Introduction to Virology and Viral Structure

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Course: Medical Virology

Summer Course

Week 1

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Course objective

- This Virology course is aimed at advanced students to provide a contemporary understanding of how viruses are built, how they infect and replicate in host cells, how they spread, evolve and cause disease, and how infection of a host can be prevented.

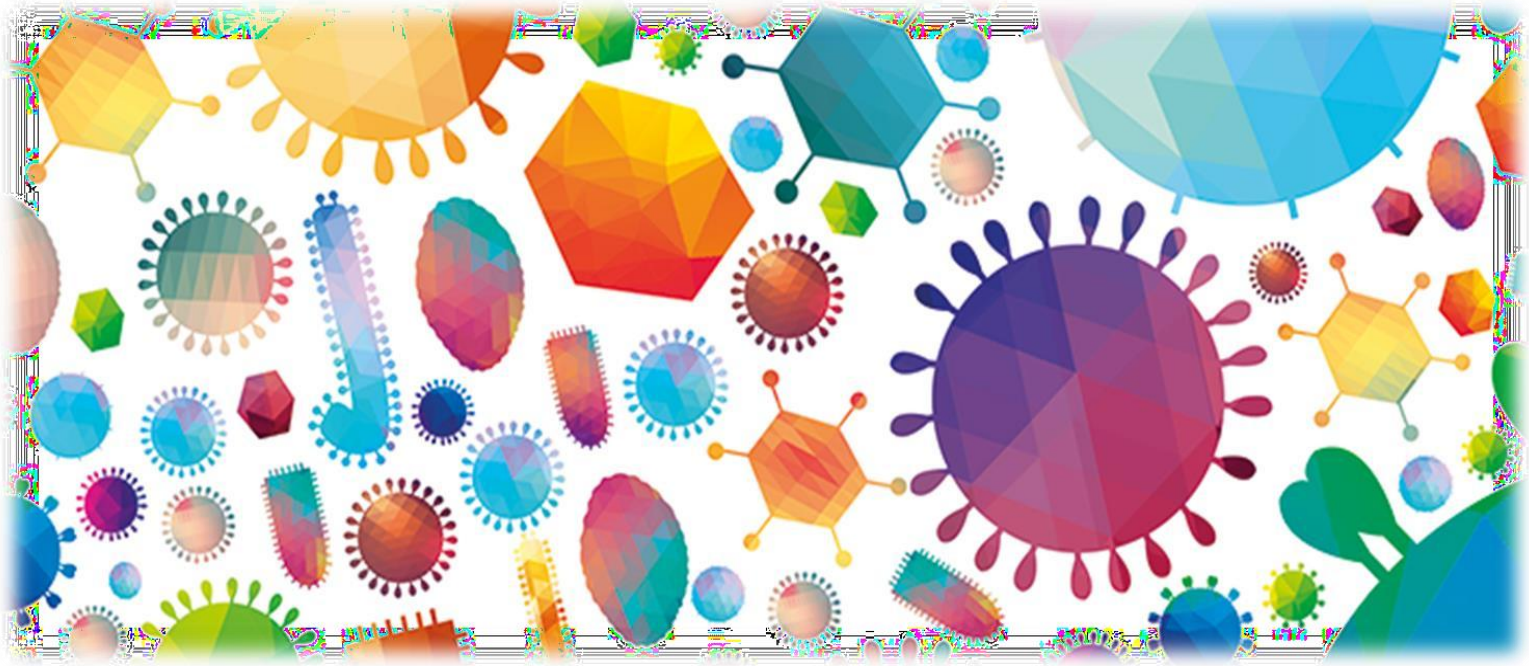
- This course will provide a balanced approach to Virology, combining the molecular and clinical aspects of virology. While it is focused on human viruses, animal viruses, plant viruses and bacteriophages as well as unusual virus-like agents (prions, viroids, etc.).

Lecture Objectives

- A simple introduction to virology, and why virology.
- What is the virus?
- Viral usage.

What is Virology?

- Virology is the bioscience of the study viral natures, in addition to the basic relationships between viruses and their hosts.



What is virus?

➢Virus is an infectious, obligate intracellular parasite because viruses can reproduce only by using the cellular machinery of other organisms.

Thus, on the one hand, viruses are considered to be living only when they multiply within host cells they infect. In this sense, viruses are parasites.

On the other hand, viruses are not considered to be living because they are inert outside living hosts. o Viruses are unique entities that bridge the gap between living and non-living things because they cannot carry out metabolic processes or reproduce on their own but can replicate and cause diseases when they infect a host cell.

They are so small that most can be seen only with an electron microscope, and they are acellular (they are not cells).

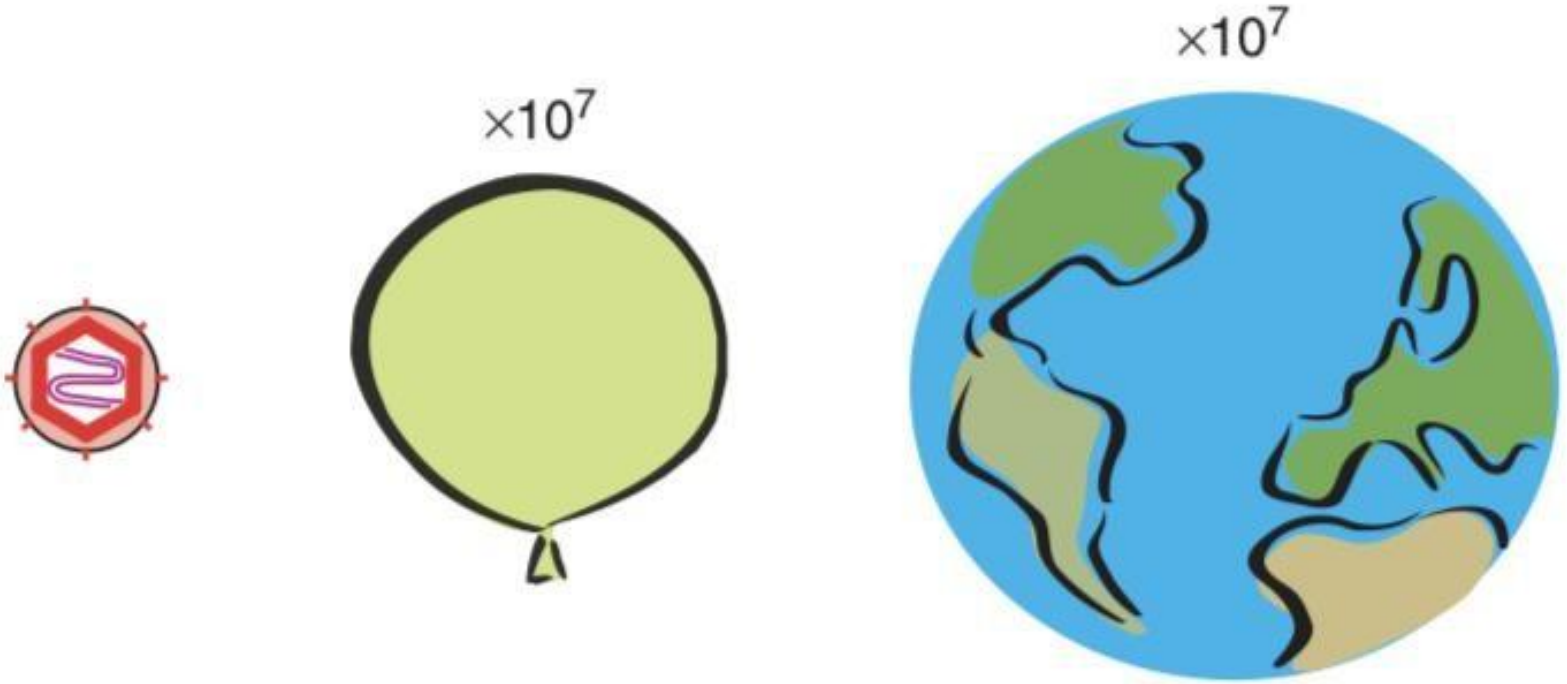
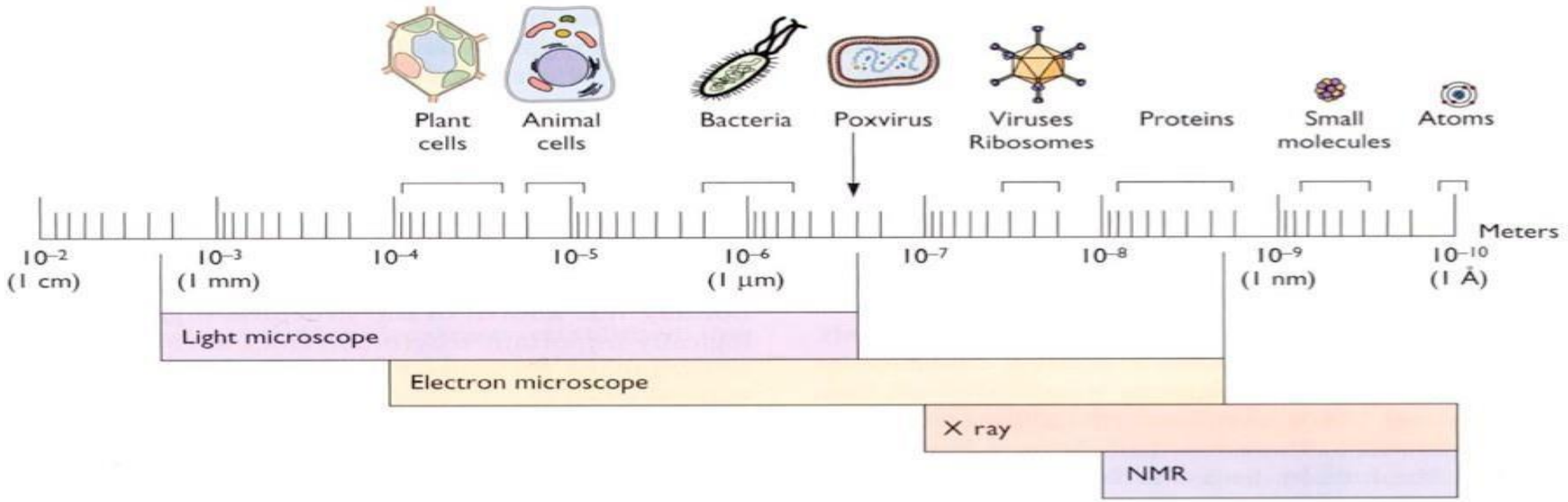
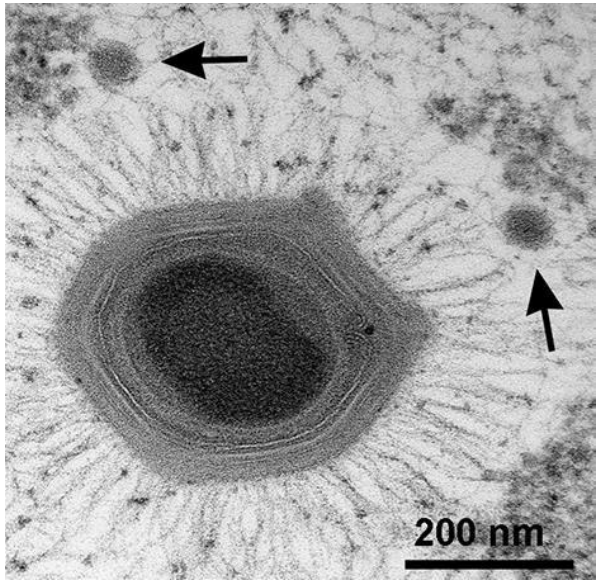


Figure 1.1 *Comparative sizes of a herpesvirus particle, a balloon and the Earth.* A large balloon is about ten million times larger than a herpesvirus particle, while the Earth is larger than the balloon by the same factor.



Genome length 1,181,549

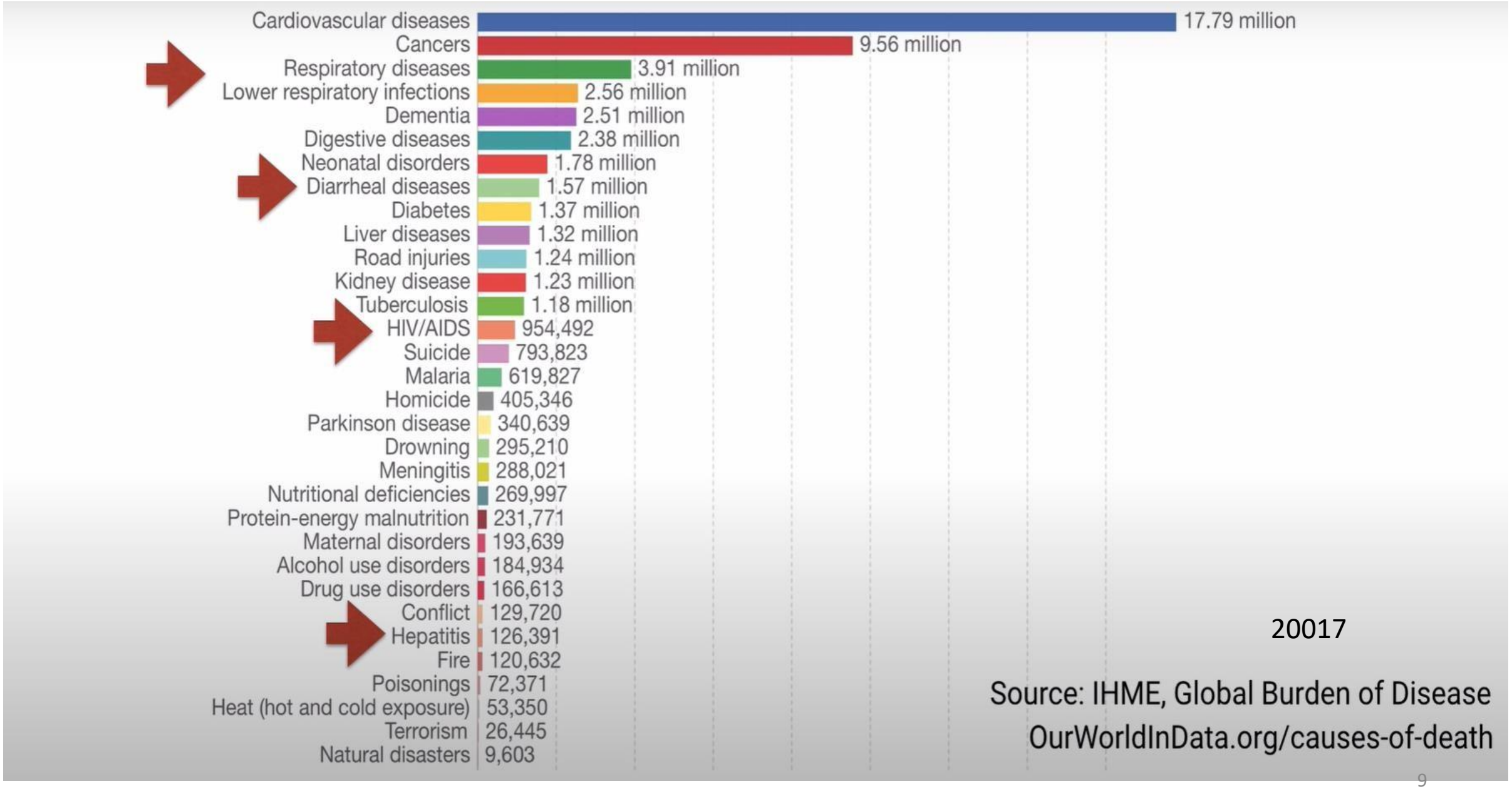
500 nm



Mimivirus

Why virology?

- Viruses infect all living things.
- We eat and breath billions of virus every day.
- We carry viral genome as our own genome!
- Viruses can be use as a crucial genetic engineering toll.

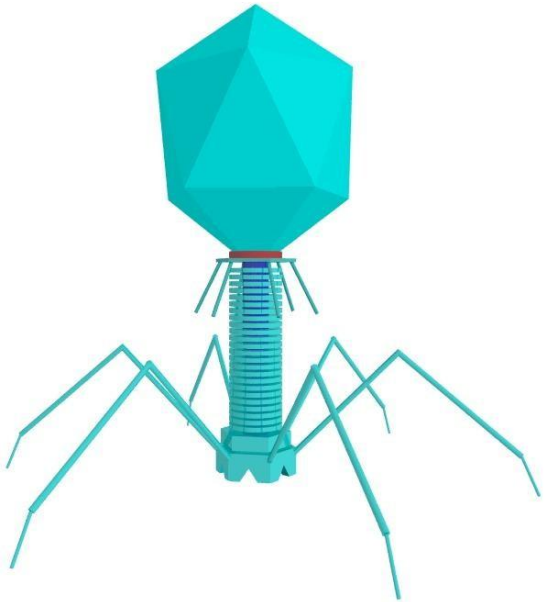

Cardiovascular diseases 17.79 million
Cancers 9.56 million
Respiratory diseases 3.91 million
Lower respiratory infections 2.56 million
Dementia 2.51 million
Digestive diseases 2.38 million
Neonatal disorders 1.78 million
Diarrheal diseases 1.57 million
Diabetes 1.37 million
Liver diseases 1.32 million
Road injuries 1.24 million
Kidney disease 1.23 million
Tuberculosis 1.18 million
HIV/AIDS 954,492
Suicide 793,823
Malaria 619,827
Homicide 405,346
Parkinson disease 340,639
Drowning 295,210
Meningitis 288,021
Nutritional deficiencies 269,997
Protein-energy malnutrition 231,771
Maternal disorders 193,639
Alcohol use disorders 184,934
Drug use disorders 166,613
Conflict 129,720
Hepatitis 126,391
Fire 120,632
Poisonings 72,371
Heat (hot and cold exposure) 53,350
Terrorism 26,445
Natural disasters 9,603
20017
Source: IHME, Global Burden of Disease
OurWorldInData.org/causes-of-death

- Dmitri Ivanovsky discovered virus in 1892
- The smallpox vaccine was the first vaccine to be developed against a contagious disease In 1796
- Edward Jenner demonstrated that an infection with the relatively mild cowpox virus
  conferred immunity against the deadly smallpox virus

Tobacco mosaic virus

Virus

- Viruses can be defined as: **Infectious particles, obligate intracellular parasites** comprising genetic material **(DNA or RNA)** surrounded by a **protein coat** and/or an **envelope** derived from the host.



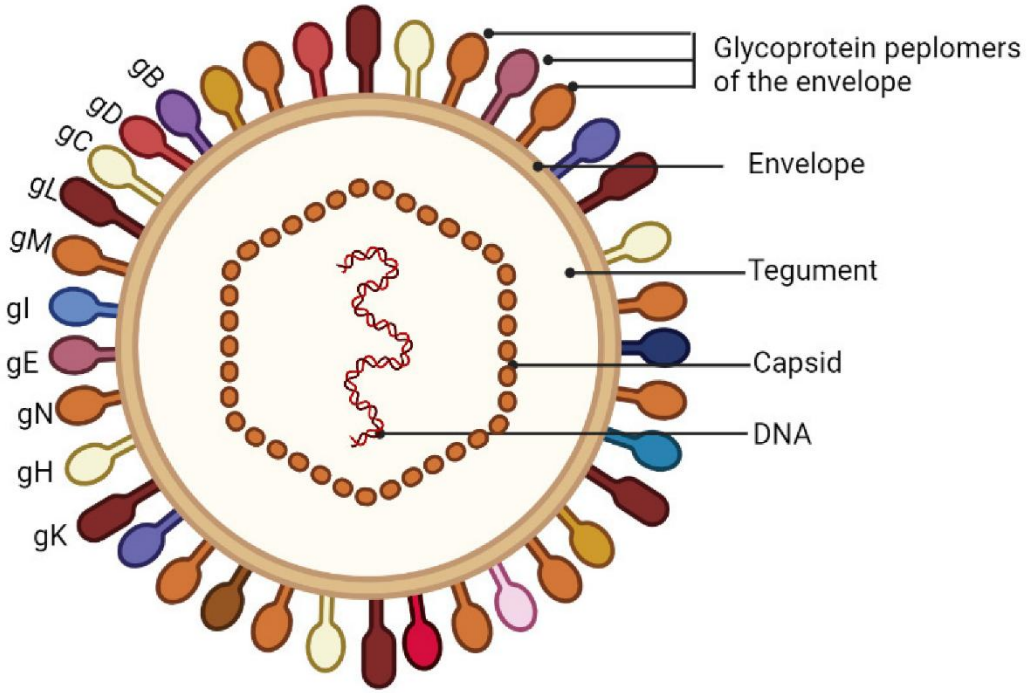
Characters of Viruses

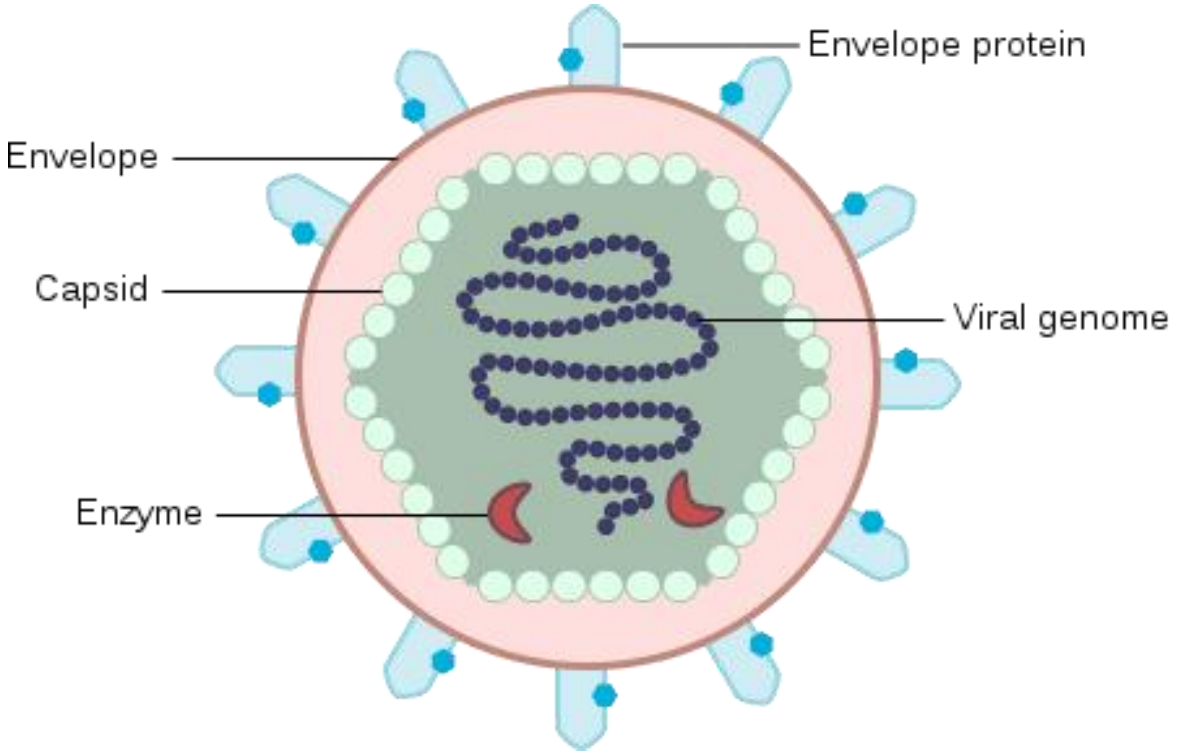
- Viruses are **very small infectious agents** (ranging from about 20 nm to about 300 nm in diameter).
- Contain only **one** kind of nucleic acid (RNA or DNA) as their genome never both.
- The nucleic acid is encased in a protein shell (**capsid**), which may be surrounded by a lipid-containing membrane (**enveloped**) or not.
- The entire infectious unit is termed a **virion**.
- Viruses are **inert** in the extracellular environment; they replicate only in **living cells**, being parasites at the genetic level.

- Viruses are **obligate intracellular parasites**, lack **cellular organelles and apparatus.**
- The viral nucleic acid contains information necessary for programming the infected host cell to synthesize virus-specific molecules required for the production of viral progeny.

- Viruses vary greatly in structure, genome organization and expression, in addition to replication & transmission strategies.
- The host range for viruses may be broad or extremely limited.

- Some viruses are known to infect unicellular organisms such as mycoplasmas, bacteria & algae. also all higher plants & animals





General Viral Structure

Important Definitions

–**Capsid :**The protein shell, or coat that encloses the nucleic acid genome .

–**Capsomeres :**Morphologic units seen in the electron microscope on the surface of the virus particles (represent clusters of polypeptides).

–**Defective virus :**A virus particle that is functionally deficient in some aspect of replication

–**Envelope :**A lipid-containing membrane that surrounds some virus particles (capsid) (acquired during viral maturation by a budding process through host cell membrane)

–**Peplomers:** Virus-encoded glycoproteins.

–**Nucleocapsid :**The protein-nucleic acid complex (representing the packaged form of the viral genome).

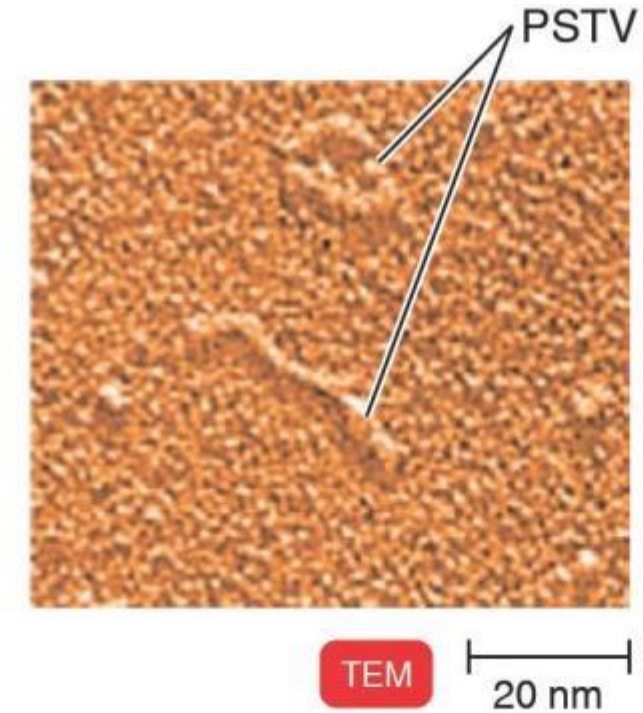
–**Structural units (Protomer):** The basic protein building blocks of the coat which are collections of more than one non- identical protein subunit.

–**Virion :**The complete infectious viral particle (serves to transfer the viral nucleic acid from one cell to another).

unconventional viruses

➢The main kinds that have been studied are

1. Virioids
2. Prions



Linear and circular potato spindle tuber viroid (PSTV).

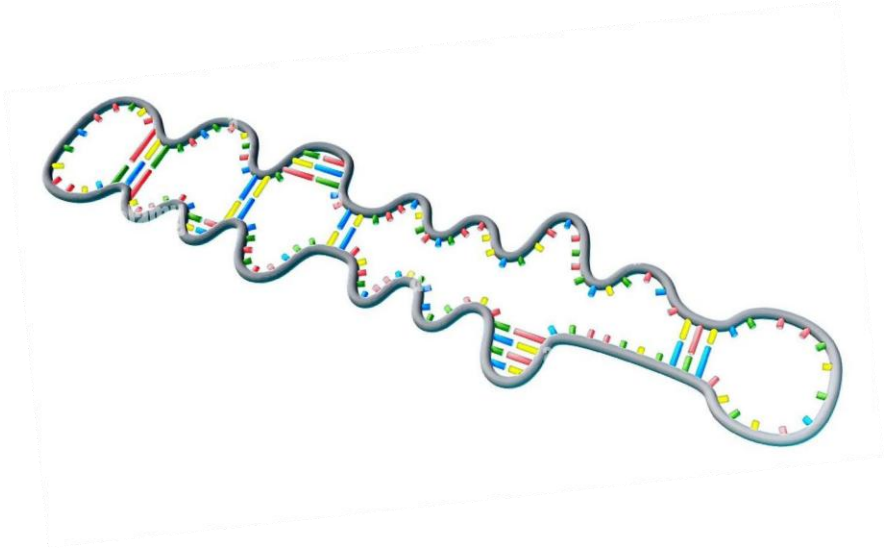
Prions isolated from the brain of infected hamster.

Viroids

- Viroid are unique infectious agents that are even simpler than viruses Viroid's are composed of a short, single-stranded, circular RNA molecule.

- The RNAs are **not packaged** (they **lack both a protein** coat (**capsid**)), do not appear to code for any proteins.

- They are associated with **plant disease.**
  However, there are some suggestions that somewhat similar agents may possibly be involved in some human diseases.



- The term “prions” refers to abnormal, pathogenic agents that are **transmissible** and are able to induce abnormal folding of specific normal cellular proteins called **prion proteins**

- Diseases of **the central nervous system** (e.g., Creutzfeldt-Jakob disease) and cause diseases in humans and animals**:** **Mad cow disease**, **kuru in humans**.

- Prions are altered conformations of a normal cellular protein

At a glance

PRION (INfectious PROtein)

Normal protein	Misfolded protein
	
More α helix than β sheet	Mainly β sheet

Prion diseases:

- scrapie (sheep)
- bovine spongiform encephalopathy
- sporadic Creutzfeldt-Jakob disease (humans)
- variant Creutzfeldt-Jakob disease (humans)