



Introduction to Virology

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Medical Virology-Theory and MA 403

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Outline

- Course Description
- Learning Outcomes
- Topics
- Introduction to Virology
- Key Terms
- Historical Development of Virology
- Importance of Virology

Objectives

- Understand virus structure, classification, and replication.
- Explain viral genetics and pathogenesis.
- Recognize major viral families and related diseases.
- Describe immune responses to viral infections.
- Understand oncogenic viruses and cancer links.
- Learn viral vectors, gene therapy, and antivirals.
- Review vaccines and prevention strategies.
- Apply virology in biotechnology and medicine.

Topics

Lect.	Topic Title
1	Introduction to Virology
2	Viral structure and classification systems
3	Viral replication
4	Viral genetics
5	Viral pathogenesis
6	Specific viral families and diseases I
7	Midterm Exam
8	The Immune Response to Viral Infection
9	Oncogenic Viruses and Viral Cancers
10	Viral vectors and gene therapy
11	Antiviral Agents and Chemotherapy
12	Vaccines and Viral Prevention Strategies
13	Enveloped and Non enveloped viruses
14	Applications of Viruses in Biotechnology
15	Final Exam

Introduction to Virology

- A virus is a submicroscopic infectious particle composed of genetic material (DNA or RNA) enclosed in a protein coat, and sometimes surrounded by a lipid envelope.
- Viruses cannot replicate independently; they must invade a living host cell and hijack its biochemical machinery to produce new viral particles.
- <https://www.youtube.com/watch?v=JJbQz-4Tz2Q>



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Are Viruses Alive?

Viruses exhibit both living and non-living characteristics.

Living-like traits:

- Contain genetic material.
- Capable of evolution (mutations, recombination).
- Reproduce — but only in a host.

Non-living traits:

- No cellular structure or metabolism.
- Cannot reproduce outside host.
- Can be crystallized and stored indefinitely.

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Key Terms:

- Virion: The complete, infectious viral particle outside a host cell.
- Viral genome: The nucleic acid carrying genetic instructions for viral replication.
- Capsid: The protein shell that encases the genome.
- Envelope: A lipid membrane derived from the host cell, present in some viruses.

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General Characteristics

Feature	Viruses	Cellular Organisms
Size	20–300 nm	1–10 μm
Nucleic Acid	DNA or RNA (not both)	DNA and RNA
Reproduction	Only inside host cell	Independent
Metabolism	None	Have metabolism
Organelles	None	Have organelles
Sensitivity	Sensitive to heat, UV, disinfectants (esp. enveloped)	Varies
Host range	Specific to host species or tissue	N/A

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Viral Genome Diversity

- DNA viruses: e.g., Herpesvirus, Adenovirus, Poxvirus
- RNA viruses: e.g., Influenza, SARS-CoV-2, Poliovirus
- Double-stranded (ds) or single-stranded (ss)
- Linear or circular
- Segmented genomes (e.g., Influenza virus has 8 RNA segments)
- Some encode their own enzymes (e.g., RNA-dependent RNA polymerase, reverse transcriptase).



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Historical Development of Virology

Year / Period	Scientist(s)	Discovery / Contribution	Significance / Milestone
1798	Edward Jenner	Demonstrated that inoculation with cowpox protected against smallpox; developed the first vaccine.	Birth of immunology and concept of vaccination — the foundation for virology.
1892	Dmitri Ivanovsky	Showed that infectious sap from diseased tobacco plants remained infectious after filtration through bacteria-proof filters.	First evidence of a filterable infectious agent smaller than bacteria — indirect discovery of viruses.
1898	Martinus Beijerinck	Coined the term <i>contagium vivum fluidum</i> (“contagious living fluid”); confirmed Ivanovsky’s findings.	Established the concept of viruses as distinct biological entities — founding of virology .
1911	Peyton Rous	Identified Rous Sarcoma Virus , proving a filterable agent could cause cancer in chickens.	Discovery of oncogenic viruses — start of tumor virology .
1935	Wendell Stanley	Crystallized Tobacco Mosaic Virus (TMV) and showed viruses could be isolated as chemical substances.	Viruses shown to be non-living chemical entities (protein-based); beginning of molecular virology .
1940s–1950s	Salvador Luria, Max Delbrück, Alfred Hershey, Martha Chase	Phage research revealed viral replication mechanisms; Hershey–Chase experiment confirmed DNA as viral genetic material.	Foundation of molecular genetics and phage biology ; viruses used as model systems.
1970	Howard Temin & David Baltimore	Discovered reverse transcriptase , showing that RNA viruses could make DNA.	Discovery of retroviruses and reversal of the “central dogma”; opened fields of HIV and gene therapy research.
1983	Luc Montagnier & Françoise Barré-Sinoussi	Isolated HIV (Human Immunodeficiency Virus).	Revolutionized understanding of immune system failure and led to antiviral drug development (HAART) .
2000s–Present	Multiple researchers	Viral genome sequencing, CRISPR discovery, mRNA and vector-based vaccines, viral bioinformatics.	Era of modern molecular virology : genomics, synthetic virology, and pandemic preparedness.



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Viruses and Bacteria Compared:

	Bacteria		Viruses
	Typical Bacteria	Rickettsias/ Chlamydias	
Intracellular Parasite	No	Yes	Yes
Plasma Membrane	Yes	Yes	No
Binary Fission	Yes	Yes	No
Pass through Bacteriological Filters	No	No/Yes	Yes
Possess Both DNA and RNA	Yes	Yes	No
ATP-Generating Metabolism	Yes	Yes/No	No
Ribosomes	Yes	Yes	No
Sensitive to Antibiotics	Yes	Yes	No
Sensitive to Interferon	No	No	Yes

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Virus Host Range:

Viruses can infect:

- ▷ Invertebrates
 - ▷ Vertebrates
 - ▷ Human
 - ▷ Other vertebrates
 - ▷ Plants
 - ▷ Protists
 - ▷ fungi
 - ▷ bacteria
- (bacteriophages)

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Viruses infect:

Viruses infect:

- **Humans**



Smallpox ¹

- **Other vertebrates**



Foot and mouth disease ²

- **Invertebrates**



Leatherjackets infected with *Tipula* iridescent virus

- **Plants**



Delayed emergence of potato caused by tobacco rattle virus infection ³



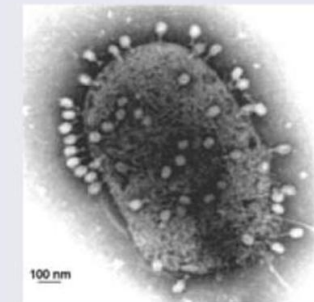
Damaged potato (spraing) caused by tobacco rattle virus infection ³

- **Fungi**



Mushroom virus X ⁴

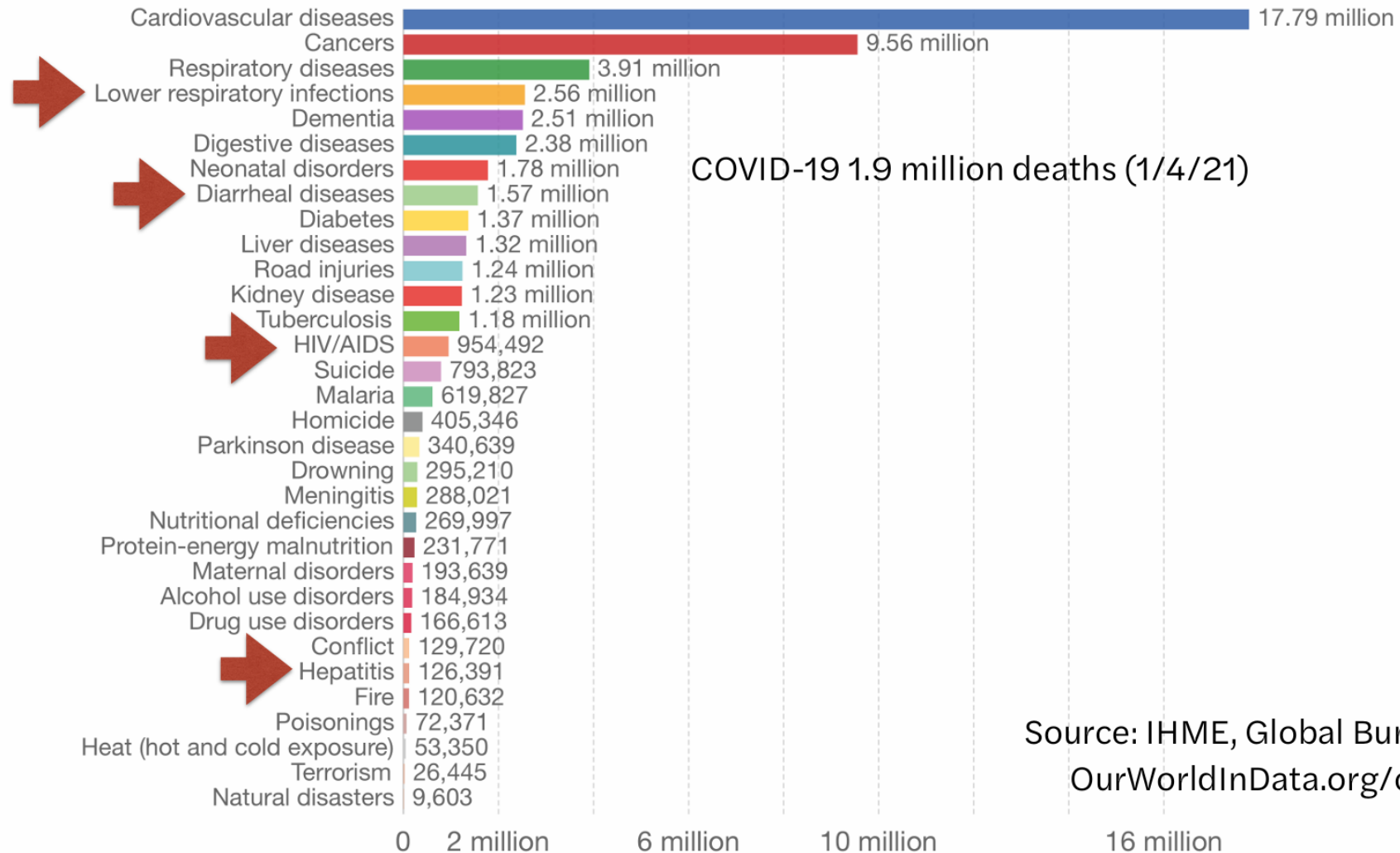
- **Bacteria**



Escherichia coli cell with phage T4 attached ⁵

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Causes of 2017 global deaths:



COVID-19 1.9 million deaths (1/4/21)

Source: IHME, Global Burden of Disease
[OurWorldInData.org/causes-of-death](https://www.ourworldindata.org/causes-of-death)

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Importance of Virology:

A. In Medicine

Understanding viral mechanisms aids in vaccine and antiviral drug development.

Examples:

- **Vaccines:** Influenza, COVID-19, HPV, Measles.
- **Antivirals:** Acyclovir (HSV), Oseltamivir (Influenza), ART (HIV).

B. In Biotechnology

- Viral vectors in **gene therapy** (e.g., AAV, lentivirus).
- CRISPR-Cas systems evolved from **bacteriophage defense mechanisms**.
- Oncolytic viruses used to **destroy cancer cells**.

C. In Public Health

- Surveillance and control of emerging viral diseases (Ebola, SARS-CoV-2, Nipah).
- Vaccination programs and herd immunity.
- Viral epidemiology and pandemic preparedness.

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Conclusion

- Viruses are unique biological entities bridging living and non-living worlds.
- They play major roles in health, evolution, and biotechnology.
- Understanding viral mechanisms is key to controlling diseases and advancing modern medicine.

Encourage you to discuss:

- What do you think defines life?

How can understanding viruses help prevent the next pandemic?

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