UNIT V FUNDAMENTALS OF MICROBIOLOGY AND IMMUNOPATHOLOGY

Structure of Bacteria and Virus - Morphological features and structural organization of bacteria and virus - List of common bacterial, fungal and viral diseases of human beings.- Basics of Microscopes : Light microscope, Electron microscope (TEM & SEM). - Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated tissue injury, Immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies.

DISCOVERY OF VIRUSES

Virus is a Latin word meaning 'poison' or 'venom'. It was generally believed that the'viruses' or poisons were carried in the night air and cause many unexplained diseases.By the late 1800, Louis Pasteur, Robert Koch and other pioneer bacteriologists haddemonstrated that many diseases in man and other organisms were caused by bacteria.Some diseases puzzled them because they could find no bacteria or other organisms thatwere responsible for the disease symptoms. One such disease was tobacco mosaic disease(TMD) occurring in tobacco plants. In 1892, a Russian biologist Iwanowski was the firstone to find out that the causative agent of TMD was a filterable tobacco mosiac virus(TMV) which could be transmitted from an infected organism to a healthy organism of thesame kind.

Nature of Viruses

The viruses deserve special consideration in our survey of distinctions between living andnon-living matter because they show characteristics of both.

Non-living Characters

i)Viruses do not have a cellular organisation.ii) They do not have protoplasm as cell do.iii) They do not carry on respiration as in cellular life nor they take in food.iv) They do not respond to external stimuli.v) They do not multiply by binary fission and are not capable of independent existenceand growth.vi) Outside the cell, they behave like chemical molecules.

Living Characters

i) They reproduce only in living cells.ii) They have the capacity for growth in size and numbers.iii) They undergo mutations of their genes and as in living; they also have the ability toundergo changes in hereditary characters.iv) They can adapt themselves to their environment through natural selection.Thus, we can say that although viruses seem to be almost on the border line between livingand non-living, the two characters of living viz. mutations and their adaptation throughnatural selection are not known anywhere outside living things. Therefore, it seemsreasonable to classify viruses as living ones, though they are very primitive and do notexhibit all the characters found in other forms of living matter.

Definition of Viruses

Viruses may be defined as extremely small obligate intracellular living forms containingonly one type of nucleic acid either DNA or RNA. Earlier they were called 'ultra-microscopic

viruses' because they could not be seen with light microscope. They were alsocalled 'Filterable Viruses', since they pass through very fine filters which hold the bacteriaback. Now they are simply called 'viruses'. A mature virus particle is called 'virion'.

Morphology of Viruses

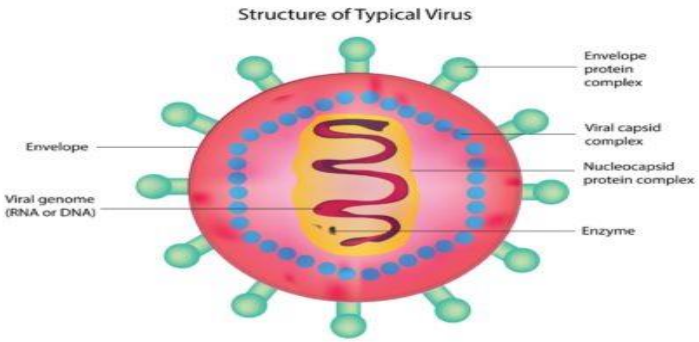
After learning the nature and definition of viruses, you will now be interested to know themorphology of viruses.

1) Size
   All viruses are extremely small and cannot be seen with a compound microscope. Thefollowing three basic techniques are used to determine the size of virus:a) Filteration through graded membrane;b) High speed centrifugation;c) Direct observation under Electron Microscope.Viruses are measured in millimicrons (mμ, one millimicron is 1000th of a micron) and varyconsiderably in size. The size ranges from 15 mμ to 450 mμ. The smallest virus is of a footand mouth disease of cattle (15 mμ) and the largest virus is of a parrot fever (450 mμ). Inhumans, the smallest virus is of yellow fever (20 mμ) and the largest virus is pox virus (400mμ).
2) Shape
   Viruses, like other microorganisms, vary in shape. The shape remains constant for anyparticular kind of virus but varies from one type of virus to another. These may bespherical, rod shaped, cuboidal, rhomboidal (multisided), needle shaped etc. Rabies virus isbullet shaped, TMV is rod shaped, polio virus is spherical, pox virus is rectangular or brickshaped. Some viruses are irregular in shape. Bacteriophages have head and tail like sperms(virus of bacteria is called bacteriophage or phage, sub-section 2.2.4).
3) Structure
   Viruses have a relatively simple structure as compared to other living things. Virus particleis called virion, which consists of two parts viz. the central core or nucleic acid core andprotein coat.Viruses

   The Central Core or Nucleic Acid Core: It may be either ribonucleic acid (RNA) or deoxyribo-nucleic acid (DNA). Plant viruses contain RNA while animal viruses have DNA orRNA. The two together are never found in a virus.

   The Protein Coat: The protein coat covers the central core and is called capsid. The capsiditself is formed of a number of subunits known as capsomeres. Some viruses aresurrounded by an envelope which is lipoprotein in nature as seen in herpes virus, pox virus,rabies virus etc.

   Envelope may have protein subunits, projecting on its surface which are called peplomeres.A virus may have more than one type of peplomere as in Influenza virus which contain twotypes of peplomeres [see Fig. 2.1(a)&(b)]. If there is no envelope surrounding the virion, itis called as naked virion.



Virion: is a complete virus particle combining these structural elements.

Prions: This infectious protein is designated the prion protein without nucleic acid.

Viriod: This infectious nucleic acid without protein.

Viruses are divided into related groups, or families, and, sometimes into subfamilies based on: 1) type and structure of the viral nucleic acid, 2) the strategy used in its replication, 3) type of symmetry of the virus capsid, and 4) presence or absence of a lipid envelope. Within a virus family, differences in additional specific properties, such as host range, serologic reactions, amino acid sequences of viral proteins, degree of nucleic acid homology, among others, form the basis for division into genera (singular = genus) and species.

Genome:

The type of nucleic acid found in the virus particle is perhaps the most fundamental and straightforward of viral properties. It may be RNA or DNA, either of which may be single-stranded (ss) or double-stranded (ds). The most common forms of viral genomes found in nature are ssRNA and dsDNA. However, both dsRNA and ssDNA genomes are found in viruses of medical significance. Single-stranded viral RNA genomes are further subdivided into those of positive polarity (that is, of messenger RNA sense, which can therefore be used as a template for protein synthesis), and those of negative polarity or are A.Professor Dr. Nada Khazal Hindi 63 antisense (that is, complementary to messenger RNA sense, which cannot therefore be used directly as a template for protein synthesis). Viruses containing these two types of RNA genomes are commonly referred to as positive-strand and negative-strand RNA viruses, respectively.

Type of symmetry of the virus capsid, capsids normally have one of three shapes

1.icosahedral (as in the poliovirus).

2-helical (as in the tobacco mosaic virus)

3.complex (as in the bacteriophages , or phages).

Viral Replication: the One-Step Growth Curve

A. Attachment of a virus to the host cell

B. Eclipse period This is the eclipse period, and it represents the time elapsed from initial entry and disassembly of the parental virus to the assembly of the first progeny virion. This period falls within a range of 1 to 20 hours.

C. Exponential growth The number of progeny virus produced within the infected cell increases exponentially for a period of time.

Steps in the Replication Cycles of Viruses The individual steps in the virus replication cycle are presented below in sequence,

1. Adsorption (attachment to the host cell)

2. Penetration

3. Uncoating of the viral genome

4. Gene expression and replication A. Mechanisms of DNA virus genome replication B. Mechanisms of RNA virus genome replication

5. Assembly and release of progeny viruses

Effects of viral infection on the host cell The response of a host cell to infection by a virus ranges from: 1) Little or no detectable effect. 2) Alteration of the antigenic specificity of the cell surface due to presence of virus glycoproteins. 3) Latent infections that, in some cases, cause cell transformation. 4) Ultimately, to cell death due to expression of viral genes that shut off essential host cell functions.

List of common bacterial, fungal and viral diseases of human beings

List of common fungal diseases of human beings

A. Tinea pedis (athlete's foot): Organisms most often isolated from infected tissue are Trichophyton rubrum, Trichophyton mentagrophytes, and Epidermophyton floccosum. The infected tissue is initially between the toes, but can spread to the nails, which become yellow and brittle. Skin fissures can lead to secondary bacterial infections, with consequent lymph node inflammation.

B. Tinea corporis (ringworm): Organisms most often isolated are E. floccosum and several species of Trichophyton and Microsporum. Lesions appear as advancing annular rings with scaly centers. The periphery of the ring, which is the site of active fungal growth, is usually inflamed and vesiculated. Although any site on the body can be affected, lesions most often occur on nonhairy areas of the trunk.

C.Tinea capitis (scalp ringworm): Several species of Trichophyton and Microsporum have been isolated from scalp ringworm lesions, the predominant infecting species depending on the geographic location of the patient. In the United States, for example, the predominant infecting species is Trichophyton tonsurans. Disease manifestations range from small, scaling patches, to involvement of the entire scalp with extensive hair loss. The hair shafts can become invaded by Microsporum hyphae, as manifested by their green fluorescence in long-wave ultraviolet light (Wood lamp).

D. Tinea cruris (jock itch): Causative organisms are E. floccosum and T. rubrum. Disease manifestations are similar to ringworm, except that lesions occur in the moist groin area, where they can spread from the upper thighs to the genitals.

E. Tinea unguium (onychomycosis): The causative organism is most often T. rubrum. The nails are thickened, discolored, and brittle. Treatment must be continued for three to four months until all infected portions of the nail grow out and are trimmed off.

F. Tinea Barbae: The causative organism is most often Trichophyton. Edematous erythematous lesion in beard hair Treatment Removal of infected skin, followed by topical application of antifungal antibiotics such as miconazole or clotrimazole, is the first course of treatment. Refractory infections usually respond well to oral griseofulvin and itraconazole. Infections of the hair and nails usually require systemic (oral) therapy. Terbinafine is the drug of choice for onychomycosis.