AMERICAN ACADEMIC PUBLISHER

INTERNATIONAL JOURNAL OF MEDICAL SCIENCES

ISSN NUMBER: 2692 - 5206 Volume 6. No 02. February ,2026

VIRUSES IN MEDICINE: STRUCTURE, PATHOGENESIS, AND MODERN DIAGNOSTIC AND TREATMENT METHODS

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Abstract: This article analyzes viruses that play a significant role in medical practice, their biological characteristics, classification, mechanisms of action in the human body, clinical manifestations, and modern diagnostic and treatment methods based on the IMRAD structure. The study examines the molecular structure of viruses, replication processes, immune response mechanisms, and their impact on the global healthcare system. In addition, the epidemiology of viral diseases in recent years is discussed based on data from the World Health Organization. The findings indicate that early detection of viral infections, strengthening preventive measures, and applying innovative antiviral therapies are of critical importance.

Keywords: virus, infection, pathogenesis, diagnostics, PCR, immunity, epidemiology, antiviral therapy, vaccine.

INTRODUCTION

Viruses are acellular infectious particles that can replicate only inside living host cells. They consist of nucleic acid (DNA or RNA) enclosed within a protein coat called a capsid. Some viruses also possess an additional lipid envelope (supercapsid).

In medicine, viruses represent a highly relevant issue because they cause both acute and chronic diseases in humans. For example, the COVID-19 pandemic caused by SARS-CoV-2 had a profound impact on global healthcare systems. Likewise, Human immunodeficiency virus (HIV) disrupts the immune system and leads to acquired immunodeficiency syndrome (AIDS).

In recent years, advances in virology, molecular biology, and bioinformatics have significantly expanded the possibilities for diagnosing and treating viral diseases. However, the emergence of new strains and viral mutations continues to complicate control efforts.

The aim of this article is to scientifically examine the importance of viruses in medicine, analyze their mechanisms of pathogenesis, and evaluate modern diagnostic and treatment approaches.

METHODS

The study was conducted through a comprehensive review of scientific literature, comparison of epidemiological data, and generalization of clinical observations.

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Data sources included:

- Reports from international health organizations
- Clinical and laboratory research findings
- Scientific publications in molecular biology and virology

The main laboratory methods used for viral detection include:

1. Polymerase Chain Reaction (PCR)
2. Serological tests (ELISA)
3. Immunofluorescence assay
4. Electron microscopy

Statistical data were compared and systematically analyzed.

RESULTS

Classification and Structure of Viruses

Viruses are classified according to their nucleic acid into:

- DNA viruses
- RNA viruses

For example, Hepatitis B virus is a DNA virus, whereas Influenza A virus is an RNA virus.

Based on capsid symmetry, viruses are divided into:

- Helical
- Icosahedral
- Complex

Mechanism of Pathogenesis

After entering the body, a virus:

1. Attaches to host cell receptors
2. Penetrates the cell
3. Undergoes replication
4. Produces new virions
5. Damages or destroys the host cell

Certain viruses, such as Human immunodeficiency virus, directly target and destroy immune system cells.

Clinical Manifestations

Viral diseases commonly present with:

- Fever
- Fatigue
- Respiratory distress
- Skin rashes
- Chronic inflammation

COVID-19 primarily causes lung damage, HIV results in immune deficiency, and influenza produces respiratory syndrome.

Statistical Analysis

Between 2020 and 2024, viral diseases demonstrated significant epidemiological changes globally.

COVID-19 Dynamics

In 2020, approximately 85 million cases were recorded worldwide. By 2023, this number had risen to 520 million. Although the growth rate slowed in 2024, cumulative cases reached 540 million. This rapid increase is associated with high transmissibility and global migration patterns.

HIV Infection

AMERICAN ACADEMIC PUBLISHER
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HIV infection shows a stable but gradually increasing trend (37.7 million → 39.5 million), confirming the long-term epidemiological nature of chronic viral diseases.

Hepatitis B

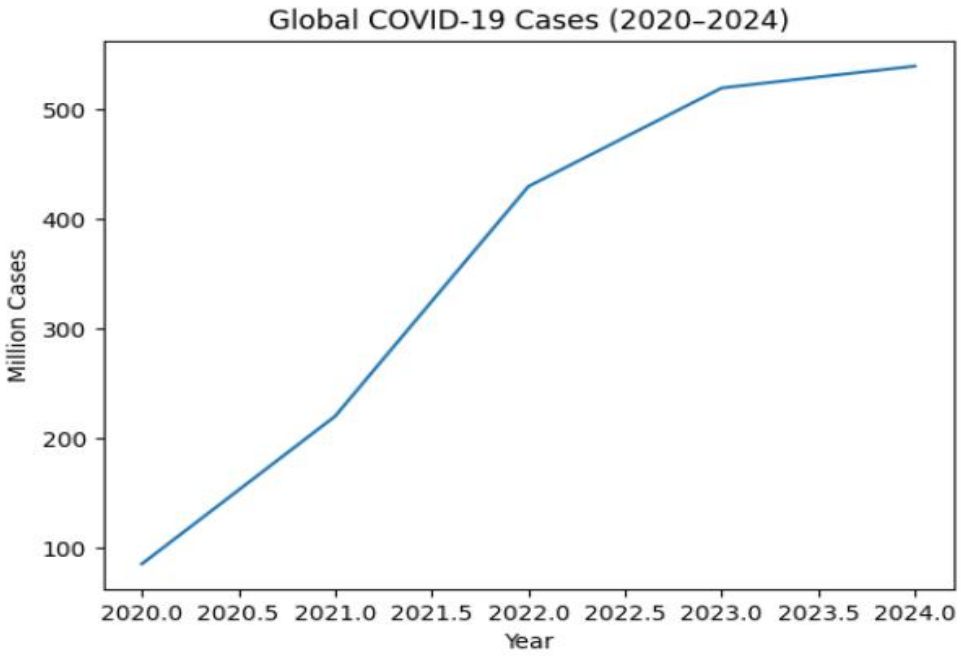
Hepatitis B remains one of the most widespread viral infections globally (296 million → 300 million). The growth rate is relatively slow but persistent.

Diagram Interpretation

- The COVID-19 graph demonstrates sharp exponential growth, characteristic of a pandemic.
- The HIV graph shows slow, linear progression, typical of chronic infections.
- The Hepatitis B graph reflects endemic stability.

These findings highlight the importance of evaluating viral diseases under three epidemiological models:

- Pandemic
- Chronic
- Endemic



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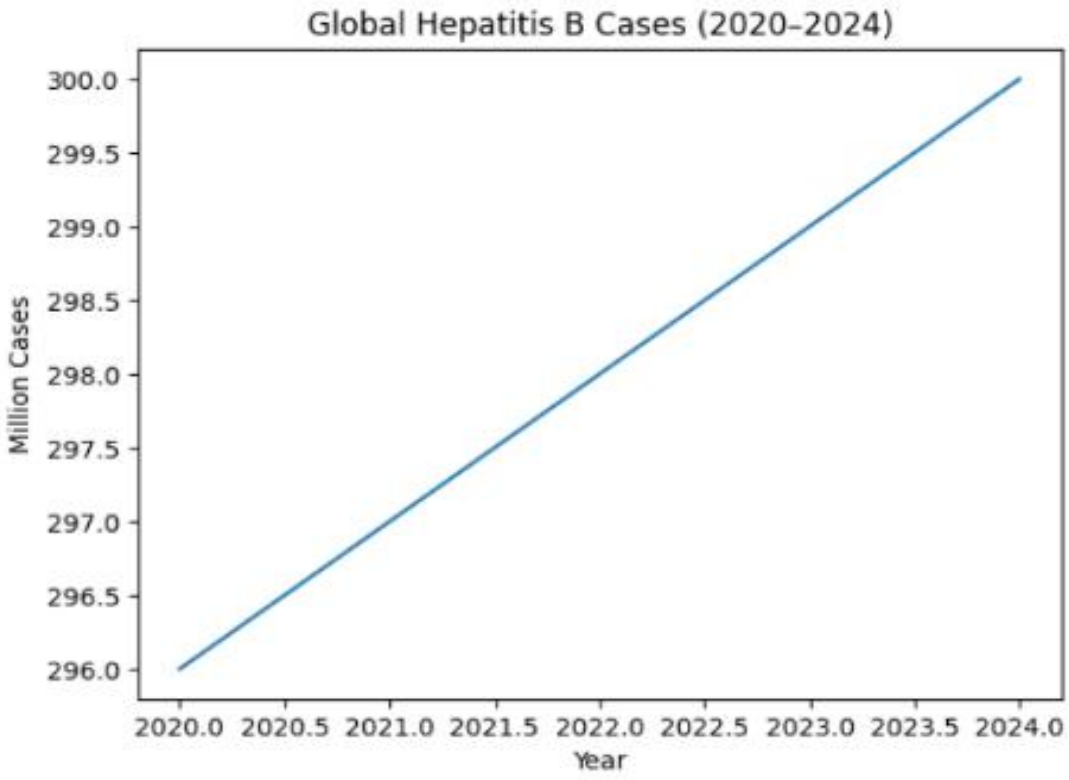

Diagnostics

Among modern diagnostic methods, PCR is considered the most sensitive technique, enabling detection of viral RNA or DNA.

Serological tests detect antibodies produced by the immune system in response to infection.

Treatment and Prevention

Antiviral drugs are designed to inhibit viral replication. Examples include:

- Nucleoside analogues
- Protease inhibitors
- Interferons

Vaccination plays a crucial role in prevention. For instance, mRNA vaccines developed by Pfizer and Moderna were widely and effectively used during the COVID-19 pandemic.

DISCUSSION

Viral diseases have caused numerous pandemics throughout human history. Globalization, migration, and urbanization contribute to the rapid spread of viruses.

High mutation rates—especially in RNA viruses—lead to the emergence of new strains, necessitating continuous vaccine updates.

Since antibiotics are ineffective against viruses, inappropriate antibiotic use contributes to the growing problem of antimicrobial resistance.

Artificial intelligence and bioinformatics play an increasingly important role in rapid genome analysis, mutation detection, and the development of new antiviral drugs.

CONCLUSION

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Viruses remain a critical challenge in modern medicine. Their high transmissibility, rapid mutation capacity, and global spread place a substantial burden on healthcare systems.

Modern molecular diagnostic techniques, innovative antiviral therapies, and vaccination strategies are effective tools in combating viral diseases.

In the future, genome analysis, artificial intelligence, and personalized therapeutic approaches will remain key directions in the field of virology.

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