Physico-Chemical Structure of TMV:

TMV is a filamentous non-enveloped RNA virus which is the causative agent of Tobacco Mosaic disease. Franklin *et. al.* (1957) have described the structure of TMV. The detail Physico-chemical structure of the virion is as follows-

Symmetry:

It is a rod-shaped virion with helical symmery. Tobacco mosaic virus is representative of one of the two major structural classes seen in viruses, those with helical symmetry.

Size: 18 × 300 nm

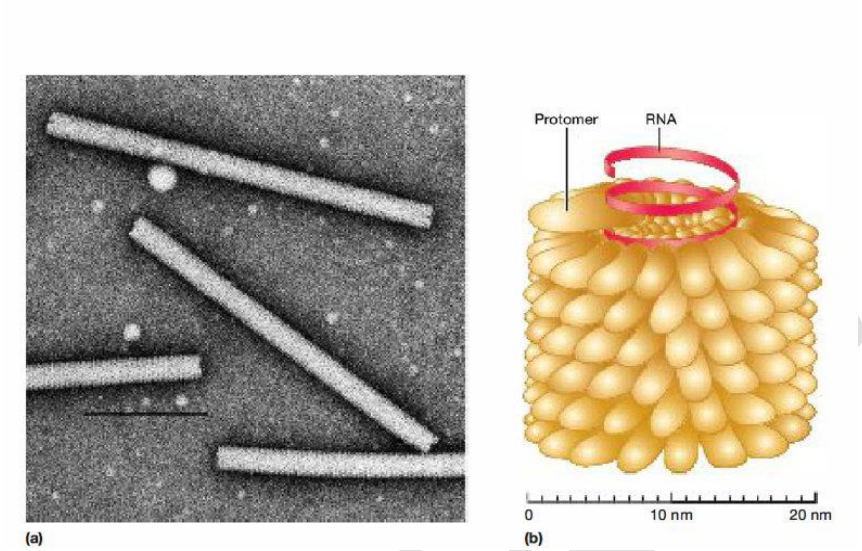
Molecular weight: 39×10^6 dalton

Components: The virion has a hollow central core of 4 nm (40Å) around which the protein subunits are arranged to form the capsid. The diameter of the virion including the central core is 18nm (180 Å). Inside the helical capsid there is a single stranded positive sense RNA which is spirally coiled to form a helix.

Capsid:

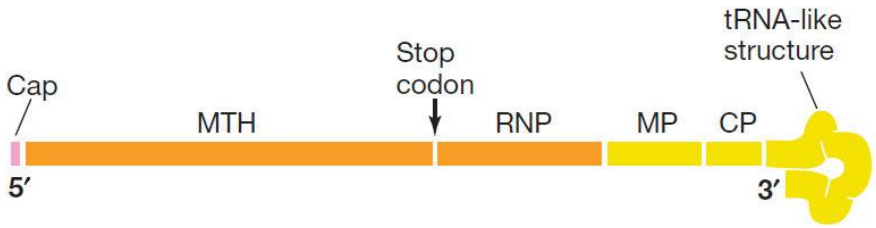
- The protein coat or the Capsid of the virion is made up of 2,130 protein subunits of identical size referred as Capsomeres.
- Each capsomere is made up of a single polypeptide chain comprising of 158 amino acids with an overall molecular weight of 17500 daltons.
- A single capsomere is linked to 3 nucleotides of RNA.
- The capsid have a helical pitch of 23Å with a overall diameter of 180Å including the central core of 40Å where the capsomeres are linked to the spirally coiled helix of ss (+)RNA.
- However, Denaturation and phase-transition studies of TMV suggest that Multiple disks can then be stacked on top of one another to form a cylinder, with the virus genome coated by the protein shell or contained in the hollow centre of the cylinder. Closer examination of the TMV particle by X-ray crystallography reveals that the structure of the capsid actually consists of a helix rather than a pile of stacked disks. A helix can be defined mathematically by two parameters: its amplitude (diameter) and pitch (the distance covered by each complete turn of the helix). For TMV, μ (subunits/helix turn) = 16.3; so there are 49 coat protein molecules per 3 helix turn, and p (axial rise/sub-unit) = 0.14 nm. Therefore, the pitch of the TMV helix is 16.3 × 0.14 = 2.28 nm. There are

130 helix turn of protein sub-units for each TMV particle. (Rf. A.J.Cann-Principles of Molecular Virology, 4th Edn.)



Genome:

- The genome of TMV is a monopartite, linear, plus-sense ssRNA which is packed tightly between the helices of protein subunits.
- The RNA genome of TMV contains 6,395 nucleotides.



- The genome of TMV particle encodes only four genes for the following proteins namely MET(with Methyl Transferase and RNA helicase domains), RNA-dependent RNA Polymerase, Movement Protein (MP) and Coat Protein (CP) (Rf. Brock's Biology of Microorganisms).
- The genome have a 5´ cap (m7G5´pppG), thus it can be used directly as an mRNA and translated.
- The 3´ end of the TMV genome folds into a transfer RNA-like structure.
- The genome of positive strand RNA virus may act as viral DNA in bacteria but as the eukaryotes cannot translate poly-cistronic mRNA, therefore, the expression of TMV genes differ from that of bacterial RNA virus.

Mode of Multiplication:

TMV, the causative agent of Tobacco Mosaic disease is a positive stranded ss RNA virus which remains a serious agricultural problem because it infects tomato plants as well as tobacco. The multiplication of TMV is discussed in the following sections:

Infection- Entry into host:

- TMV infection of a plant requires damage to plant cell walls as the virion usually enter the host through abrasion or wound on the plant.
- Systemic transport of TMV through vacular system (normally through Phloem sieve elements) is required for successful colonization of the entire plant.
- The virion moves passively with the flow of photosynthates and it moves from phloem to the surrounding cells where it reproduces and spreads by cell to cell movements.

Movement to adjacent cell:

- Plant cells are interconnected by narrow cytoplasmic strands called Plasmodesmata which are so narrow that neither TMV virion nor free RNA can easily cross this openings. The TMV 'Movement Protein (MP)' binds to the newly formed genomic positive sense RNA and forms a complex extremely thin (c. 2.5nm) that can move through plasmodesmata and infect neighboring cells. TMV thus spreads slowly, about 1 mm per day or less, moving from cell to cell through the plasmodesmata.

Gene Expression:

- The uncoating of the nucleic acid of the virion takes place inside the cell where the RNA of TMV serves as infectious particle.
- RNA of TMV serves both as the genome and as viral mRNA.
- The genome of TMV particle encodes only four genes for the following proteins namely MET(with Methyl Transferase and RNA helicase domains), RNA-dependent RNA Polymerase, Movement Protein (MP) and Coat Protein (CP) (Rf. Brock's Biology of Microorganisms).
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Replication:

- The viral RNA moves into the nucleus and first induces the formation of RNA Dependent RNA Polymerase which has both replicase and transcriptase activity.
- The virus synthesize a negative strand RNA copy as Replicative Strand which can be used as template to make more copies of genomic RNA.

Assembly:

- In cooperation with Ribosome and tRNA of the host cell, each mRNA directs the synthesis of protein subunits.
- After the production of desired capsomeres, the new viral RNA is considered to organize the protein sub-units around it resulting the formation of complete virus particle.

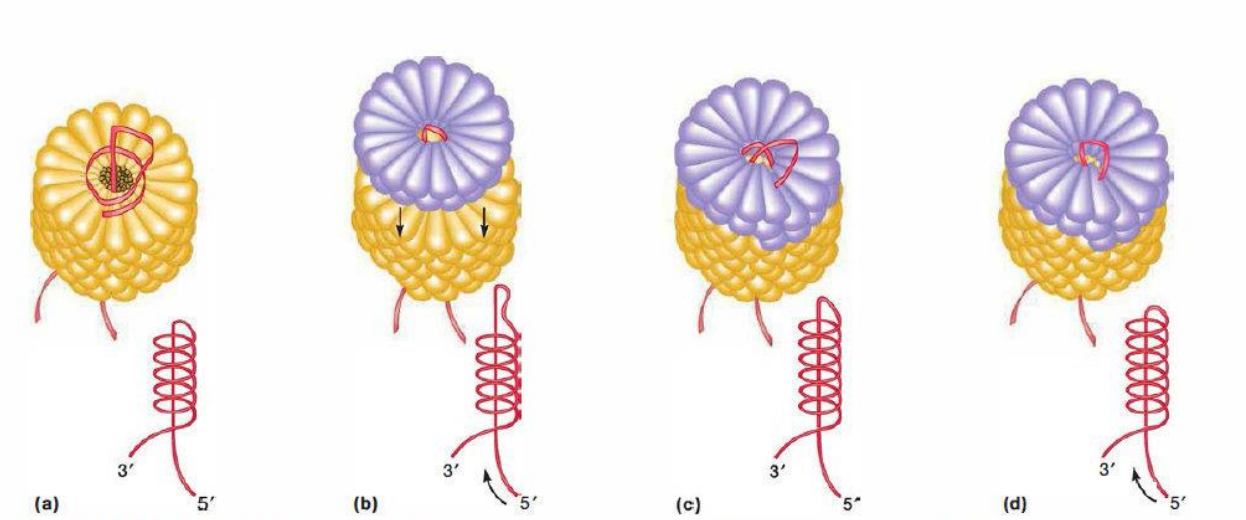

Figure 27.27 TMV Assembly. The elongation phase of tobacco mosaic virus nucleocapsid construction. The lengthening of the helical capsid through the addition of a protein disk to its end is shown in a sequence of four illustrations; line drawings depicting RNA behavior are included. The RNA genome inserts itself through the hole of an approaching disk and then binds to the groove in the disk as it locks into place at the end of the cylinder.