9.11I: Retroviruses and Hepadnavirus

Hepadnaviruses, retroviruses, use virally encoded reverse transcriptase to convert RNA into DNA.

Learning Objectives

• Differentiate between retroviruses and hepadnaviruses

Key Points

• Retrovirus RNA serves as a template for reverse transcriptase and is copied into DNA.
• Hepadnaviruses are a family of viruses which can cause liver infections in humans and animals.

Key Terms

• **endogenous**: produced, originating or growing from within
• **episome**: A segment of DNA that can exist and replicate either autonomously in the cytoplasm or as part of a chromosome, mainly found in bacteria.

A well-studied family of this class of viruses includes the retroviruses. One defining feature is the use of reverse transcriptase to convert the positive-sense RNA into DNA. Instead of using the RNA for templates of proteins, they use DNA to create the templates, which is spliced into the host genome using integrase. Replication can then commence with the help of the host cell’s polymerases. A well-studied example of this includes HIV.

A special variant of retroviruses are endogenous retroviruses, which are integrated into the genome of the host and...
inherited across generations.

The virus itself stores its nucleic acid in the form of a +mRNA (including the 5’cap and 3’PolyA inside the virion ) genome. This then serves as a means of delivery of that genome into cells it targets as an obligate parasite, and constitutes the infection. Once in the host’s cell, the RNA strands undergo reverse transcription in the cytoplasm and are integrated into the host’s genome, at which point the retroviral DNA is referred to as a provirus. It is difficult to detect the virus until it has infected the host.

In most viruses, DNA is transcribed into RNA, and then RNA is translated into protein. However, retroviruses function differently – their RNA is reverse-transcribed into DNA, which is integrated into the host cell’s genome (when it becomes a provirus), and then undergoes the usual transcription and translational processes to express the genes carried by the virus. So, the information contained in a retroviral gene is used to generate the corresponding protein via the sequence: RNA → DNA → RNA → protein. This extends the fundamental process identified by Francis Crick, in which the sequence is: DNA → RNA → protein. Retroviruses are proving to be valuable research tools in molecular biology and have been used successfully in gene delivery systems.

Figure: **Hepatitis B Virus**: TEM micrograph showing hepatitis B virions.

Hepadnaviruses are a family of viruses which can cause liver infections in humans and animals. There are two recognized genera:

- Genus *Orthohepadnavirus* ; type species: *Hepatitis B virus*
- Genus *Avihepadnavirus* ; type species: *Duck hepatitis B virus*

Hepadnaviruses have very small genomes of partially double-stranded, partially single stranded circular DNA. The genome consists of two uneven strands of DNA. One has a negative-sense orientation, and the other, shorter, strand has a positive-sense orientation. Hepadnaviruses replicate through an RNA intermediate (which they transcribe back into cDNA using reverse transcriptase). The reverse transcriptase becomes covalently linked to a short 3- or 4-nucleotide primer. Most hepadnaviruses will only replicate in specific hosts, and this makes experiments using in vitro methods very difficult.

HBV infection is initiated through viral attachment to an unknown cell surface receptor. The virally encoded DNA polymerase acts upon the DNA, leaving it fully double-stranded.