Tikrit University
College of Veterinary Medicine

Lect. 3-Virology

Subject name: Replication cycles in animal viruses

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Viral replication cycles

Replication cycles in animal viruses

Viruses that infect multicellular organisms such as animals may be specific not only to a particular organism, but also to a particular cell or tissue type. This is known as the *tissue tropism* of the virus, and is due to the fact that attachment occurs via specific receptors on the host cell surface.

- **Tissue Tropism** The capacity of a virus to selectively infect cells in particular organs is.

The growth cycles of animal viruses have the same main stages as described for bacteriophages, but may differ in some of the details. Most of these variations are a reflection of differences in structure between bacterial and animal host cells.

Adsorption and penetration

Animal viruses do not have the head and tail structure of phages, therefore, their method of attachment is different. The specific interaction with a host receptor is made via some component of the capsid, or, in the case of enveloped viruses, by special structures such as spikes (*peplomers*).

- Viral membrane contains glycolipids or glycoprotein which appears as projections fromthe envelope called spikes or peplomers..

Viral attachment sites can frequently be blocked by host antibody molecules; however some viruses (e.g. the rhinoviruses) have overcome this by having their sites situated in deep depressions, inaccessible to the antibodies.

Whereas bacteriophages inject their nucleic acid component from the outside, the process in animal viruses is more complex. Animal viruses do

not have to cope with a thick cell wall, and in many such cases the entire virion is internalised. This necessitates the extra step of uncoating, a process carried out by host enzymes. Many animal viruses possess an envelope; such viruses are taken into the cell either:

- by fusion with the cell membrane,
- or by endocytosis.

While some non-enveloped types release only their nucleic acid component into the cytoplasm, others require additionally that virus-encoded enzymes be introduced to ensure successful replication.

Replication (DNA viruses)

The DNA of animal cells, unlike that of bacteria, is found in the nucleus, and it is here that replication and transcription of viral DNA generally occur* . Messenger RNA then passes to ribosomes in the cytoplasm for translation. In the case of viruses with a ssDNA genome, a double-stranded intermediate is formed, which serves as a template for mRNA synthesis.

Assembly

Translation products are finally returned to the nucleus for assembly into new virus particles.

*

Poxviruses are an exception. Both replication and assembly occur in the cytoplasm.

Release

Naked (non-enveloped) viruses are generally released by lysis of the host cell. In the case of enveloped forms, release is more gradual. The host's plasma membrane is modified by the insertion of virus-encoded proteins, before engulfing the virus particle and releasing it by a process of *budding*.

This can be seen as essentially the reverse of the process of internalisation by fusion.

Replication of RNA viruses

The phage and animal virus growth cycles we have described so far have all involved double-stranded DNA genomes. As you will remember from the start of this chapter, however, many viruses contain RNA instead of DNA as their genetic material, and we now need to consider briefly how these viruses complete their replication cycles. Replication of RNA viruses occurs in the cytoplasm of the host; depending on whether the RNA is single- or double-stranded, and (+) or (−) sense, the details differ. The genome of a (+) *sense single stranded RNA virus* functions directly as an mRNA molecule, producing a giant polyprotein, which is then cleaved into the various structural and functional proteins of the virus. In order for the (+) sense RNA to be replicated, a complementary (−) sense strand must be made, which acts as a template for the production of more (+) sense RNA. The RNA of a (−) *sense RNA virus* must first act as a template for the formation of its complementary sequence by a virally encoded RNA polymerase. The (+) sense RNA so formed has two functions: (i) to act as mRNA and undergo translation into the virus's various proteins, and (ii) to act as template for the production of more genomic (−) sense RNA.

Double-stranded RNA viruses are all segmented. They form separate mRNAs for each of their proteins by transcription of the (−) strand of their genome. These are each translated, and later form an aggregate (*subviral particle*) with specific proteins, where they act as templates for the synthesis of a double-stranded RNA genome, ready for incorporation into a new viral particle. Two final, rather complicated, variations on the viral replication cycles involve the enzyme *reverse transcriptase*, first discovered in 1970.

Retroviruses

These viruses, which include some important human pathogens, have a genome that exists as RNA and DNA at different part of their replication cycle. Retroviruses have a (+) sense ss-RNA genome which is unique among viruses in being diploid. The two copies of the genome serve as templates for the enzyme reverse transcriptase to produce a complementary strand of DNA. The RNA component of this hybrid is then degraded, allowing the synthesis of a second strand of DNA. This *proviral DNA* passes to the nucleus, where it is incorporated into the host's genome. Transcription by means of a host RNA polymerase results in mRNA, which is translated into viral proteins and also serves as genomic material for the new retrovirus particles. The human immunodeficiency virus (HIV), the causative agent of acquired immune deficiency syndrome, is an important example of a retrovirus.