SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

DEPARTMENT OF CARDIAC TECHNOLOGY

COURSE NAME: GENERAL MICROBIOLOGY

TOPIC : HUMAN IMMUNODEFICIENCY VIRUS (HIV)

HIV (Human Immunodeficiency Virus)

- HIV is a round, ball-shaped virus which targets the immune system of a person.
- HIV weakens and eventually damages the immune system of the individual.
- The body starts to lose the ability to defend itself against germs, bacteria and infections.
- It has two single strands of RNA for its genome.
- The RNA is used to carry the genetic information that is passed on when new HIV particles are produced.
- This is different than a normal cell, which uses DNA to carry its genetic information.
- AIDS – Chronic immune system disease caused by HIV.

Shape and size

- HIV is a spherical virus of about 90 nm in diameter.
- Size; 90nm

Envelope

- HIV is enveloped RNA virus.
- Lipid bilayer surrounding the viral matrix protein(p18)
- Below the envelope, there is an icosahedral shell called matrix (P17).
- Has many spikes of the glycoprotein- gp160
- The outer part of glycoprotein called gp120 is attached to the gp41 which is the inner part of the glycoprotein.
- The envelope of HIV also contains other proteins including some HLA antigens (Human Leucocyte Antigen).

Core:

- The core consists of cylindrical capsid (p24) which contains the genetic material

Genome:

- HIV is ss RNA virus.
- Genome of HIV consists of 9 gene, 3 structural gene and 6 non-structural gene (regulatory gene).

- **Structural gene -** (env, gag and pol),
- **Regulatory gene -** (tat, rev, nef, vif, vpr and vpu in HIV-I and vpx in HIV-2)

Enzymes

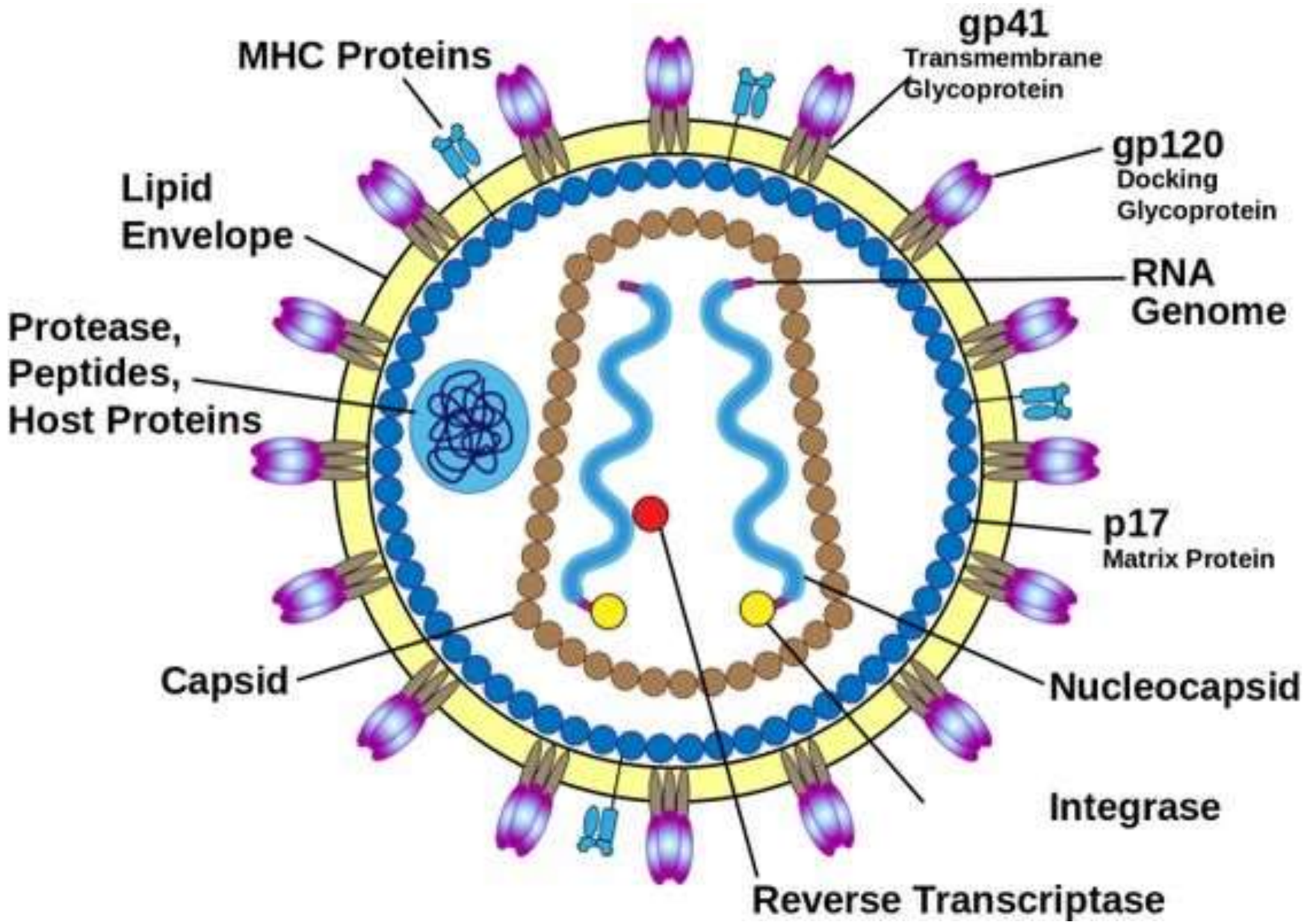
- **Reverse transcriptase** (RNA dependent DNA polymerase) - Responsible for the conversion of the RNA to form the DNA.

- **Integrase -** which helps the viral genome to incorporate in the host cell.

- **Protease** - HIV protease cuts up large precursor proteins into smaller proteins.

1. These smaller proteins combine with HIV's genetic material to form a new HIV virus.

2. Protease inhibitors (PIs) prevent HIV from replicating by blocking protease.


MHC Proteins
gp41
Transmembrane
Glycoprotein
gp120
Docking
Glycoprotein
Lipid
Envelope
RNA
Genome
Protease,
Peptides,
Host Proteins
p17
Matrix Protein
Capsid
Nucleocapsid
Integrase
Reverse Transcriptase

STEPS INVOLVED IN REPLICATION

1. Binding and Fusion:

- HIV begins to enter a CD4 cell by binding, or attaching itself, to a specific point, called a CD4 receptor, on the cell's surface.
- HIV must then bind to a second receptor, either the CCR5 co-receptor or the CXCR4 co-receptor.
- This allows the virus to join, or merge, with the CD4 cell in a process called fusion.
- After fusion, HIV releases its genetic material and enzymes (proteins that cause chemical reactions) into the CD4 cell.

2. Reverse Transcription:

- HIV's genetic material is called RNA.
- It contains the "instructions" that will reprogram the CD4 cell so that it produces more viruses.
- To be effective, HIV's RNA must be changed into DNA.
- An HIV enzyme called reverse transcriptase changes the HIV RNA into HIV DNA.

3. Integration:

- Next, the newly formed HIV DNA enters the nucleus (command center) of the CD4 cell.
- Another HIV enzyme called integrase combines, or integrates, HIV's DNA with the CD4 cell's DNA.

4. Transcription:

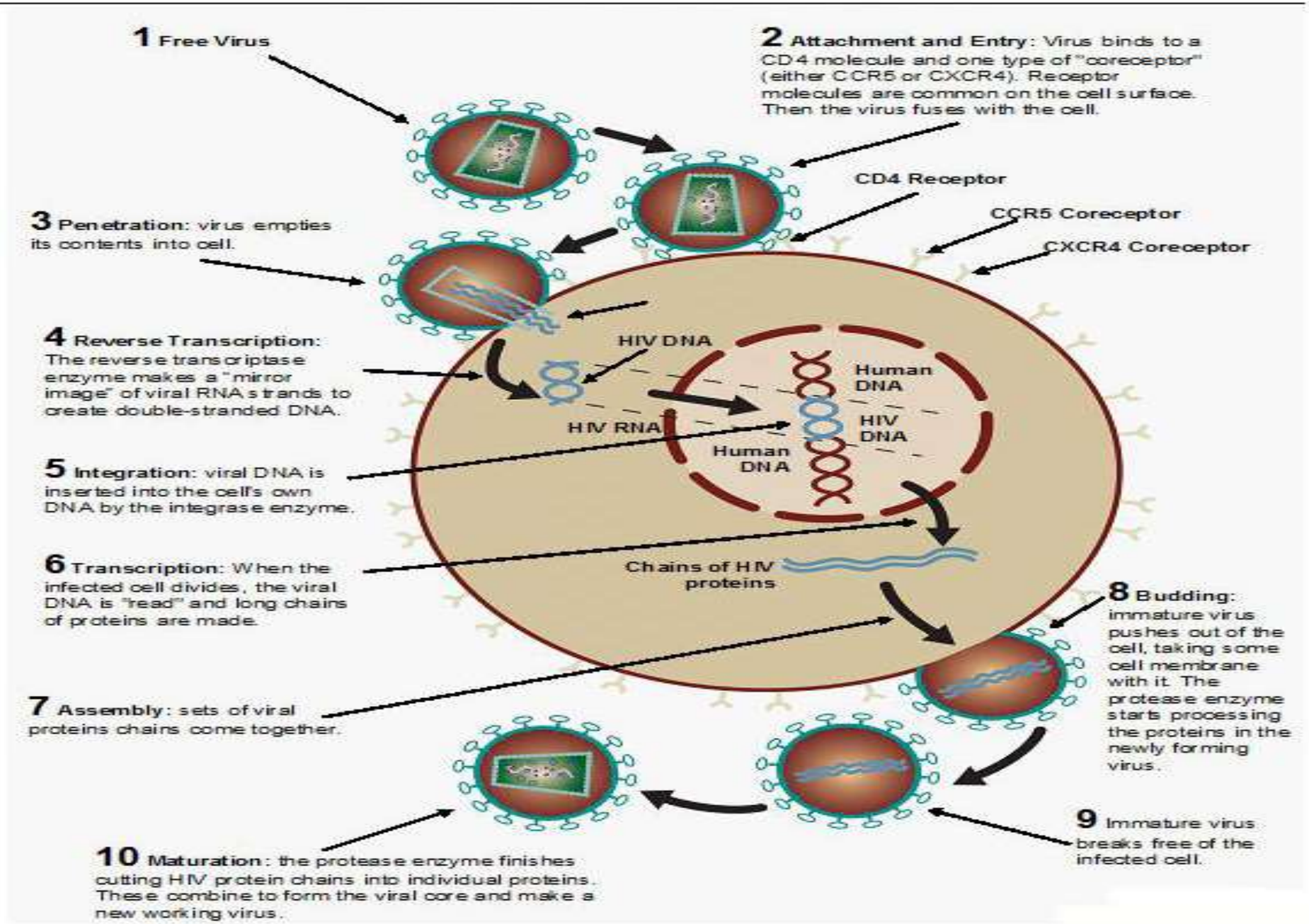
- Once the virus is integrated into the CD4 cell, it commands the CD4 cell to start making new HIV proteins.
- These proteins are the building blocks for new HIV viruses.

5. Assembly:

- An HIV enzyme called protease cuts the long chains of HIV proteins into smaller pieces - come together with copies of HIV's RNA, a new virus is put together

6. Budding:

The newly assembled virus pushes ("buds") out of the original CD4 cell. This new virus can now target and infect other CD4 cells.


1 Free Virus
2 Attachment and Entry: Virus binds to a CD4 molecule and one type of "coreceptor" (either CCR5 or CXCR4). Receptor molecules are common on the cell surface. Then the virus fuses with the cell.
CD4 Receptor
CCR5 Coreceptor
CXCR4 Coreceptor
3 Penetration: virus empties its contents into cell.
4 Reverse Transcription: The reverse transcriptase enzyme makes a "mirror image" of viral RNA strands to create double-stranded DNA.
HIV DNA
HIV RNA
Human DNA
HIV DNA
Human DNA
5 Integration: viral DNA is inserted into the cell's own DNA by the integrase enzyme.
6 Transcription: When the infected cell divides, the viral DNA is "read" and long chains of proteins are made.
Chains of HIV proteins
8 Budding: immature virus pushes out of the cell, taking some cell membrane with it. The protease enzyme starts processing the proteins in the newly forming virus.
7 Assembly: sets of viral proteins chains come together.
9 Immature virus breaks free of the infected cell.
10 Maturation: the protease enzyme finishes cutting HIV protein chains into individual proteins. These combine to form the viral core and make a new working virus.

PATHOGENESIS

- HIV – Excreted in blood and body fluids (semen, vaginal secretions, breast milk, cerebrospinal fluid, amniotic fluid and synovial fluid) of an infected individual.
- Both Intracellular and extracellular viral particles can be infectious.
- Gp 120 in viral envelope – binds to CD4 receptors and co receptors of either CCR5 or CXCR4 present on host cells.
- HIV can infect helper T cells, monocytes, microglial cells, oligodendrocytes, astrocytes of brain and retinal cells in human eyes.

NATURAL PROGRESSION

- Clinically, HIV infection is staged in 4 ways:
- Group I - Acute Phase
- Group II – Chronic asymtomatic phase
- Group III – Generalized persistent lymphadenopathy
- Group IV – AIDS

OPPORTUNISTIC INFECTIONS:

- Tuberculosis (most common)
- Candidiasis
- Cryptosporidiosis
- Toxoplasmosis

TRANSMISSION

1. Sexual Route:

- Penetrative sexual acts (Vaginal, Anal or oral), both heterosexual and homosexual.

2. Parenteral Route:

- By contaminated blood transfusion, IV drug use, organ transplantation, by sharing of needles and syringes.

3. Vertical transmission:

- From mother to child during pregnancy, child birth or by breast feeding

LAB DIAGNOSIS FOR THE PRESENCE OF VIRUS OR VIRAL PRODUCTS IN HOST

1. **Nucleic Acid Amplification Test (NAAT)** – Most sensitive test used to detect HIV nucleic acids copy numbers.
2. **P24 antigen detection** – either in acute stage or in late stage
3. **CD4 T - cell enumeration** – used for monitoring response to therapy.

Commonly used serological tests to detect host response to the virus – demonstrate HIV specific antibodies:

- Enzyme Linked Immunosorbent Assays (ELISA)
- Western Blot
- Immunofluorescence assays
- Chemiluminescence assays

LABORATORY DIAGNOSIS

Direct Methods	Indirect Methods
Cultivation of T lymphocytes	ELISA
Detection of reverse transcriptase	Western Blot Assay
Phase contrast microscopy	Radioimmunoprecipitation assay
Electron microscopy	PCR – Polymerase Chain Reaction
Animal Study	Dot Blot Hybridization

ANTI RETROVIRAL TREATMENT

HAART – Highly Active Anti- Retroviral Treatment is helpful in

- Reducing viral replication
- Reducing frequency of opportunistic infections
- Prolonging latent period
- Prolonging longevity
- Improving quality of life

HIV Drugs:

- Suramine – blocks the action of reverse transcriptase
- Phosphonoformate
- Zidovudin
- Dideoxyinosine
- Nevirapine or Pyridinone

3 classes of drugs used in combination as advocated by NACO (National AIDS Control Programme)

Antiretroviral Drugs:

- **Nucleoside/ Nucleotide reverse transcriptase inhibitor (NRTI)** – cause DNA chain termination
- **Non - Nucleoside/ Nucleotide reverse transcriptase inhibitor (NNRTI)** – inhibits HIV reverse transriptase enzyme
- **Protease inhibitor** – Prevents viral maturation

Newer Classes of Anti – HIV Drugs:

Fusion Inhibitors: Enfuvirtide - Stops the integration of virus DNA with host DNA

PREVENTION

Currently no vaccine available to treat HIV. However, taking certain steps can help prevent the transmission of HIV.

Safer sex

- Transfer through anal or vaginal sex without a condom or other barrier method.

Get tested for HIV:

- It's important to learn their status and that of their partner.

Get tested for other sexually transmitted infections (STIs):

- If they test positive for one, they should get it treated, because having an STI increases the risk of contracting HIV.

Use condoms:

Take their medications as directed if they have HIV:

This lowers the risk of transmitting the virus to their sexual partner.

Other prevention methods

- **Avoid sharing needles or other paraphernalia**
- HIV is transmitted through blood and can be contracted by using materials that have come in contact with the blood of someone who has HIV.

Consider PrEP and PEP (Pre and Post Exposure Prophylaxis):

- Persons working in health care setting may get exposed to biological material which may be a source of HIV infection.
- Hollow needles, device visibly contaminated with patient's blood, deep injury, large volume of blood involved in exposure and known high viral load in blood at the time of exposure are associated with high risk.
- A person who has been exposed to HIV should contact their healthcare provider about obtaining post-exposure prophylaxis (PEP).
- PEP can reduce the risk of contracting HIV.
- It consists of three antiretroviral medications given for 28 days.
- PEP should be started as soon as possible after exposure but before 36 to 72 hours have passed.

Assessment

1. Define HIV and its structure?

2. Steps involved in replication of HIV?

3. Transmission of HIV?

4. Symptoms?

5. Lab Diagnosis?

6. Prevention and Treatment?

THANK YOU