Human Tumour Viruses:

1. HPV uses a mechanism similar to SV40 or adenovirus to cause cancer.
2. The viral protein E6 and E7 inactivated p53 and Rb, respectively.
3. In all other cases of human viruses causing cancer, the mechanisms are different from those of animal tumour viruses.
4. It is important to note that human tumour viruses:
    - Do *not* contain oncogenes derived from the host cell.
    - Do *not*, in general, cause transformation by integration next a proto-oncogene.

5. Most human tumour viruses are **not** retroviruses – human T cell leukaemia virus 1 and 2 are the *only* examples.
6. This is because HTLV-1 contains an *extra viral gene* called **Tax**.
7. Tax encodes a protein that activates transcription of pro-viral DNA and, as a side effect, also stimulates expression of cellular growth factors that induce cell proliferation.
8. **Combination of increased proliferation and reduced checkpoint control** my increase the chances of mutations, leading to neoplasia.
9. For all human cancers associated with viral infection, only a small minority of infected individuals develop cancer and only after a long latency period.
10. This implies that there must be *co-factors* present because a virus infection is not sufficient for tumour development.

Human Tumour Viruses Co-Factors:

1. EBV causes glandular fever in developed countries.
2. In Burkitt's lymphoma, the **co-factor is malaria and as well as HIV**. This is because both malaria and HIV compromise the immune systems response to EBV infection.
3. Thus causing a decreased control of EBV-stimulated B cell proliferation, and thereby increasing the chances of a particular chromosome translocation during B cell development, activating the MYC proto-oncogene.
4. For HHV-8, the co-factor to it leading to Kaposi sarcoma is **HIV-induced immune suppression.**
5. Hepatitis B virus co-factors:
    - A vigorous immune response leads to viral clearance.
    - A low/absent response leads to a "healthy" carrier state.
    - An intermediate response leads to chronic hepatitis and cirrhosis. This is because prolonged attempts at regeneration increase the risk of mutations during cell replication. In addition, exposure to dietary carcinogens may increase risk further.