The Threaten of Lethal Viruses

Joint Graduate Seminar

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Contents

- **Ebolavirus** – one of the most deadly viruses with a case fatality rate up to 90%
- **Influenza viruses** – most deadly virus all time
- **Human immunodeficiency virus** – most deadly virus nowadays

Definition

- **Case fatality rate**: the ratio of deaths within a designated population of people with a particular condition, over a certain period of time.

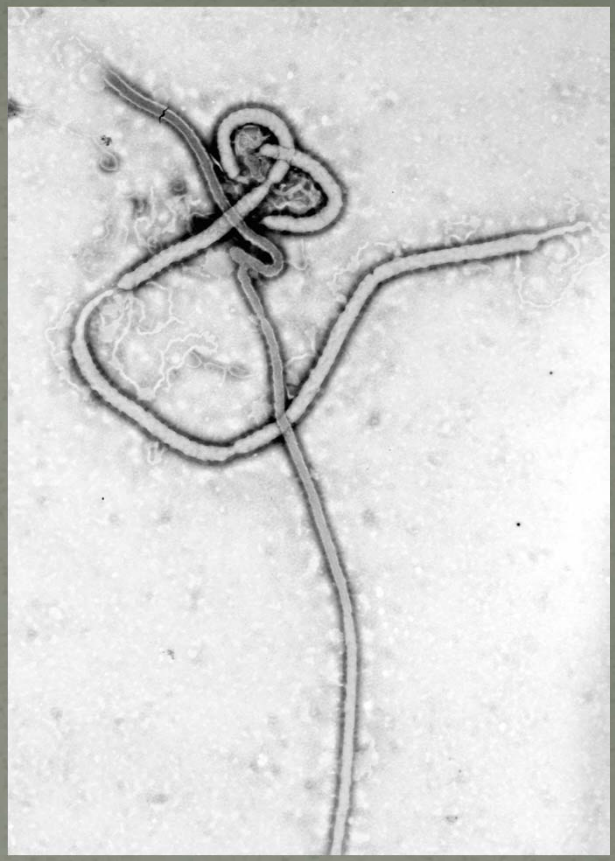
- **Mortality rate**: the number of deaths (in general, or due to a specific cause) in some population, scaled to the size of that population, per unit time.

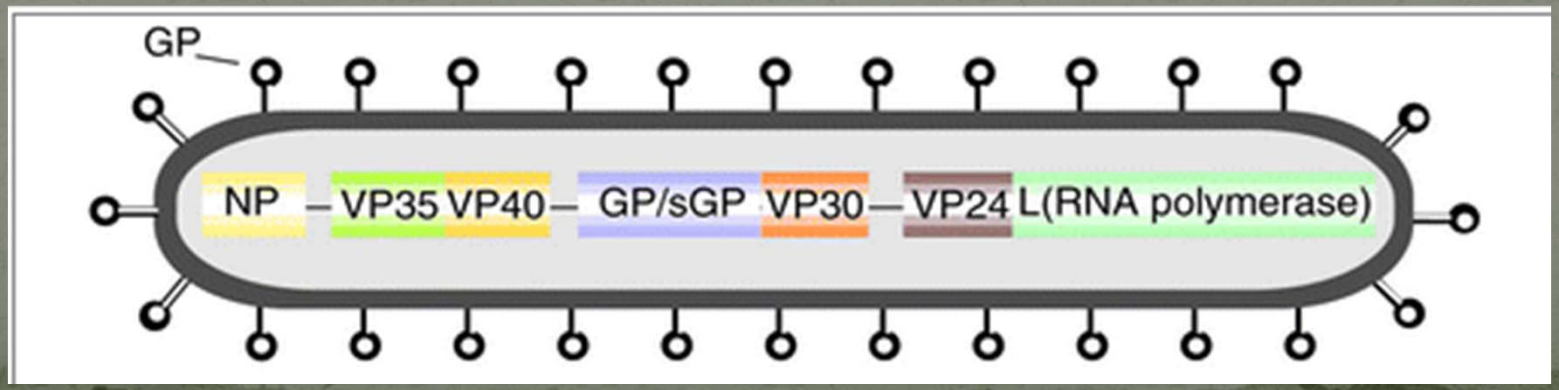
Ebolavirus

- First recognized near the Ebola River valley during an outbreak in Zaire in 1976.
- An RNA virus of the family *Filoviridae*
- 5 recognized species: Zaire (type species), Sudan, Reston, Ivory Coast, and Bundibugyo.
- Causes Ebola Hemorrhagic Fever (EHF).
- The case fatality rate ranges from 50 to 90%.

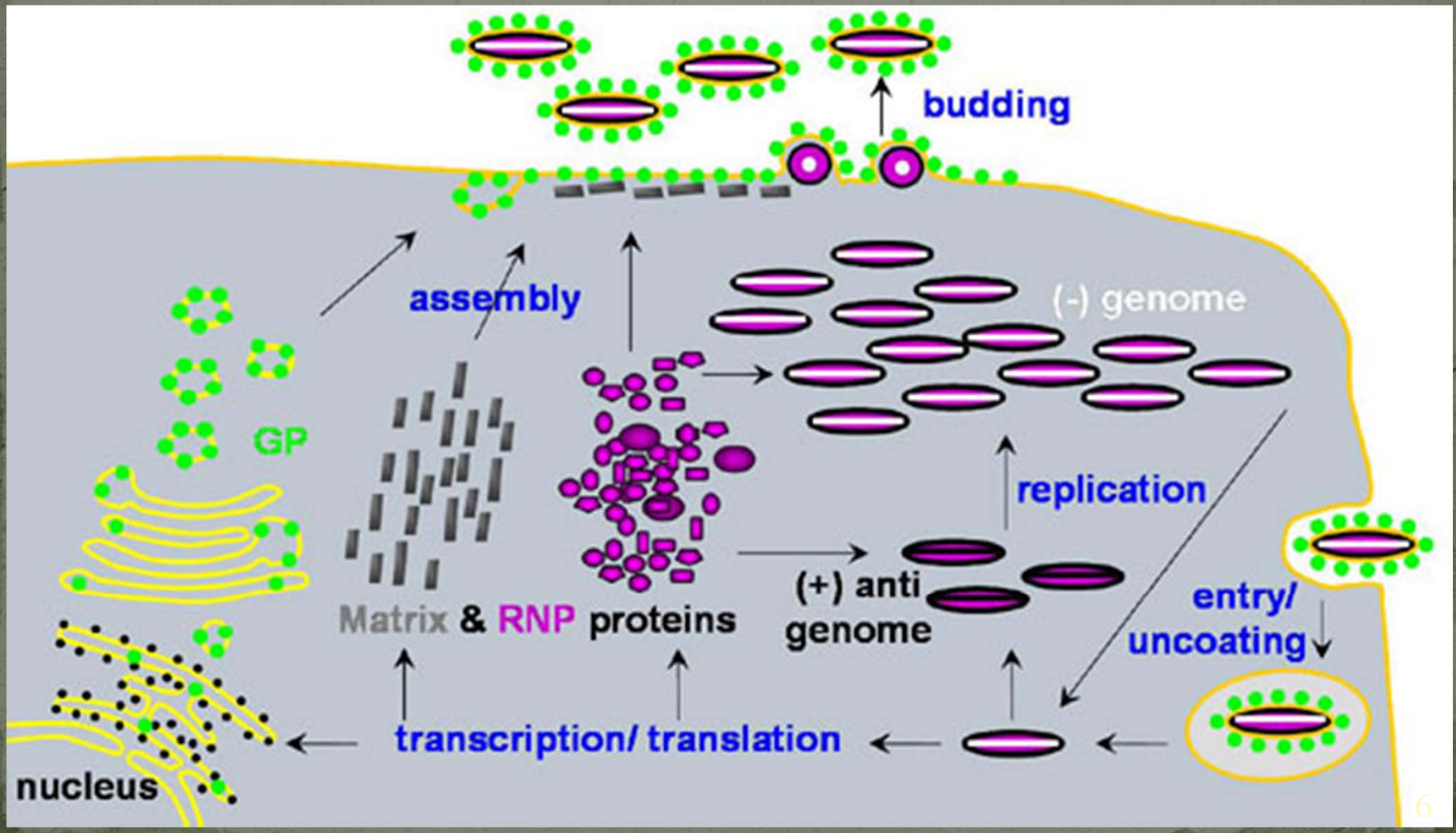
Virology

- Structure:
  - Enveloped virus
  - Tubular form
- Genome:
  - Linear, single-stranded, negative-sense RNA
  - 7 open reading frames

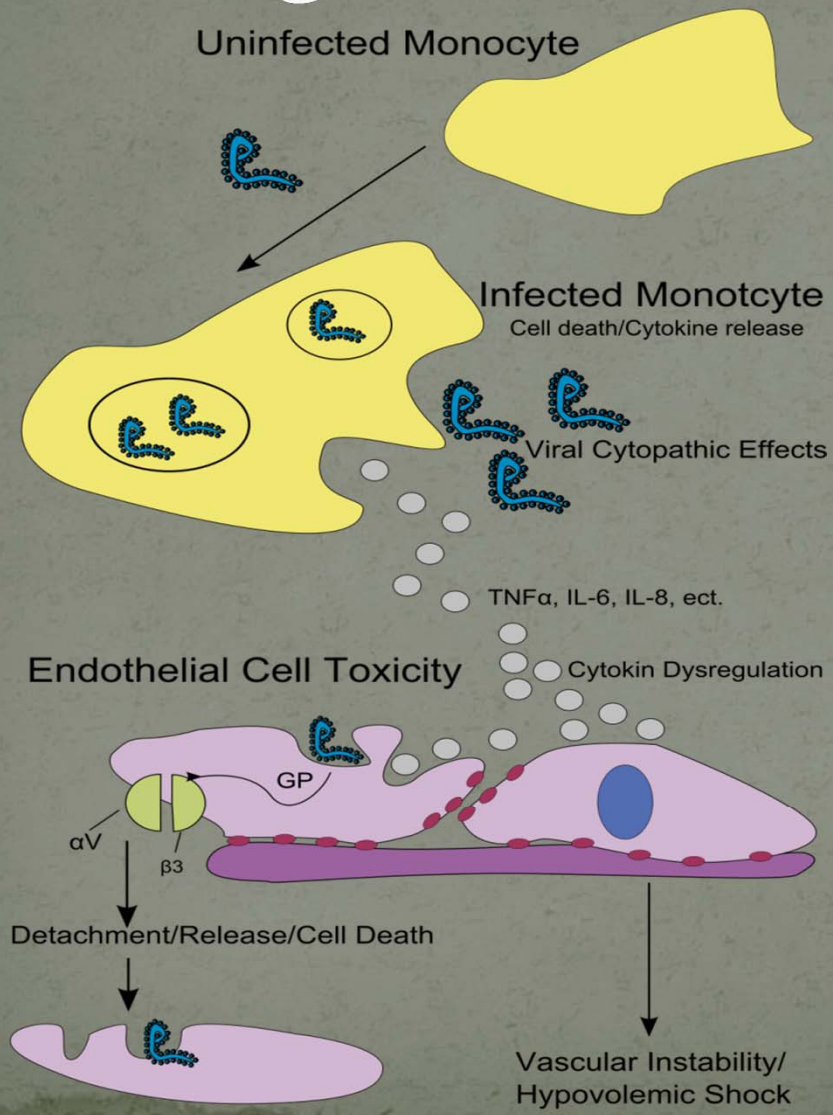




Life Cycle

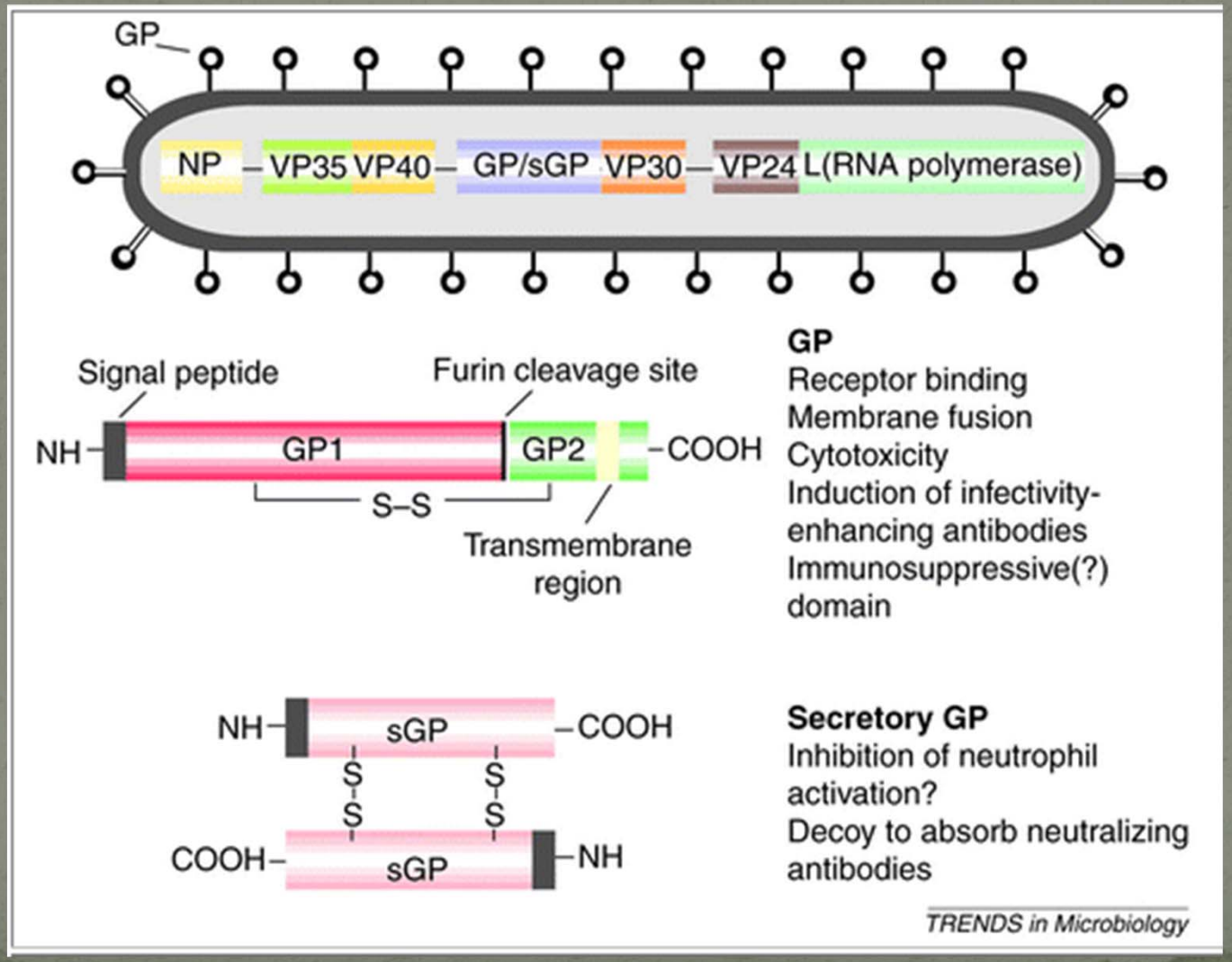

budding
assembly
(-) genome
GP
replication
Matrix & RNP proteins
(+) anti genome
entry/ uncoating
transcription/ translation
nucleus

Pathogenesis



- Targets endothelial cells, mononuclear phagocytes, and hepatocytes
- Hemorrhagic diathesis
- Massive damage to the cells of the phagocyte mononuclear system

Pathogenesis



Symptoms

- Nonspecific flu-like symptoms
- Severe bleeding and coagulation abnormalities, and a range of hematological irregularities
- Exaggerated inflammatory responses
- Disseminated intravascular coagulopathy
- Diffuse bleeding

Ebola Patient (Intensive Care)

Epidemiology

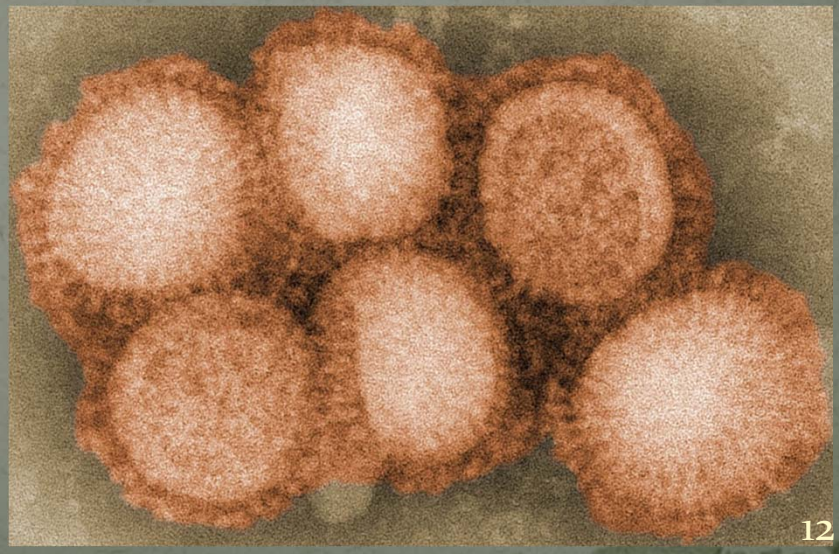
- Major outbreaks: central Africa
- Isolated outbreaks: Ivory Coast
- Natural reservoir: bats are considered the most likely candidate
- Transmitted through bodily fluids and conjunctiva exposure

Prevention / Treatment

- Vaccines have successfully protected non-human primates
- Vaccines for human are still on clinical trial
  - Adenoviral (ADL) vector
  - Attenuated recombinant vesicular stomatitis virus(VSV)
- No standard treatment for EHF; no way to heal.

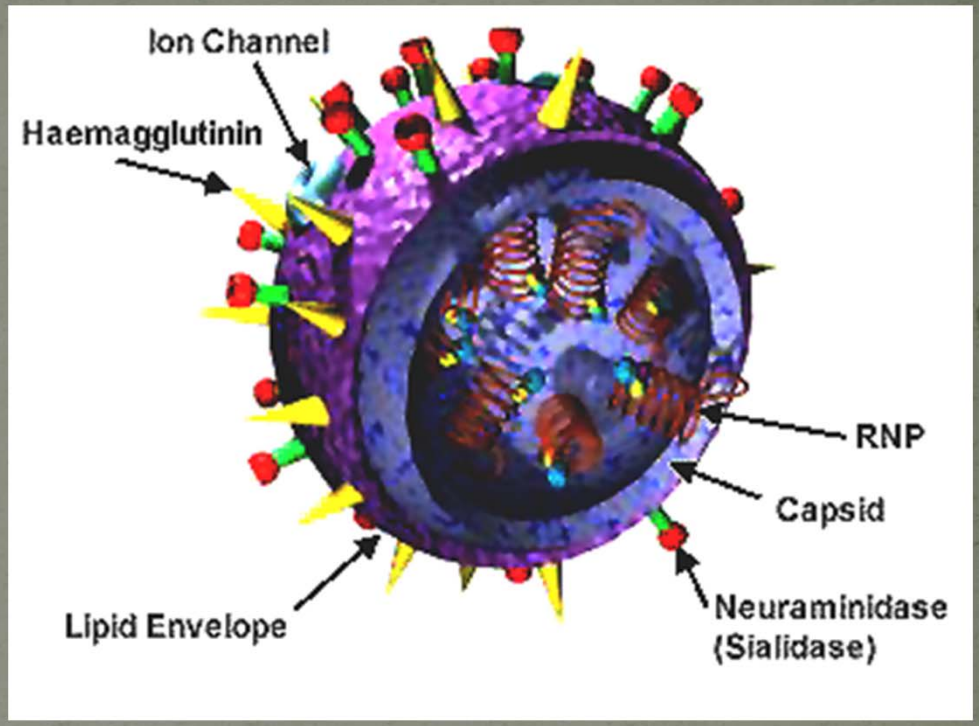
Influenza Viruses

- RNA viruses of the family *Orthomyxoviridae*
- 3 types: influenza A, B and C
- Causes influenza, commonly referred to as the flu
- Results in 500,000 global deaths per year.



Virology

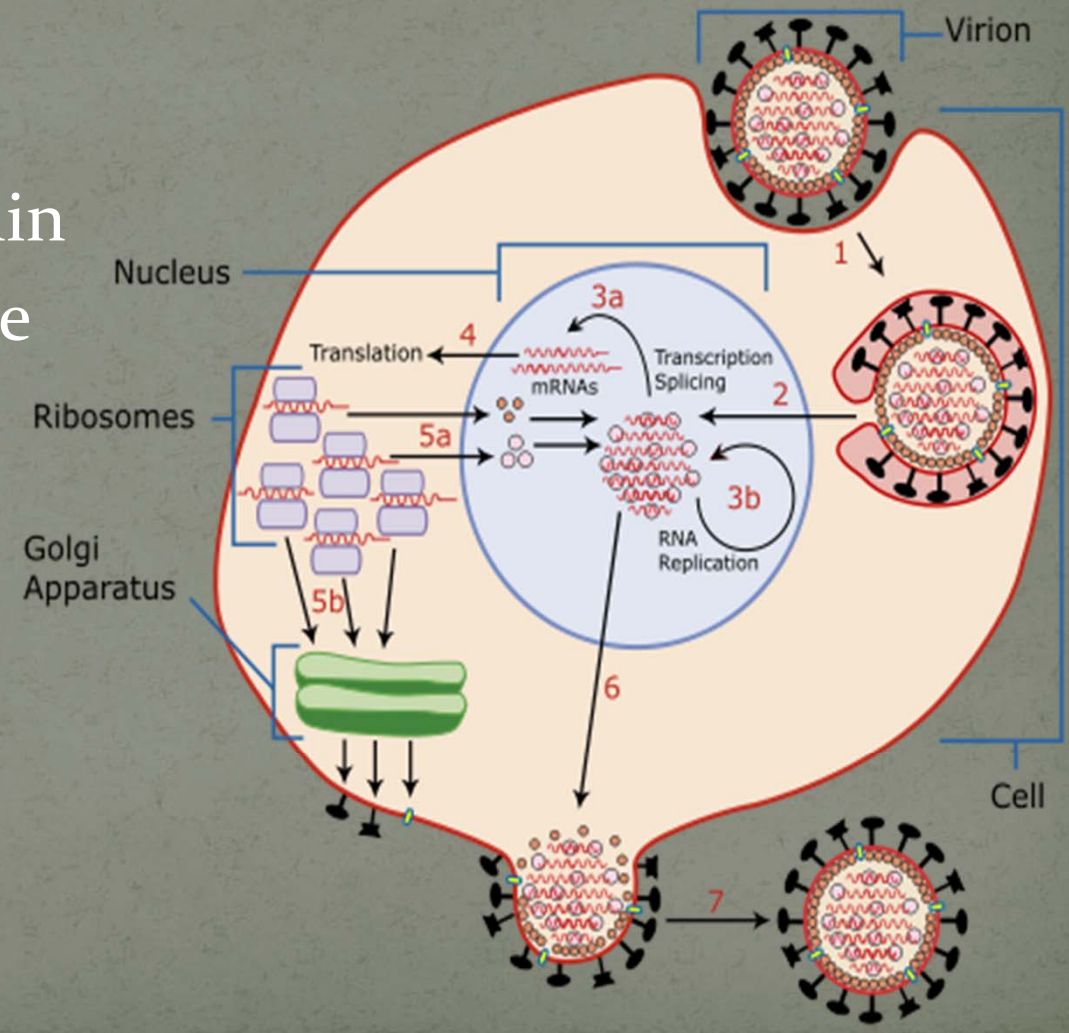
- Structure:
  - Enveloped virus
  - Spherical or filamentous in form



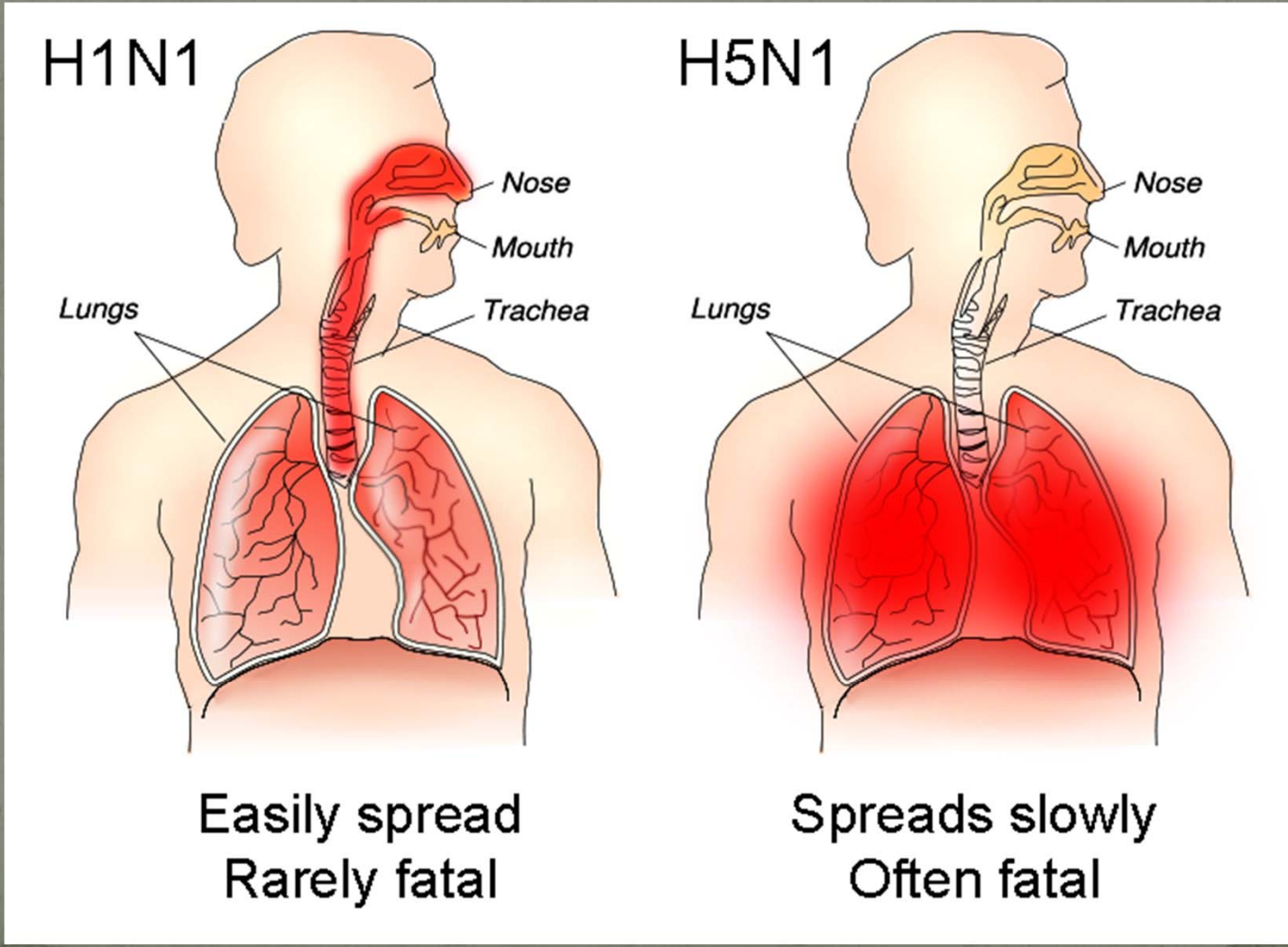
- Genome:
  - negative sense, single-stranded, segmented RNA
  - contained on 8 single (non-paired) RNA strands that encode for 11 proteins

Life Cycle

- HA: Haemagglutinin
- NA: Neuraminidase



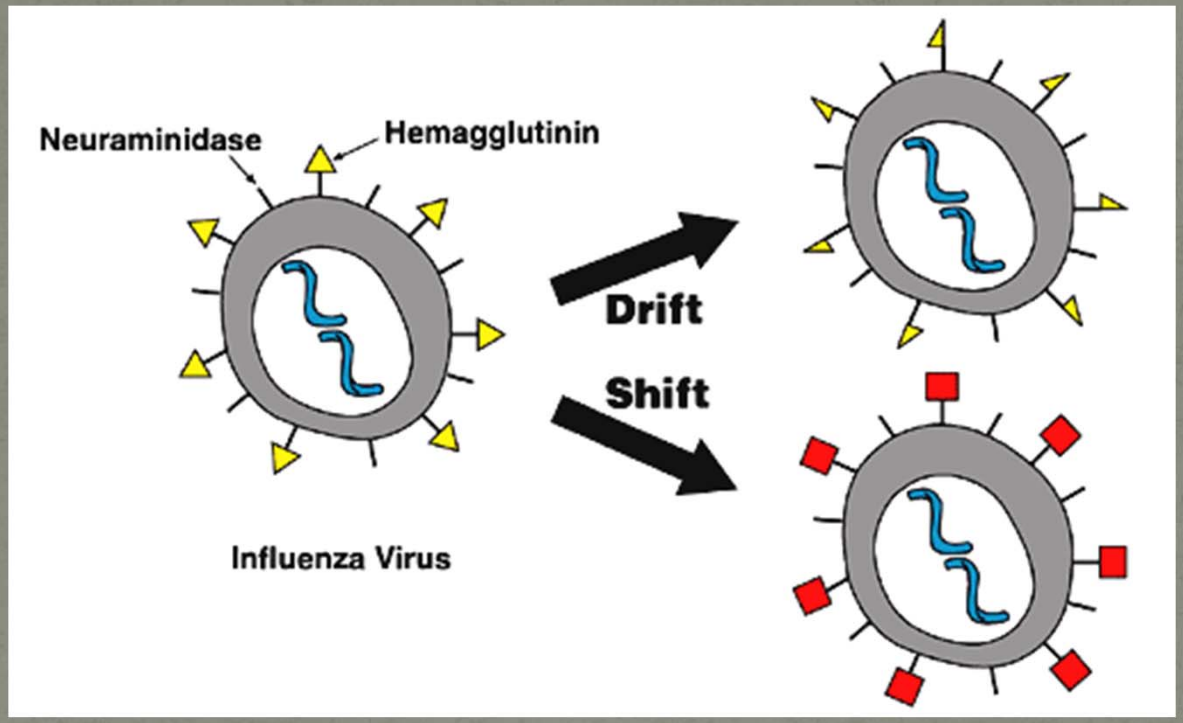
Pathophysiology



Epidemiology

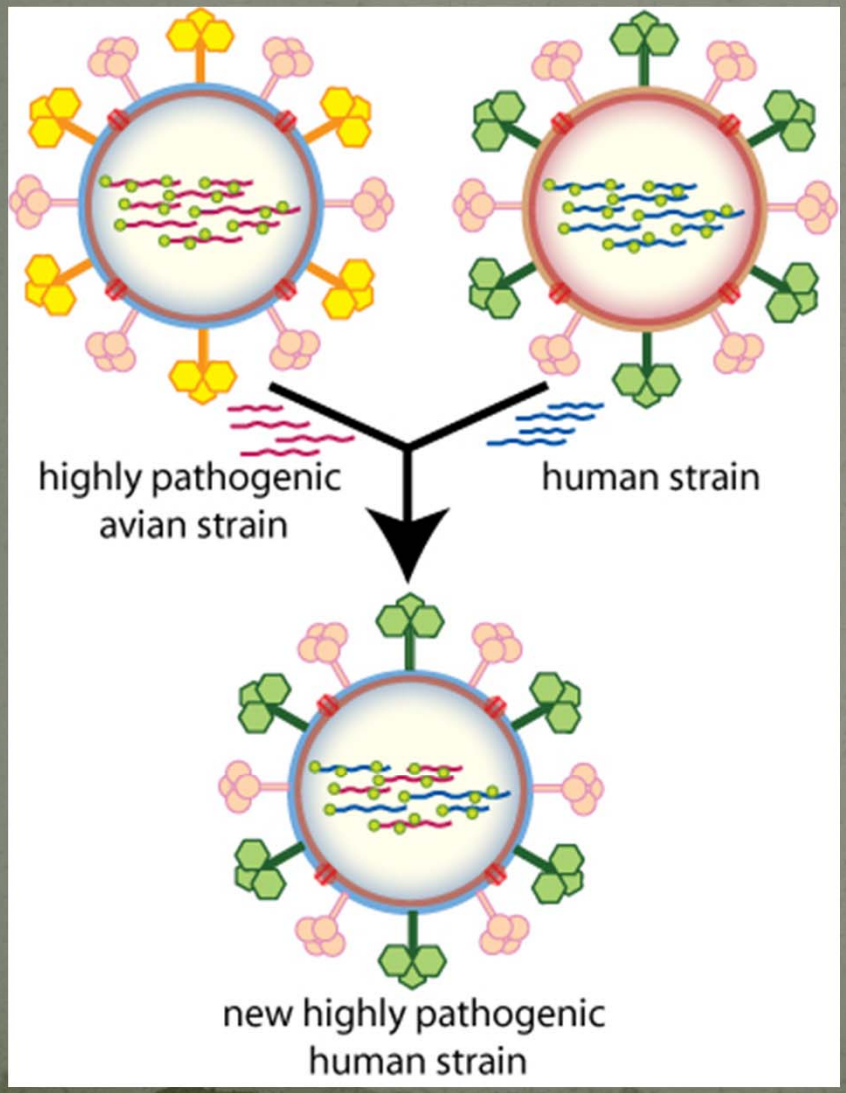
- Transmitted through droplets and personal contact.
- Influenza spreads around the world in seasonal epidemics, resulting in the deaths of 250,000 and 500,000 people every year, up to millions in some pandemic years. Each of these pandemics is caused by the appearance of a new strain of the virus in humans.

Antigenic Drift & Antigenic Shift



- Antigenic drift creates influenza viruses with slightly modified antigens.
- Antigenic shift generates viruses with entirely novel antigens.

Reassortment of Influenza Viruses



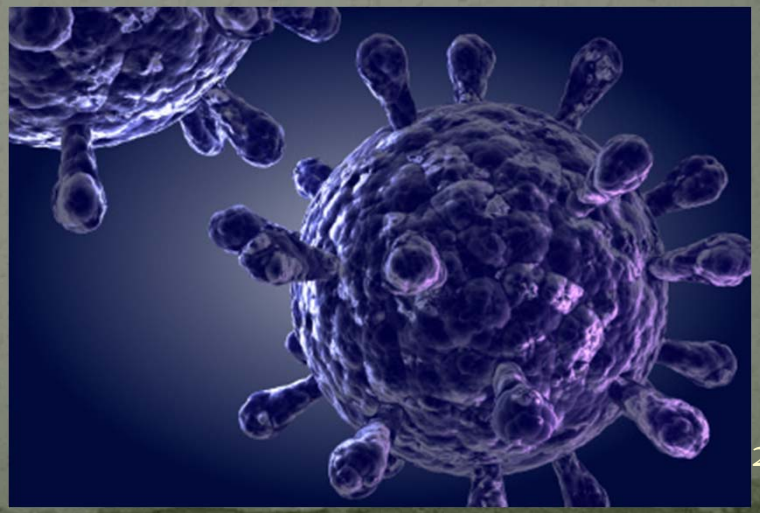
- Intermediate Host:
  - Pig
  - Human

Prevention / Treatment

- Vaccines are often recommended for high-risk groups
- A particular influenza vaccine usually confers protection for no more than a few years
- Researchers are looking at non-egg-based options for vaccine production

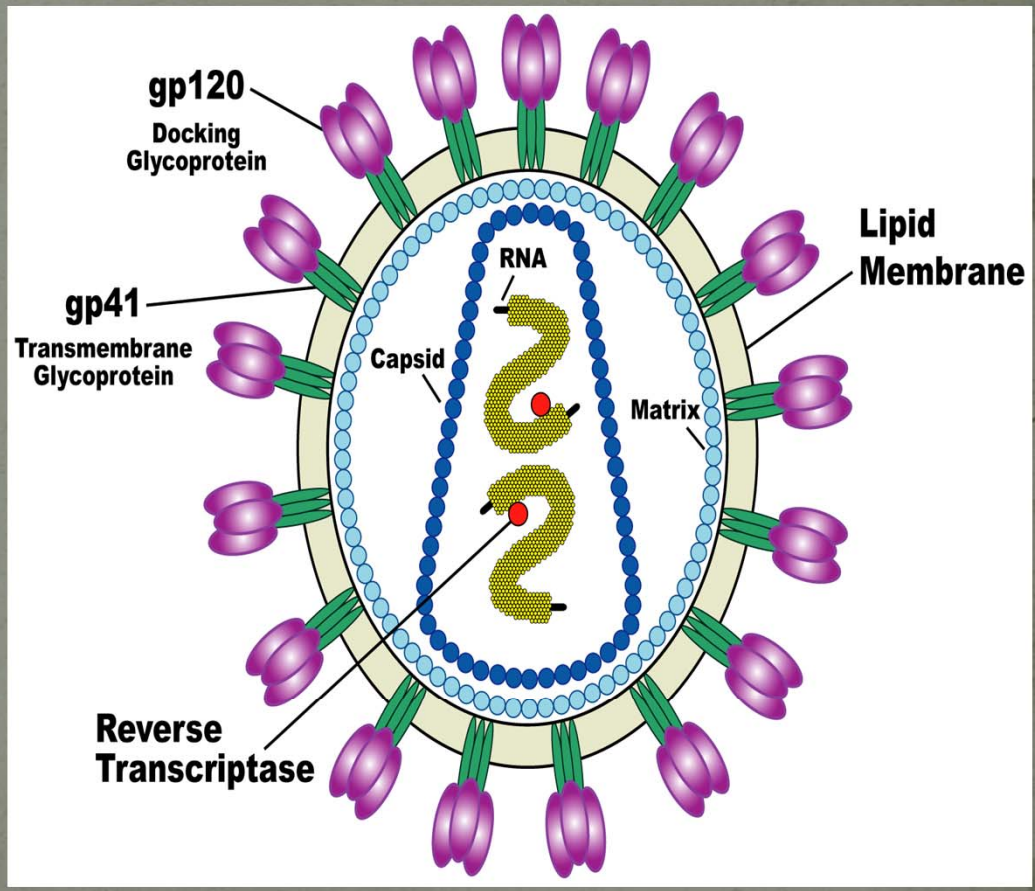
Human immunodeficiency virus

- Originated in non-human primates in sub-Saharan Africa and was transferred to humans late in the 19th or early in the 20th century
- A lentivirus of family *Retroviridae*
- Causes acquired immunodeficiency syndrome (AIDS)
- Results in 3.1 million global deaths per year



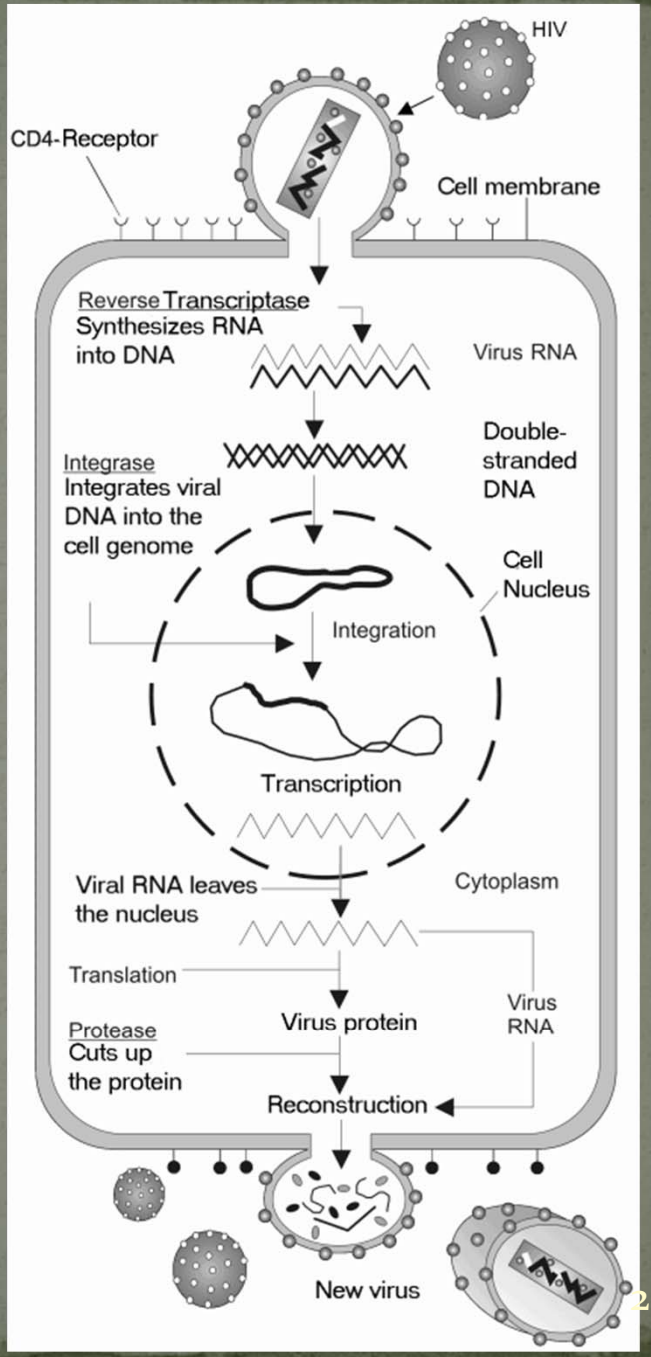
Virology

- Structure:
  - Enveloped virus
  - Roughly spherical
- Genome:
  - 2 copies of positive single-stranded RNA



Life Cycle

- Entry to the cell:
  - Adsorption
  - Fusion
  - HIV capsid release
- Replication and transcription:
  - Reverse transcriptase
  - Host cellular DNA polymerase
  - RNA polymerase II
- Assembly and release



Pathogenesis

- Infects primarily vital cells in the human immune system
- Leads to low levels of CD4+ T cells through 3 main mechanisms:
  - Direct viral killing of infected cells
  - increased rates of apoptosis in infected cells
  - killing of infected CD4+ T cells by CD8 cytotoxic lymphocytes that recognize infected cells
- Lose cell-mediated immunity and the body become progressively more susceptible to opportunistic infections.

Prevention / Treatment

- No effective vaccine against HIV exists.
- HAART - highly active antiretroviral therapy
  - Can suppress virus load to undetectable level
  - Restore immunity (CD_4 cells increase)
  - Improve health (reduced complications)
  - Problems: side effects, life long treatment

The End.