# VIROIDS

AHMAD. MASOOD
DEPT. OF BOTANY
H. D. JAIN COLLEGE
ARA

Viroids are infectious agents consisting of a short, single-stranded, circular RNA molecules without a protein coat. The RNA molecule vary in length from 240 to 470 nucleotides, and are found mainly in plants (recently human viroid causing hepatitis D is also known).

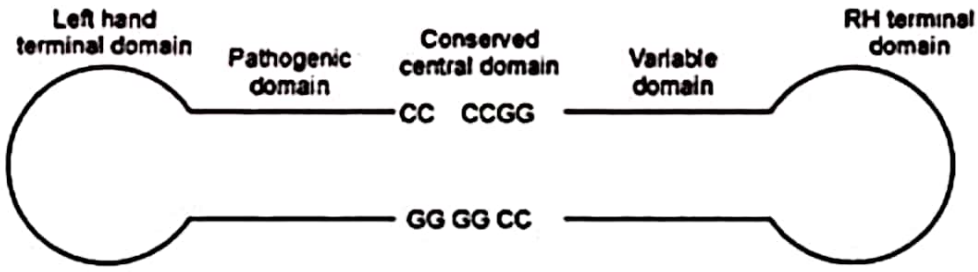
Discovery: Viroids were first discovered and given this name by Theodor Otto Diener (1971), a plant pathologist working at Agricultural Research Centre in Maryland. The first viroid to be identified was the potato spindle Tuber Viroid (PSTVd). At present more than 30 species have been identified.

Classification: Viroids are classified in two group (taxonomic families) based on differences in their structural and functional properties.

I. Pospiviroidae - named for potato spindle tuber viroid. The members adopt a rod-like secondary structure with five domains — the Central Conserved domain, Pathogenic domain, Variable domain, Left terminal domain and Right terminal domain. The Structural domains are related to specific functions. The Conserved Central domain, mainly the upper strand, is involved with cleavage and ligation of RNA. pathogenicity seems to arise from variation in pathogenic domain and Left terminal domain.

The folded Structure probably protects it from the attack by cellular enzymes.

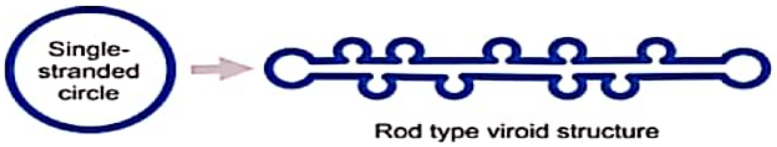
They replicates in nucleus.



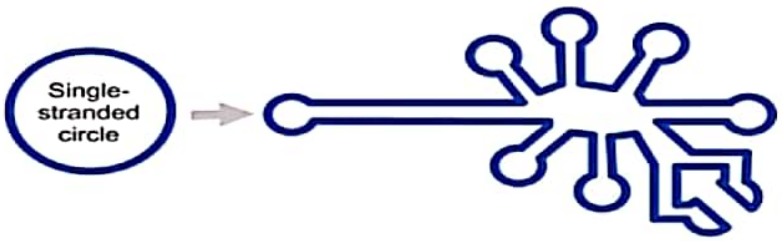

structure of Pospiviroid

II - Avsunviroidae — named for Avocado sunblotch viroid. The members have both rod-like and branched regions, but lack central conserved region or domain and replicate in chloroplast. They possess a ribozyme activity (a ribozyme is a catalytic RNA molecule) which undergo self-cleavage during replication (as they lack central conserved domain).

Thus, in contrast to the pospiviroids, Avsunviroids RNA molecules are functional ribozymes and this activity is essential for replication.



Rod type viroid structure



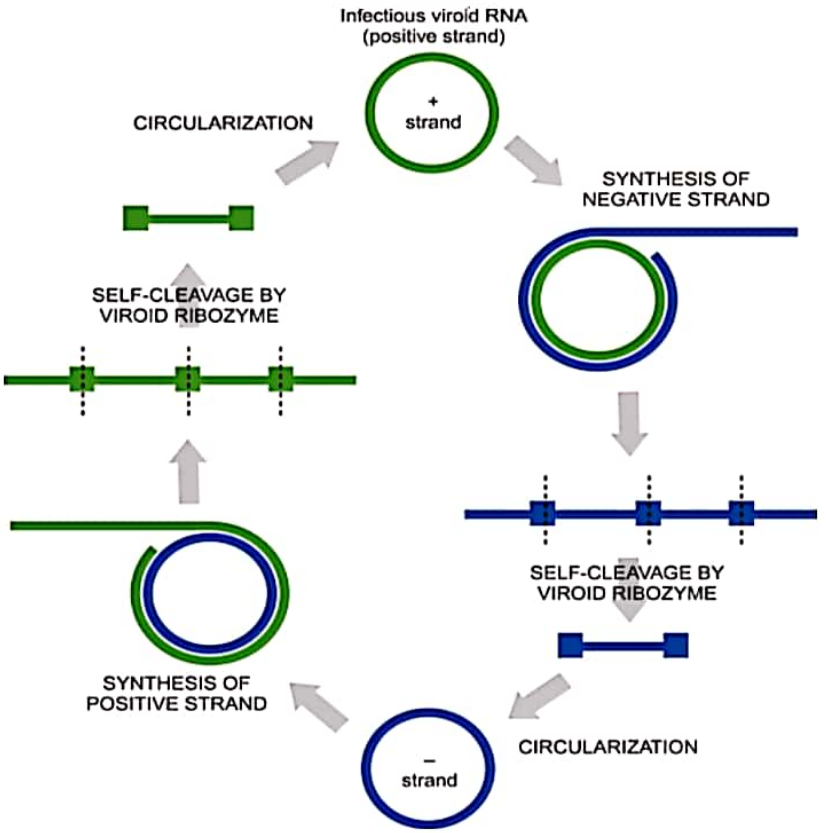
Branched viroid structure

Infection and replication: Viroids inject plants and replicate at the expense of the host cell. Since viroids have no protein coat, they lack attachment proteins and cannot recognize and penetrate healthy cells as can a true virus. Thus, viroids can infiltrate a cell only when its surrounding is already damaged. Once inside, they replicate by rolling circle mechanism.

Replication in Pospiviroidae: In plants infected with the members of pospiviroidae, Viroid RNA is imported into the nucleus, copied by plant DNA dependent RNA Polymerase II. By rolling circle mechanism, the viroid is copied that produced complementary linear, concatameric RNAs. These are copied again to produce concatameric, linear molecules, which are cleaved by the host enzyme RNAse III. Their ends are joined by a host enzyme to form circle.

Replication in Avsunviroidae : In plants infected with the members of this group, viroid RNA is imported into the chloroplast, and complementary concatameric RNAs are produced by chloroplast DNA - dependent RNA polymerase. Cleavage of these molecules is carried out by a ribozyme, an enzyme encoded in this viroid RNA.

Rolling circle mechanism : Two rounds of rolling circle replication are used by viroids to replicate themselves. Upon entry into a plant cell, the circular positive single-stranded RNA uses the plant (host) RNA polymerase to make a minus strand. The polymerase continues to make multiple copies using the rolling circle mechanism. The linear, negative single-stranded RNA uses its own catalytic activity to cut itself into genome-sized units that are circularized. The circular, negative single-stranded RNA then undergoes another round of rolling circle replication and self cleavage to produce multiple copies of the linear plus strand. Finally, these are circularized to give the infectious circular, positive single-stranded RNA form.



After replication, viroid progeny exit the nucleus or chloroplast and move to adjacent cells through plasmodesmata and can travel systemically via the phloem to infect other cells. Viroids enter the pollen and ovule, from where they are transmitted to the seed. When the seed germinates, the new plant becomes infected. Viroids can also be transmitted among plants by contaminated farm machinery and insects.

Symptoms of viroid infection: The symptoms include stunting of growth, deformation of leaves & fruits, stem necrosis, and death of the infected plants.

Some common viroids infecting the agricultural products:

Potato - Potato spindle tuber viroid (PSTVd)

Citrus plants - Citrus exocortis viroid (CEVd)
Hop stunt viroid (HSVd)

Coconut - Coconut Cadang-Cadang viroid (CCCVd)

Tomato - Tomato apical stunt viroid (TASVd)

Apple - Apple scar skin viroid (ASSVd)

Avocado - Avocado Sunblotch viroid (ASBVd).


**Viroid infected potato tubers**

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