Introduction to viruses

What are viruses?

Well… some textbooks describe a virus as "a bad news wrapped up in a protein coat", the *bad news* being the nucleic acid either DNA or RNA but not both. In short, viruses are obligate intracellular parasites. This means that they can't live or replicate outside a living cell. To replicate, they need the machinery of a host cell such as (lysozymes, mitochondria, ribosomes… etc.) for protein synthesis and other purposes.

Structure of a virus

Knowing the structure of viruses is fundamental in understanding and classification of viruses. The structure of a virus depends on its size. If it is small then it has a simple structure, if it is big (such as Pox) then it has a complex structure.

- **Nucleic acid genome**: that is either DNA or RNA but never both.
- **Protein coat (capsid)**: for protection from rough environments.
- **Lipid envelope**: found in some viruses. It is derived from host cell plasma membrane
- **Size**: they are very small (20-400 nm)

Basics:

- **Different Structure**: viruses have a different structure from all other microorganisms in that other microorganisms have two types of nucleic acids (both DNA & RNA) together while viruses have only one. In this aspect we can divide viruses into two main groups: DNA viruses and RNA viruses. Even within one group of viruses (e.g. DNA viruses) we have different structures (size, shape, type of the capsid, number of capsomeres… etc.).

- **Different methods of replication**: the method of replication greatly depends on the type of nucleic acid that the virus contains. DNA viruses do not replicate like RNA viruses, especially on a molecular level. Even within the same family of nucleic acid viruses we have different methods of replication depending on whether the nucleic acid is single-stranded or double-stranded (in case of RNA). If it is single-stranded, it could have a positive sense or a negative sense or it could be either linear or circular.

- The reason we study the structure and different replication methods of viruses is implicated on **diagnosis**, **treatment** and **prevention**. If we know the structure of the virus, we have a proper diagnosis (i.e. we know our enemy). Then we can treat it accordingly if we have a treatment. If we don't have a treatment we can apply a proper strategy for prevention (e.g. vaccination).

Control Methods:

To control a viral disease we have to investigate several points:

1) Reservoir: the source that the virus comes from. E.g. humans, migrating birds, domestic animals.

2) Mode of Transmission: the mode in which the virus is transmitted from the reservoir. If we know the means, we can eliminate the mode of transmission. Examples:

- Direct contact
- Insects (mosquitos, ticks, and fleas): they suck blood from an infected animal and deposit the virus inside humans with their saliva as they bite.
- Animals

3) Methods of Inactivation: we have to find antiseptics to inactivate viruses to clean community hospitals. E.g. alcohol, potassium hypochlorite, iodine and others.

4) Vaccines: this is the most important point.

5) Antiviral drugs

6) Development of drug resistance by the virus

Emerging Viral Diseases:

- **Emerging**: happening for the first time (a new viral disease). E.g. AIDS, HPS, Monkey Pox, WNV, SARS.
- **Re-emerging:** an existing virus that emerges in a new strain. E.g. influenza → swine flu

Consequences of viral infections:

It has been reported that 50% of absenteeism in all fields of work is caused by a viral infections especially in children because they are more prone to get a viral infection as they have an underdeveloped immune system. The consequences of viral infections depend on the pathogenicity of the virus.

1) Suffering for a couple of days **followed by complete recovery** as in case of a rhino virus (low pathogenicity)

2) Persistent disease: a disease that will be with you for the rest of your life. E.g. Hepatits B.

3) Fatal disease: rabies, hemorrhagic fever, yellow fever, hepatitis B and C if not diagnosed early.

4) Congenital disease: diseases transmitted from a pregnant mother to her fetus. E.g. rubella, cytomegalovirus, HIV.

5) Contributory factor in cancer (oncogenic viruses): viral infections that predispose to cancer.
E.g. Leukemia, HTLV 1 and 2 (a retrovirus), Herpes (some of them).

6) Contributory factor in other diseases: influenza →secondary bacterial infection. That is why in case of some viral infections we prescribe antibiotics to prevent secondary bacterial infections (complication).

7) Some are asymptomatic: these are subclinical infections in which the patient does not exhibit any signs or symptoms and acts as a carrier for the virus. E.g. Hepatits A.

Uses of viruses:

1) Vaccines

2) Gene Therapy: this can be used to cure certain genetic diseases (e.g. single-gene defects), where the gene is delivered to the body of the patient by injecting him with a harmless virus (e.g. adenovirus) containing the gene. Then the virus will reproduce inside the patient's body replacing the deficiency of the gene.

3) Host Cell Investigation