Viruses, Viroids, and Prions

Viruses are too small to be seen with a light microscope and can't be cultured outside their hosts. Advances in molecular biological techniques in the 1980s and 1990s led to the recognition of several new viruses, including human immunodeficiency virus (HIV) and SARS-associated coronavirus.

Are viruses living or non-living organisms?

Life can be defined as a complex set of processes resulting from the actions of proteins specified by nucleic acids. The nucleic acids of living cells are in action all the time.

Because viruses are inert outside living host cells, in this sense they aren't considered to be living organisms. However, once viruses enter a host cell, the viral nucleic acids become active, and viral multiplication results. In this sense, viruses are alive when they multiply in the host cells they infect.

From a clinical point of view, viruses are alive because they cause infection and disease, just as pathogenic bacteria, fungi, and protozoa do.

General Characteristics of Viruses

1. They are **obligatory intracellular parasites**, that is, they absolutely require living host cells in order to multiply. However, both of these properties are shared by certain small bacteria, such as some rickettsias.

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. No ribosomes

4. They lack enzymes for protein synthesis and ATP generation. To multiply, viruses must take over the metabolic machinery of the host cell.

Host Range

Host range refers to the spectrum of host cells in which a virus can multiply. Most viruses infect only specific types of cells in one host species. Host range is determined by the specific attachment site on the host cell's surface and the availability of host cellular factors. Viruses that infect bacteria are called **bacteriophages,** or **phages.**

For the virus to infect the host cell, the outer surface of the virus must chemically interact with specific receptor sites on the surface of the cell.

- For some bacteriophages, the receptor site is part of the cell wall of the host; in other cases, it is part of the fimbriae or flagella.
- For animal viruses, the receptor sites are on the plasma membranes of the host cells.

Treating diseases with Viruses

The potential to use viruses to treat diseases is fascinating because of their narrow host range and their ability to kill their host cells.

Experimentally induced viral infections in cancer patients during the 1920s suggested that viruses might have antitumor activity. These tumor-destroying, or oncolytic, viruses may selectively infect and kill tumor cells or cause an immune response against tumor cells.

phage therapy: using bacteriophages to treat bacterial infections.

Viral Size

Viral sizes are determined with the aid of electron microscopy. Although most are smaller than bacteria, some of the larger viruses (such as the **vaccinia** virus) are about the same size as some very small bacteria (such as the mycoplasmas, rickettsias, and chlamydias). Viruses range from 20 to 1000 nm in length.

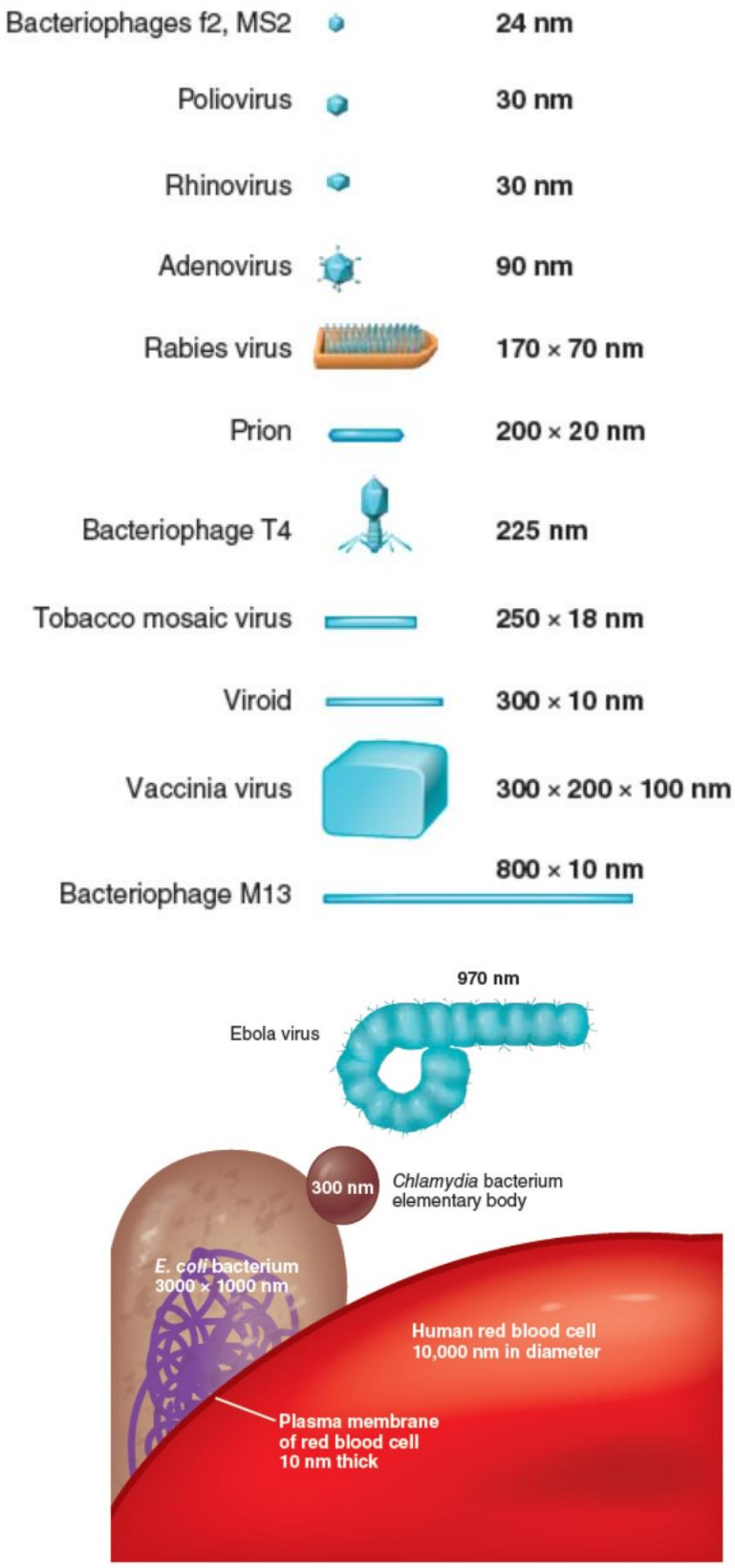


Fig 7: Virus sizes: compared with a human red blood cell and bacterial cells,

Viral Structure

Viroid: infectious RNA without capsid that cause some plant diseases, such as potato spindle tuber disease.

A **virion** is an infectious viral particle composed of nucleic acid and surrounded by a protein coat outside a host cell.

Nucleic Acid

- virus have either DNA or RNA, but never both.
- The nucleic acid of a virus can be single-stranded or double-stranded.
- The nucleic acid can be linear or circular.
- In some viruses (such as the influenza virus), the nucleic acid is in several separate segments.

Capsid and Envelope

The nucleic acid of a virus is protected by a protein coat called the **capsid**

Each capsid is composed of protein subunits called **capsomeres.**

In some viruses, the capsid is covered by an **envelope**, which consists of some combination of lipids, proteins, and carbohydrates.

Spikes: Depending on the virus, envelopes may or may not be covered by **spikes,** which are carbohydrate-protein complexes that project from the surface of the envelope. Some viruses attach to host cells by means of spikes.

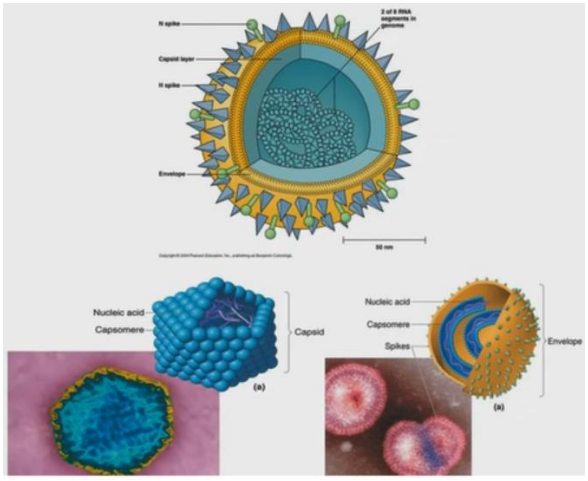


Fig 8: Viral structures

The ability of certain viruses, such as the influenza virus to clump red blood cells is associated with spikes. Such viruses bind to red blood cells and form bridges between them. The resulting clumping is called *hemagglutination* and is the basis for several useful laboratory tests.

why you can get influenza more than once?

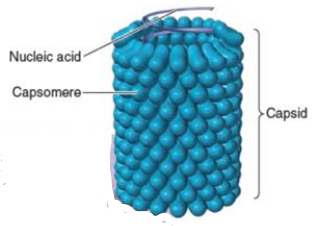
When the host has been infected by a virus, the host's immune system is stimulated to produce antibodies (proteins that react with the surface proteins of the virus). This interaction between host antibodies and virus proteins should inactivate the virus and stop the infection. However, some viruses can escape antibodies because regions of the genes that code for these viruses' surface proteins are susceptible to mutations. The progeny of mutant viruses has altered surface proteins, such that the antibodies aren't able to react with them.

General Morphology

Viruses may be classified into several different morphological types on the basis of their capsid architecture.

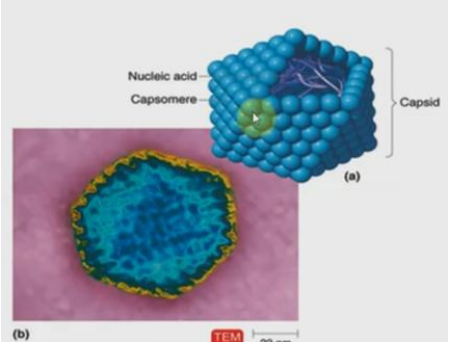
1- Helical Viruses

Helical viruses resemble long rods that may be rigid or flexible. The viral nucleic acid is found within a hollow, cylindrical capsid that has a helical structure (such as rabies and Ebola)



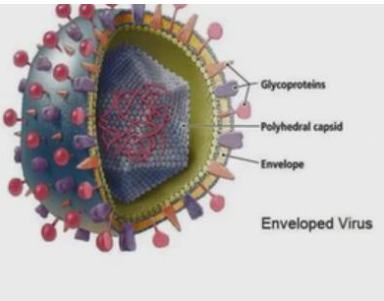
2- Polyhedral Viruses

Many animal, plant, and bacterial viruses are polyhedral, or many-sided, viruses. The capsid of most polyhedral viruses is in the shape of an *icosahedron*, a regular polyhedron with 20 triangular faces and 12 corners. Examples of a polyhedral viruses are the adenovirus and the poliovirus.



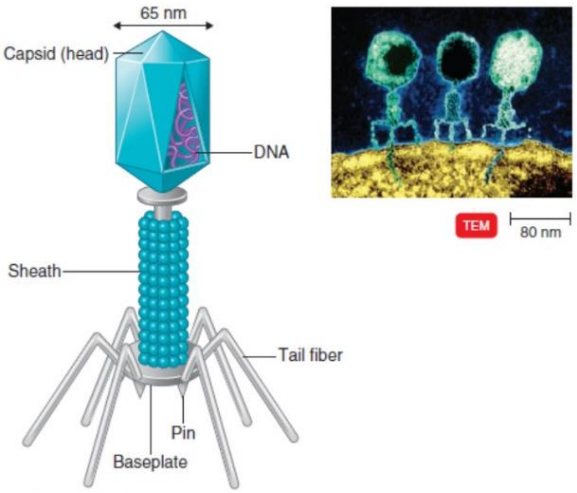
3- Enveloped Viruses

Enveloped viruses are roughly spherical. When helical or polyhedral viruses are enclosed by envelopes, they are called *enveloped helical* or *enveloped polyhedral viruses. Such as* the influenza virus and the human herpes virus



4- Complex Viruses

Some viruses, particularly bacterial viruses, have complicated structures and are called **complex viruses.** One example of a complex virus is a bacteriophage.



Taxonomy of Viruses

Classification of viruses is based on type of nucleic acid, strategy for replication, and morphology. Virus family names end in *-viridae;* genus names end in *-virus.* Family Herpesviridae, genus Simplexvirus.

A viral species is a group of viruses sharing the same genetic information and ecological niche. viral species are designated by descriptive common names, such as human immunodeficiency virus (HIV), with subspecies (if any) designated by a number (HIV-1).

Isolation, Cultivation, and Identification of Viruses

Viruses must be grown in living cells. The bacteriophages are grown in bacteria.

Growing Bacteriophages in the Laboratory

The plaque method mixes bacteriophages with host bacteria and nutrient agar. After several viral multiplication cycles, the bacteria in the area surrounding the original virus are destroyed; the area of lysis is called a plaque. Each plaque originates with a single viral particle; the concentration of viruses is expressed as plaque-forming units (PFU).

Growing Animal Viruses in the Laboratory

- Cultivation of some animal viruses requires whole animals.
- Some animal viruses can be cultivated in embryonated eggs.
- In cell cultures virally infected cells are detected via their deterioration, known as cytopathic effects (CPE).

Viral Identification

Serological tests: Western blotting (reaction of the virus with antibodies).

Nucleic acids: Viruses may be identified by RFLPs and PCR.

Prions

Proteinaceous infectious particle, inherited and transmissible by ingestion, transplant, and surgical instruments, first discovered in the 1980s.

Prion diseases, such as Creutzfeldt-Jakob disease (CJD) and mad cow disease, all involve the degeneration of brain tissue.

Multiplication of Bacteriophages

Bacteriophages can multiply by two alternative mechanisms: the lytic cycle or the lysogenic cycle. The **lytic cycle** ends with the lysis and death of the host cell, whereas the host cell remains alive in the **lysogenic cycle.**

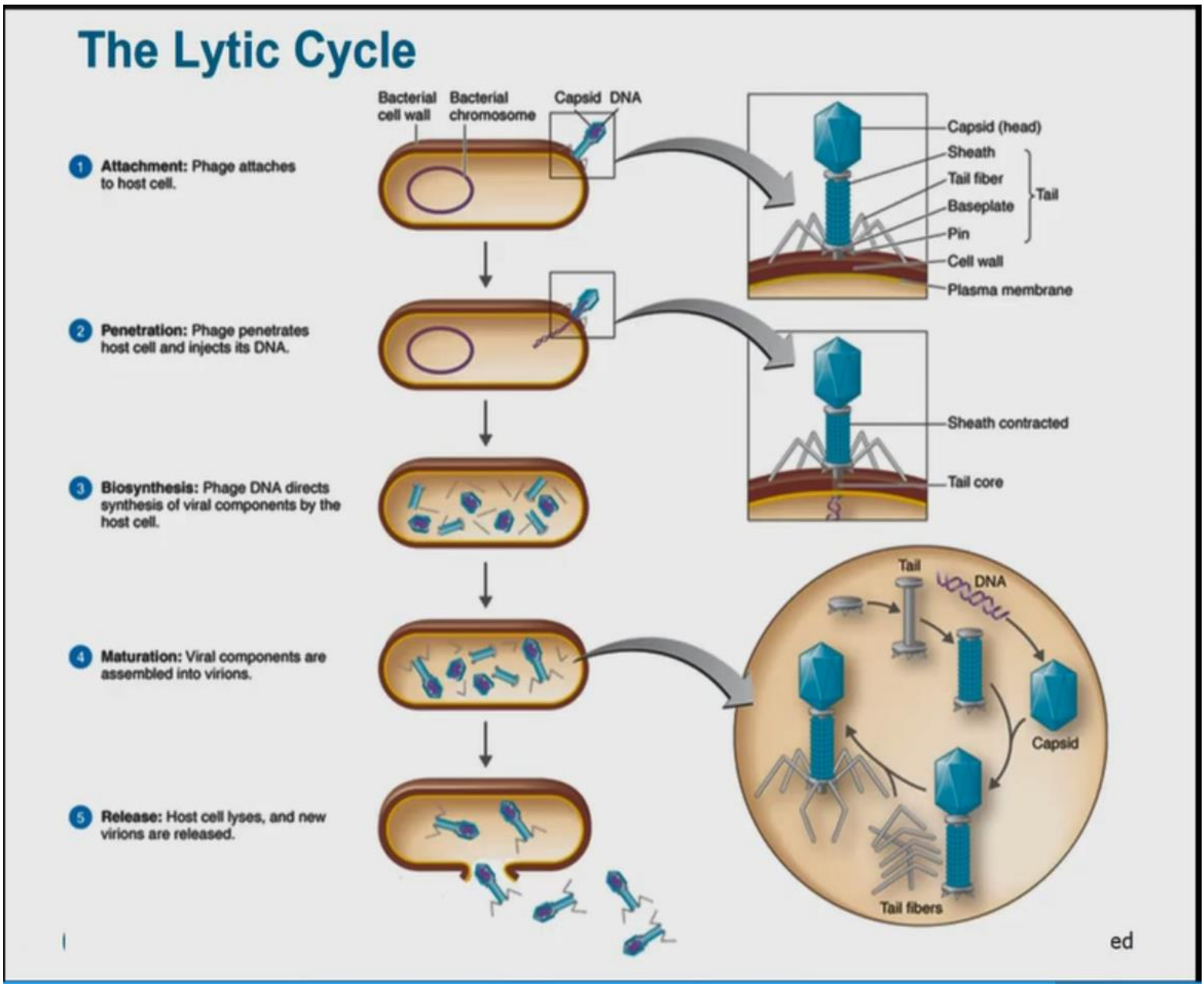


Fig 9: The lytic cycle of a T-even bacteriophage.