Introduction to Prions and Viruses

1. Define:

Prion – A prion is an infectious agent composed of protein in a misfolded form (as identified by Stanley B. Prusiner [1972], as the causative agents of Scrapie, a spongiform encephalopathy of sheep). Prions can cause transmissible spongiform encephalopathies in various mammals, e.g., mad cow disease in cattle, chronic wasting disease in elk, moose and deer, and Creutzfeldt-Jakob Disease (CJD), variant Creutzfeldt-Jakob Disease (vCJD), Gerstmann–Sträussler–Scheinker syndrome, Fatal Familial Insomnia and kuru in humans. Prion proteins cause normal brain proteins to misfold forming more prions; all known transmissible spongiform encephalopathies are untreatable and fatal. Prion proteins are most often acquired through ingestion, but can also develop through mutation of the gene encoding the normal brain protein targeted by prions.

Prophage – A prophage is a bacteriophage that has entered into a host cell and has become incorporated into the host cell's chromosome. When it is a prophage, the virus will be replicated along with the host cell's DNA and transferred to newly formed cells. The prophage is not usually disruptive to host cell function, but can cause lysogenic conversion.

Lysogenic conversion – Lysogenic conversion is a condition that exists when a population of bacteria are expressing viral genes. The bacteria display a new phenotype because they are expressing characteristics determined by the viral genes. For example, many bacteria that produce protein-type toxins (exotoxins) are expressing viral genes. Toxin production is a common viral characteristic.

Retrovirus – A retrovirus (family Retroviridae) is a virus that has an RNA genome and carries the enzyme reverse transcriptase (RNA-dependent DNA polymerase). Such a virus will reverse transcribe its RNA genome into DNA and then replicate this DNA forming a double helix, after it has entered a host cell. The newly formed DNA can then become incorporated into the host cell's chromosome to form a provirus.

Reverse transcriptase – Reverse transcriptase, also known as RNA-dependent DNA polymerase, is a type of enzyme that allows the information contained in RNA molecules to be reverse transcribed into single-stranded DNA molecules, and will then replicate these DNA strands to form double helices. Reverse transcriptase enzymes were originally found in retroviruses, but are now used in laboratories to form complimentary DNA (c-DNA) from various human m-RNA molecules.

2. Poison

3. Virion/ protein coat called a capsid

4. Nucleic acid core/ capsomers

5. Nucleic acid (may be DNA or RNA but usually not both)/ capsid/ tail assembly

6 The viral genome may be double-stranded or single-stranded DNA or double-stranded or single-stranded RNA. It may be linear or a closed loop; it may be composed of one segment

or many. The size of the viral genome is quite variable and in different viruses ranges from 4 to over 400 genes.

7. Cytolytic bacteriophage/ adsorption

8. Temperate/ prophage

9. Adsorption/ penetration

10. Avoid host restriction enzymes and increase transcription of viral genes/ proteins of the viral capsid and tail assembly

11. a) Immediate early phage genes encode enzymes involved in evading host resistance, and increasing transcription of viral genes. Some of these enzymes disable the host restriction enzymes or modify viral DNA so it will not be cut by restriction enzymes. One viral enzyme is a highly active viral RNA polymerase with a high affinity for viral DNA (i.e., will transcribe viral DNA more readily than cellular DNA). Other enzymes destroy host sigma factors and thus force cellular RNA polymerase enzymes to use viral sigma factors (with high affinity for viral DNA).

    b) Delayed early phage genes encode enzymes that chop up the host cell's DNA and replicate viral DNA. These enzymes insure that the nucleotides needed to replicate viral DNA will be readily available.

    c) Late phage genes encode proteins of the capsid, tail assembly and enzymes needed to lyse the host cell.

12. Many viruses use host cell RNA polymerase to transcribe their immediate early genes (and may eliminate cellular sigma factors to insure that only viral sigma factors, with high affinity for viral DNA are used). All viruses are dependent upon the host cell's ribosomes to translate their m-RNA into protein sequences. Viruses are also dependent upon the host cell's ability to provide energy (ATP) for both transcription and translation processes.

13. Prophage/ lysogenic conversion

14. Lysogenic conversion/ protein toxins (exotoxins)

15. Envelope

16. Bacteriophage lambda (θλ)/ prophage/ repressor

17. Retrovirus/ reverse transcriptase/ The viral DNA is replicated to form a double-stranded molecule that has cohesive termini at both ends. This is then able to make use of a viral enzyme called integrase to insert itself into the host cell's chromosome and become a provirus. The viral DNA (provirus) will stay within the host cell's chromosome as long as the cell lives, and will be replicated along with the host genome whenever it is reproduced.

18. Viral envelope

19. Reverse transcribe
20. Integrase
21. Reverse transcriptase or RNA-dependent DNA polymerase/ retroviruses/ the human immunodeficiency virus (HIV)
22. Tumors or cancer (They do this by bringing oncogenes into the host cell or by activating oncogenes already present.)
23. Oncogenes
24. Antigenic drift/ antigenic shift
25. Matching letter sequence is – I, H, E, G, A, C, F, B, J, and D.