Virus, Viroids and Mycoplasma

(Paper-V, Cytology) B.Sc . Part III

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Virus

- The viruses are non-cellular organisms.
- They, in fact, have an inert crystalline structure outside the living cell.
- Once they infect a cell, they take over the machinery of the host cell to replicate themselves, killing the host.

- Pasteur. D.J. Ivanowsky (1892) gave the name virus.
- It means venom or poisonous fluid.
- According to his research, certain microbes caused the mosaic disease of tobacco.
- These organisms were smaller than bacteria because they passed through bacteria-proof filters.
- M.W. Beijerinek (1898) demonstrated that the extract of the infected plants of tobacco could cause infection in healthy plants.
- He named the fluid as *Contagium vivum fluidum* (infectious living fluid).

- W.M. Stanley (1935) discovered that viruses could be crystallized. These virus crystals are composed largely of proteins.
- They are inert outside their specific host cell. Viruses are nothing but obligate parasites.

Genetic Material of Viruses:

•In addition to proteins, viruses also contain genetic material, that could be either RNA or DNA.

• No virus contains both RNA and DNA. A virus is a nucleoprotein and the genetic material is infectious.

•Speaking in strictly general terms, viruses infecting plants have single-stranded RNA.

• On the other hand, viruses that infect animals have either single or double-stranded RNA or they might have double-stranded DNA

•Bacterial viruses or bacteriophages usually have a double-stranded DNA structure. By bacteriophages, we mean viruses that infect the bacteria.

• The protein coat, capsid made of small subunits (capsomeres) protects the nucleic acid.

•They have these capsomeres arranged in various geometric forms like helical or polyhedral forms.

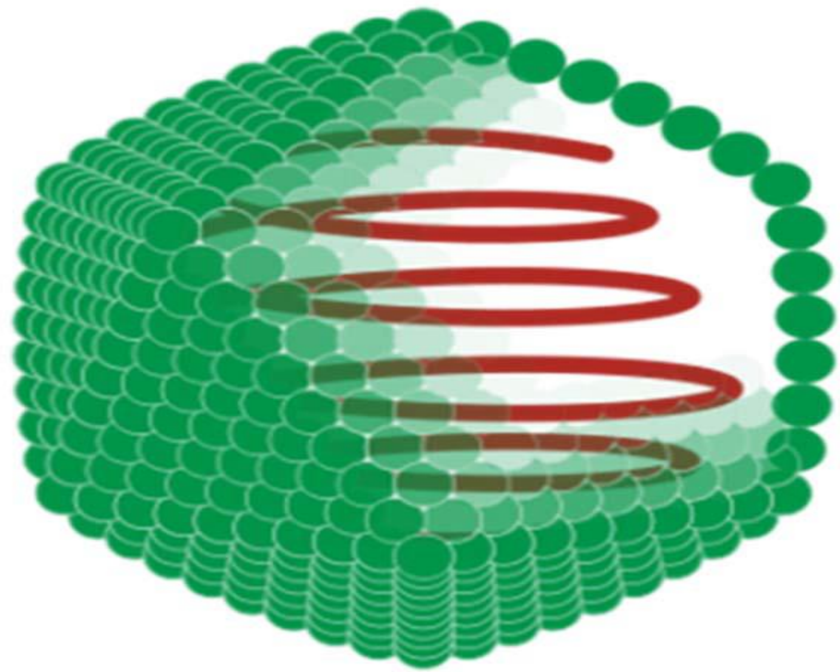
Virus Structure

Viruses come in an amazing variety of shapes and sizes. They are very small and are measured in nanometers, which is one-billionth of a meter. Viruses can range in the size between 20 to 750nm, which is 45,000 times smaller than the width of a human hair. The majority of viruses cannot be seen with a light microscope because the resolution of a light microscope is limited to about 200nm, so a scanning electron microscope is required to view most viruses.

The basic structure of a virus is made up of a genetic information molecule and a protein layer that protects that information molecule. The arrangement of the protein layer and the genetic information comes in a variety of presentations. The core of the virus is made up of nucleic acids, which then make up the genetic information in the form of RNA or DNA. The protein layer that surrounds and protects the nucleic acids is called the capsid. When a single virus is in its complete form and has reached full infectivity outside of the cell, it is known as a virion. A virus structure can be one of the following: icosahedral, enveloped, complex or helical.

Icosahedral:

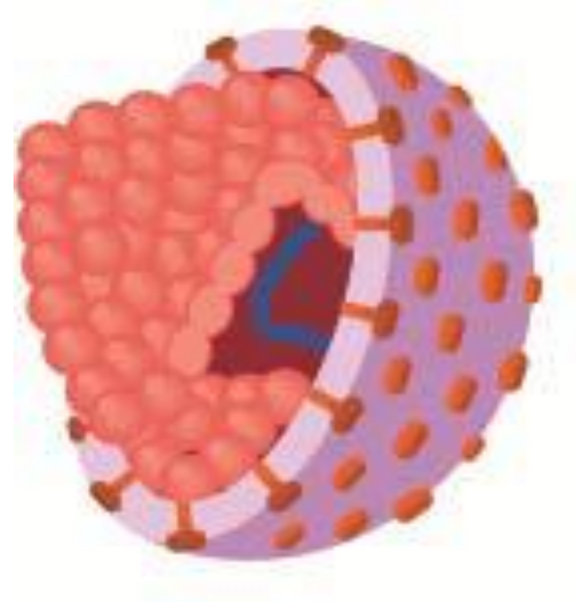
These viruses appear spherical in shape, but a closer look actually reveals they are icosahedral. The icosahedron is made up of equilateral triangles fused together in a spherical shape. This is the most optimal way of forming a closed shell using identical protein sub-units. The genetic material is fully enclosed inside of the capsid. Viruses with icosahedral structures are released into the environment when the cell dies, breaks down and lyses, thus releasing the virions. Examples of viruses with an icosahedral structure are the poliovirus, rhinovirus, and adenovirus.



Icosahedral
Rhinovirus

Envelope

This virus structure is a conventional icosahedral or helical structure that is surrounded by a lipid bilayer membrane,
meaning the virus is encased or enveloped.
The envelope of the virus is formed when the virus is exiting the cell via budding, and the infectivity of these viruses is mostly dependent on the envelope. The most well known examples of enveloped viruses are the influenza virus, Hepatitis C and HIV.



Envelope
Hepatitis C

Complex

These virus structures have a combination of icosahedral and helical shape and may have a complex outer wall or head-tail morphology.

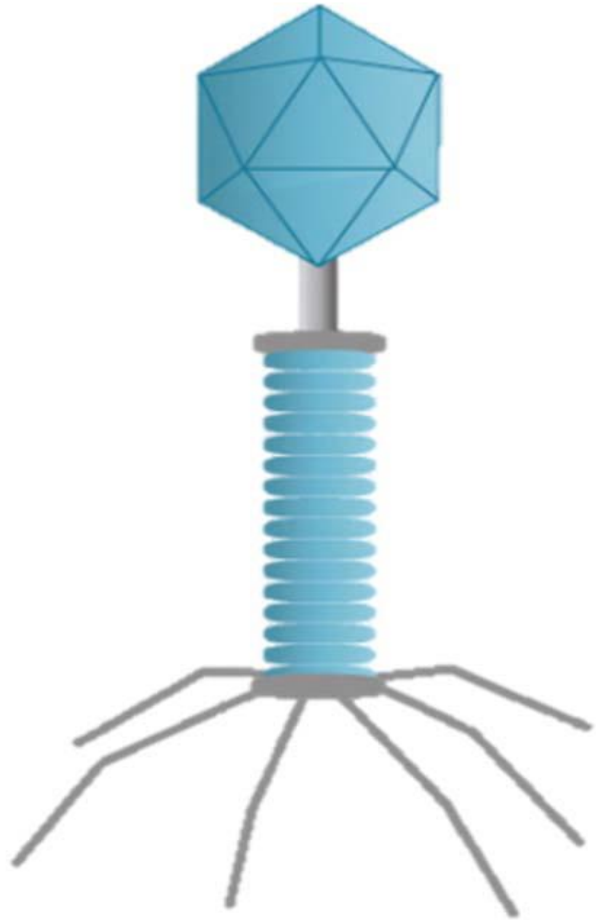
The head-tail morphology structure is unique to viruses that only infect bacteria and are known as bacteriophages.

The head of the virus has an icosahedral shape with a helical shaped tail.

The bacteriophage uses its tail to attach to the bacterium, creates a hole in the cell wall, and then inserts its DNA into the cell using the tail as a channel.

The Poxvirus is one of the largest viruses in size and has a complex structure with a unique outer wall and capsid.

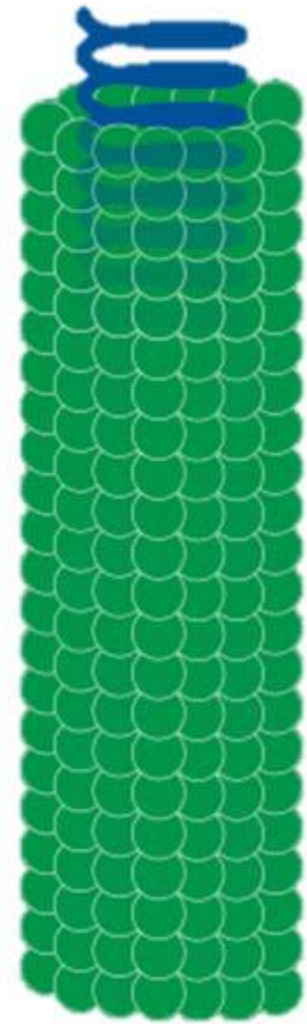
One of the most famous types of poxviruses is the variola virus which causes smallpox.



Complex Bacteriophage

Helical

This virus structure has a capsid with a central cavity or hollow tube that is made by proteins arranged in a circular fashion, creating a disc like shape. The disc shapes are attached helically
(like a toy slinky) creating a tube with room for the nucleic acid in the middle. All filamentous viruses are helical in shape. They are
usually 15-19nm wide and range in length from 300 to 500nm depending on the genome size. An example of a virus with a helical symmetry is the tobacco mosaic virus.



Helical Tobacco Mosaic Virus

Viroids

Viroids, the smallest known pathogens, are naked, circular, single-stranded RNA molecules that do not encode protein yet replicate autonomously when introduced into host plants. Potato spindle tuber viroid, discovered in 1971, is the prototype; 29 other viroids have since been discovered ranging in length from 120 to 475 nucleotides. Viroids only infect plants; some cause economically important diseases of crop plants, while others appear to be benign. Two examples of economically important viroids are coconut cadang-cadang viroid (which causes a lethal infection of coconut palms) and apple scar skin viroid (which causes an infection that results in visually unappealing apples).

The 30 known viroids have been classified in two families. Members of the *Pospiviroidae*, named for *po*tato *spi*ndle tuber viroid, have a rod-like secondary structure with small single stranded regions, a central conserved region, and replicate in the nucleus . The *Avsunviroidae*, named for *av*ocado *sun*blotch viroid, have both rod-like and branched regions, but lack a central conserved region and replicate in chloroplasts. In contrast to the *Pospiviroidae*, the latter RNA molecules are functional ribozymes, and this activity is essential for replication.

Viroids were first discovered and given this name by Theodor Otto Diener (1971), a plant pathologist working at Agricultural Research Centre in Maryland. The first viroid to be identified was the Potato spindle Tuber Viroid (PsTVd). At present-33 species have been identified.

2. Structure of Viroids:

Structure of viroid was first shown directly by electron microscope, Viroid's are small, circular, single stranded RNA molecules. They consist a short stretch (a few hundred nucleobase) of highly complementary circular single stranded RNA without protein coat with molecular weight between 1,07,000 and 1,27,000. Viroid's are 240 to 380 nucleotides long and all of them have dumb-bell

The smallest viroid is 220 nucleobase ScRNA (small cytoplasmic RNA) associated with the rice yellow mottle sobemovirus (RYMV) is reported.

H. J. Cross (1979) sequenced the nucleotide sequence of the Potato spindle Tuber Virus (PSTV). It consists of 359 ribonucleotides and is characterized by numerous intermolecular base pairings that lends ability in the structure.
Structurally, the pospiviroid and Avsunviroid are also different.

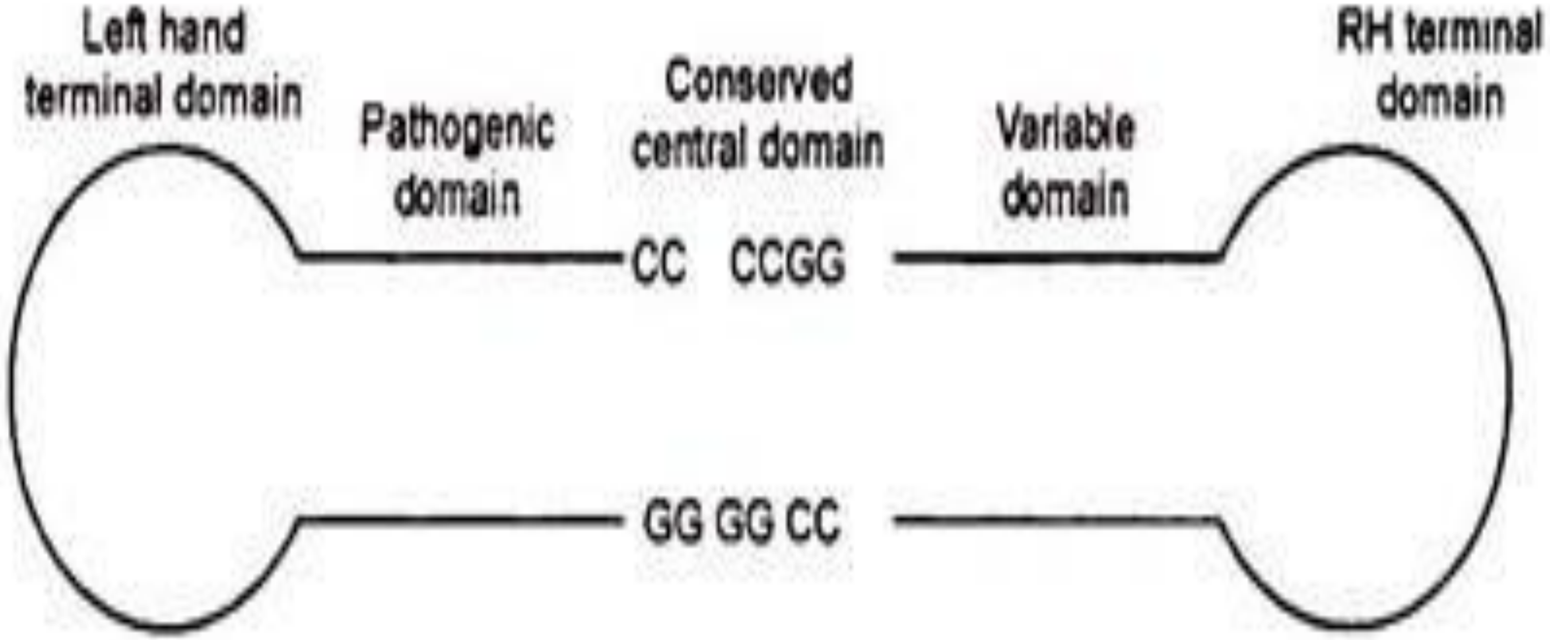


Fig. 1. Structure of Pospiviroid.

Mycoplasma

Mycoplasmas are the smallest among the known aerobic prokaryotes.

. They were first discovered by Pasteur in 1843, during his work on the possible causal agent of pleuro-pneumonia of cattle.

Thus they were called pleuro- pneumonia-like organism (PPLO).

Pasteur was unable to isolate them in pure culture.

Later, Nocard and Roux (1898), the French microbiologists, were successful in growing them in pure culture-medium containing serum and confirmed about them by inoculation and subsequent expression of disease in healthy cattle.

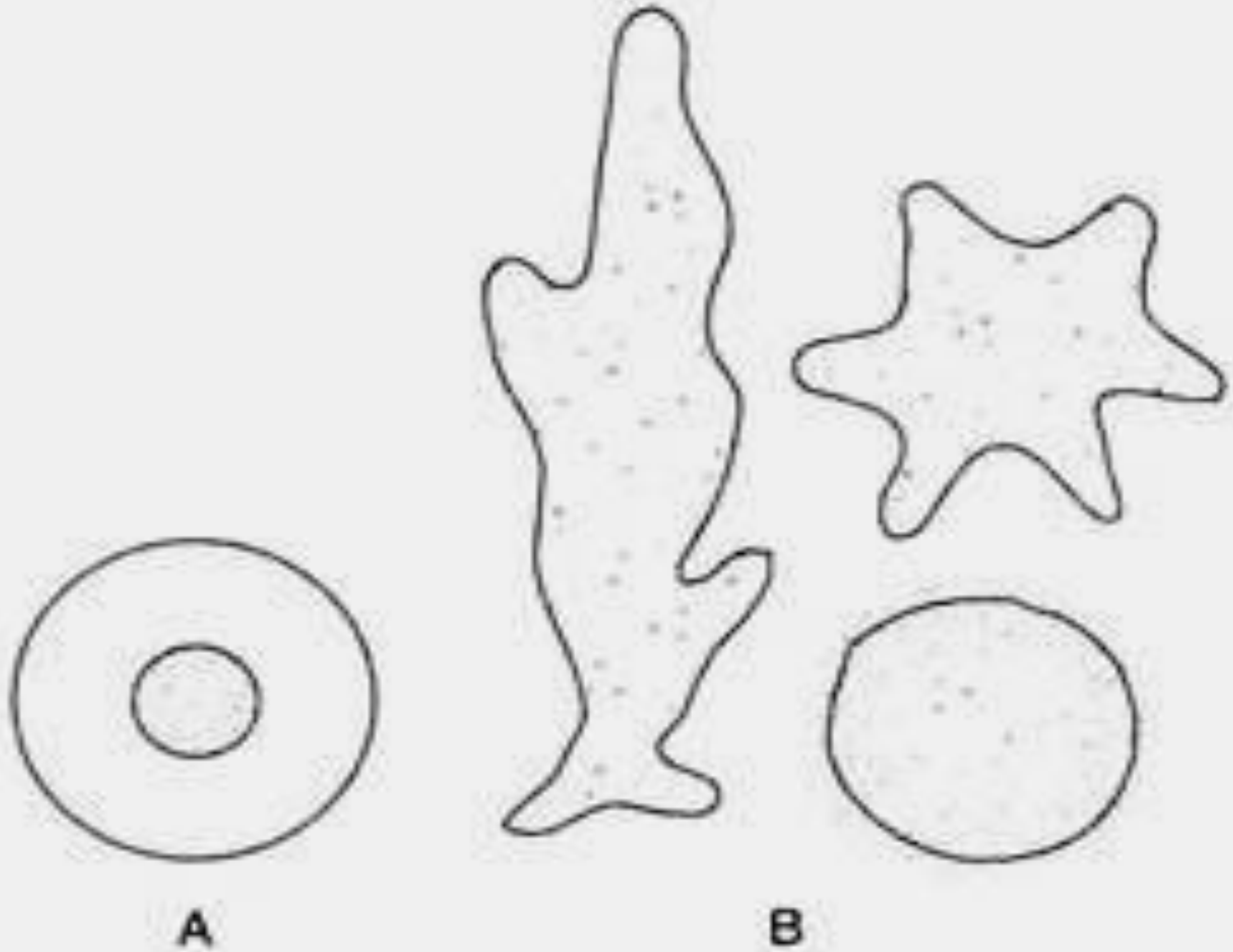


Fig. 2.50 : Mycoplasmas : A. Single colony, B. Cells of various shapes

Classification of Mycoplasmas:

Based on nutritional requirement, mycoplasmas are divided into the following three genera:

1. Mycoplasma:

They require cholesterol for their growth. They parasitise on animals including man by causing damage to the mucous membranes and different joints of the body.

2. Acholeplasma:

They do not require cholesterol for their growth. They are available in sewage water and soil as saprophytes and in vertebrates and also in plants as parasites.

3. Thermoplasma:

They also do not require cholesterol for their growth. They are aerobic microorganisms showing good growth in acidic pH between 0.96-3.0, with an optimum temperature of 59°C.

Structure of Mycoplasmas:

The cell is devoid of cell wall which makes them readily deformable showing irregular and variable shapes.
They may be ring-like, granular, coccoid, pear-shaped, filamentous, etc.
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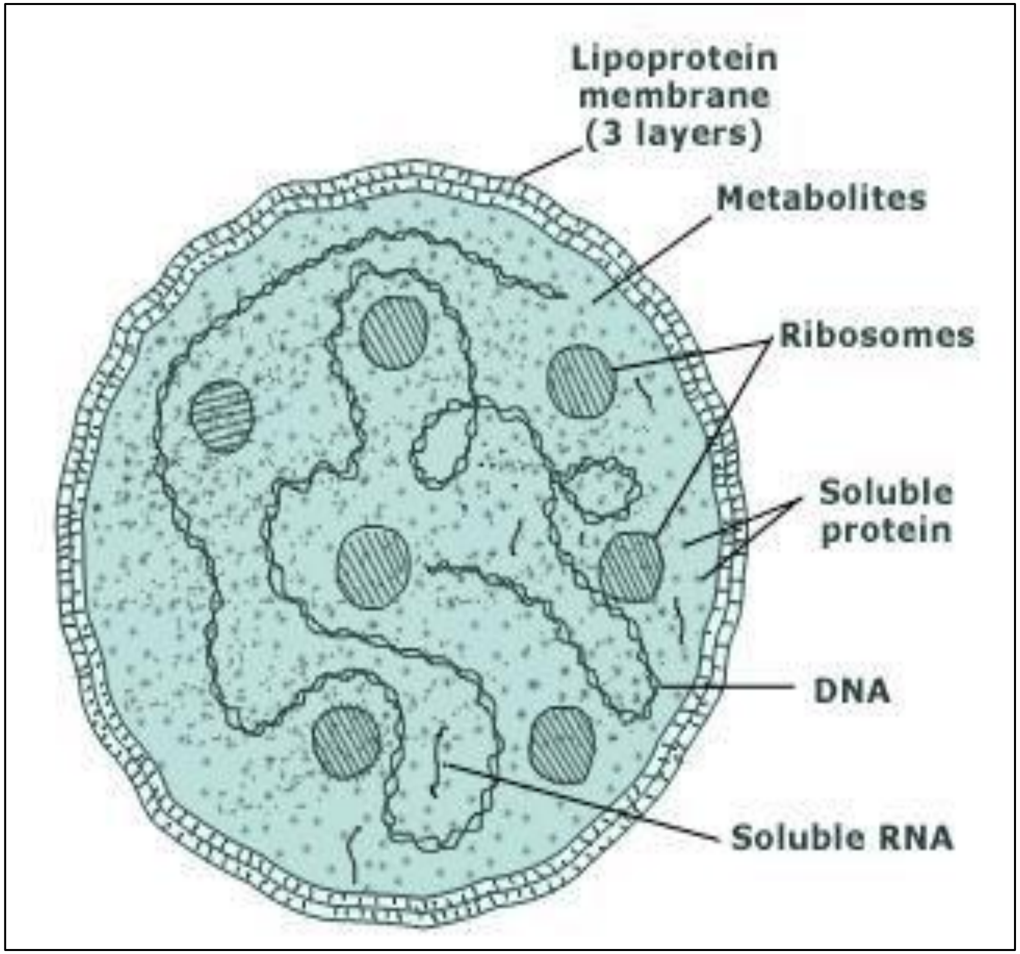
The filaments are of two types: unbranched or branched. The cells are very small and measure 0.3-0.9 µm in diameter.

The cells are covered by cytoplasmic (lipoprotein) membrane (Fig. 2.51). Cell membrane covers the cytoplasm which contains nucleo-plasm like structure and ribosomes.

The genetic material is composed of DNA and RNA. It is about less than 50%, the amount present in other prokaryotic organisms. The amount of RNA (8%) is more than DNA (4%).

Structure.......



They are usually non-motile, but some forms show gliding movements.

They reproduce by vegetative means i.e., by binary fission and budding.

They are sensitive to antibiotics like chloramphenicol, streptomycin, erythromycin etc., but are insensitive to penicillin, ampicillin etc., due to the absence of cell wall.

Disease:

Mycoplasmas cause different serious diseases in plants and animals including man.

Some of these are:

(a) Plant Diseases:

(i) Little leaf disease of brinjal,
(ii) Bunchy top of papaya,
(iii) Big bud of tomato,
(v) Yellow dwarf of tobacco,
(vi) Strip disease of sugarcane,
(vii) Clover dwarf,
(viii) Cotton vires- cence.
(iv) Witches broom of legumes,

(b) Human Diseases:

(i) Primary atypical pneumonia (PAP) by Mycoplasma pneumoniae,
(ii) Mycoplasma hominis causes pleuropneumonia, prostatitis, inflammations of genitals etc.
(iii) Mycoplasma fermentants causes infertility in man.

(c) Animal Diseases:

(i) Mycoplasma agalactia causes agalactia of goat and sheep,
(ii) Mycoplasma mycoides causes pleuropneumonia of cattle,
(iii) M. bovigenitalium causes inflammation of genitals of different animals.