Viruses

What are Viruses?

Viruses are **small obligate intracellular parasites**, which contain either a RNA or DNA genome surrounded by a protective, virus-coded protein coat.

Origin of Viruses

There are three different opinions:

1. Viruses may have arisen from mobile genetic elements that gained the ability to move between cells.

2. They may be descendants of previously free-living organisms that adapted a parasitic replication strategy.

3. Perhaps viruses existed before, and led to the evolution of, cellular life.

Comparison with bacteria

-- Bacteria live and grow independently whereas **viruses can grow only intracellularly** although they **can survive outside a cell**.

-- Bacteria contain both RNA and DNA but a **virus can contain only one nucleic acid.**

-- The average virus is about **one-hundredth the size of the average bacterium.**

Some of the Differences Between Bacteria and Viruses are as follows:

S.N.	Characteristics	Bacteria	Viruses
1	**Size**	Larger (1000 nm)	Smaller (20-400 nm)
2	**Cell Wall**	Peptidoglycan or Lipopolysaccharide	No cell wall. Protein coat present instead.
3	**Ribosomes**	Present	Absent
4	**Number of cells**	One cell (Unicellular)	No cells
5	**Living/Non-Living**	Living organisms	Between living and non-living things.
6	**DNA and RNA**	DNA and RNA floating freely in cytoplasm.	DNA or RNA enclosed inside a coat of protein.
7	**Infection**	Localized	Systemic
8	**Reproduce**	Able to reproduce by itself	Need a living cell to reproduce
9	**Reproduction**	Fission- a form of asexual reproduction	Invades a host cell and takes over the cell causing it to make copies of the viral DNA/RNA. Destroys the host cell releasing new viruses.

Size

-- Most viruses that have been studied have a diameter between **10 and 300 nanometres.**

-- Some **filoviruses** have a total **length of up to 1400 nm**; their **diameters are only about 80 nm.**

-- **Mimivirus** is the **largest known virus**, with a **diameter of 400 nm.** Protein filaments measuring 100 nm project from the surface.

Shape

-- Shapes are referred to in common terms such as **spheres, rods, bullets** etc. but actually viruses are **complex structures** of precise geometric symmetry.

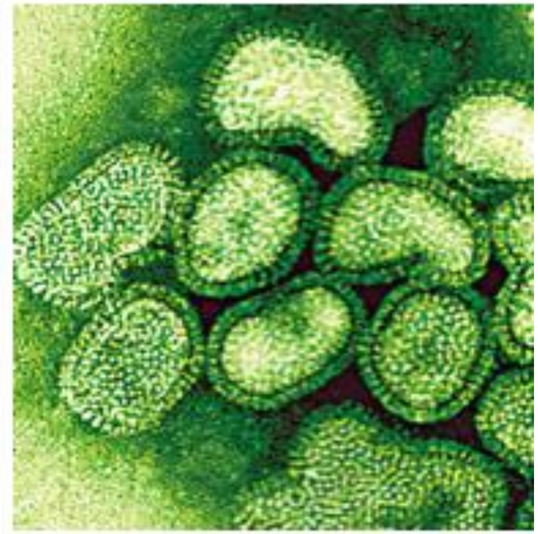
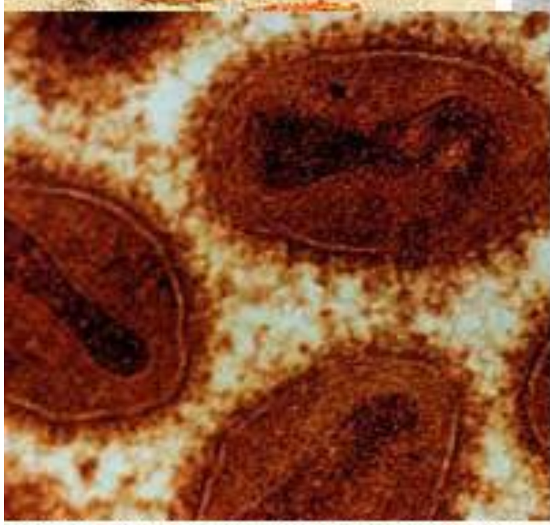
-- Shape is determined by repeating subunits that form the protein coat, called **capsid**.

-- The shapes of viruses range from simple **helical (rod)** and **icosahedral (spherical)** forms to more complex structures.

-- The rod shape is due to the **linear array of the nucleic acid** and the protein subunits making up the capsid.

-- The sphere shape is actually a **20-sided polygon (icosahedron).**





Centers for Disease Control & Prevention

A virus has three basic structures:

1. **Nucleic acid**
2. **Protein coating (capsid)**
3. **Envelope -- which may or may not be present**

Viral nucleic acid

-- The genetic material is made from **either DNA or RNA (single-stranded** or **double stranded)**.

-- **DNA is always a single molecule.**

-- **RNA can exist either as a single molecule or in several pieces**, e.g., **influenza virus** and **rotavirus**.

-- All viruses are **haploid** except **retroviruses** which are diploid.

Viral capsid

-- A protein coat that protects these genes is called a **capsid**.

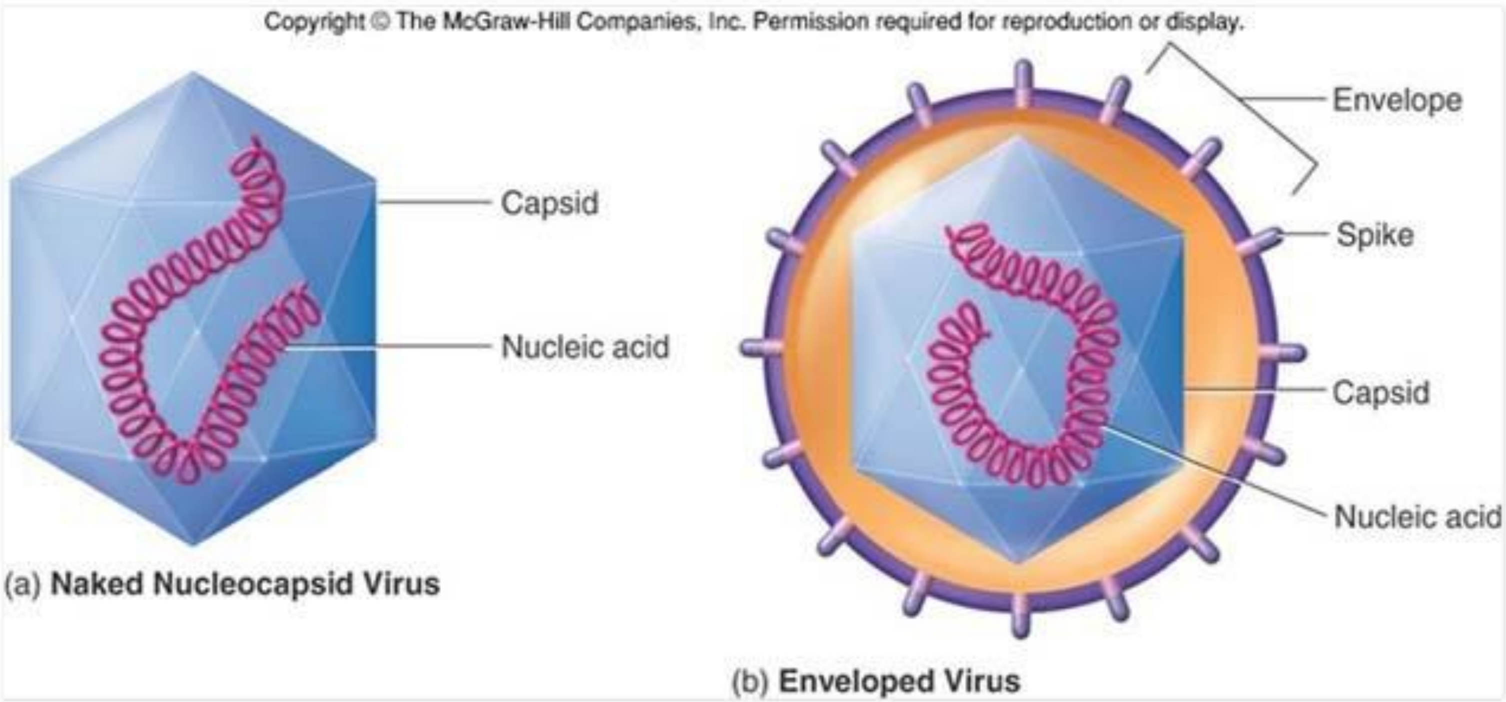
-- Capsids are formed from identical protein subunits called **capsomeres.**

-- Arrangement of capsomeres gives a virus its **characteristic shape.**

-- Capsid and genetic material are collectively called **nucleocapsid**.

Lipid envelope

-- In some cases an **envelope of lipids** is present that surrounds the protein coat when virions are outside a cell.



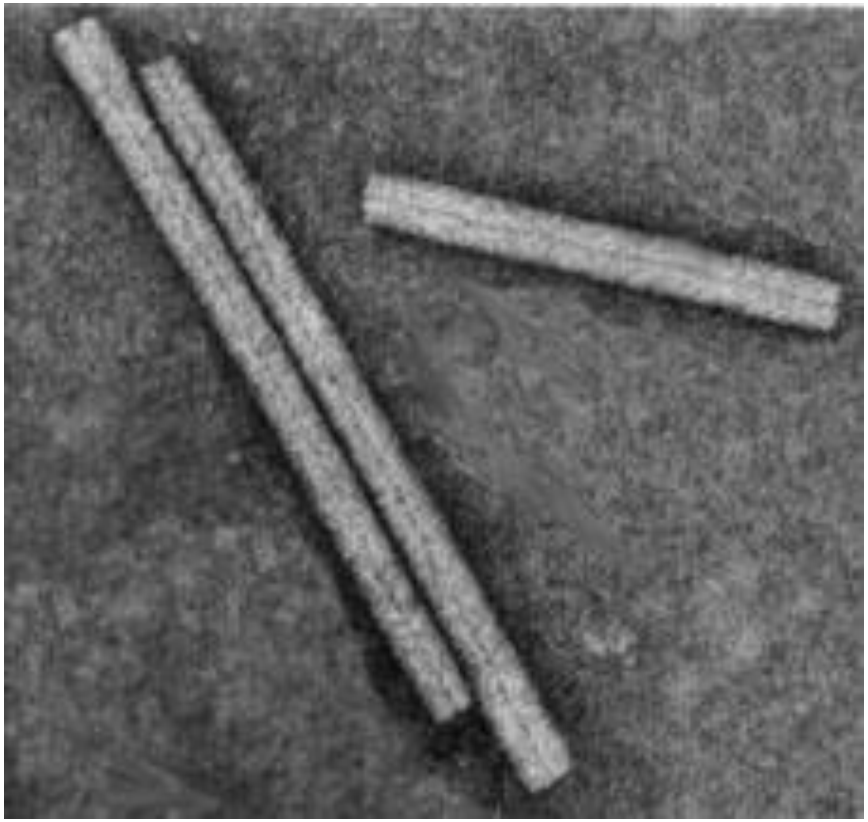
Helical viruses

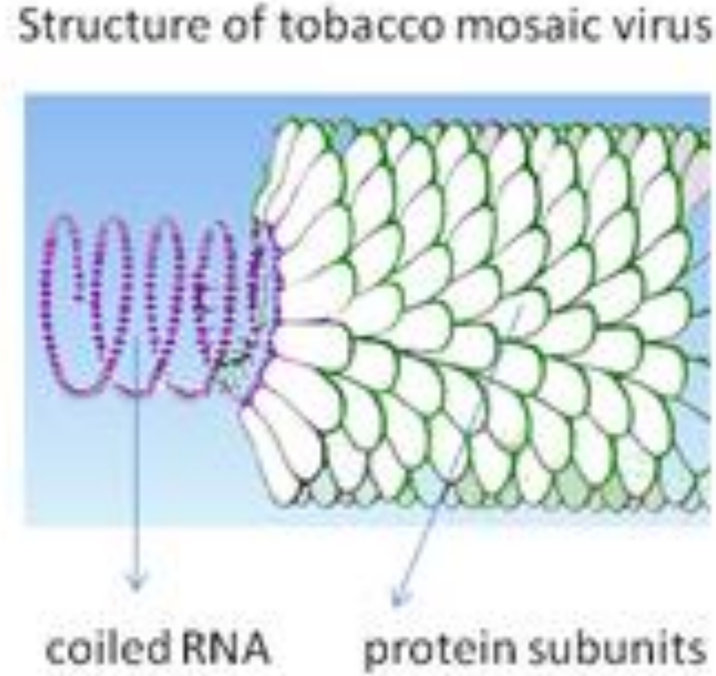
-- These viruses are composed of a **single type of capsomere stacked around a central axis** to form a helical structure, which may have a **central cavity, or hollow tube**.

-- Overall, the **length** of a helical capsid is related to the **length of the nucleic acid** contained within it and the **diameter** is dependent on the **size and arrangement of capsomeres**.

-- The well-studied **tobacco mosaic virus** is an example of a helical virus.

-- **There is no helical human virus that is not covered with an envelope but plant helical viruses are usually naked.**



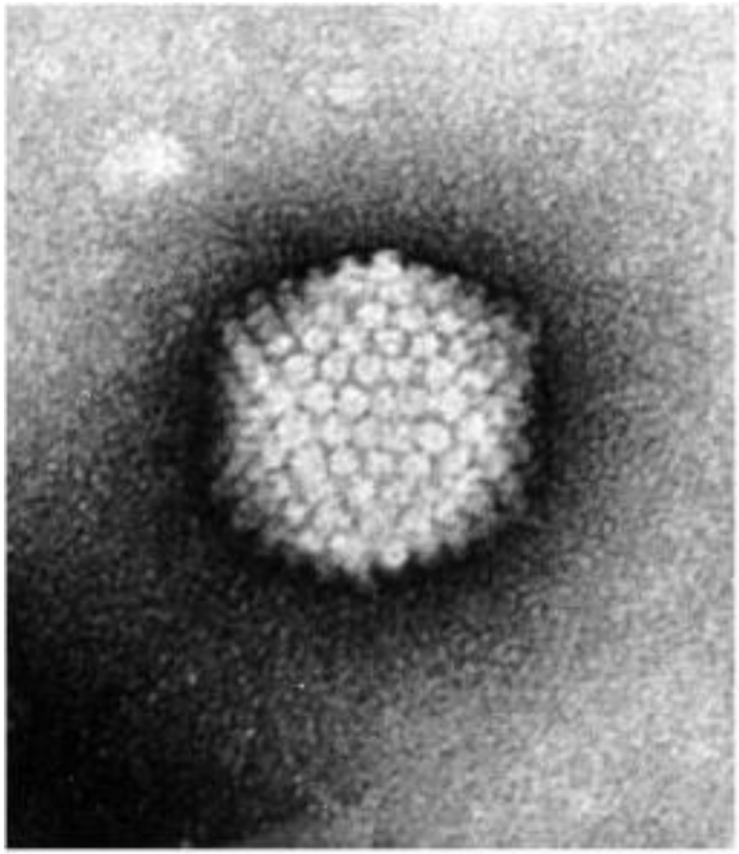

Structure of tobacco mosaic virus
coiled RNA
protein subunits

Icosahedral

-- Most **animal viruses** are **icosahedral or near-spherical** with icosahedral symmetry.

-- A regular icosahedron is the **optimum way** of forming a closed shell from identical sub-units.

-- These viruses may **either be enveloped or naked**d.



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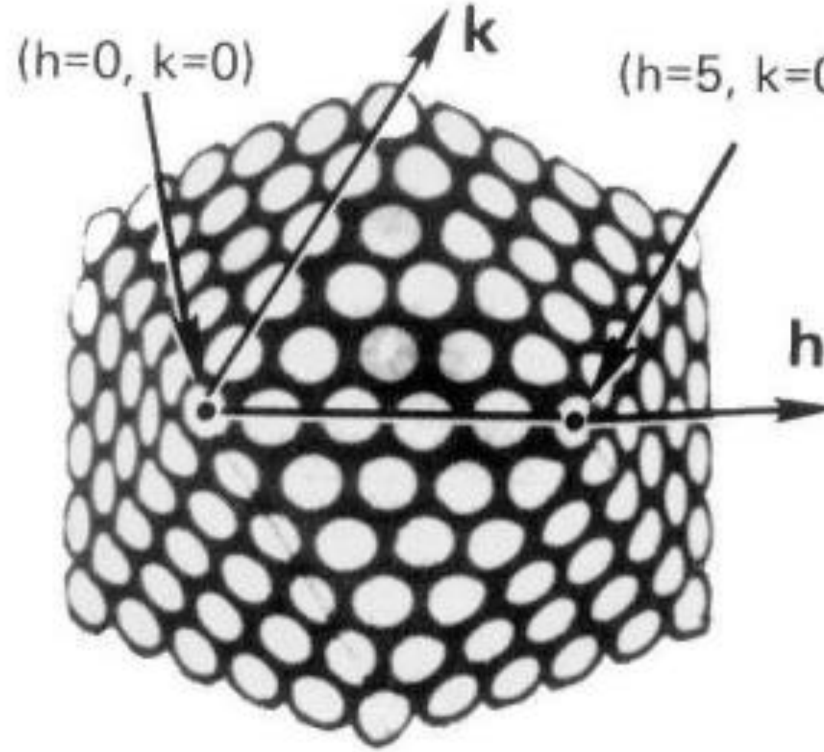

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Viral proteins

-- These serve several important functions.

-- The **capsid proteins** protect the genome from **degradation by nucleases**.

-- **Surface proteins** mediate **attachment to specific receptors** on cell surface **defining organ specificity.**

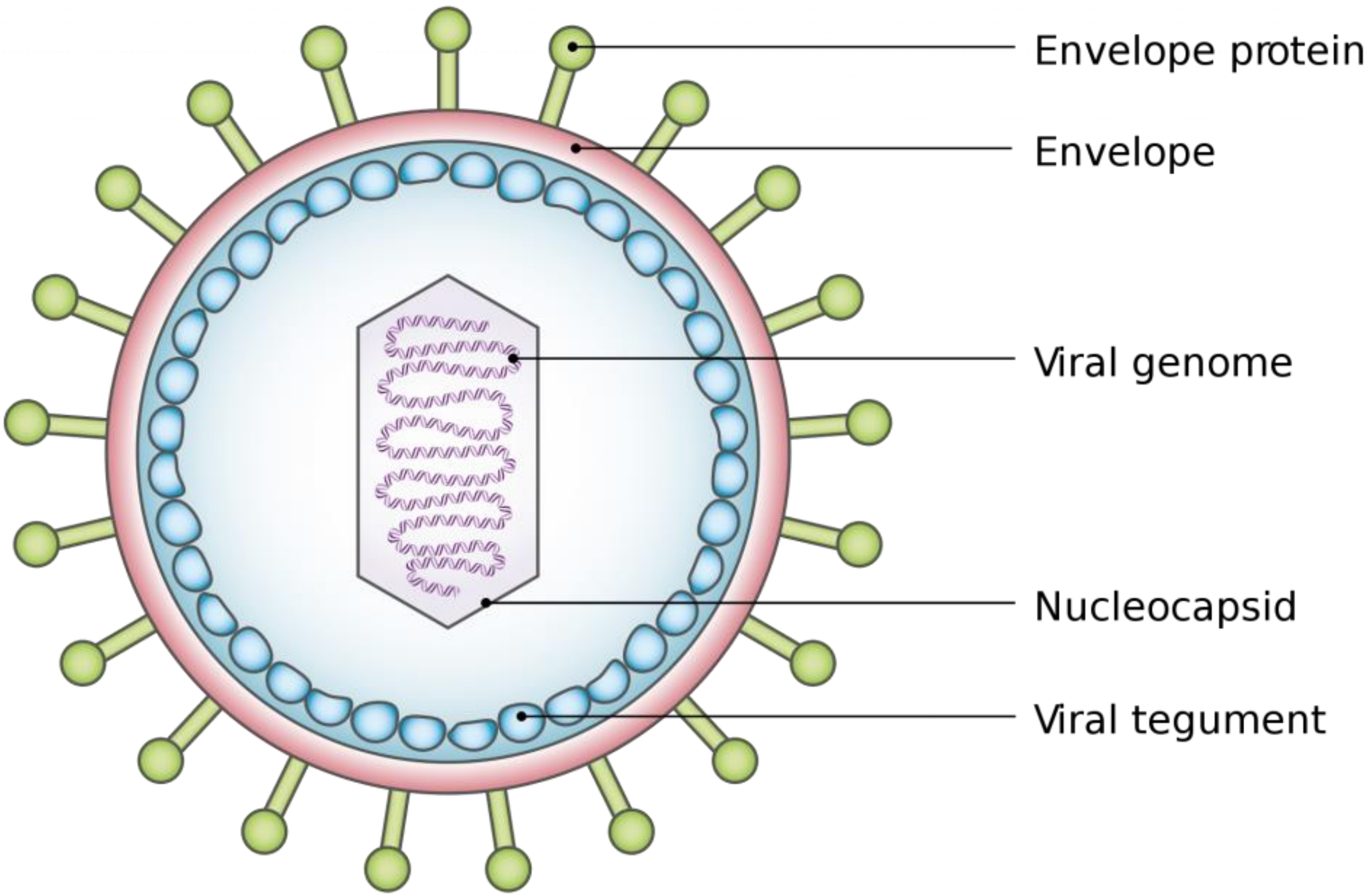
-- These surface proteins also **induce antibody and activate T cells** to kill virus infected cells. Conversely they serve as targets for antibodies for neutralization.

-- **Internal proteins** can either be **structural (capsid)** or **enzymes** (e.g., polymerases that synthesize mRNA).

-- Some viruses have **DNA or RNA polymerase** attached to the genome; others do not.

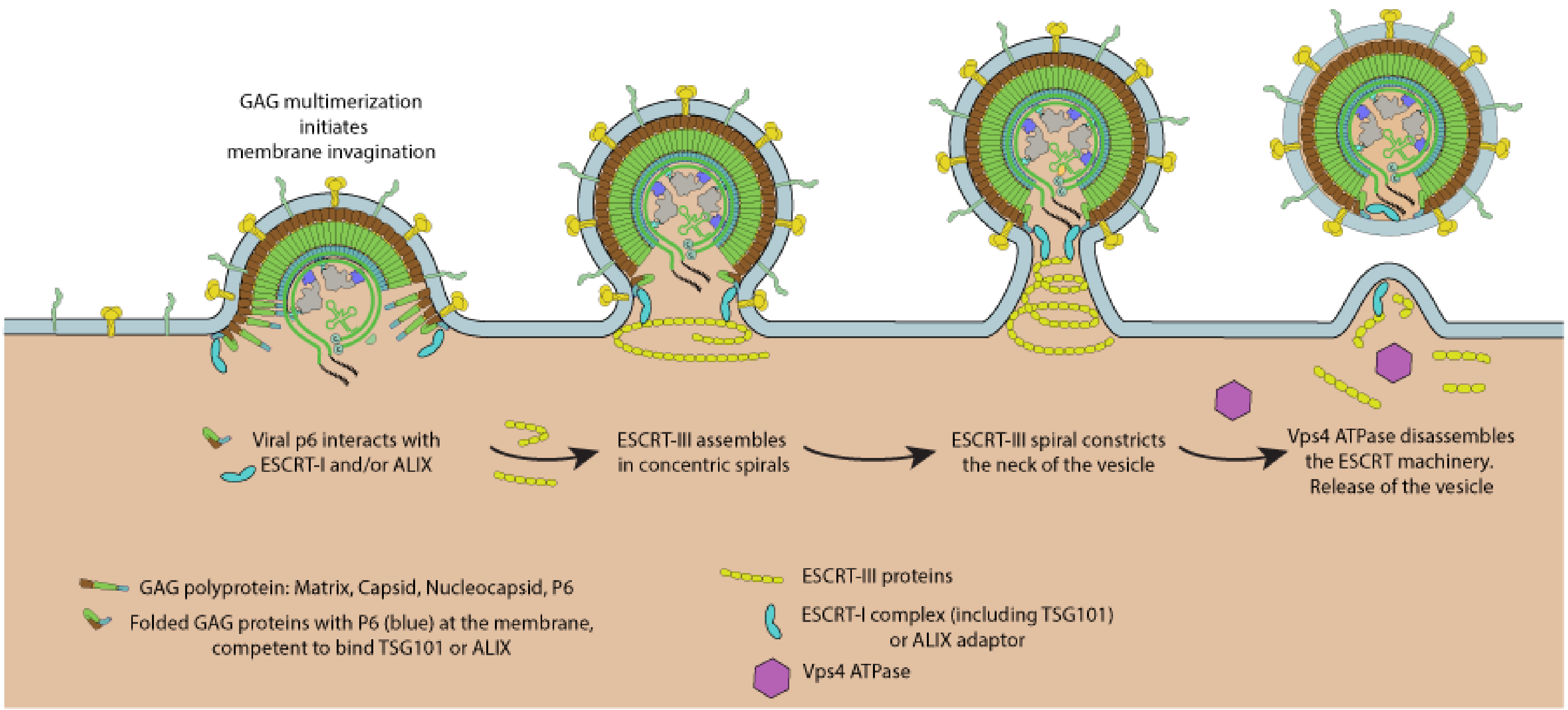
-- Some viruses contain **regulatory proteins** called **tegument** located between nucleocapsid and the envelope.

-- These include **transcription and translation vectors** that control either viral or cellular processes.


Envelope protein
Envelope
Viral genome
Nucleocapsid
Viral tegument

Viral envelope

-- Some species of virus **envelope** themselves in various cell membranes gaining an outer lipid bilayer known as a viral envelope by a process called **"budding".**



-- The lipid membrane itself and any carbohydrates present **originate entirely from the host.**

-- The lipid bilayer is interspersed with protein molecules and may contain material from the membrane of a **host cell as well as that of viral origin.**

-- For better attachment and infectivity, viruses modify their lipid envelopes by the **synthesis of several classes of proteins.**

Atypical Virus-Like Agents

Defective viruses

-- **Defective viruses cannot replicate without a "helper virus"** because of a mutation or a deletion in their genetic material.

-- During the growth of human viruses, **defective viruses outnumber infectious viruses by as much as 100:1.**

-- They may actually **aid in recovery** from an infection by limiting the ability of the infectious particles to attach and grow.

Pseudovirions

-- **Pseudovirions** contain **host cell DNA instead of viral DNA** when the host cell DNA is fragmented and its pieces are incorporated within the capsid protein.

-- **They can infect cells but do not replicate.**

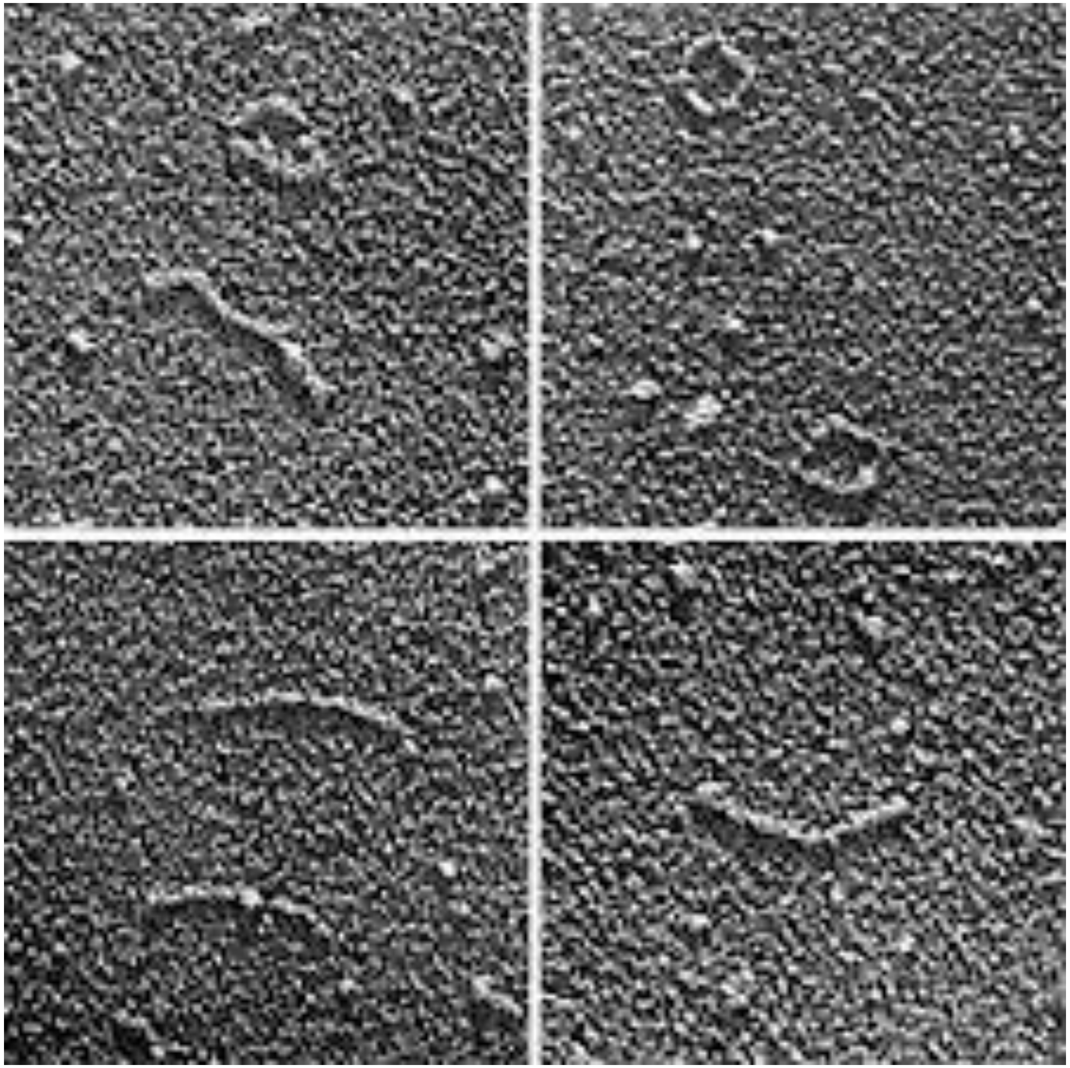
Viroids

-- **Viroids** are **plant pathogens** that consist of a short stretch (a few hundred nucleobases) of circular, single-stranded RNA.

-- The human pathogen **Hepatitis D virus** is similar to viroids.

-- Viroids are **extremely small in size**, ranging from 246 to 467 nucleotide (nt) long genome and consisting of fewer than 10,000 atoms.

-- **Viroid RNA does not code for any protein.**

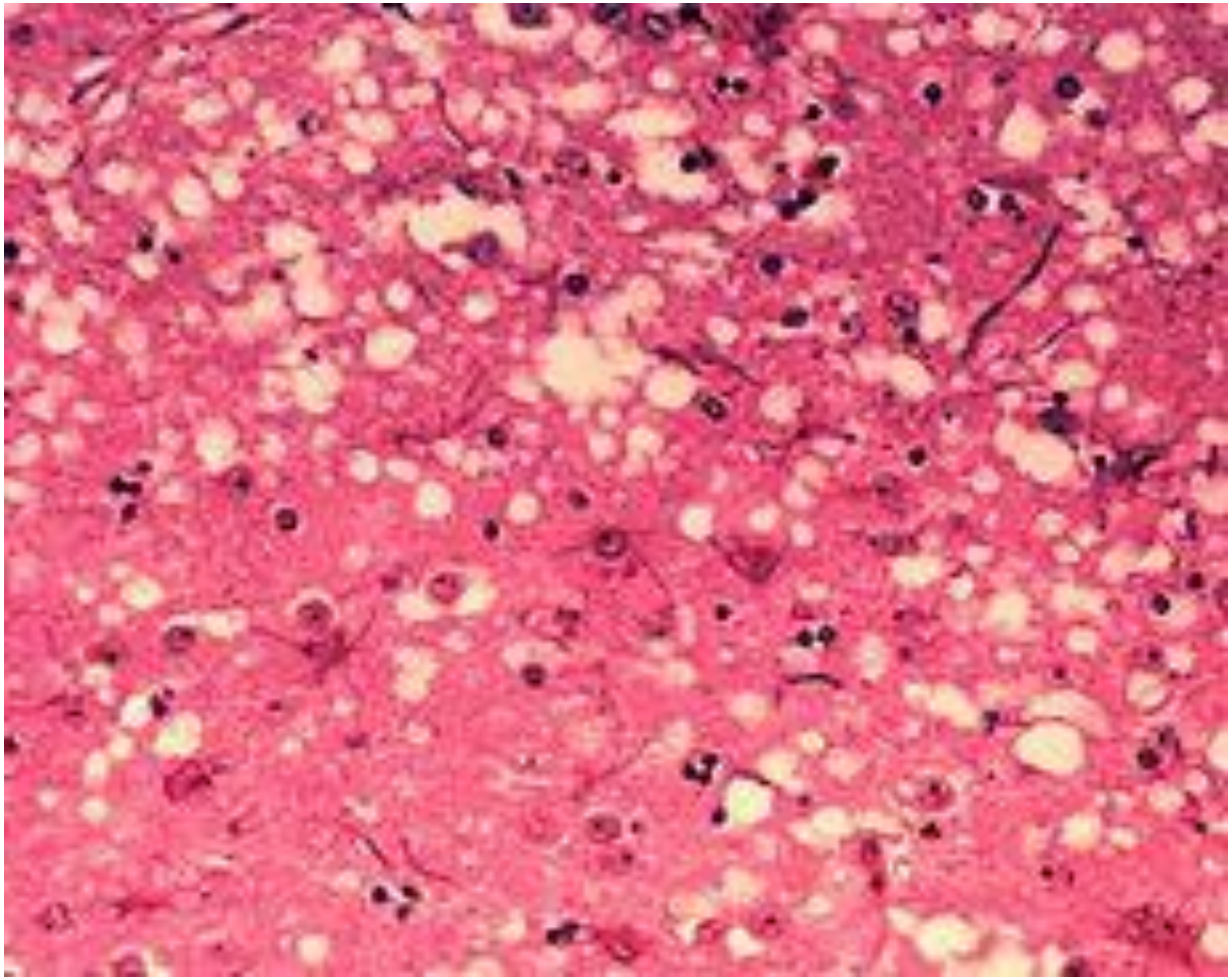


Prions

-- **Prions** are responsible for the transmissible **spongiform encephalopathies** in a variety of mammals.

-- These include **bovine spongiform encephalopathy** (**BSE**, also known as **"mad cow disease"**) in cattle and **Creutzfeldt-Jakob disease (CJD)** in humans.

-- **All known prion diseases affect the structure of the brain or other neural tissue and all are currently untreatable and universally fatal.**



spongiform encephalopathy

-- A prion in the **Scrapie form (PrPSc)** is an **infectious agent composed of protein in a misfolded form.**

-- This is the central idea of the **Prion Hypothesis**, which **remains debated.**

-- **This would be in contrast to all other known infectious agents (which must contain nucleic acid).**

-- When a prion enters a healthy organism, it **induces existing, properly folded proteins to convert into the disease-associated PrPSc form.**

-- They have an **incubation period of months** to decades during which disease has started but there are **no symptoms.**

-- Prions are generally **quite resistant to proteases, heat, radiation, and formalin treatments**, although their infectivity can be reduced by such treatments.

-- **Effective prion decontamination relies upon protein hydrolysis or reduction or destruction of protein tertiary structure.**

Examples include **bleach, caustic soda, and strongly acidic detergents**.


Thank You