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# Viruses, Viroids,and Prions

## General Characteristics of Viruses

I. Depending on one's viewpoint, viruses may be regarded as exceptionally complex aggregations of nonliving chemicals or as exceptionally simple living microbes.
2. Viruses contain a single type of nucleic acid (DNA or RNA) and a protein coat, sometimes enclosed by an envelope composed of lipids, proteins, and carbohydrates.
3. Viruses are obligatory intracellular parasites. They multiply by using the host cell's synthesizing machinery to cause the synthesis of specialized elements that can transfer the viral nucleic acid to other cells.

### Host Range

4. Host range refers to the spectrum of host cells in which a virus can multiply.
5. Most viruses infect only specific types of cells in one host species.
6. Host range is determined by the specific attachment site on the host cell's surface and the availability of host cellular factors.

## Viral Size

7. Viral size is ascertained by electron microscopy.
8. Viruses range from 20 to IOOO nm in length.

## Viral Structure

I. A virion is a complete, fully developed viral particle composed of nucleic acid surrounded by a coat.

## Nucleic Acid

2. Viruses contain either DNA or RNA, never both, and the nucleic acid may be single- or double-stranded, linear or circular, or divided into several separate molecules.
3. The proportion of nucleic acid in relation to protein in viruses ranges from about 1 % to about 50%.

## Capsid and Envelope

4. The protein coat surrounding the nucleic acid of a virus is called the capsid.
5. The capsid is composed of subunits, capsomeres, which can be a single type of protein or several types.
6. The capsid of some viruses is enclosed by an envelope consisting of lipids, proteins, and carbohydrates.
7. Some envelopes are covered with carbohydrate-protein complexes called spikes.

## General Morphology

8. Helical viruses (for example, Ebola virus) resemble long rods, and their capsids arc hollow cylinders surrounding the nucleic acid.
9. Polyhedral viruses (for example, adenovirus) are many-sided. Usually the capsid is an icosahedron.

10. Enveloped viruses are covered by an envelope and are roughly spherical but highly pleomorphic. There are also enveloped helical viruses (for example, influenza virus) and enveloped polyhedral viruses (for example, *Simplexvirus).*

II. Complex viruses have complex structures. For example, many bacteriophages

have a polyhedral capsid with a helical tail attached**.**

## Taxonomy of Viruses

1. Classification of viruses is based on type of nucleic acid, stra tegy for replication, and morphology.
2. Virus family names end in *-viridae;* genus names end in *-virus.*
3. A viral species is a group of viruses sharing the same genetic information and ecological niche.

## Isolation, Cultivation, and Identification of Viruses

1. Viruses must be grown in living cells.
2. The easiest viruses to grow are bacteriophages.

## Growing Bacteriophages in the laboratory

3. The plaque method mixes bacteriophages with host bacteria and nutrient agar.
4. After several viral multiplication cycles, the bacteria in the area surrounding the original virus are destroyed; the area of lysis is called a plaque.

5. Each plaque originates with a single viral particle; the concentration of viruses is given as plaque-forming units.

## Growing Animal Viruses in the Laboratory

6. Cultivation of some animal viruses requires whole animals.
7. Simian AIDS and feline AIDS provide models for studying human AIDS.
8. Some animal viruses can be cultivated in embryonated eggs.
9. Cell cultures are cells growing in culture media in the laboratory.
10. Primary cell lines and embryonic diploid cell lines grow for a short time in vitro.
11. Continuous cell lines can be maintained in vitro indefinitely.
12. Viral growth can cause cytopathic effects in the cell culture,

## Viral Identification

13. Serological tests are used most often to identify viruses.
14. Viruses may be identified by RFLPs and PCR.

## Viral Multiplication

1. Viruses do not contain enzymes for energy production or protein synthesis.
2. For a virus to multiply, it must invade a host cell and direct the host's metabolic machinery to produce viral enzymes and components.

## Multiplication of Bacteriophages

3. During the lytic cycle, a phage causes the lysis and death of a host cell.
4. Some viruses can either cause lysis or have their DNA incorporated as a prophage into the DNA of the host cell. The latter situation is called lysogeny.

5. During the attachment phase of the lytic cycle, sites on the phage's tail fibers attach to complementary receptor si tes on the bacterial cell.
6. In penetration, phage lysozyme opens a portion of the bacterial cell wall, the tail sheath contracts to force the tail core through the cell wall, and phage DNA enters the bacterial cell. The capsid remains outside.
7. In biosynthesis, transcription of phage DNA produces mRNA coding for proteins necessary for phage

multiplication. Phage DNA is replicated, and capsid proteins are produced. During the eclipse period, separate phage DNA and protein can be found.

8. During maturation, phage DNA and capsids are assembled into complete viruses.
9. During release, phage lysozyme breaks down the bacterial cell wall, and the new phages are released.
10. During the lysogenic cycle, prophage genes are regulated by a repressor coded for by the prophage. The prophage is replicated each time the cell divides.

II. Exposure to certain mutagens can lead to excision of the prophage and initiation of the lytic cycle.

12. Because of lysogeny, lysogenic cells become immune to reinfection with the same phage and may undergo phage conversion.
13. A lysogenic phage can transfer bacterial genes from one cell 10 another through transduction. Any genes can be transferred in generalized transduction, and specific genes can be transferred in specialized transduction.

## Multiplication of Animal Viruses

14. Animal viruses attach to the plasma membrane of the host cell.
15. Entry occurs by endocytosis or fusion.
16. Animal viruses are uncoated by viral or host cell enzymes.
17. The DNA of most DNA viruses is released into the nucleus of the host cell. Transcription of viral DNA and translation produce viral DNA and, later, capsid proteins. Capsid proteins are synthesized in the cytoplasm of the host cell.
18. DNA viruses include members of the families Adenoviridae, Poxviridae, Herpesviridae, Papovaviridae, and Hepadnaviridae.
19. Multiplication of RNA viruses occurs in the cytoplasm of the host cell. RNA-dependent RNA polymerase synthesizes a double stranded RNA.
20. Picornaviridae + strand RNA acts as mRNA and directs the synthesis of RNA-dependent RNA polymerase.
21. Togaviridae + strand RNA acts as a template for RNA-dependent RNA polymerase, and mRNA is transcribed from a new - RNA strand.
22. Rhabdoviridae - strand RNA is a template for viral RNA-dependent RNA IlOlymerase, which transcribes mRNA.
23. Reoviridae are digested in host cell cytoplasm to release mRNA for viral biosynthesis.
24. Retroviridae reverse transcriptase (RNA-dependent DNA polymerase) transcribes DNA from RNA.
*25.* After maturation, viruses are released, One method of release (and envelope forma tion) is budding. Nonenveloped viruses are released through ruptures in the host cell membrane.

## Viruses and Cancer

I. The earliest relationship between cancer and viruses was demonstrated in the early 19005, when chicken leukemia and chicken sarcoma were transferred to healthy animals by cell -free filtrates.

## The Transformation of Normal Cells Into Tumor Cells

2. When activated, oncogenes transform normal cells into cancerous cells.
3. Viruses capable of producing tumors are called oncogenic viruses.
4. Several DNA viruses and retroviruses are oncogenic.
5. The genetic material of oncogenic viruses becomes integrated into the host cell 's DNA.
6. Transformed cells lose contact inhibition, contain virus-specific antigens (TSTA and T antigen), exhibit chromosome abnormalities, and can produce tumors when injected into susceptible animals.

## DNA Oncogenic Viruses

7. Oncogenic viruses are found among the Adenoviridae, Herpesviridae, Poxviridae, and Papovaviridae.
8. The EB virus, a herpesvirus, causes Burkitt's lymphoma and nasopharyngeal carcinoma. *Hepadnavirus* causes liver cancer.

## RNA Oncogenic Viruses

9. Among the RNA viruses, only retroviruses seem to be oncogenic.
10. HTLV-I and HTLV-2 have been associated with human leukemia and lymphoma.
II. The virus's ability to produce tumors is related to the production o f reverse transcriptase. The DNA synthesized from the viral RNA becomes incorporated as a provirus into the host cell's DNA.
12. A provirus can remain latent, can produce viruses, or can transform the host celL

## latent Viral Infections

I. A la tent viral infection is one in which the virus remains in the host cell for long periods without producing an infection.
2. Examples are cold *sores* and shingles.

## Persistent Viral Infections

I. Persistent viral infections are disease processes that occur over a long period and are generally fatal.
2. Persistent viral infections are caused by conventional viruses;

viruses accumulate over a long period .

## Prions

I. Prions are infectious proteins first discovered in the 1980s.
2. Prion diseases, such as CJD and mad cow disease, all involve the degeneration of brain tissue.
3. Prion diseases are the result of an altered protein; the cause can be a mutation in the normal gene for $Prp^{c}$ or contact with an altered protein $(Prp)^{Sc}$.

## Plant Viruses and Viroids

I. Plant viruses must enter plant hosts through wounds or with invasive parasites, such as insects.
2. Some plant viruses also multiply in insect (vector) cells.
3. Viroids are infectious pieces of RNA that cause some plant diseases, such as potato spindle tuber disease.

References':1- Microbiology an introduction TWELFTH EDITION. Gerard. Tortora.2016.

2- Microbiology an introduction TENTH EDITION. Gerard. Tortora.2010.