FACULTY OF AGRICULTURE SCIENCES AND ALLIED INDUSTRIES

Course Material

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LECTURE 9

GENERAL CHARACTERISTICS AND CLASSIFICATION OF VIRAL PLANT PATHOGENS

GENERAL CHARACTERISTICS AND STRUCTURE

Characteristics of viruses which separate them from other causes of plant pathogens are:

They are acellular.
They are sub-microscopic and intracellular.
They lack lipid membrane system and energy production.
They use host machinery for their replication.

Structure of virus
Virion is a technical term used for the virus particle.

A virion consists of nucleic acid surrounded by a protein coat.

The nucleic acid is called ‗nucleoid' which may be either de-oxyribonucleic aci (DNA) or ribonucleic acid RNA (mostly RNA in plant viruses), but never both; and forms the genome.

The protein coat is called capsid. It consists of many subunits which are similar and occasionally dissimilar, and these subunits are called capsomeres.

The combined genome and the capsid are called nucleocapsid.

Some viruses possess an envelope around the protein coat which is made of virus proteins and host cell lipids. These viruses are called enveloped viruses.

In many groups of viruses, there is an additional protein layer between the capsid and the nucleoid. This is called virus core. In addition to the typical nucleoprotein composition, some viruses have carbohydrates/ lipids / enzymes.

Nucleoid

The nucleoid (nucleic acid component) is located internally within a protein coat.

Only one type of nucleic acid, i.e. either RNA or DNA is found in a virus.

The amount of nucleic acid in a virion varies from 1 to 50 per cent.

Higher percentage of nucleic acid is associated with larger DNA viruses like

bacteriophages; while low content is found in animal viruses.

The nucleic acid is infectious part and contains the genetic information for the synthesis of proteins and its own replication; and their assembly into the virion.

Most of the plant viruses contain RNA, with exceptions like Cauliflower mosaic virus.

Capsid

The capsid is a protein coat surrounding the nucleoid and has the following functions:

It protects nucleic acid from unfavourable extracellular environment.

It facilitates nucleic acid entry into the host cells.

It is antigenic. As compared to nucleoid, the protein coat shows a complex structure and provides shape to the virus particles.

It interacts with the vector for specific transmission.

Composition and structure of viruses

Morphology

Plant viruses come in different shapes and sizes. Nearly half of them are elongate (rigid rods or flexuous threads), and almost as many are spherical (isometric or polyhedral), with the remaining being cylindrical bacillus-like rods.

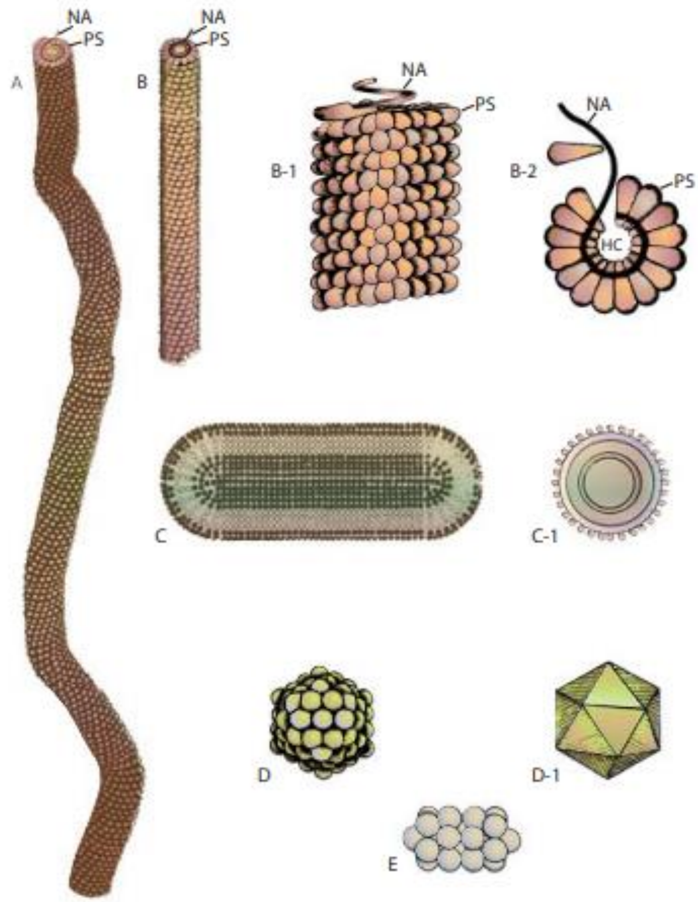

Figure: Relative shapes, sizes, and structures of some representative plant viruses. (A) Flexuous thread-like virus. (B) Rigid rod-shaped virus. (B-1) Side arrangement of protein subunits (PS) and nucleic acid (NA) in viruses A and B. (B-2) Cross-section view of the same viruses. HC, hollow core. (C) Short, bacillus-like virus. (C-1) Cross-section view of such a virus. (D) Isometric polyhedral virus. (D-1) Icosahedron representing the 20-sided symmetry of the protein subunits of the isometric virus. (E) Geminivirus consisting of twin particles.

- Some elongated viruses are rigid rods about 15 by 300 nanometers, but most appear as long, thin, flexible threads that are usually 10 to 13 nanometers wide and range in length from 480 to 2,000 nanometers.
- Rhabdoviruses are short, bacilluslike, cylindrical rods, approximately three to five times as long as they are wide (52–75 by 300– 380nm).
- Most spherical viruses are actually polyhedral, ranging in diameter from about 17 nanometers (tobacco necrosis satellite virus) to 60 nanometers (wound tumor virus).

- Tomato spotted wilt virus is surrounded by a membrane and has a flexible, spherical shape about 100 nanometers in diameter. Many plant viruses have split genomes, i.e., they consist of two or more distinct nucleic acid strands encapsidated in different-sized particles made of the same protein subunits. Thus, some, like tobacco rattle virus, consist of two rods, a long one (195 by 25nm) and a shorter one (43 by 25nm), whereas others, like alfalfa mosaic virus, consist of four components of different sizes.
- Also, many isometric viruses have two or three different components of the same size but containing nucleic acid strands of different lengths. In multicomponent viruses, all of the nucleic acid strand components must be present in the plant for the virus to multiply and perform in its usual manner.
- The surface of viruses consists of a definite number of protein subunits, which are arranged spirally in the elongated viruses and packed on the sides of the polyhedral particles of the spherical viruses
- In cross section, the elongated viruses appear as hollow tubes with the protein subunits forming the outer coat and the nucleic acid, also arranged spirally, embedded between the inner ends of two successive spirals of the protein subunits. In spherical viruses the visible shell.

Composition and Structure

Each plant virus consists of at least a nucleic acid and a protein. Some viruses consist of more than one size of nucleic acid and proteins, and some of them contain enzymes or membrane lipids.

The nucleic acid makes up 5 to 40% of the virus, protein making up the remaining 60 to 95%.

The lower nucleic acid percentages are found in the elongated viruses, whereas the spherical viruses contain higher percentages of nucleic acid.

The total mass of the nucleoprotein of different virus particles varies from 4.6 to 73 million daltons. The weight of the nucleic acid alone, however, ranges only between 1 and 3 million ($1–3 \times 10^6$) daltons per virus particle for most viruses, although some have up to 6×10^6 daltons and the 12 component wound tumor virus nucleic acid is approximately 16×10^6

daltons. All viral nucleic acid sizes are quite small when compared to 0.5×10^9 daltons for mollicutes and 1.5×10^9 daltons for bacteria.