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PREFACE

The World Health Organization has declared the XXI century 'the century of viruses'! Viruses are the smallest living organisms on the planet, which are ubiquitous due to their unique life cycle - absolute intracellular parasitism.

Scientists have long proven the important role of viruses in the existence of various ecosystems, including the human body.

The interaction of a virus with the cells of the human body is interpreted as an infectious process. In turn, pathophysiological and pathomorphological changes in cells as a result of productive and integrative reproduction of viruses are treated as an infectious disease. In addition, the repeated interaction of the macroorganism with viral particles leads to the fact that the genome of the host cells changes over the years, bearing the signs of the genome of viruses.

The role of viruses in human pathology can hardly be overestimated because we are talking not only about acute viral diseases, which end in the complete elimination of the virus from the macroorganism. Currently, viruses that cause latent and slow infections are of great importance. So the persistence of herpes viruses leads to the development of acquired immunodeficiency states, in which patients become extremely susceptible to other infectious diseases. The tutorial focuses on oncogenic viruses, as well as viruses - pathogens of emergent infections such as viruses: Zika, Ebola, Corona. The devastating consequences of epidemics and pandemics of these viruses lead to large numbers of human victims. At the time of September 2021, according to official data, 3 million people have died from coronavirus in the world.

This textbook is intended not only to acquaint students with the biology of viruses, to study the patterns of pathogenesis, but also to determine the possibilities of laboratory diagnostic methods.

A LIST OF ABBREVIATIONS

AB – antibody
AIDS – acquired immune deficiency syndrome
Ag – antigen
CBT – complement binding test
CJD - Creutzfeldt-Jakob disease
CNS – central nervous system
CMV – cytomegalovirus
CPE – cytopathic effect
CSF – cerebrospinal fluid
EBV – Epstein – Barr Virus
ELISA – enzyme linked immunosorbent assay
EM – electron microscopy
IEM – immune electron microscopy
IF – immune fluorescence
Ig – immunoglobulin
IL – interleukin
IFN - interferon
FAT – fluorescence antibody test
GIT – gastrointestinal tract
HA - hemagglutination
HAIT – hemagglutination inhibition test
HBsAg – hepatitis B virus s antigen
HBV - hepatitis B virus
HIV – human immune deficiency virus
HPV – human papilloma virus
HSV – herpes simplex virus
NK – natural killer
PCR – polymerase chain reaction
RBC – red blood cell
RIA – radioimmune assay

SECTION 1.

GENERAL VIROLOGY

1.1. FEATURES OF VIRUSES

- ✓ Non-cellular structure.
- ✓ Submicroscopic sizes.
- ✓ One type of nucleic acid – DNA or RNA.
- ✓ Absence of biosynthesis systems.
- ✓ Obligatory intracellular parasite.
- ✓ Absence of growth and metabolism.
- ✓ Disjunctive reproduction.

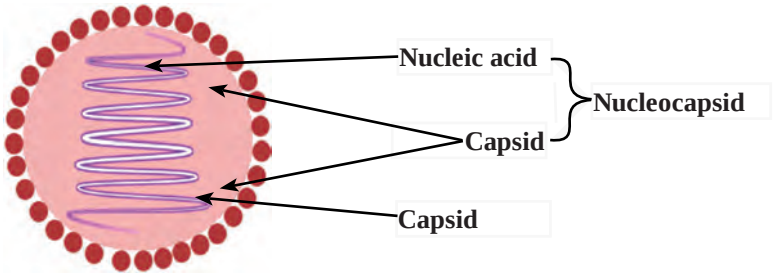
1.2. PROPERTIES OF UNICELLULAR MICROORGANISMS AND VIRUSES

Property	Bacteria	Rickettsiae	Chlamydiae	Virus
Cellular structure	+	+	+	-
Diameter (nm)	1000	500	300	25-250
Type of nucleic acid	DNA and RNA	DNA and RNA	DNA and RNA	DNA or RNA
Biosynthesis	+	+	+	-
Energy production	+	+	-	-
Binary fission	+	+	+	-
Growth out of host-cell	+	-	-	-

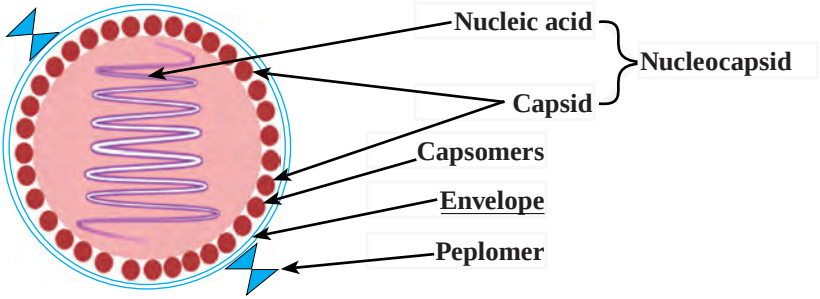
1.3. VIRAL STRUCTURE

General viral components	Simple (Naked) virus	Complex (Enveloped) virus
Nucleic acid	+	+
Protein coat (capsid)	+	+
Envelope	-	+

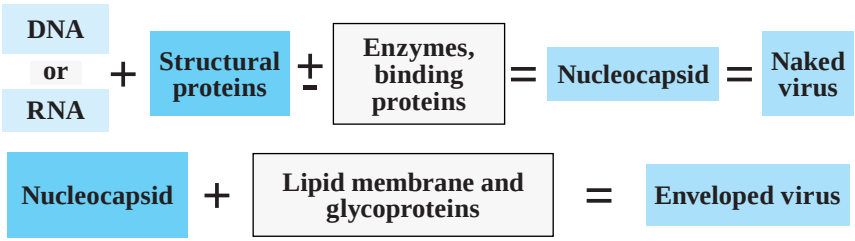
1.4. SCHEMATIC VIEW OF SIMPLE (NAKED) VIRUS



1.5. SCHEMATIC VIEW COMPLEX (ENVELOPED) VIRUS



1.6. COMPONENTS OF THE VIRION



1.7. DIFFERNCES IN NAKED AND ENVELOPED CAPSID VIRUSES

NAKED CAPSID VIRUSES	ENVELOPED CAPSID VIRUSES
CHEMICAL COMPONENTS	
Proteins	Proteins Lipids Glycoproteins
PROPERTIES	
Environmentally stable to temperature, acids, detergents, drying; Release by lysis	Environmentally labile (destroyed by acids, detergents, drying, heat); Modify cell membrane during replication; Release by budding and lysis
FEATURES	
Can be spread easily (on fomites, from hand to hand, by dust and droplets); Can dry out and retain infectivity; Survive the gastrointestinal tract	Can be spread by large droplets, secretions, organ transplantation, blood transfusions; Have to stay wet; Cannot survive the gastrointestinal tract; Do not need cell death to spread

1.8. VIRUS GENOMES

DNA	RNA
Single stranded	+ or -
Double stranded	Segmented
Circular	Double stranded segmented

1.9. PROTEIN COAT (CAPSID)

- ✓ Consists of oligomeric structural subunits - capsomers
- ✓ Protects nucleic acid
- ✓ Takes part in transport of nucleic acid from cell to cell
- ✓ Provides specificity of attachment
- ✓ Has 3 types of symmetry:
  1)**ICOSAHEDRAL** (CUBIC) – Picornaviridae, Flaviviridae, Retroviridae, Poxviridae etc.
  2)**HELICAL** – Myxoviridae, Rabiesvirus.
  3)**COMPLEX** – Phages.

ENVELOPE

- ✓ Is by-product of host cell membrane
- ✓ Consists of 2 lipid layers
- ✓ Includes viral glycoproteic spikes (peplomers)
- ✓ Covers capsids of complex viruses
- ✓ Provides identification and binding to receptor site of host cell
- ✓ Camouflages virus from host immune response

1.10. VIRUS-HOST INTERACTION

Type of interaction	Description	Examples of viruses
Productive:	Virus replication leads to release of the new viruses from the cell	Influenza virus
Lytic	Virus enters the cell to rapidly multiply and in the process kills the target cell	
Persistent	Virus is released gently from the cell through exocytosis or budding without killing the target cell	
Integrative (lysogenic, latent)	It is the process characterized by the incorporation of viral DNA to the cellular DNA. Once incorporated, the viral DNA replicates along with the host DNA. The incorporated viral DNA permits the host cell to undergo normal cell cycle.	HIV, HSV, VZV
Abortive (failed)	The violation of viral reproduction on one of its stages and formation of defective viral particles.	All viruses

Persistent interaction

- **Chronic** Latent
- **Reccurent** Transforming

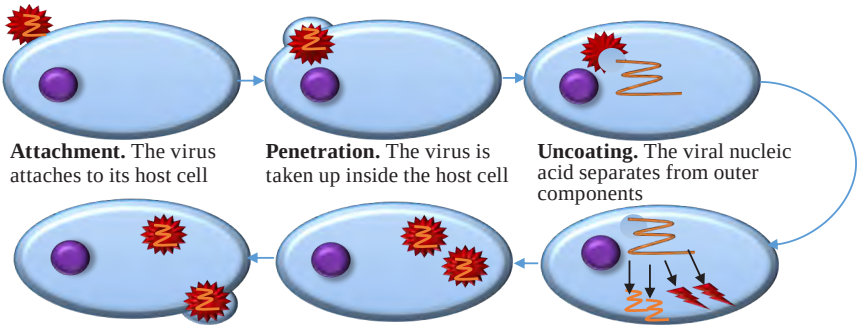
1.11.TYPES OF VIRUS-HOST INTERACTION AT THE CELLULAR LEVEL

Type	Production of viruses	Fluency on host cell
Productive (lytic)	+	Death
Abortive	-	-
• **Persistent:** • **Chronic (productive)** • **Latent** • **Transforming**	 + - +/-	 Senescence - Immortalization

1.12. STAGES OF VIRAL REPLICATION

4. Recognition of the target cell
5. Attachment
6. Penetration → Receptor-mediated endocytosis / Membrane fusion
7. Uncoating
8. Biosynthesis
9. Assembly
10. Release → Lysis / Budding

1.13. STAGES OF VIRAL REPLICATION



Attachment. The virus attaches to its host cell

Penetration. The virus is taken up inside the host cell

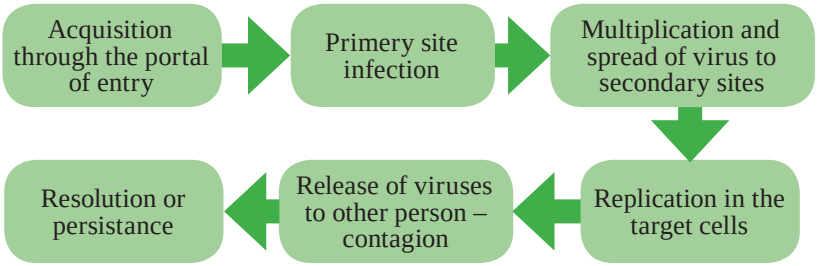
Uncoating. The viral nucleic acid separates from outer components

Biosynthesis. The cell synthesizes the basic components of new viruses

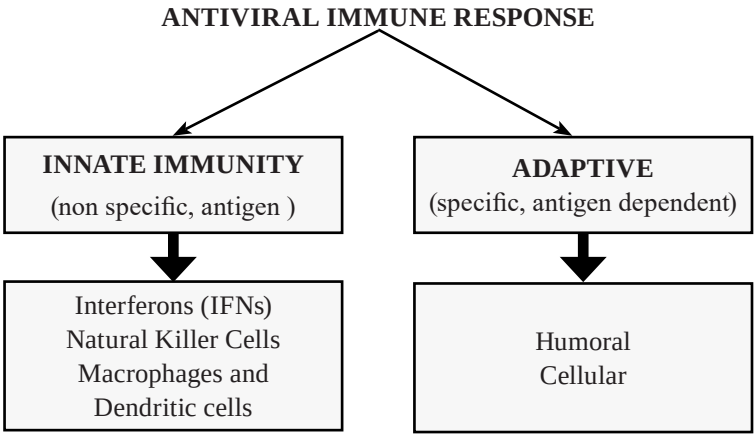
Assembly. The basic components of new viruses assemble together to form new viruses

Release. Viruses lyse or bud off of the membrane.

1.14. PROGRESSION OF VIRAL DISEASE



1.15 MEANS OF ANTIVIRAL IMMUNE RESPONSE



1.16. HOST DEFENSES TO VIRUSES

Innate immunity	Anatomic barriers, chemical barriers
Cellular resistance	Nonpermissive cells (without conditions for viral replication)
Inflammation	Limits the spread of viruses from the primary site; creates uncomfortable conditions for viral replication
Interferons	Viral-induced glycoproteins that inhibit viral replication
Humoral immunity	Production of neutralizing and nonneutralizing antibodies by B-cells
Cellular immunity	Cytotoxic T-cells, NK cells, activated macrophages
Viral-induced immunopathology	Tissue damage due to cytotoxic cells or antibodies and complement as a result of different immunological reactions

1.17. FUNCTIONS OF INTERFERONS

- ✓ Inhibition of the synthesis of viral envelope proteins
- ✓ Inhibition of viral messenger RNA synthesis
- ✓ Destruction of viral RNA

1.18. TYPES OF INTERFERONS

Type	Producer cells	Direction of action
IFN α	Mononuclear phagocytes	Cells infected with a virus: change the properties of the cell membrane, stimulate specific enzymes, affect the RNA of the virus and prevent its replication
IFNβ	Fibroblasts	Antiviral effect, Tumor cells
IFN γ (1a, 2a)	Th1 lymphocytes, NK cells	Activate Mononuclear phagocytes, Natural killer, T-lymphocytes

1.19. MEHANISMS OF ACTION OF INTERFERON