9.6A: Defective Viruses

Learning Objectives

- Distinguish between defective viruses, satellite viruses, and helper viruses

Virologists also study subviral particles, infectious entities notably smaller and simpler than viruses:

- viroids (naked circular RNA molecules infecting plants)
- satellites (nucleic acid molecules with or without a capsid that require a helper virus for infection and reproduction)
- prions (proteins that can exist in a pathological conformation that induces other prion molecules to assume the same conformation)

Not all viruses can reproduce in a host cell by themselves. Since viruses are so small, the size of their genome is limited. For example, some viruses have coded instructions for only making a few different proteins for the viruses’ capsid. On the other hand, the human genome codes for over 30,000 different proteins. Therefore, the lack of coded instructions causes some viruses to need the presence of other viruses to help them reproduce themselves. Such viruses are called replication defective.

Satellites depend on co-infection of a host cell with a helper virus for productive multiplication. Their nucleic acids have substantially distinct nucleotide sequences from either their helper virus or host. When a satellite subviral agent encodes the coat protein in which it is encapsulated, it is then called a satellite virus. Satellite viral particles should not be confused with satellite DNA.
Hepatocellular Carcinoma: Cirrhosis leading to hepatocellular carcinoma (autopsy specimen). The photo shows a view of a longitudinal slice taken through the full length of the liver.

The hepatitis delta virus of humans has an RNA genome similar to viroids, but has a protein coat derived from hepatitis B virus and cannot produce one of its own. Therefore, it is a defective virus and cannot replicate without the help of hepatitis B virus. In similar manner, the sputnik virophage is dependent on mimivirus, which infects the protozoan Acanthamoeba castellanii. These viruses that are dependent on the presence of other virus species in the host cell are called satellites. They may represent evolutionary intermediates of viroids and viruses.

Hepatitis D, also referred to as hepatitis D virus (HDV) and classified as Hepatitis delta virus, is a disease caused by a small circular enveloped RNA virus. It is one of five known hepatitis viruses: A, B, C, D, and E. HDV is considered to be a subviral satellite because it can only propagate in the presence of the hepatitis B virus (HBV). Transmission of HDV can occur either via simultaneous infection with HBV (coinfection) or superimposed on chronic hepatitis B or hepatitis B carrier state (superinfection). Both superinfection and coinfection with HDV results in more severe complications compared to infection with HBV alone. These complications include a greater likelihood of experiencing liver failure in acute infections and a rapid progression to liver cirrhosis, with an increased chance of developing liver cancer in chronic infections. In combination with hepatitis B virus, hepatitis D has the highest mortality rate of all the hepatitis infections of 20%.

**Key Points**

- Not all viruses can reproduce in a host cell by themselves. Since viruses are so small, the size of their genome is limited. The lack of coded instructions causes some viruses to need the presence of other viruses to help them reproduce themselves. Such viruses are called replication defective.

- A satellite is a subviral agent composed of nucleic acid that depends on the co-infection of a host cell with a helper or master virus for its multiplication. When a satellite encodes the coat protein in which its nucleic acid is encapsidated it is referred to as a satellite virus.

- These viruses that are dependent on the presence of other virus species in the host cell are called satellites and may represent evolutionary intermediates of viroids and viruses.
Key Terms

- **Helper virus**: A helper virus is a virus used when producing copies of a helper dependent viral vector which does not have the ability to replicate on its own. The helper virus is used to coinfect cells alongside the viral vector and provides the necessary enzymes for replication of the genome of the viral vector.

- **Satellite**: A subviral agent composed of nucleic acid that depends on the co-infection of a host cell with a helper or master virus for its multiplication.