt; poison) to describe the disease causing particles present in the infectious fluid.

. Pfankuch & Ruska in 1939 described the TMV as rod shaped structures.

Virus - All life (stages) cycle.
Virion - only the infectious stage of life cycle

General Characters of Viruses:

i) They are the obligate intracellular parasite:
Viruses are not free living. They live & multiply only in living cells.

ii. All the viruses are ultramicroscopic.

iii) The viruses cannot be grown in artificial media in any case and the living cell seems essential for multiplication of Viruses.

iv) They have no cellular organisation:
They do not have cellular organisation i.e. protoplasm and cell organelles are absent.

v) They are simple in structure:
They are simple in structure having two parts only, a central core of nucleic acid (DNA or RNA) and outer protein coat called capsid

vi) They have no independent metabolism:
Viruses do not have their own metabolic system.

vii) They have no growth & division:
They do not increase in size, only their genetic material divide that too, inside a host cell (multiplication)

viii) They have nucleic acid:
The nucleic acid as genetic material is present. It may be either DNA or RNA but both are never present.

ix) They have chemical like nature:
They can be crystallised. Even in the crystalline form, they retain their infectivity.

x) They are specific in action:
They are specific in action i.e. they always infect particular organs of particular organism.

xi) They give response to stimuli:
They give response to external stimuli i.e. they react with various environmental conditions like heat & UV rays.

xii) They have definite shape & Size:
They are seen only under electron microscope and hence they are called ultramicroscopic.
- Generally the size varies from 10 μ - 300 μ
They have variety of shapes such as spherical or polyhedral (polio virus), Cylindrical or rod like (TMV - tobacco mosaic virus), complex viruses (bacteriophages) having complex shapes like tadpole.

xiii) Structure:
A virus consists of two parts such as Capsid & Nucleic acid.
- The capsid is outer coat of a virus,
- It is made up of specific protein.
- It is composed of many similar small units called capsomeres.
- It provides shape to the virus and also gives protection to the nucleic acid.
- The central core of virus contains a single molecule of the nucleic acid either DNA or RNA.
- Some viruses are covered by an envelop which contains lipids & proteins. Such viruses with envelop are called as the enveloped viruses.
- The viruses without envelop are called as the naked viruses.

xiv) Chemical composition:
Chemically the viruses are nucleoproteins which consist of proteinaceous capsomeres and nucleic acid.

xv) Nature of Viruses:
The nature of viruses is a matter of controversy because they show both characters like living organisms and characters like non-living things.

Characters like living Organism:
- They can live only in a living cell.
- They possess nucleic acid.
- They can infect healthy plants just like bacteria & fungi.
- They multiply in number & ~~grow in size~~, as they living organisms reproduce and grow.
- They have a capacity to mutate.
- They have definite shape & size.
- They have physiological specialization in relation to the insect vectors & the plants.
- They respond to stimuli, such as acids, alkalies, light & temperature.

Characters like non-living things:

- They are too small to be observed under visible light.
- They do not have ~~no~~ cellular organization.
- They do not have independent metabolic system.
- They do not increase in size.
- They can be crystallized like a chemical substance
- They can be sedimented like protein.
- They can be precipitated by a number of chemical substances.
- They retain the power of infection even after 31 years in non-living tobacco leaves.

- Some workers did not agree with any of the above extreme views and adopted a middle course.
- They regarded viruses, representing a stage in between living and non-living with the acquired property of multiplication.
- Due to such nature, they are also called as "Mysterious particles" and are biological puzzle to the biologists.

Classification of Viruses:

- During early days, based on the basis of their hosts.

i) Plant viruses
- Infect plants
- Rod like / cylindrical
- only RNA as nucleic acid

eg TMV, BMV (Beet)

ii) Animal viruses
- Infecting animals
- To man → human viruses.
- Spherical / polyhedral
- Nucleic acid = DNA or RNA

eg. Polio virus

iii) Bacterial virus: = Bacteriophages.
- infecting bacteria
- complex tadpole like
- NA → DNA

Viral Replication:

Viral replication is the formation of biological viruses during the infection process in the target host cells.

- Viruses must first get into the cell before viral replication can occur.
- Through the generation of abundant copies of its genome & packaging these copies, the virus continues infecting new hosts.
- Replication between viruses is greatly varied & depends on the type of genes involved in them.
- Most DNA viruses assemble in the nucleus while most RNA viruses (assemble in the nucleus) develop solely in cytoplasm.
- Virus particles are non-motile & reach the hosts passively through cell sap of the previous host.
- The whole process is called the virus growth cycle. (20 min in bacteriophages)

Growth cycle of Bacteriophages:

- Bacteriophages, on the basis of their growth cycles i.e. lytic & lysogenic can by divided into two groups = the virulent & temperate phages.

Lytic - Virulent - & T series
Lysogenic - temperate

- The virulent phages show a lytic cycle in which the sensitive bacterium lyses & a large number of newly formed virus particles are liberated.

- In the lysogenic cycle, the virus (temperate phage) does not multiply, and there is no death of host cells.
- At the critical time, called induction, the phage enters the lytic cycle.

The Lytic Cycle:

- This cycle occurs in T series of phages which attack E. coli
- The sequence of events in lytic cycle are

Lytic Cycle:

This cycle occurs in T series of phages which attack E. coli

- The sequence of events in Lytic cycle are

1. Adsorption
2. Injection
3. Transcription
4. Protein synthesis
5. Genome synthesis
6. Maturation
7. Release

1. Adsorption:

The phage attaches or adsorbs on specific 'receptor sites' on the bacterial wall with the help of tail fibers & the basal plate.

2. Injection:

- The small fibers (tail pins) hold the phage in position and a pore is dissolved in the wall probably by phage enzyme.
- Then by the contractile action of the sheath, the hollow central tube penetrate through the wall and the DNA is injected into the cell.

3. Transcription / mRNA production:

The phage DNA takes over the protein synthesis machinery of the cell & forms viral messenger RNA and

through them the protein.

4. Protein synthesis:
The virus mRNA is translated on cell ribosome into two types of virus proteins

i) Structural protein:
- The proteins which make up the virus particle are known as structural protein.
- It forms the proteins of coat of virus.

ii) Non-structural protein:
- The non-structural proteins are ~~the~~ a used as enzymes for the virus genom replication.

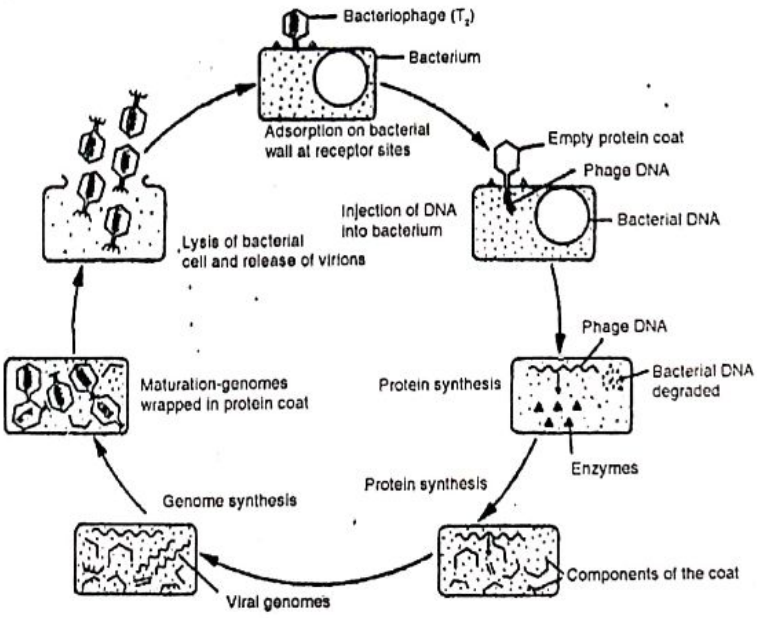


Fig. 20.1: Lytic cycle of a bacteriophage (T_2)

5. Genome synthesis:
Virus genome by replication gives rise to several copies of the viral genome for the production of progeny.

6. Maturation:
The genomes are wrapped by protein coat parts to form mature phages.

7. Release:
At a certain critical time, the wall of the host bacterium lyses and about 200 mature phages per cell are liberated.

Lysogenic Cycle:

- Lysogenic cycle occurs in Lambda (λ) phage attacking E. coli.
- Lysogenic cycle was discovered by Andre Lwoff of Pasteur Research Institute, Paris.

- The phages that show lysogenic cycle are called as 'temperate phages'.
- The bacteria in which lysogenic cycle occurs are called as 'lysogenic strain'. And the process is called as 'Lysogeny'.

- In lysogenic cycle bacterial cells do not lyse and no virus particles are formed.
- A kind of symbiotic association develops which is called 'lysogenic state'.

- The first step is adsorption of phage on the bacterial cell wall.
- It takes place with the help of tail fibers on specific receptor site.
- The small fibers hold the phage in position & a pore is dissolved in the wall & the DNA is injected into the cell.
- The DNA of the phage, after injection enters the cell but insted of taking over the host's protein synthesis machinery, the viral genome gets integrated with the bacterial genome.

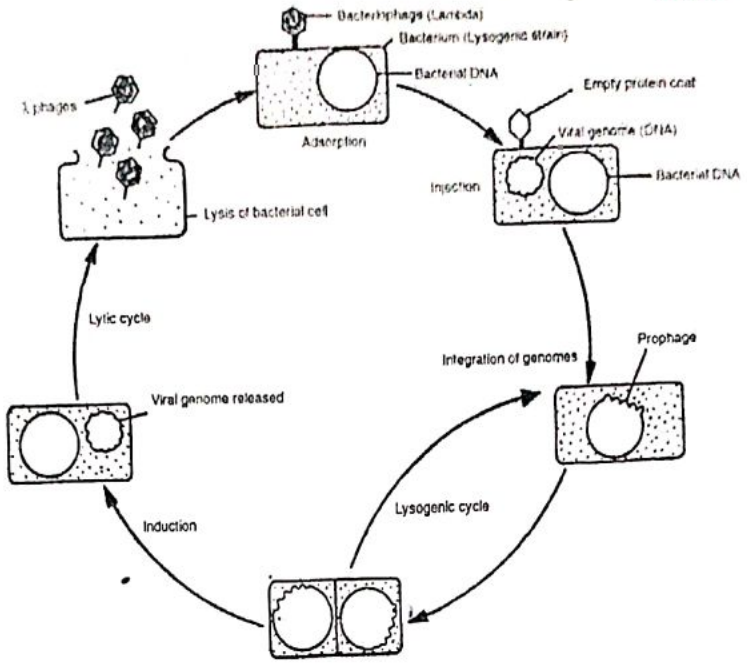


Fig. 20.2: Lysogenic cycle of λ bacteriophage.

- The viral genome in this integrated state is called a 'Prophage.'
- This new genome, made of viral and bacterial genome, replicates as one unit and the daughter genomes are passed on to offsprings.
- Thus the virus genome continues multiplying in the daughter lysogenic bacteria indefinitely.
- However, occasionally (at the rate of 1 in a million cells), the association breaks down and the viral genome is released into the cytoplasm.
- This dissociation is called 'induction'.
- It can be artificially induced by ultraviolet light or other methods.
- On release, the viral genome enters the lytic cycle and forms mature temperate phages, which are released by lysis of the bacterial cell.

RNA Virus

Tobacco mosaic virus (TMV)

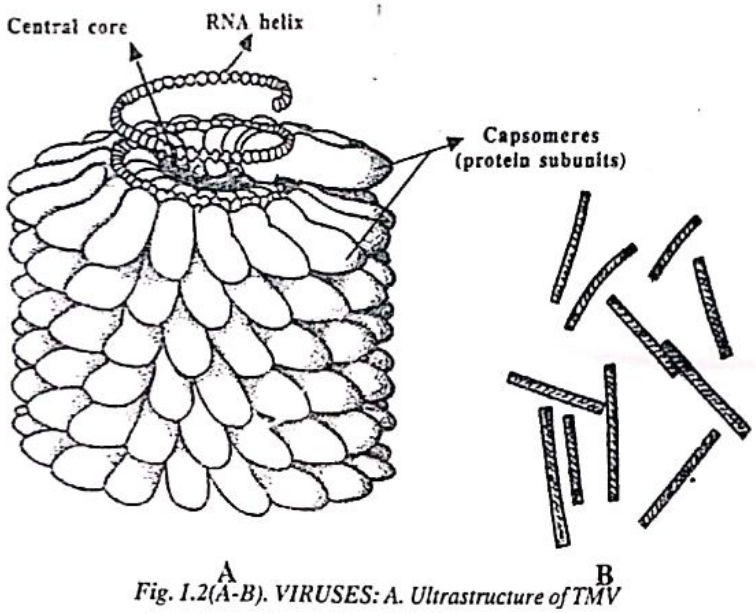


Fig. 1.2(A-B). VIRUSES: A. Ultrastructure of TMV
B. Rod shaped particles of TMV

- Tobacco mosaic virus is extensively studied virus in plants.
- It was discovered by Iwanowski (1892) and obtained in pure state by Stanley (1935)
- Tobacco mosaic virus is structurally simple
- It has helical symmetry.
- TMV is Rod shaped / needle like or cylindrical structure.
- It is 300 nm in length & 15.18 nm in diameter.
- Tobacco mosaic virus consist of two parts such as protein & nucleic acid.

1. Protein:
Outermost protective coat of virus is formed by protein and it is known as capsid.
- It is made up of specific protein
- It is composed of many, similar, small protein units called capsomeres.
- There are about 2130 capsomere units forming capsid.
- Each capsomere is composed of single chain of 158 amino acids.

functions:
- Capsomere provide shape to the virus.
- It also provide protection to the nucleic acid.

2. Nucleic Acid:
- The nucleic acid of Tobacco mosaic virus is the RNA.
- It is single stranded molecule consisting of 6500 nucleotides.
- It lies in the centre forming a central core.

✱ Economic importance of viruses:

Beneficial activity of Viruses:

1. Biological control:
   - The viruses have been used as the biological agents to control the population of harmful organisms (insect & pest)
   - In USA caterpillars damaging the crop of Medicago sativa are killed by the viral application against them.

2. Pollution control:
   - Phages are used as scavengers to eradicate the bacteria present in the polluted water.
   - The water of the river holy Ganga is pure in some extent because it contains bacteriophages which kill the harmful bacteria in the water.

3. Research tool:
   - Due to simple structure and rapid multiplication the viruses are widely used in research in the field of molecular biology, medicine, genetic engineering, etc.

4. Virotherapy:
   - It uses viruses as vectors to treat various diseases, as they can specifically target cells & DNA.
   - It shows promising use in the treatment of cancer & in gene therapy.

5. Phage typing:
Bacteriophages (Viruses) are specific in action. Therefore they are used in the identification & classification of bacteria. The process is called phage typing.

6. Vaccines:
- Many diseases are prevented by the vaccines prepared from different viruses.

7. Alternative to antibiotics:
- The viruses represent largest reservoir of unexplored genetic diversity on earth.
- They can be used as alternative to the antibiotics because of the high level of antibiotic resistance now found in some pathogenic bacteria.

8. In Nanotechnology:
- In nanotechnology, viruses can be regarded as organic nanoparticles, because of their size, shape & well defined chemical structures, viruses have been used as templates for organizing material on the nanoscale.

9. Space Research:
- In space research, lysogenic phage cultures are used as radiation detector by Russions in the space ship (Vostok)

10. By holding both the living and non-living characters, viruses got the importance in determining the origin of life.

Harmful Activities:

1. Pathogenic Nature:
- Viruses are the disease producing agents.
- They cause various dreadful diseases in plants & animals including man.

eg. Black ring spot of cabbage
Viral fever of sheep
Influenza
Jaundice
Common cold

2. Role in Agriculture
- The nitrogen fixing bacteria are infected & destroyed by the viruses.
- It reduces nitrogen content of soil & ultimately fertility of the soil.

3. Sewage disposal:
- The process of sewage disposal depends upon the activity of certain microorganisms
- These microorganisms are affected by viruses, to that the entire process of sewage disposal suffers.

4. Role in industries:
In different fermentation industries like antibiotic industries, vitamin industries, many microorganisms infected by some viruses, they get destroyed & it causes a great loss in the industrial production.

5. Cancer:
- Viruses cause cancer (tumour) in animals (Monkey, dogs, mice, cats, frog, etc.)

6. Biological war:

- Viruses can cause devastating epidemics in human society.
- They can be weaponised for biological warfare.

★ Yellow Vein Mosaic of Bhendi :

1. Host :

Host : Bhendi
Common name : Lady's finger
Vernacular name : Bhendi
Scientific name : Abelmoschus esculentus
Family : Malvaceae

2. Occurance :

In India the disease is very common, found in all bhendi growing states.

3. Symptoms :

1. Symptoms start to appear when the crop is 4-5 week old.
2. It is found that the fully grown up plant or old plant is generally not affected.
3. First symptoms are found on leaves. On lower surface of leaf the vein appears distinctly.
4. The main symptom of this disease is vein clearing so it is known as vein clearing disease of Bhendi.
5. The veins & veinlets become thick, clear & yellow. Due to this network of yellow veins is formed.
6. In severe cases chlorosis take place & results in complete yellowing of the leaf.
7. The symptoms also appear on the fruits. The infected fruits are yellowish green and dwarf.

Fig.1.3. *VIRUSES*: Infected leaf of Bhendi showing yellow network of veins.

4. Causal Organism:
- The causal organism of this disease is yellow vein mosaic virus or Hibiscus virus-I
- It is viral disease.

5. Disease Cycle:
- It is insect borne disease. Insects are called as vectors.
- White flies carry virus from diseased plant to healthy plant. The white fly is scientifically known as Bemisia tabaci.
- It is found that on unavailability of Bhendi plant the virus may survive on Weed plant. The weed is known as Alternate Host.

6. Control Measures:

1. Eradication:

The process in which affected or unwanted plants are removed & destroyed is called as eradication.
- The alternative host ie. is completely removed & destroyed

2. Use of insecticides
The crop is protected from white fly & other insects by spraying insecticides eg. folidol, Rogel (0.05%), etc.

3. Use of disease resistant varieties

Bacteria

Dear God, what marvels these are in so small a creature.
- Leeuwenhoek.

Introduction:

- Bacteria are very small, primitive, microscopic, mostly unicellular prokaryotes.
- A Dutch man Anton van Leeuwenhoek was the first to discover the bacteria in 1675.
- At the time of their discovery, these organisms were supposed to be animals and referred a 'animalcules'
- The detail work of Louis Pasteur (1864) & Robert Koch (1876) highlighted the importance of bacteria.
- Now a days the bacterial studies are developed into an independent field of science known as the bacteriology
- Bacteriology:
  The branch of biology which deals with the study of bacteria is known as bacteriology.

Occurance:

- Bacteria are omnipresent.
- They are found everywhere under all possible natural conditions.
- They are found in great abundance in tropical & temperate regions.
- They are found in water, air, soil, on living and dead organic substances.
- They are resistant to heat, cold & certain chemicals.
- They are also found in intestines of human being & animals.
- Certain bacteria may live in the temp. as high as 78°c in hot springs.
- They are found on the snow as well as in the deep soil.

General Characters:

1. Bacteria are unicellular, minute, primitive, microscopic and prokaryotic organism.
2. They are autotrophic, saprophytic & parasitic org.
3. They are either motile or non-motile.
4. They show variety of forms like spherical, rod shaped, spiral or helical, & comma shaped, etc.
5. They are the smallest living org. (0.5 - 50 μ).
6. A bacterial cell exhibits a typical prokaryotic str. It has mainly two parts cell wall & protoplasm.
7. The bacterial cells have a thick rigid cell wall.
   The cell wall is composed of amino acids, sugars, proteins, glycopeptides & muramic acid.
   - Cellulose & chitin are absent.
   - ~~Cell wall provides~~
8. Protoplasm is surrounded by a thin membrane called P.M.
   - The respiratory enzymes & other are located on the P.M.

- It contain a mixture of proteins, carbohydrates, lipids, ribosomes, mesosomes, glycogen granules, fats, volutin, etc.

9. They are aerobic or anaerobic

10. They have locomotory organs the flagella. The flagella are one to many.

11. They reproduce asexually & sexually.

12. They belong to kingdom monera.

13. They are both useful & harmful. Hence they are said to be our friends or foes.

Cell Structure :-

- The bacterial cells are very minute.
- They are of different shapes & sizes.
- They are prokaryotic in nature.

Prokaryotic : Gk word (pro = first / primitive, Karyon = nucleus)

Prokaryon = primitive nucleus
Bcoz it is originated first on earth.

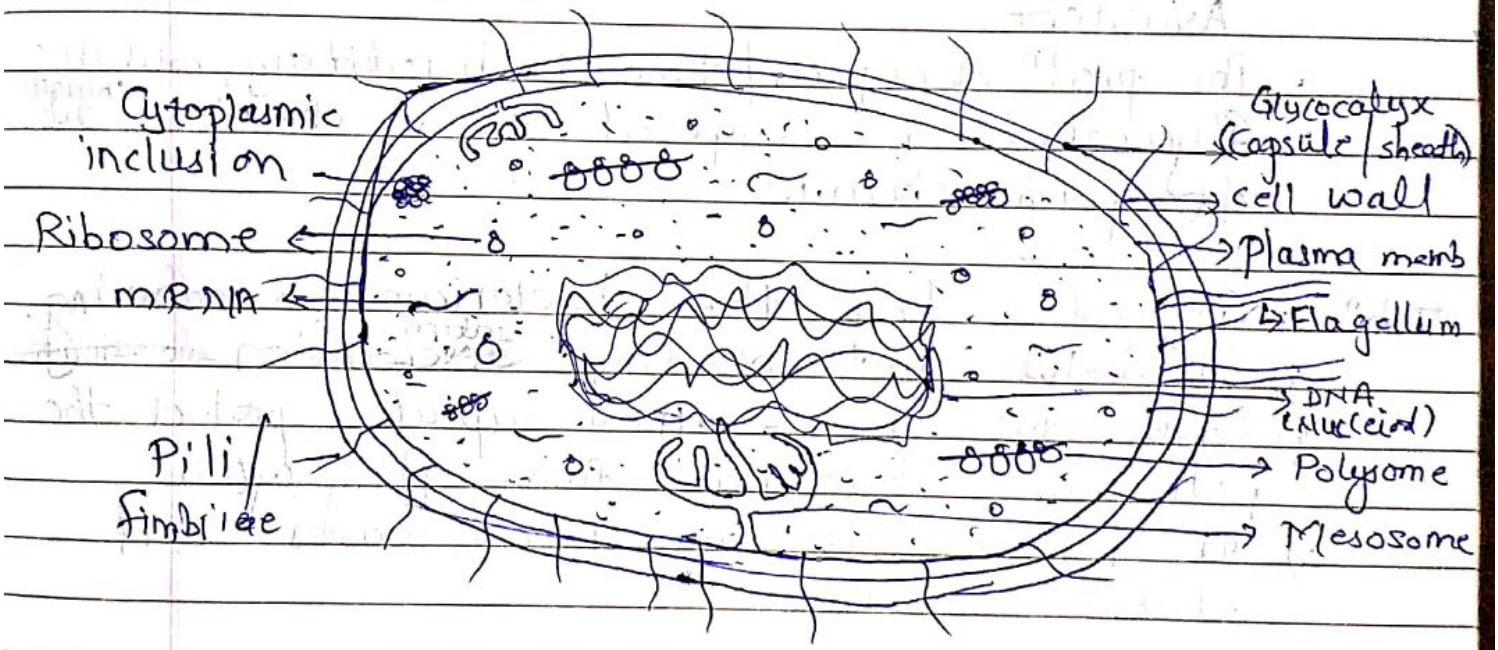
- Cell containing prokaryotic nucleus / prokaryon is known as prokaryotic cell.
- Prokaryotic Nucleus : The nucleus (which is not) without bounded/ covered by nuclear membrane.

- This cell is evolved first as compared to eukaryotic cell. So this cell is old primitive cell.
- ∴ Bacteria viz containing prokaryotic cell is also primitive.

- The ultrastructure of a bacterial cell can be studied only with the help of electron microscope.

A Bacterial cell is composed of well developed cell envelop, cytoplasm & nuclear material.

1- Cell envelop:
Three layers i.e. glycocalyx, cell wall & cell membrane / plasma membrane) together form single envelop system.



Bacteria: Ultrastructure of Typical bacterial cell

1) Glycocalyx:
- It is outer layer of bacterial cell.
- It may or may not be present (+ or -)
- Whenever it is absent cell wall is the outer layer.
- Nature of glycocalyx is variable It may be thin or thick in nature.
- In many bacterial cells the glycocalyx form thin, mucilagenous, sticky layer called 'slime'.

· In other bacterial cell it becomes very much thick, compact layer which is called capsule.
Because of this capsule the bacteria become pathogenic / virulent.

· Capsule is responsible for pathogenicity / virulence. (Disease causing ability)
· The bacteria without capsule is called non-capsulated & it is non-pathogenic / Avirulent.
· The prodⁿ of capsule / slime is hereditary, mutable
· Glycocalyx is composed of a chemical subst. (charge) called polysaccharide.

Funⁿ: 1) Glycocalyx help the bacterium in adhering.
2) It helps in avoiding desiccation ~~desiccation~~
3) Gives protection - the capsule protect the pathogenic bacteria from phagocytosis.
4) It protects cell against antibodies and adverse condition.

2) Cell wall:
· It is next to glycocalyx.
· In higher orgs → presence of cell wall is characteristic of plant cell whereas such type of definite cell wall is absent in animal cell.
· Cell wall is thick & rigid.

- The definite shape of cell is due to cell wall.
- It is the main protective str. of Bacterial cell.

- Common plant cell is characterised by having cellulose in cell wall (cellulotic)

But the cell wall of bacteria differ from plants in being made up of peptidoglycan / mucopeptide & not cellulose.

- Peptidoglycan is a chemical complex. This complex is made up of alternating units of NAG (N-acetyl glucosamine) & (NAM (N-acetyl muramic acid) joined by β, 1-4 linkages.
- NAG & NAM are amino sugars.

- This difference of Bacterial cell wall (Non-cellulosic) provides a site where bacterial pathogens can be attacked by antibiotics without damaging the diseased eukaryotic plant or animal cells.

- The cell wall contains protein known as porins, which form aqueous channel/ pore.
- Through this pore several different components pass in & out of the cell. So this layer is c/d permeable.

fun^{n} – Protection
Allow the diff. component in & out
Shape.

3) Plasma Membrane (Cell membrane)

- It is the innermost layer of cell envelop.
- It is the Boundry of cytoplasm.
- Also cld limiting layer of cytoplasm.
- It is thin, papery, delicate in nature.
- It is chemically made up of 2 sub i.e. lipid & protein (lipoprotein in nature)
- It is semi-permeable in Nature i.e it allows the entry & exit of only selected substances)

- Plasma membrane of Bacterial cell is very imp layer because it is related to many physiological processes like respi, photosynthesis, protein synthesis, etc. Because in prokaryotes 'Independent membrane bounded cell organelles are absent.

B. Cytoplasm:

- It is granular & viscous in appearance.
- Starting from P.M. & to genetic material it is continuous.
(In eukaryotes nuclear memb. separate the cytoplasm from genetic material)
- Cytoplasm contains nucleoid, ribosomes, polysomes, mesosomes, cytoplasmic inclusions, (gas vacuole), plasmid.
- The other cell organelles like mitochondria, golgi bodies, E.R, chloroplast are absent.
- It contains reserved food material in the form of complex mixture of proteins, carbohydrates, lipids, vitamins, volutin & glycogen granules.

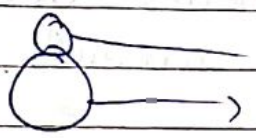
1. Ribosome:
Cell organelle containing nucleic acid RNA.
- Very small particles of 100A° in diameter of cytoplasm are known as ribosome (Ribo = Ribonucleic acid; Soma = body)
The definite (specific bodies) which are characterised by presence of Ribonucleic acid (RNA).

- They give granular appearance along with the reserve materials to the otherwise homogeneous cytoplasm.

- (Prokaryotic) Bacterial ribosomes are smaller as compared to eukaryotic ribosome.
- They are 70s type (S- sedimentation co-efficient) Svedberg's unit) where as eukaryotic ribosomes are 80s type.

(Sedimentation = Particle settel down)

- It has 2 subunits



→ Small subunit → 30S
→ large —u— → 50S + → 70S

- Ribosome = Association of small & large subunit
- Ribosome = RNA + protein
  ∴ Nucleoprotein in nature
- Ribosome acts as the site for the protein synthesis.

* Polysome / polyribosome
  A cluster of ribosomes held together by a strand of messenger RNA which each is translating into polypeptides

2. Lamellae & Chromatophores

- Photosynthetic bacteria & cyanobacteria have lamellae (thylakoid) & chromatophore instead of chloroplast.

- Lamellae consist of two parallel unit membranes, which may be small or long.
They are extending throughout the cytoplasm.

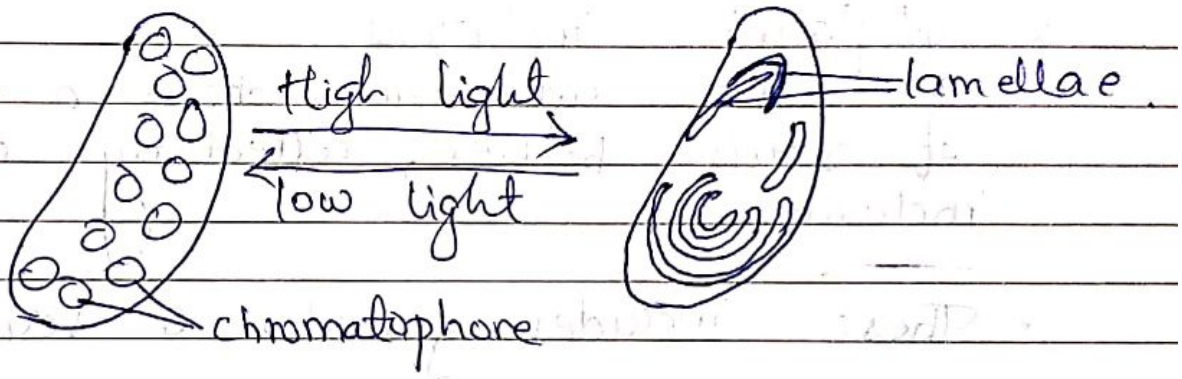


Fig: Photosynthetic organelle of chromatium, the sulphur purple bacterium

- Chromatophore (vesicles) are hollow, spherical structure.
300 A° in Diameter.

- The bacterial photosynthetic apparatus (lamellae & chromatophore) contain pigments with enzymes
also contain the electron transport system for the photosynthetic phosphorylation of the light rea^{n}.
- They are devoid of the enzymes associated with the dark rea^{n}.

3. Mesosomes:
These are extensions of the plasma membrane.

- It has diverse fun" which vary from cell to cell & even vary from one growth phase to another.
- They initiate DNA replication & septum formation during cell div".

4. Cytoplasmic inclusions:
The cytoplasm shows a variety of small bodies, collectively called inclusions.

- These includes granules & Vesicles.

a) Granules:-
The cytoplasm is a homogenous aqueous solution of soluble proteins, enzymes, cell solutes, inorganic ions, and metabolites of small molecular weights.
- Under electron microscope, the cytoplasm appears granular due to the reserve materials.
- These reserve materials can be classified into three categories:
Organic polymers, Inorganic metaphosphate granules & elemental sulfur.

b) Vesicle:

Some aquatic bacteria & cyanobacteria have membrane bound gas vesicles (or vacuoles)

- They provide buoyancy which is helpful in floating.

3) Nucleoid (Nucle = Nucleus; oid = like)

- Nucleus without nuclear membrane
- It is similar to eukaryotic nucleus in function i.e. it governs all the activity of cell. So it is also called governer of cell.
- Without nucleolus & nucleoplasm
- Nucleoid is represented by one, ds, circular DNA.
- It is also called bacterial chromosome.
- DNA is not associated with histone protein but with some non-histone protein & RNA.
- DNA is attached to P.M. possibly at the mesosome.

Fun - Control all the activity of bacterial cell.

* The plasmid:

In addition to the 'chromosome' some bacteria have one or more, small circular DNA molecules, called plasmids.

- There provide additional genetic information which is not essential for basic life processes but help the bacteria in various ways.

- It is also cld as extra-chromosomal DNA or minichromosome.

- It is circular & ds DNA.
- It is able to replicate independently. (Autonomous or self replicating)

- Plasmid can exist either free in the cytoplasm or integrated with the chromosome.
- When it is free, it replicate indepen-dently & when it is integrated with chromosome, it replicate along with the chromosome & it is called Episome :-

The special type of plasmid which joins to chromosomal DNA & replicate with it.

Type & fun^n

- F plasmid - code for protein of sex-pili
- Resistance (R) plasmid - carry gene that provide resistance to antibiotics like chloramphenicol, tetracycline
- Virulence plasmid - produce toxins.
- Tumor (Ti) plasmid - responsible for form of tumor in plants.

Flagella:

are the organs of locomotion in motile forms

- They are fundamentally different from the flagella of eukaryotes in lacking the '9+2' str.

- ~~Cilia~~ = Bacterial flagellum (120-150 Å° in diameter)
- ~~Flagella & cilia of~~ Piti is cylindrical, hollow strand made up of protein old flagellin. (Hair & muscle)

→ Pili:

are elongate, rigid, tubular appendages made of special protein old pilin.

- The serve to connect two cells during conjugation & allow the DNA to pass from donor cell into the recipient.

Botany

Date: / /

Reproduction in Bacteria:

i) Vegetative Reproduction:

Reproduction is the biological process in which new individual organisms are produced from parents.

- Bacteria reproduce by vegetative, asexual & sexual reproduction.

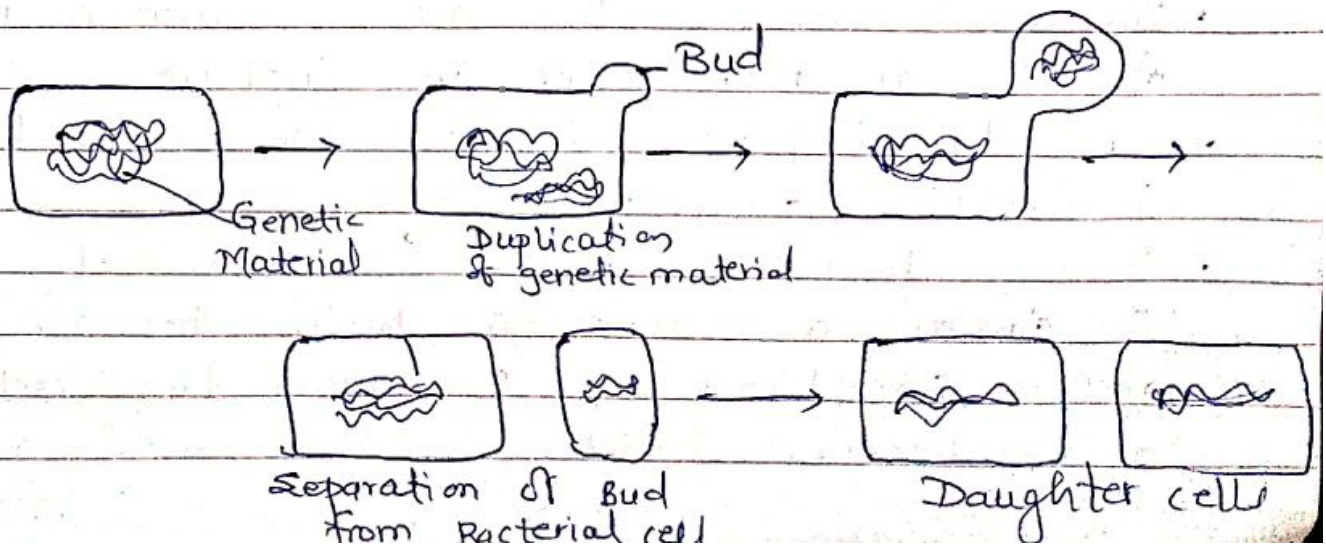
i) Vegetative reproduction:

Vegetative reproduction in bacteria takes place by ~~bacteria~~, budding.

a) Budding:

- Budding is a comparatively rare process of reproduction in bacteria observed in fews like Rhodopseudomonas.

- It is the process by which the vegetative cells forms a lateral protuberance in the form of outer bulge.
- The bulge (bud) contain a fragment of genetic material or nucleoid in it.
- Bud may separate from the parent cell & develop into a new bacterial cell.



- The bacterial cell develops small swelling one side.
- This swelling gradually grows / increase in size.
- Simultaneously the nucleus undergo division where one remains with the mother & other one with some cytoplasm goes to the swelling.
- This outgrowth is the bud, which gets separated from the mother by partition wall.

eg Hyphomicrobium vulgare
Rhodomicrobium

3) Asexual Reproduction:

The bacteria reproduce asexually by binary fission.

a) Binary fission:

The process of splitting of bacterial cell into two new equal daughter cells is called as the binary fission.

- Binary fission is the most common method of asexual reproduction in Bacteria.
- It takes place during the period of favourable conditions.
- Binary fission involves formation of a septum & chromosome division. Both the events occur simultaneously & are triggered by a mesosome.

During the process of binary fission the bacterial cell elongates first.

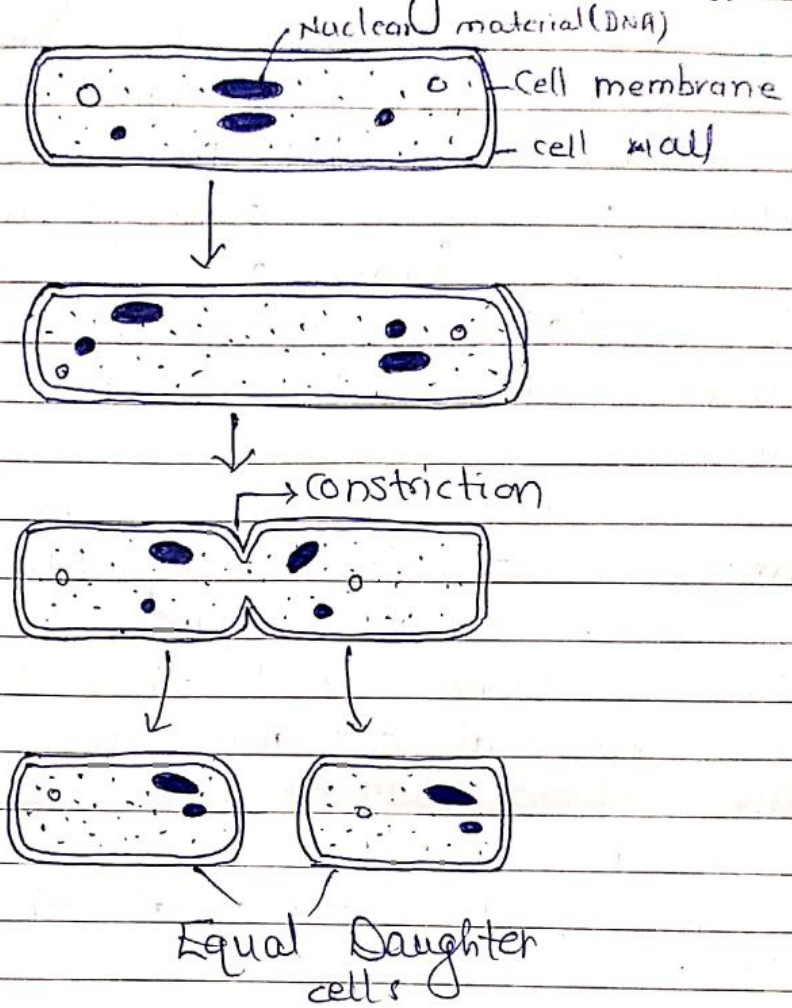


Fig: Binary fission in Bacteria

- Binary fission takes place in two steps DNA replication and cell division.

i) DNA replication:

The bacterial chromosome replicates resulting in the production of two circular chromosomes.

- In both the daughter chromosomes one strand is derived from the parent & other is new.
- This type of replication, in which one strand is old & other is newly synthesized is called the semiconservative replication.

ii) Cell Division:

- In cell division the protoplasm divides mitotically & results into the formation of two parts.
- Meanwhile, the plasma membrane just at the middle of the cell and between the two parts of protoplasm forms a constriction.
- The constriction grows inward & finally forms a transverse plate between two parts of the protoplasm.
- As the process proceeds, the cell wall also forms a constriction at middle & grows inward forming a transverse wall.
- The transverse wall thus formed splits the parent bacterial cell into two equal daughter cells.
- These newly formed equal daughter cells grow in size and behave as the new bacterial cells.

3) Sexual Reproduction:

The sexual reproduction in bacteria involves genetic recombination of bacterial genome.

- There are three mechanisms of genetic transfer in bacteria.
  i) Conjugation
  ii) Transformation
  iii) Transduction

Conjugation:

The process in which the DNA is passed from one cell to the other cell by physical contact through a conjugation tube is known as conjugation.

- Lederberg & Tatum, in 1946 discovered conjugation in Escherichia coli.
- The strains of E. coli show sexual differences.
- One strain acts as donor of genes & known as male. It is designated as F^+ male.
- The other strain act as recipient of genes known as female & it is designated as F^- female.
- The donor strains produce tubular F pili, which make contact with the recipient cell.
- The F pili act as conjugation tube for the passage of DNA.
- The maleness of donor strain is due to the presence of a fertility factor called F factor or F plasmid.
- And the maleness in not due to the chromosomal genes.
- The F factor is a small circular DNA molecule
- In a conjugation between F^+ and F^- strain the bacterial chromosome is not involved. Only a copy of the F factor passes into the female cell.
- Due to passing of F factor from donor to recipient, the recipient is converted into a male cell.

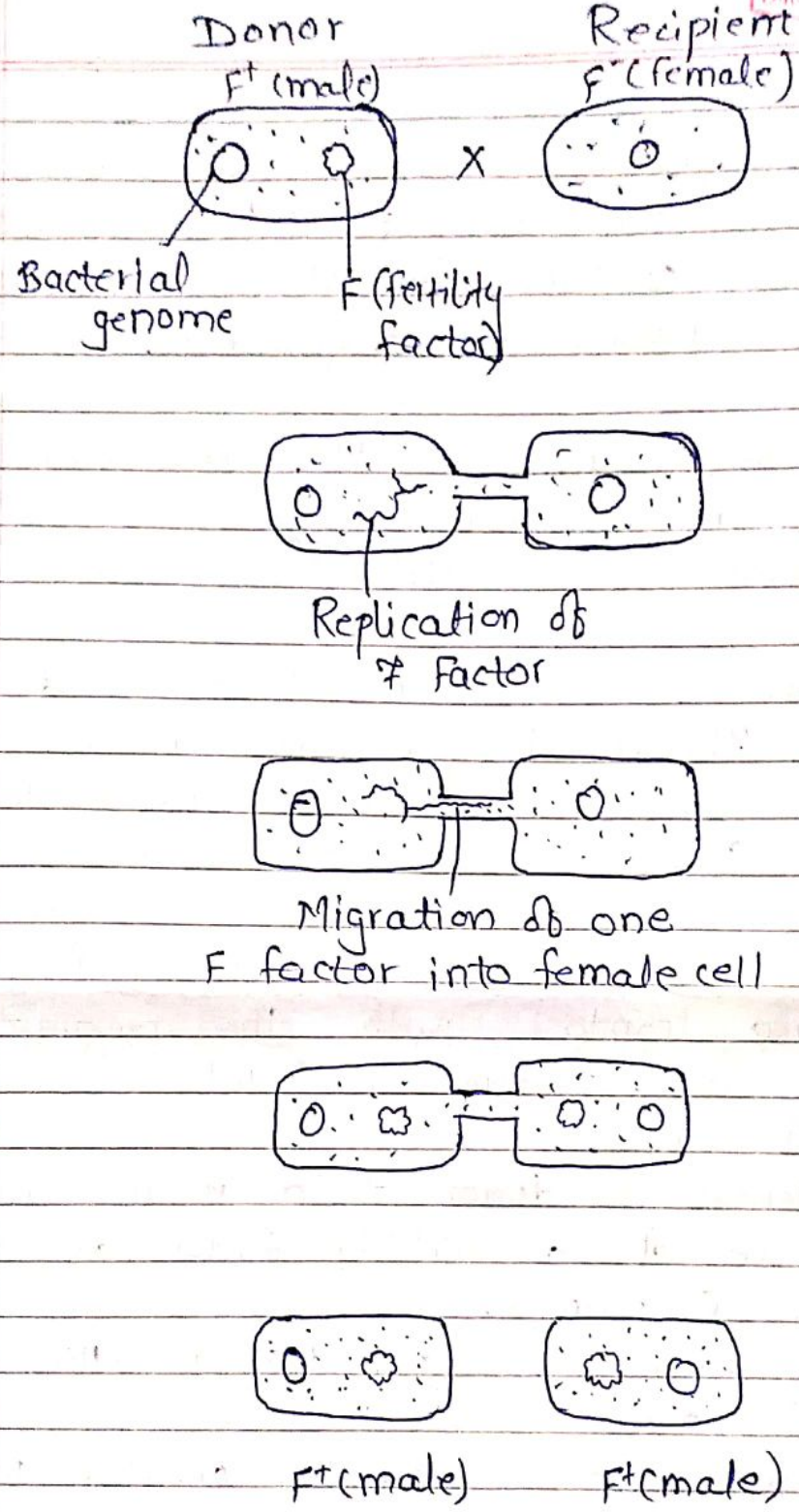
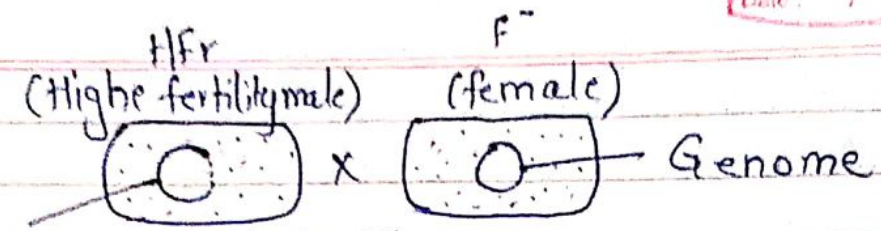
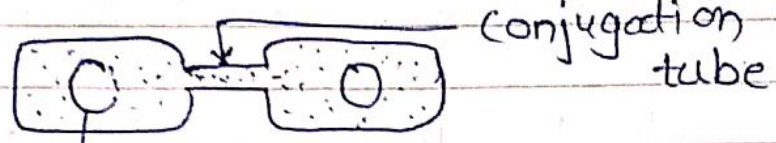


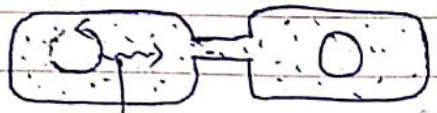
Fig: Conjugation between F^+ (male) and F^- (female) resulting in the conversion of female into male due to transfer of the fertility factor, F.

- The F plasmid can live in two states either free in the cytoplasm or integrated with a bacterial chromosome.
- When it is integrated or inserted into the bacterial chromosome, the F^+ male becomes a Hfr male (High frequency of recombination)
- When such Hfr male conjugates with a female F^-, the genetic material is transferred.
- The bacterial chromosome breaks at the site of attachment & become linear DNA molecule having F factor always at the end.
- Chromosome replication starts at that end which is directed towards the conjugation tube.
- One of the daughter chromosomes enters the female cell.
- For the transfer of complete replicate of DNA, about two hours are needed, but in nature the mating never lasts so long.
- Due to the interruption in the mating, only a portion of the chromosome enter the female cell
- The female is not converted into a male as the F^+ factor is not passed on.
- The genetic material may replace the homologous portions of the female genome. This brings about genetic recombination.

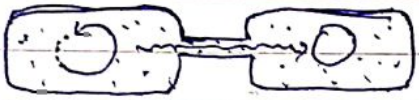




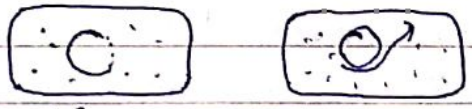
Breaking of the integrated DNA for replication



Replication of DNA



Migration of a portion of daughter chromosome into female cell



Synapsis of Homologous portions

Recombinant F

Fig: Conjugation between high fertility male (Hfr) and female (F⁻) cells, resulting in production of recombinant female

Citrus Canker

Host : Citrus / lemon
Botanical name : Citrus acida
Family : Rutaceae

Occurance & Distribution:

- The disease citrus canker is world wide in distribution.
- It is found in all citrus growing countries of world It is very commonly found in countries like China, Japan, Ghana, Java, India, etc.
- In India the disease is found in all citrus growing states.

Symptoms:

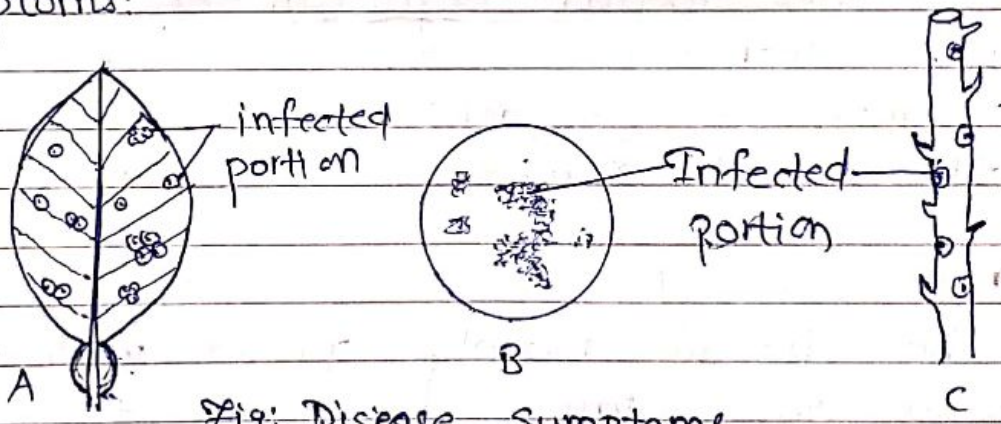


Fig: Disease symptoms
A: on leaves ; B: on fruit ; C: on twig

- All the aerial parts of the plant are affected. Symptoms are found on leaves, twigs, fruit & even thorns.
- Symptoms start to appear on leaves first. On lower surface of leaf small, watery, spherical & translucent spots are developed.
- Later spots increase in size & finally turn brown in colour.

- The spots open from centre & give crater like appearance, when it ruptures look corky or scabby. So the disease is known canker.
- The spots developed on leaf are encircles by yellow ring known as Halo. Such halo is not developed on fruits.
- But the brown coloured spots are developed on fruits, twig & thorn.
- Spots occuring on petiole & midrib may cause premature defoliation.
- Due to infection, the fruits become deformed, however the pulp or juice remain unaffected.

Causal Organism:

The causal organism of citrus canker is Xanthomonas citri, also called as Xanthomonas campestris.

- It is rod shaped gram negative bacteria.

Disease Cycle:

- The disease mainly spread with the help of wind driven rains.
- The disease can also spread with the help of insect vectors.
- Goat weed has been reported to be a new host of X. campestris in India.

Control Measure:

1. Rogueing:

The process of removal and discarding of the diseased plant is known as rogueing.

. The infected plant parts like leaves, branches, etc are collected and destroyed.

2. Use of Chemicals:
. The chemicals like Bordeaux mixture are very commonly used in controlling disease.
. The repeated sprey of Bordeaux mixture is highly effective.

3. Use of Antibiotics:
. The disease is brought under contol by using antibiotics.
. The commonly used antibiotics are streptocyclin, streptomycine, etc.

4. Use of neem cakes:
. The disease can also be brought under control by using neem cakes.
. Neem cake is mixed with water and suspension is applied to infected plant.

5. Use of disease resistant varieties:
. The disease resistant varieties are cultivated to get disease free plants.
eg. Kumquats & Hajara

6. Disease free nursery plantlets:
. The plantlets are made available from the disease free nurseries.