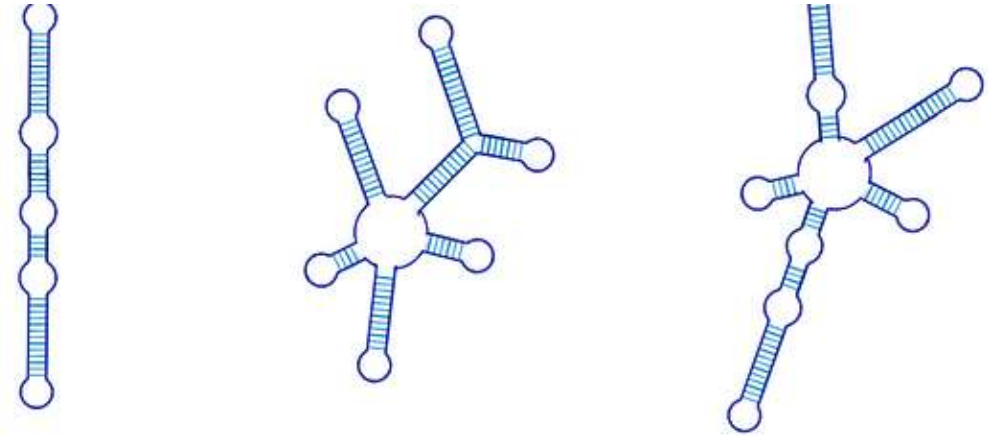
Subject: Virology

Subject Code: MDSE (MB)-202A



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Viroids

Discovery of Viroids

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.

General characteristics

- Viroids are the species of nucleic acid with relatively low molecular weight and a unique structure.
- Viroids are formed only of the RNA.
- These are known to be smaller in size and infect only the plants.
- These are among the smallest known agents causing infectious disease.
- They reproduce within the host cell which they affect and cause variations in them leading to their death.

- Viroids are mainly classified into *two families* :

1. *Pospiviroidae- nuclear viroids* (replicates in nucleus and nucleolus) and
2. *Avsunviroidae- chloroplastic viroids* (replicates in chloroplasts).

- Viroids are known to cause different plant diseases.

- They move within a plant, probably in association with the host proteins via the phloem vascular channels and plasmodemata (cell contact points).

Transmission

Viroids are transmitted by mechanical method, vegetative propagation and through pollens and seeds for e.g., Chrysanthemum stunt viroid (CSVd) is transmitted by vegetative propagation. Citrus exocortis viroid (CEVd), Hop stunt viroid (HSVd) is transmitted by mechanical method.

Avocado sun-blotch Viroid (ASBVd) is transmitted by seeds and pollens.

Plot spindle tuber viroid (PSTVd) is transmitted at low frequency in a non-persistent manner by the aphid *Macrosiphum euphorbiae*.

The only human disease known to be caused by a viroid is hepatitis D; in this case the viroid is ***enclosed in a hepatitis B virus capsule***.

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 of circular single stranded RNA without protein coat with molecular weight between 1,07,000 and 1,27,000.

Viroids are 240 to 380 nucleotides long and most of them have dumb-bell structures.

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.

Structurally, the pospiviroid and Avsunviroid are also different.

The pospiviroid has been divided into file structural/functional domains:

1. Conserved central domain.
2. Pathogenic domain
3. Variable domain
4. Left terminal domain, and
5. Right terminal domain.

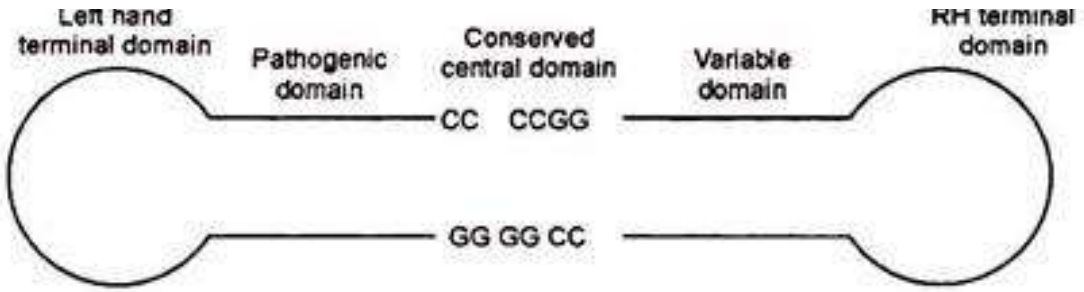


Fig. 1. Structure of Pospiviroid.

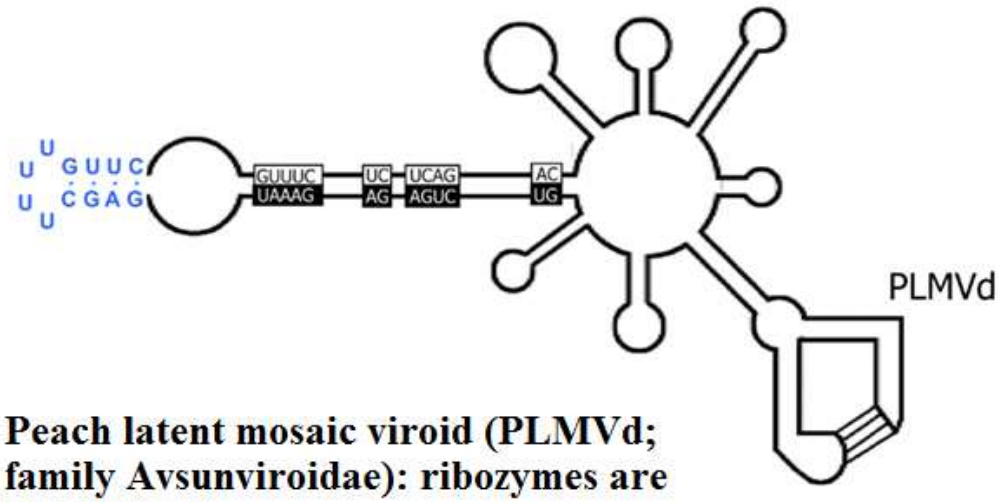
The structural domains are related to specific functions.

The conserved central domain, mainly the upper strand is involved with cleavage and ligation of RNA.

Members of the avsunviroid group have different structure.

They have ***multi-branched secondary structure***.

They lack a conserved central Domain (CCR) and possess a ribozyme activity (a ribozyme is a catalytic RNA molecule, in the case RNA cleavage in the ribozymic activity).



Peach latent mosaic viroid (PLMVd; family Avsunviroidae): ribozymes are highlighted

Multiplication of Viroids

Viroid RNA does not code for any protein.

They replicate automatically and spread in the plant by using host proteins.

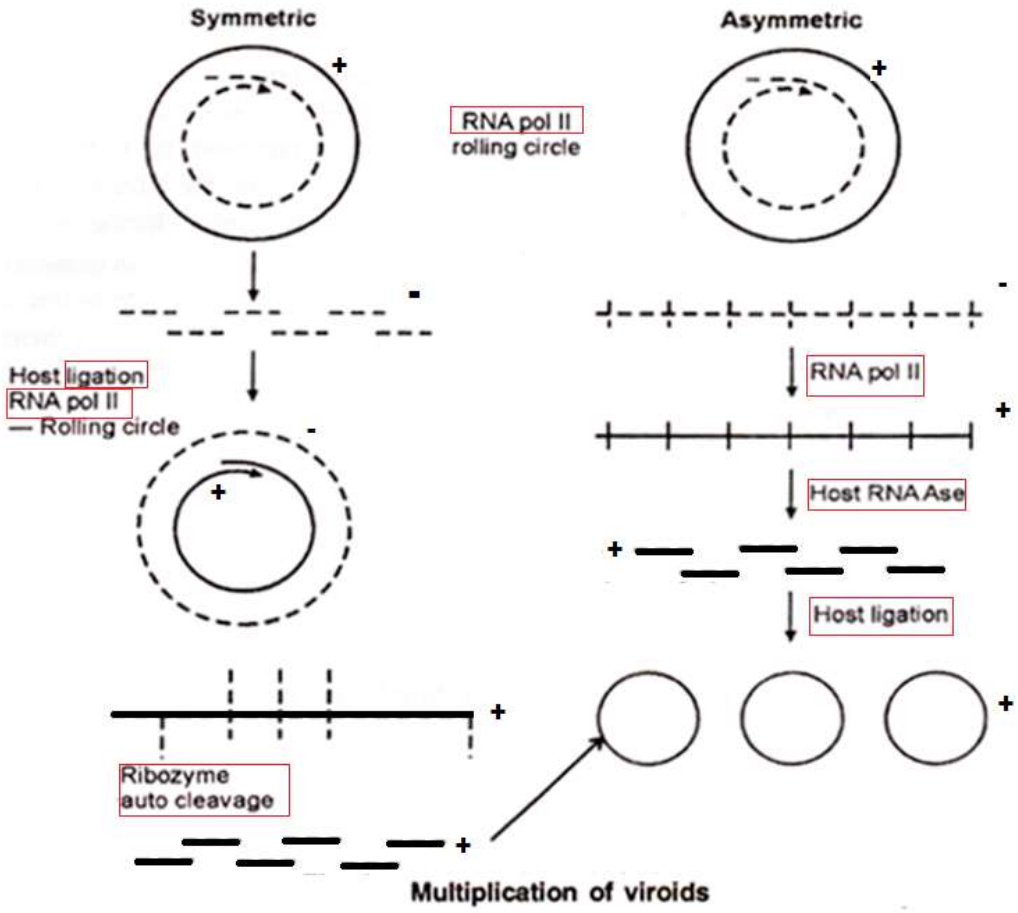
Three enzymatic activities are required for viroid replication:

- RNA pol. II,
- RNAase and
- RNA ligase.

The two groups of viroids replicate by two different methods.

Avsunviroids replicates via symmetric rolling circular mechanism.

The positive circular RNA strand of viroid serves as a template to make a large, multimetric -ve strand.



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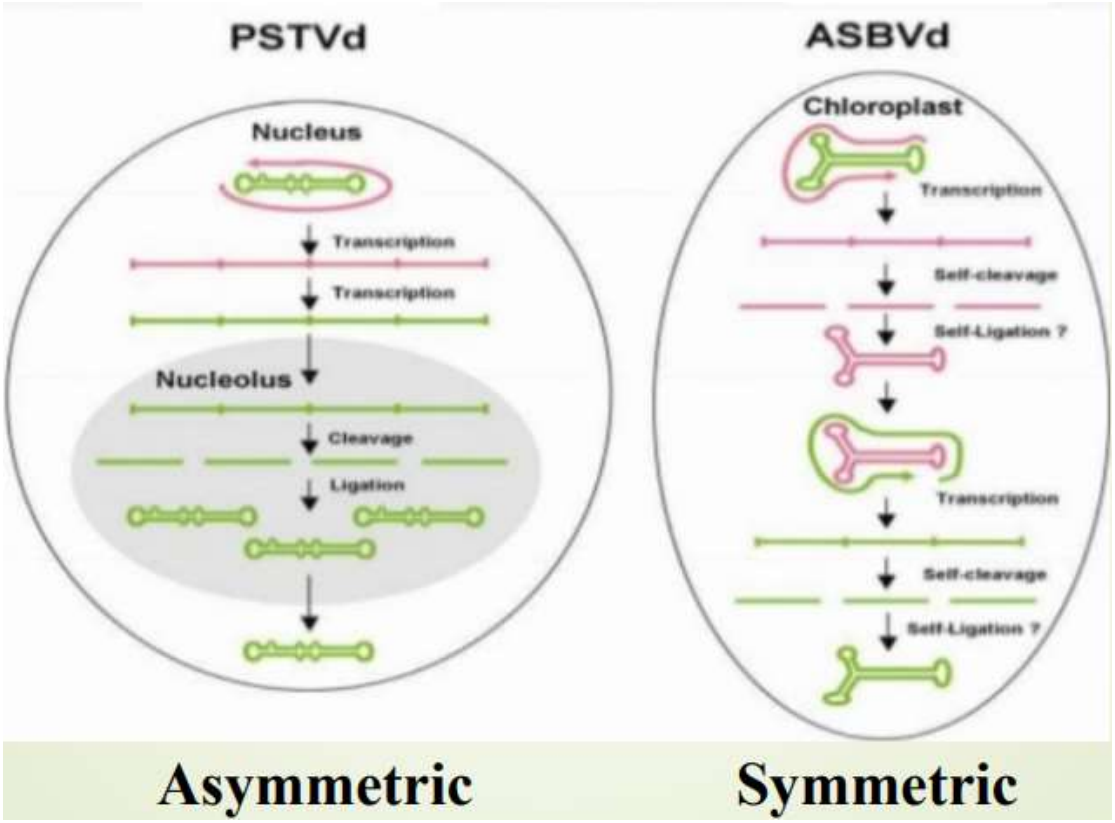

Probably it is done by the activity of RNA pol II enzyme.

The long ─RNA is self-cleaved by the associated ribozyme activity (into unit ***viroid length***). RNA circularizes to form a -ve circle.

A second rolling circle event makes a long +ve strand which is again cleaved by ribozyme activity.

The short viroid RNA is then ligated to the circular form.

Pospiviroids with an asymmetric pathway make +RNA from the long linear molecule.

A host RNAase activity cleaves the + strand into unit ***viroid length***.

The molecule then forms a circular viroid.

The symmetric replication pathway was named because both plus and minus strands are produced the same way.

Viroids, due to their small size and lack of protein-coding capacity, must rely essentially on their hosts for replication. Intriguingly, viroids have evolved the ability to replicate in two cellular organella, the nucleus (family Pospiviroidae) and the chloroplast (family Avsunviroidae).

Viroid replication proceeds through an RNA-based rolling-circle mechanism with three steps that, with some variations, operate in both polarity strands: i) synthesis of longer-than-unit strands catalyzed by either the nuclear RNA polymerase II or a nuclear-encoded chloroplastic RNA polymerase, in both instances redirected to transcribe RNA templates, ii) cleavage to unit-length, which in the family Avsunviroidae is mediated by hammerhead ribozymes embedded in both polarity strands, while in the family Pospiviroidae the oligomeric RNAs provide the proper conformation but not the catalytic activity, and iii) circularization.

The host RNA polymerases, most likely assisted by additional host proteins, start transcription from specific sites, thus implying the existence of viroid promoters.

Cleavage and ligation in the family Pospiviroidae is probably catalyzed by an RNase III-like enzyme and an RNA ligase able to circularize the resulting 5' and 3' termini. Whether a chloroplastic RNA ligase mediates circularization in the family Avsunviroidae, or this reaction is autocatalytic, remains an open issue.

THANK YOU