

Structure & Function of Viruses

Discovery of Viruses

- Louis Pasteur- looks for a causative agent for rabies, says too small, can not find it
- 1892 Dimitry Ivanosky- studies tobacco disease, can not find bacteria responsible thinks the cause is a toxin
- 1898 Martinus Beijerinck- not convinced says causative agent is a fluid pathogen... called it a virus
- Wendell Stanley- show that virus to be a particle not a fluid
- F. Loeffler & Frosch- identify first animal virus, a aphthovirus, that causes foot and mouth disease

Discovery of Viruses

- Frederick Twort- discovers bacteriophages
- 1931 Ernst Ruska & Max Knoll- first to capture an image of a virus using the electron microscope
- 1935 W. Stanley- determines tobacco virus consists of mainly protein and some nucleic acids
- 1955 H.F. Conrat & R. Williams show that the tobacco virus can self assemble its proteins and nucleic acids

**Tobacco
Mosaic Virus**



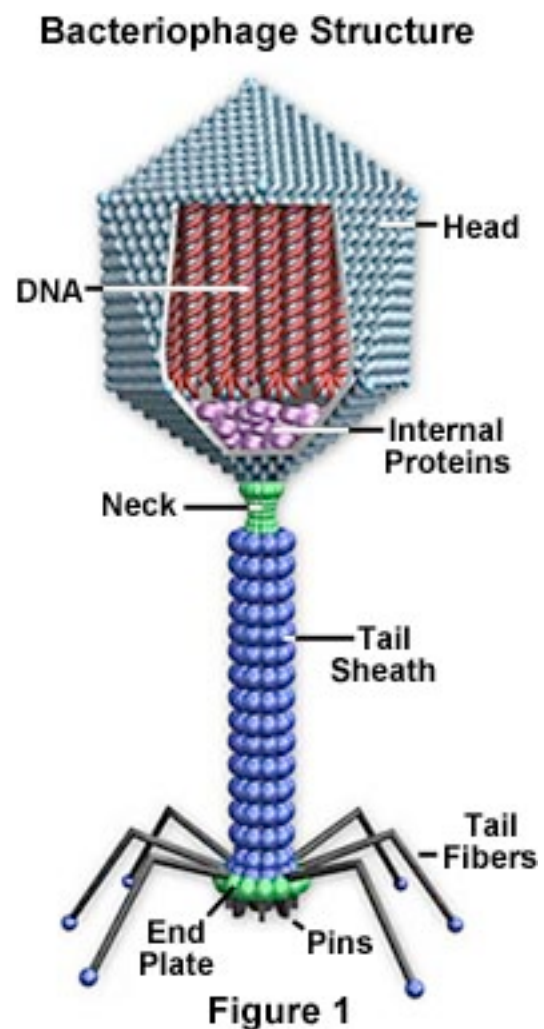
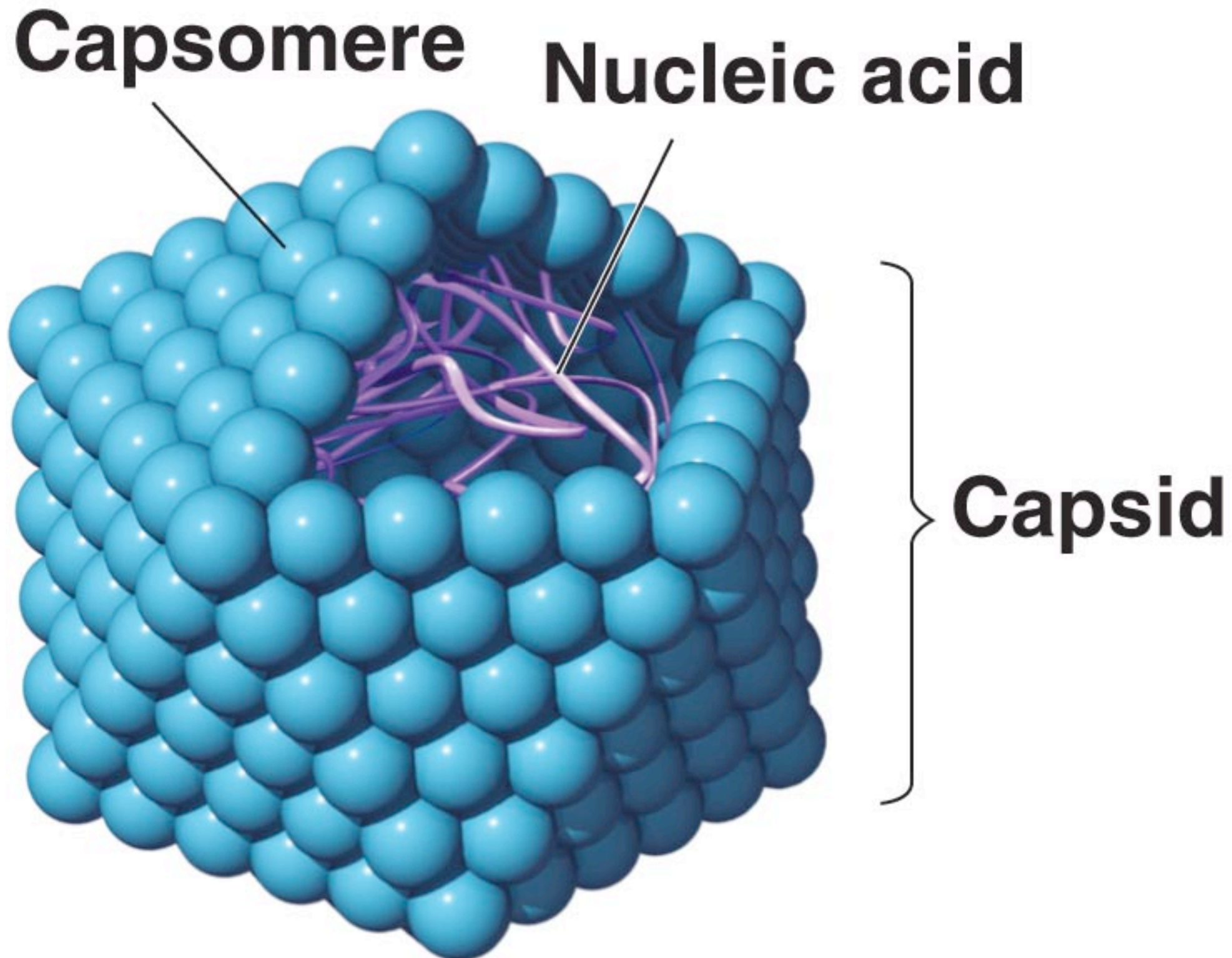
Discovery of Viruses

- Second half of the 20th century becomes known as the “golden age” of viral discoveries
- 1957 Bovine Diarrhea virus discovered
- 1963 Hepatitis B virus discovered
- 1965 the first retrovirus is discovered and described
- 1970 reverse transcriptase is discovered
- 1983 HIV is isolated

Viral Structure

- A virus has only 2-4 parts.
- ALL have a nucleic acid (DNA or RNA)
- ALL have a protein shell (*capsids*)
 - Some have membranous envelopes around them
 - Some carry enzymes like reverse transcriptase

Viral Structure



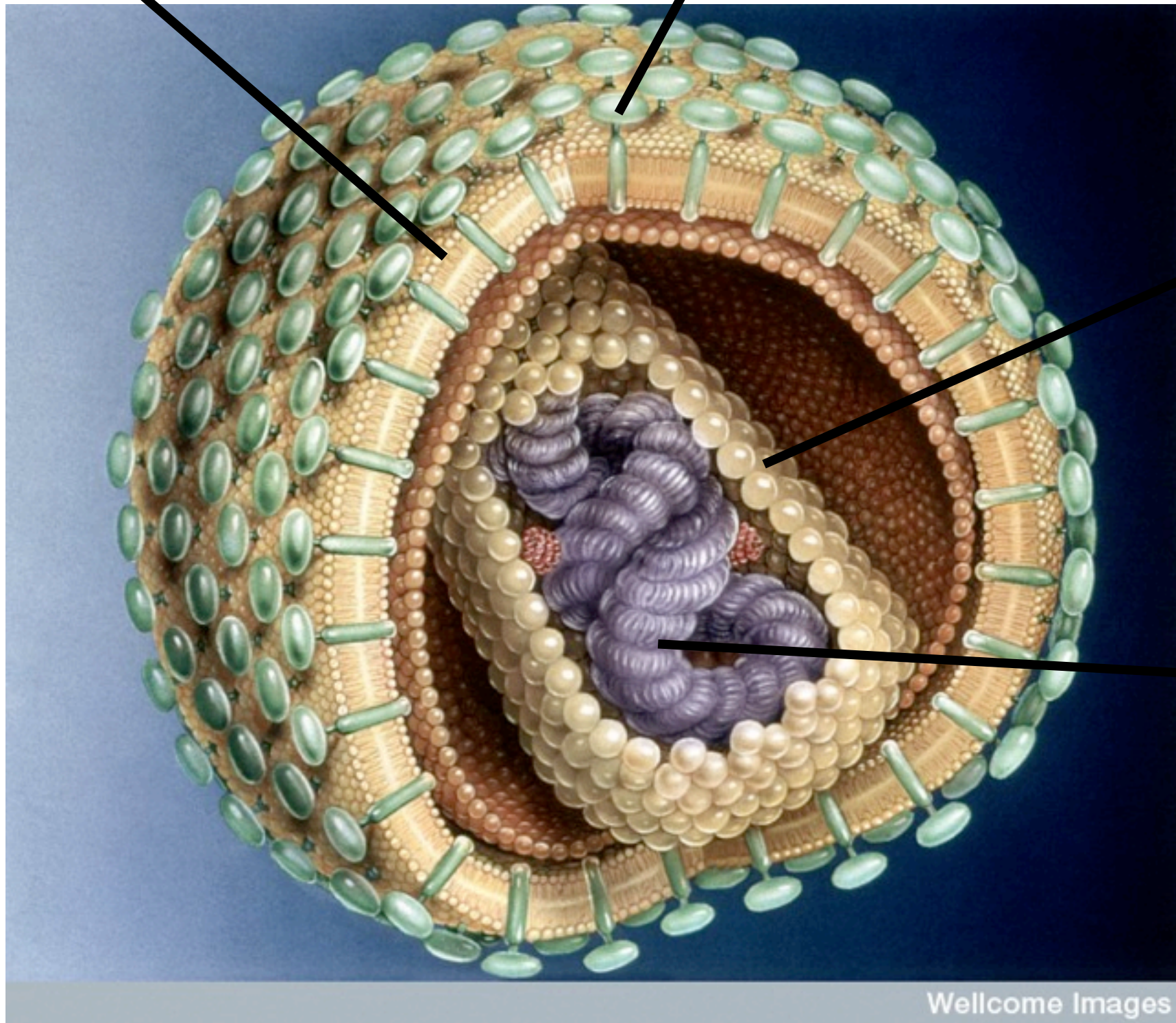
Viral Structure

Membranous Envelope

Glycoproteins

Capsid

DNA
or
RNA

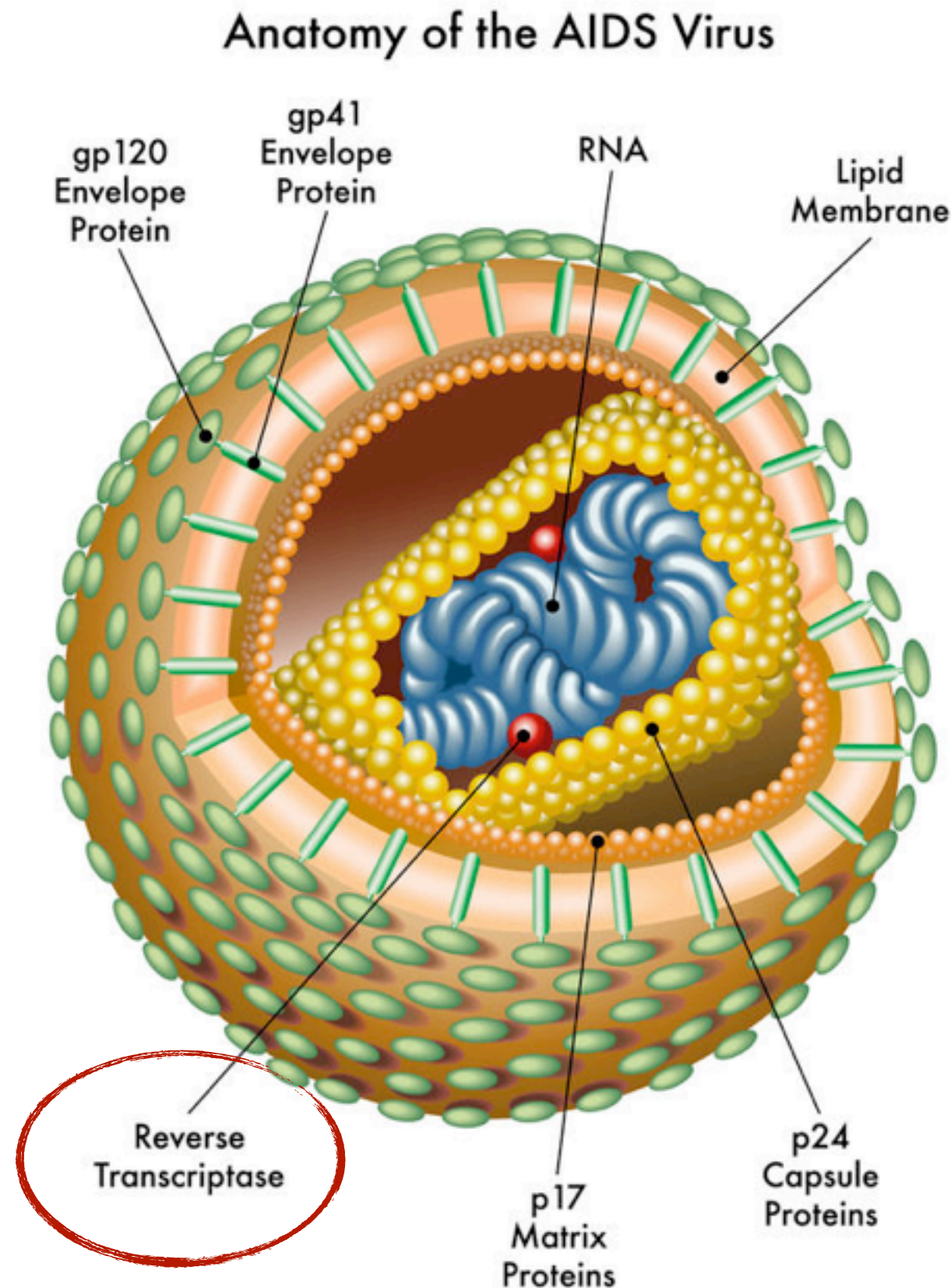


Wellcome Images

Viral Structure

A retrovirus carries reverse transcriptase to copy its RNA into DNA.

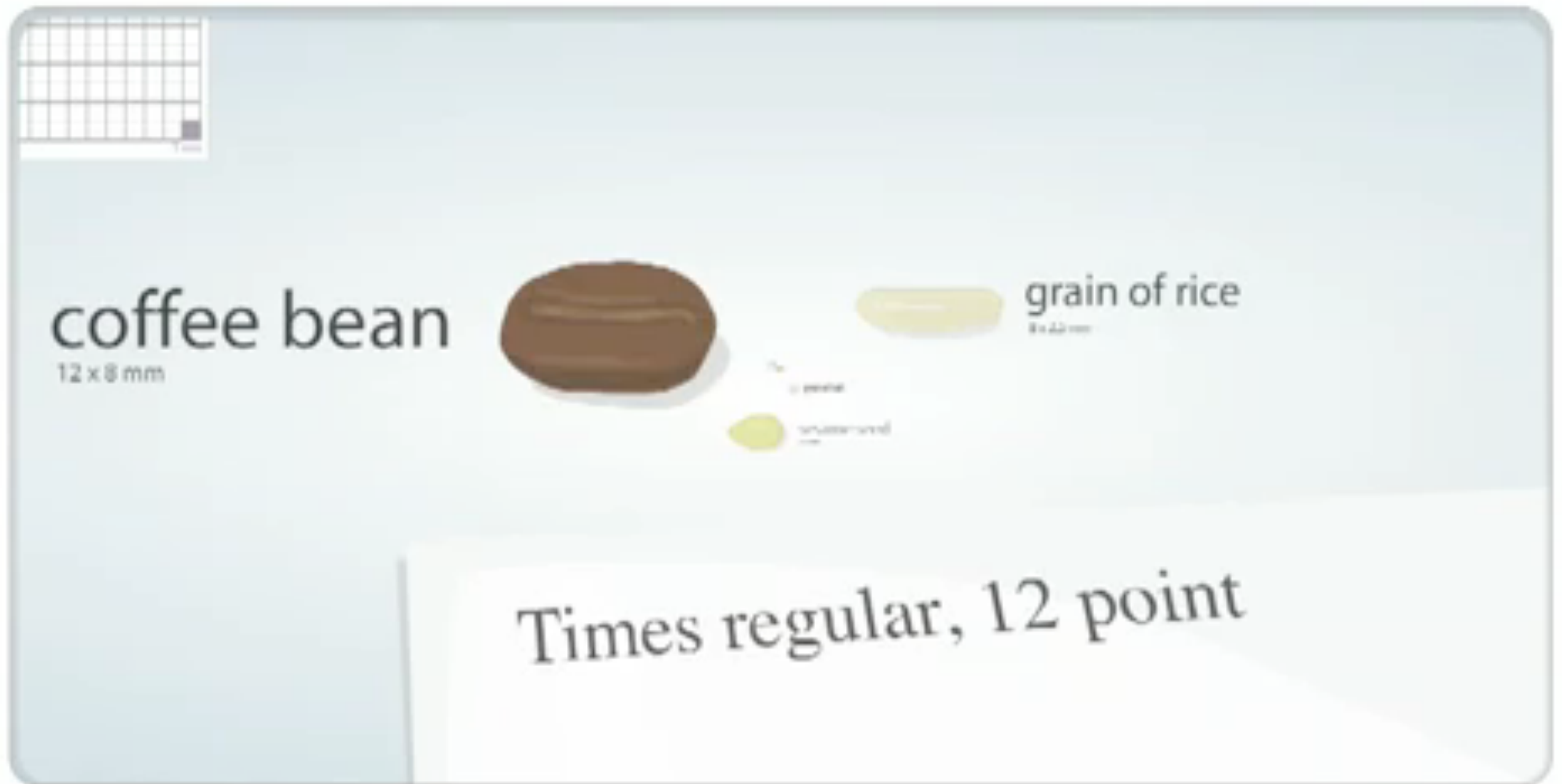
This allows the virus to incorporate its genes into the hosts genome.



Viral Structure: Size

Viruses are very small

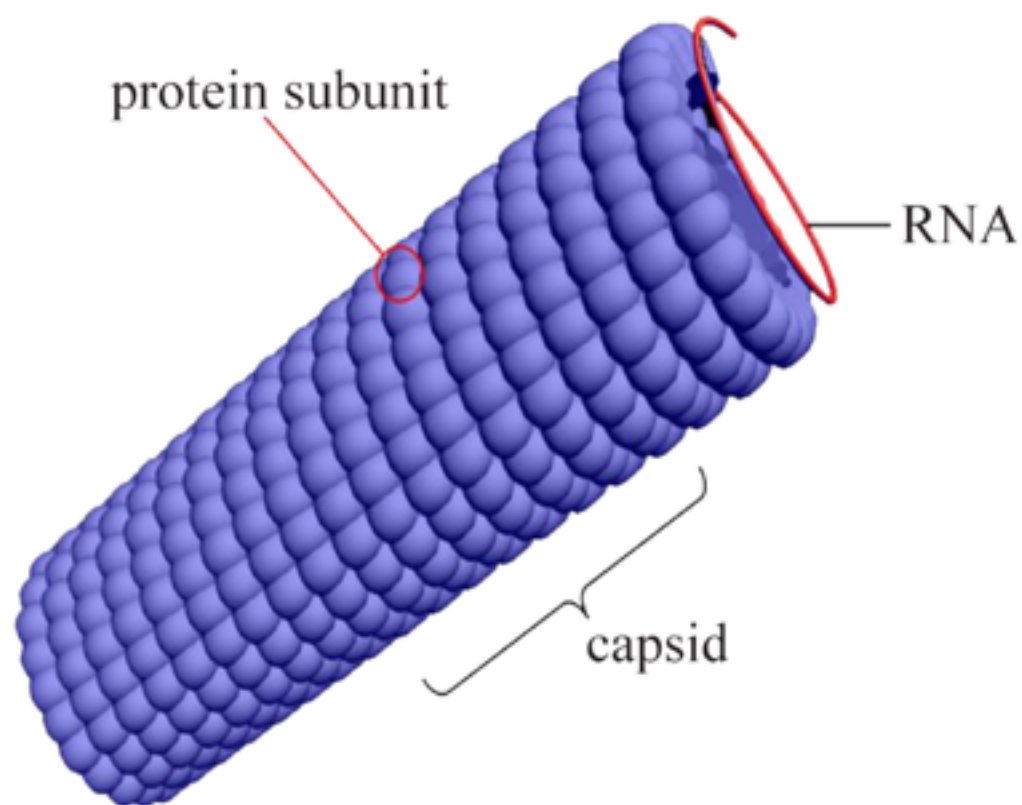
CELL SIZE AND SCALE



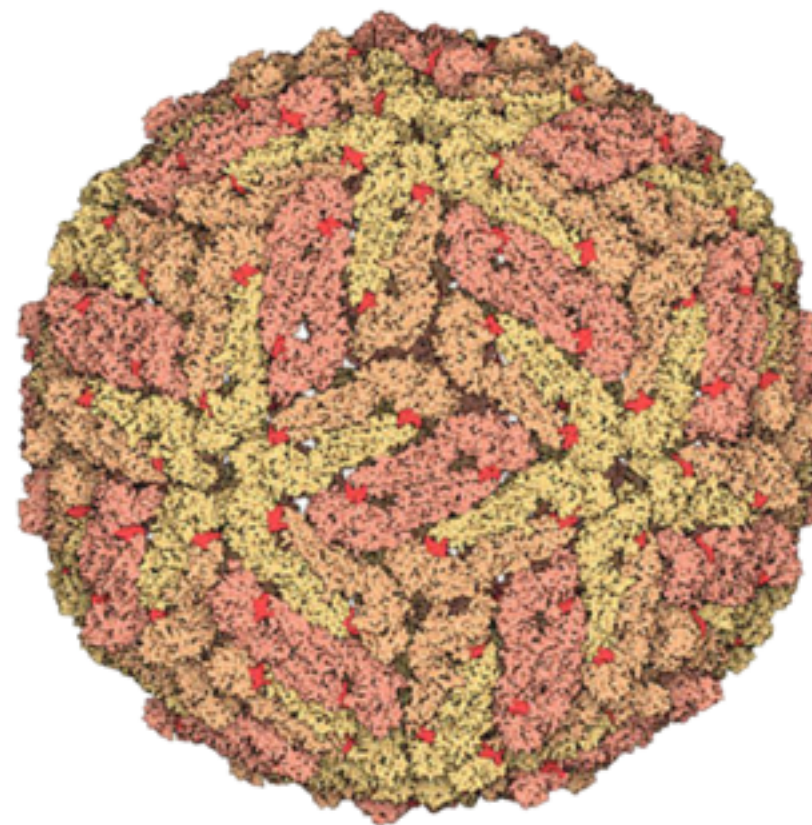
Viral Structure: Shape

Viruses come in three general shapes.

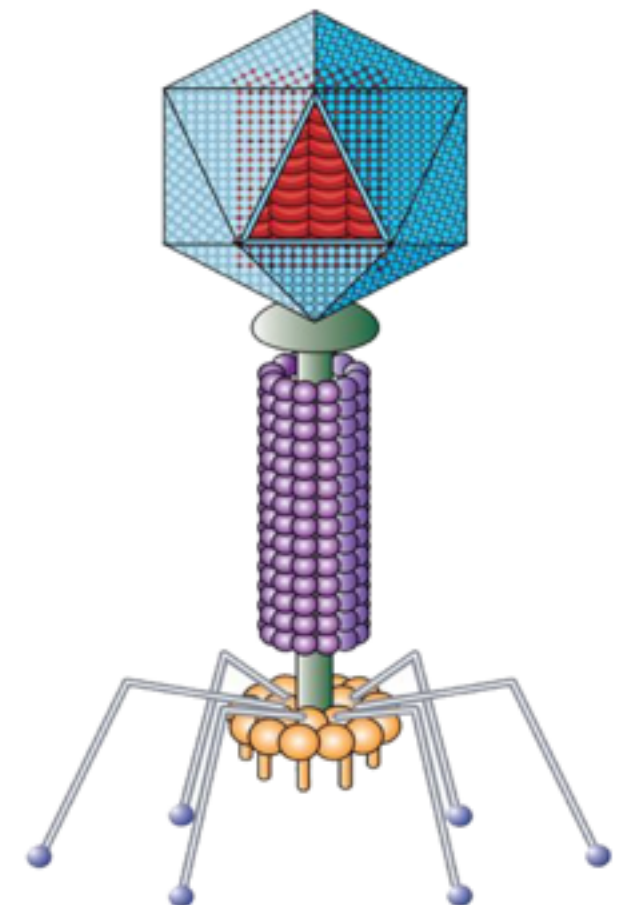
Helical



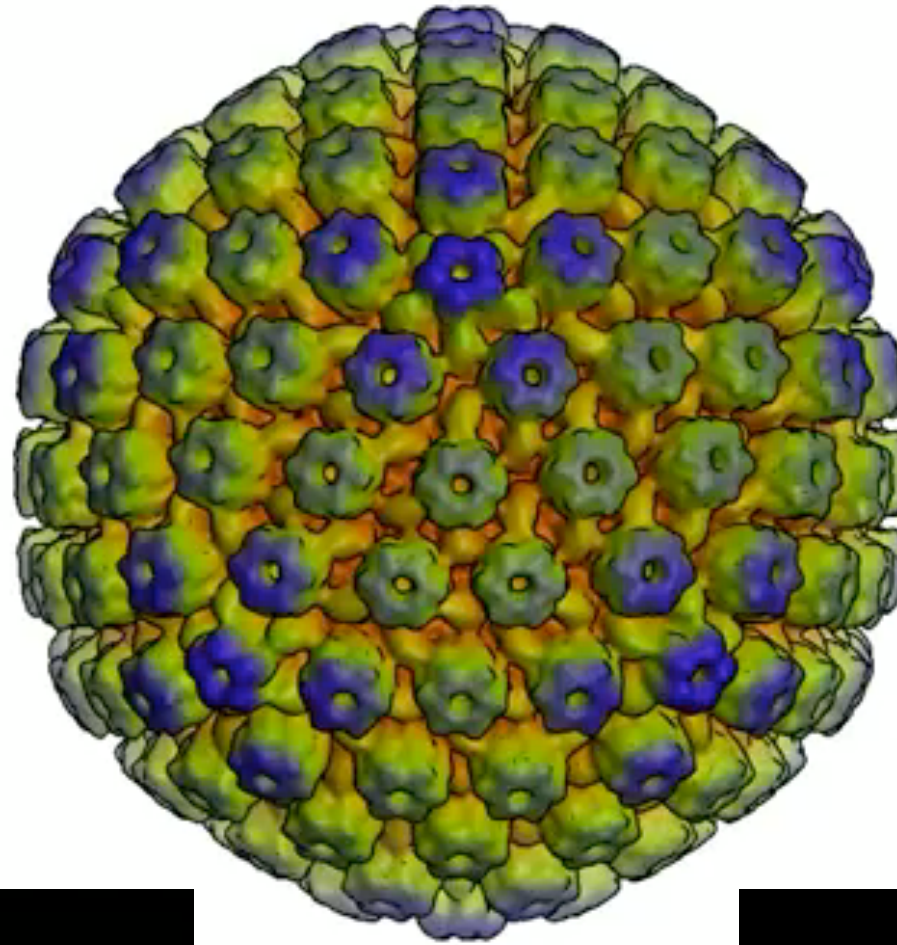
Icosahedral



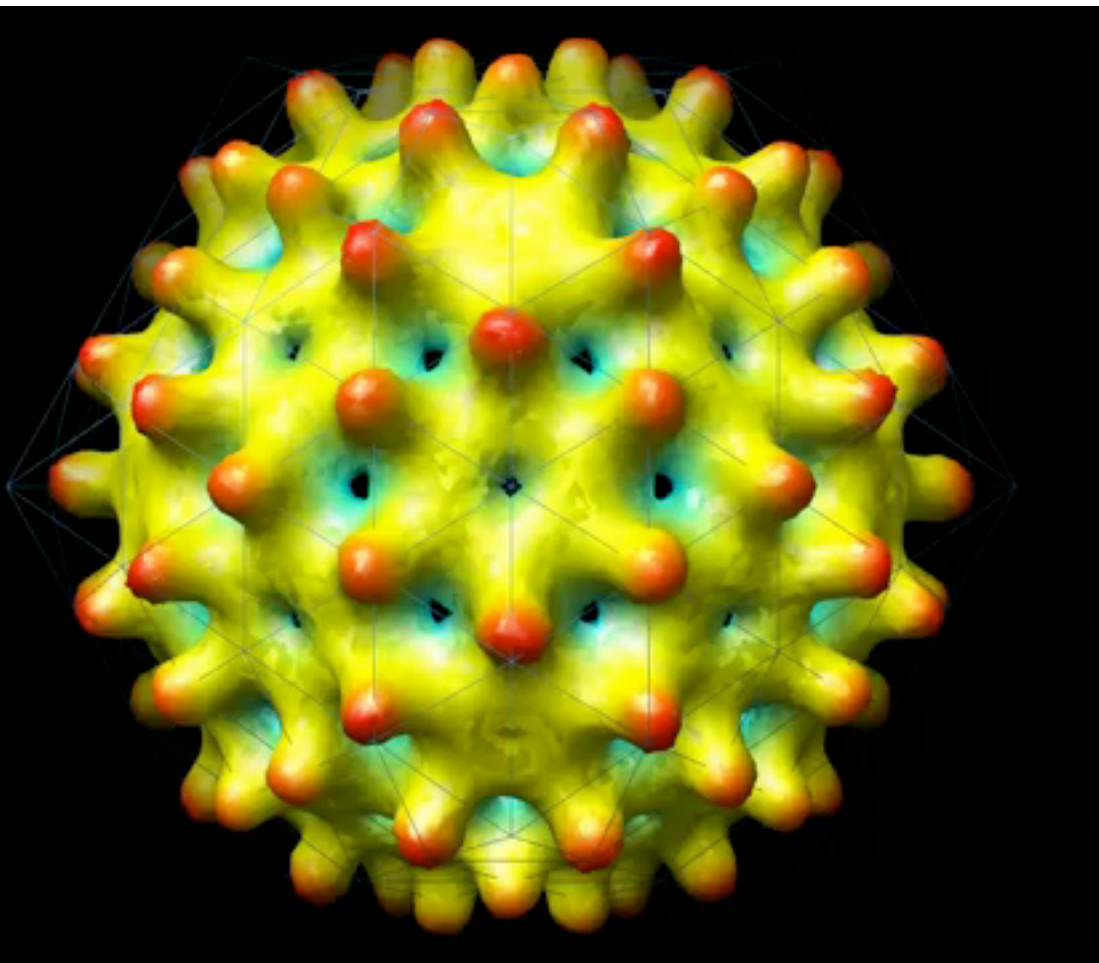
Complex



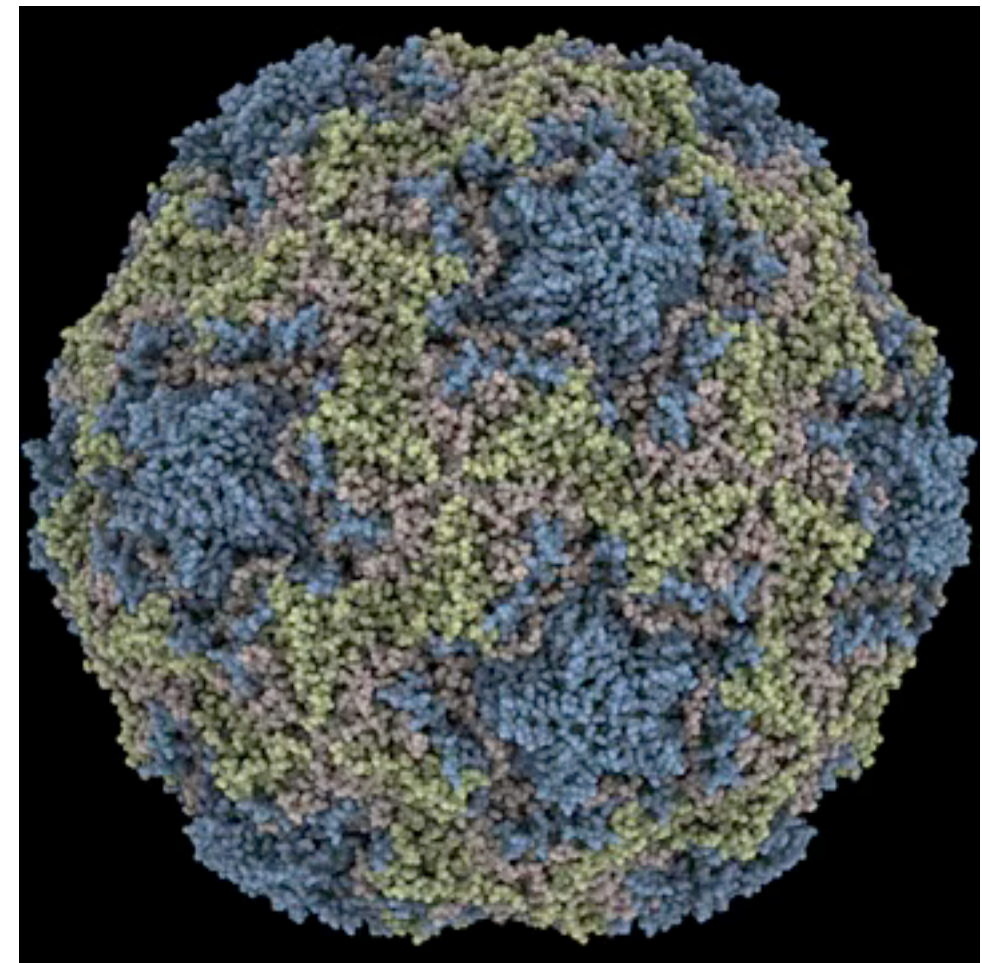
Herpes



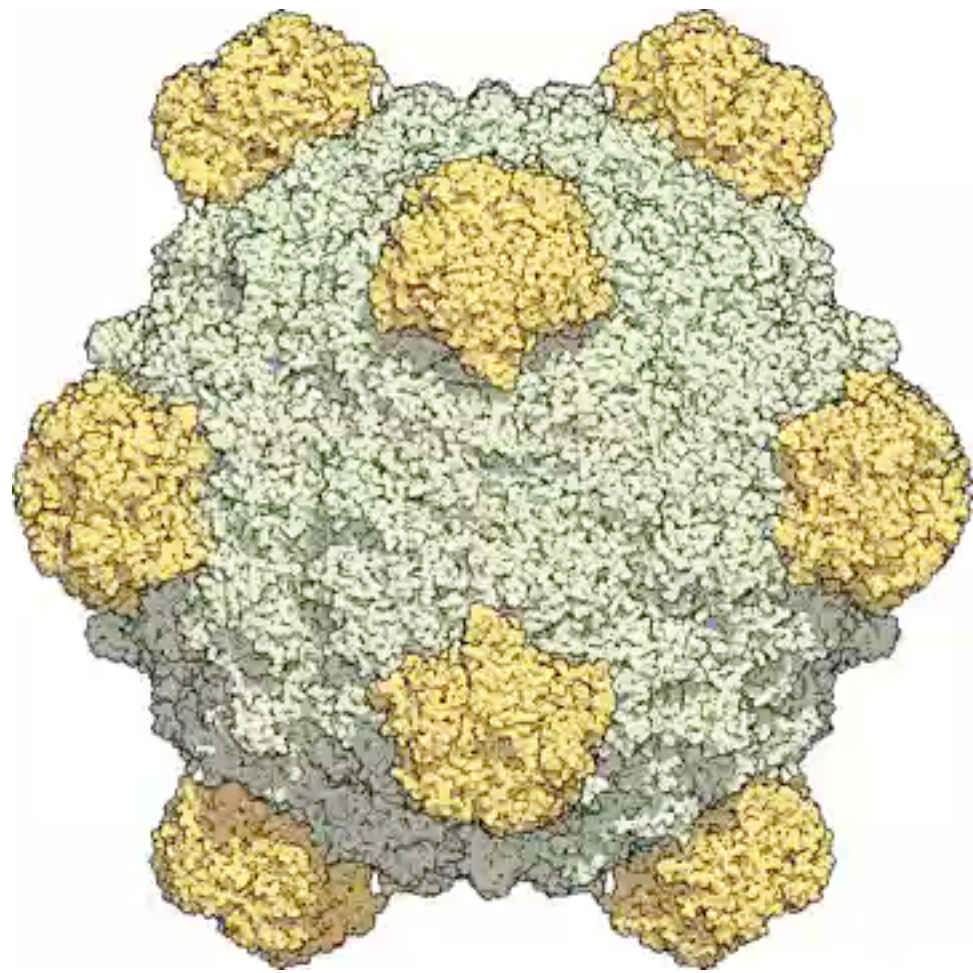
Hepatitis B



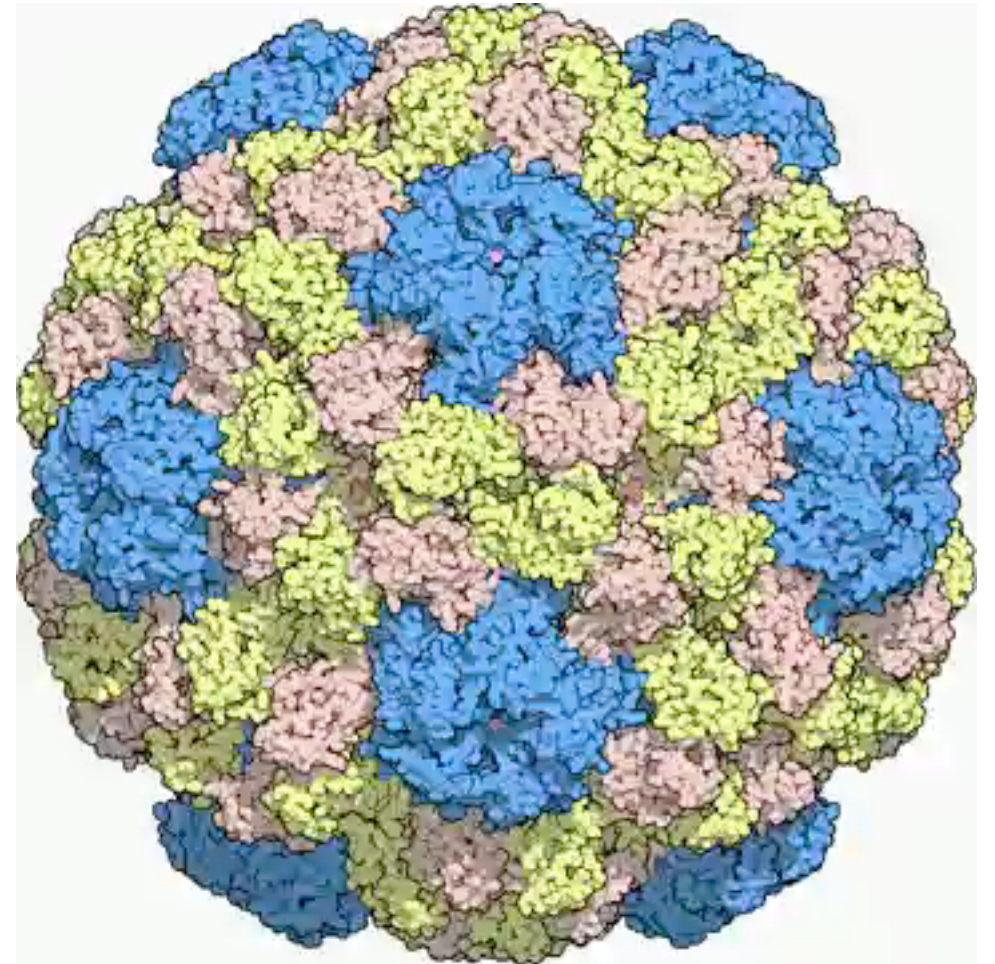
Rhinovirus



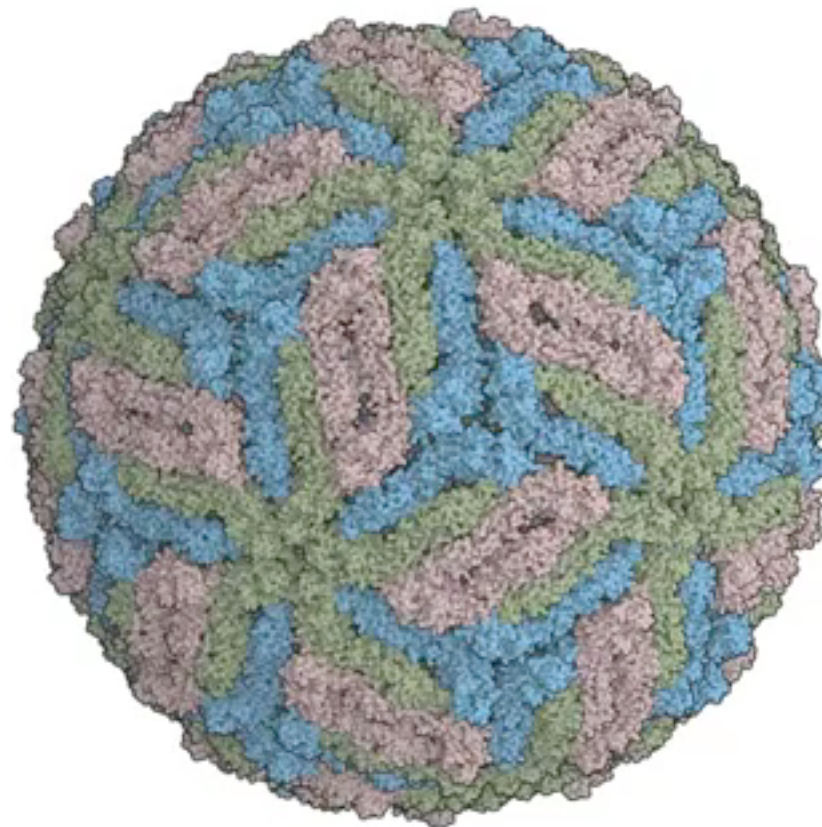
Bacteriophage



Brome Mosaic



West Nile



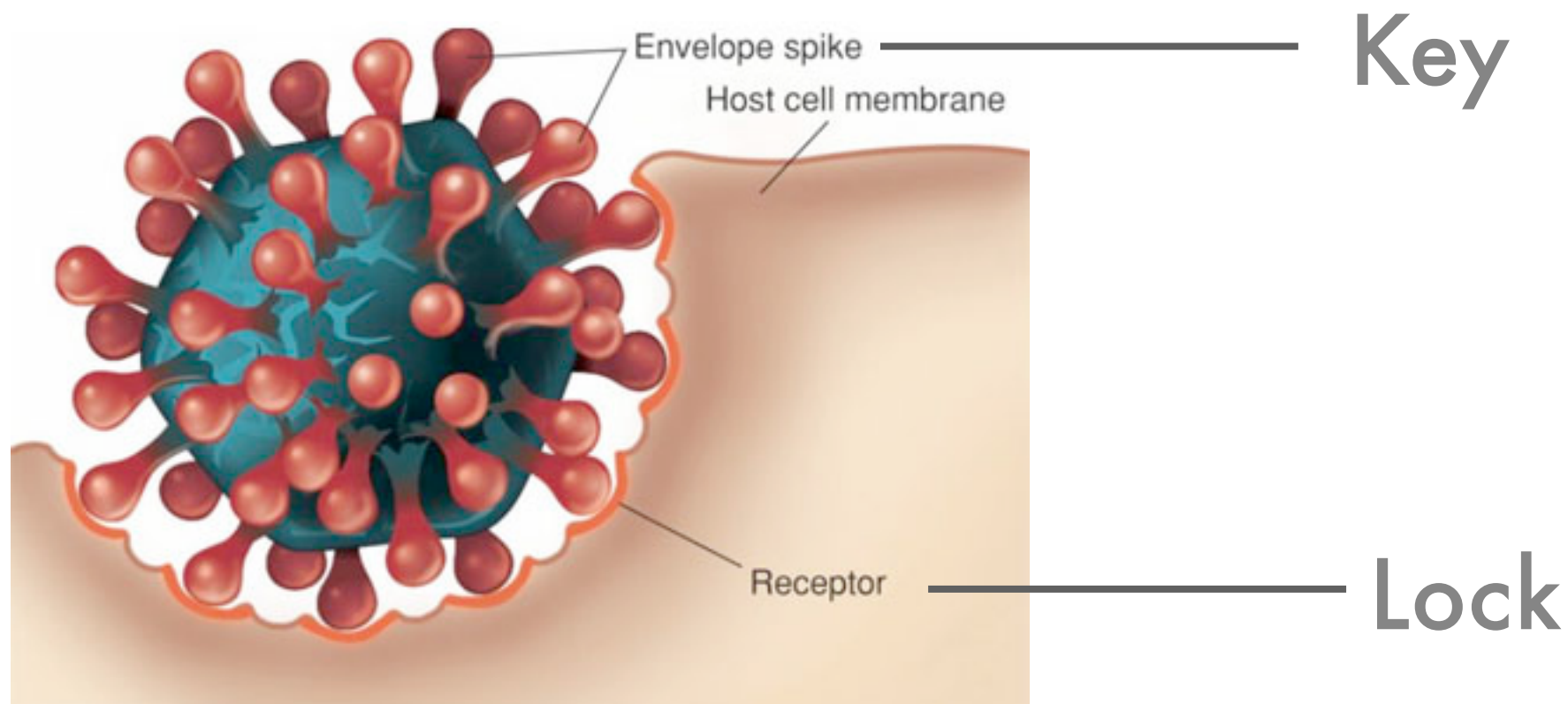
Viral Functions/Reproduction

- Viruses have no functions other than reproduction.
- In fact some debate whether they are even alive.

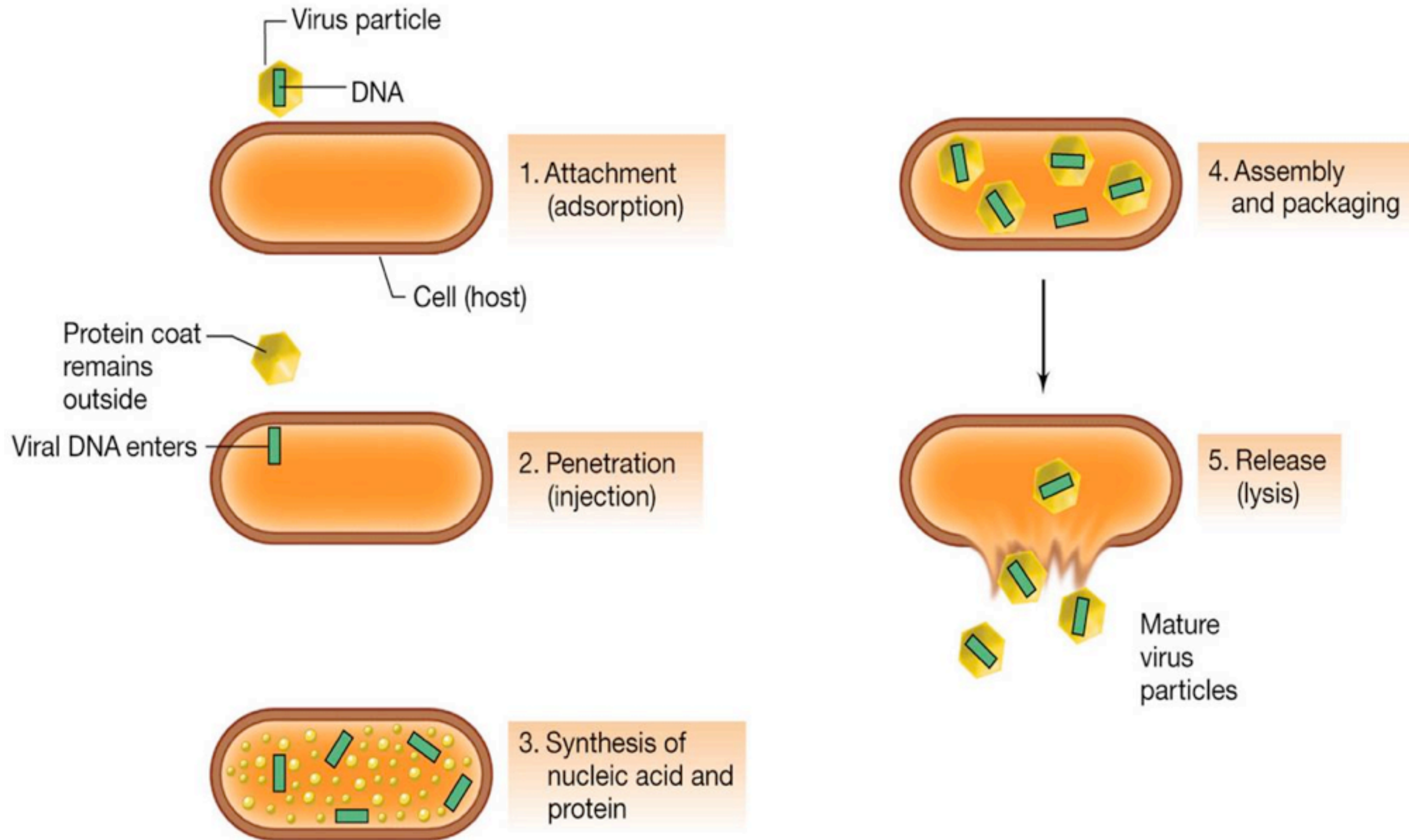
<i>Characteristics of Living Things</i>	<i>Virus</i>
Reproduce	They do but not by themselves, and inside a host cell they can self assemble
Made of Cells	No
Grow & Develop	No
Obtain & Use Energy	No
Respond to the Environment	No
Adapt to the Environment (evolve)	Yes

Viral Functions/Reproduction

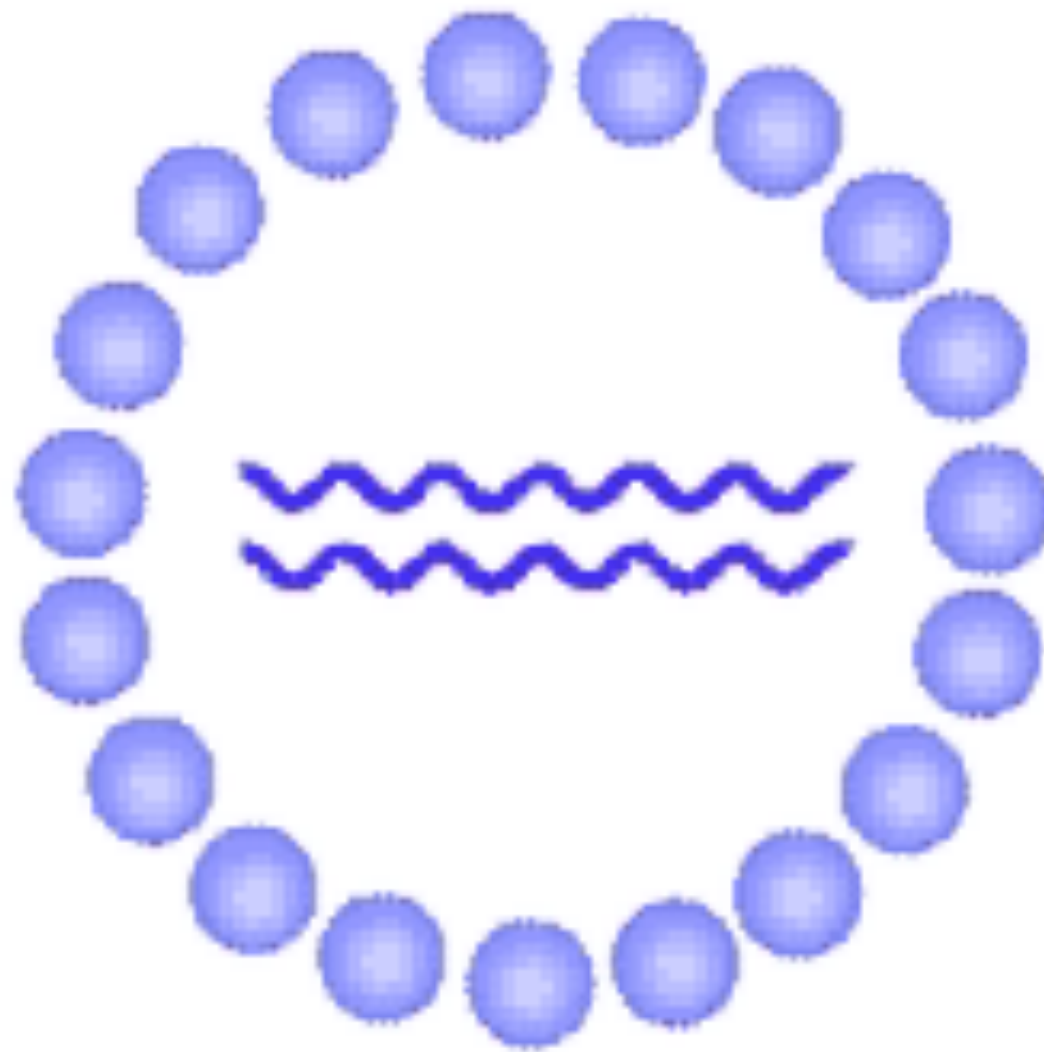
- Viruses are *obligate intracellular parasites*.
 - They require a host cell to reproduce.
- Each virus has a *host range*.
 - A limited number of hosts that it can infect and reproduce in.



Viral Reproduction: General Idea



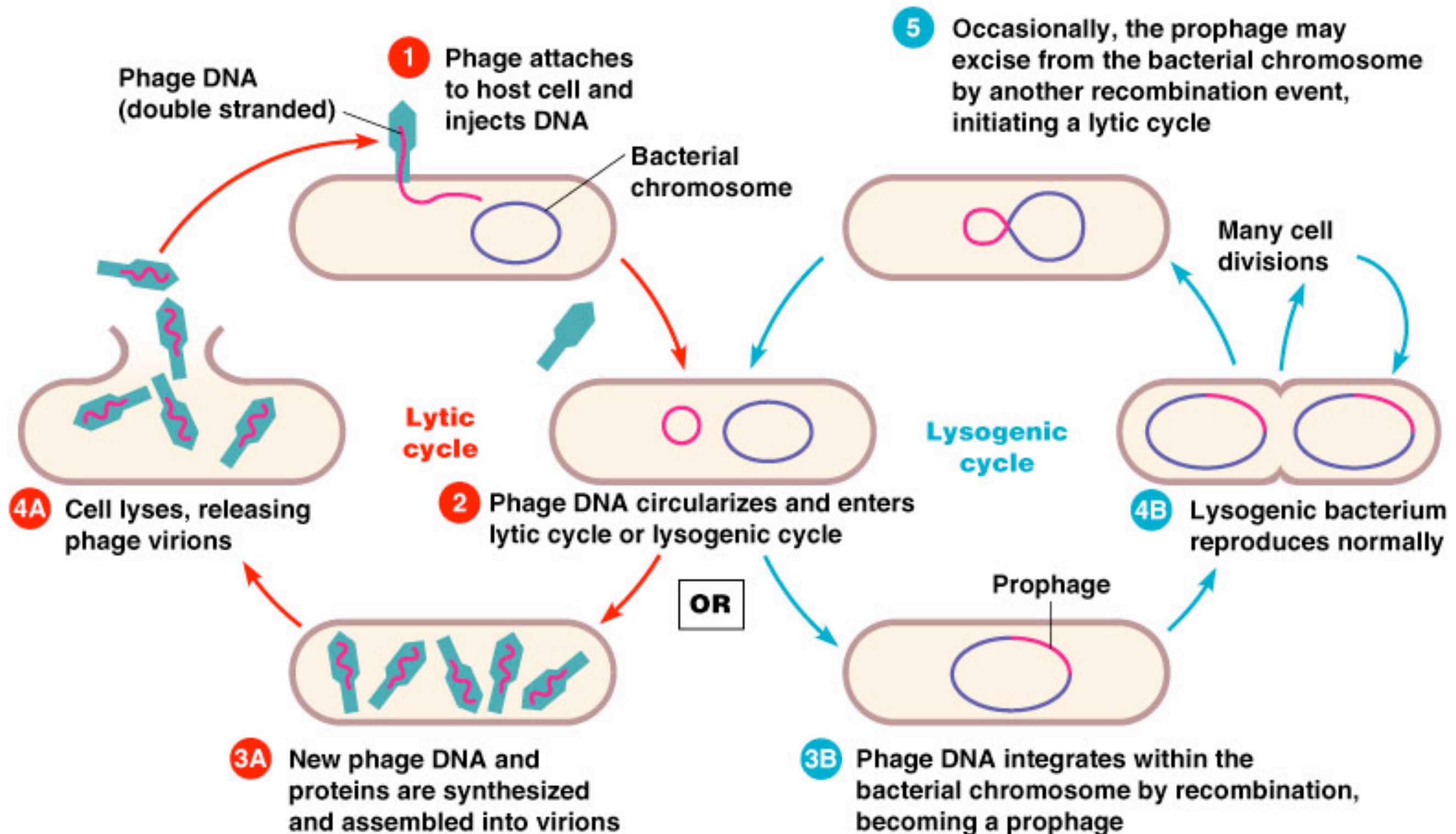
Viral Reproduction: General Idea



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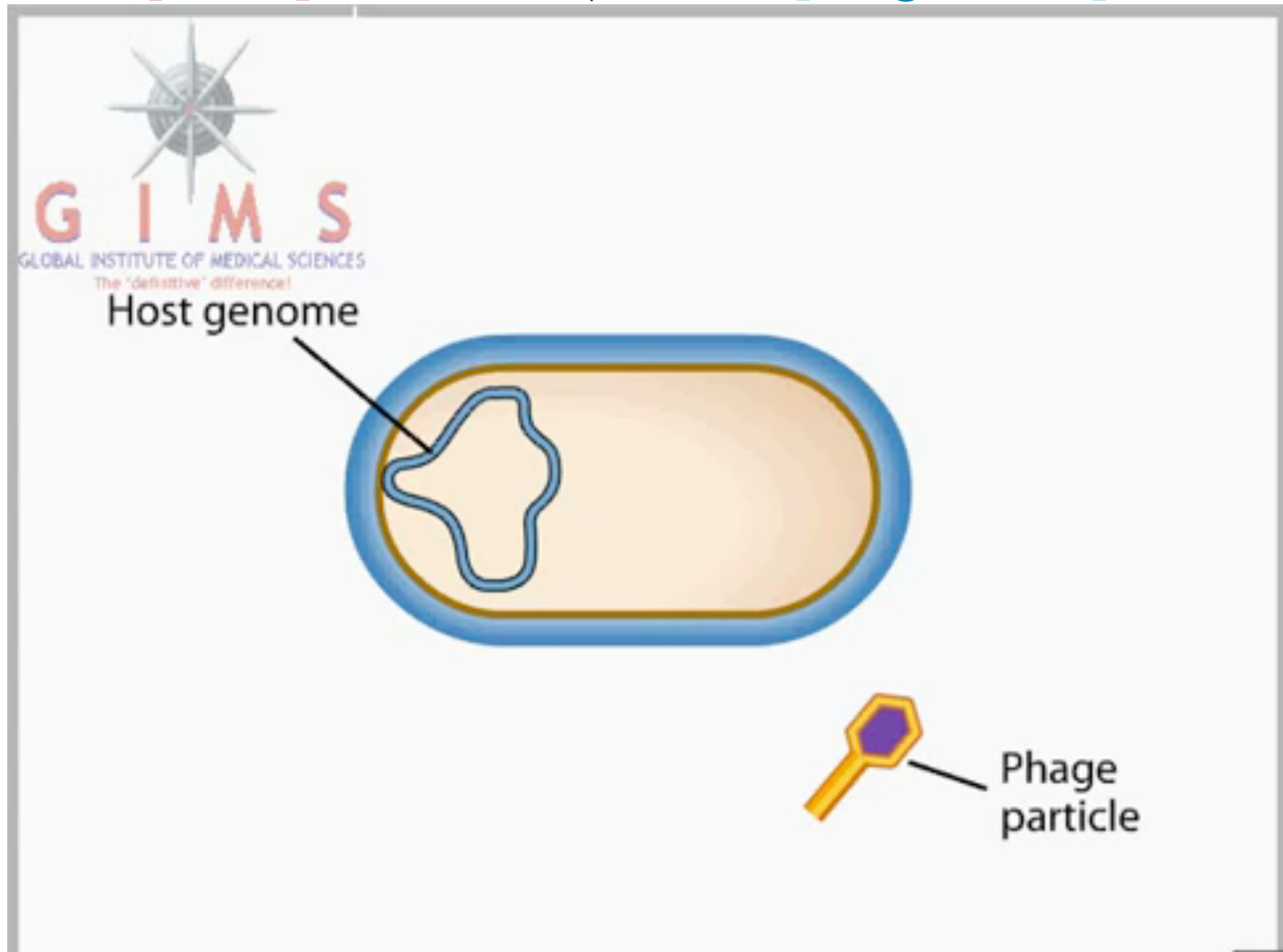
Viral Reproduction: Bacteriophages

Lytic Cycle and/or Lysogenic Cycles



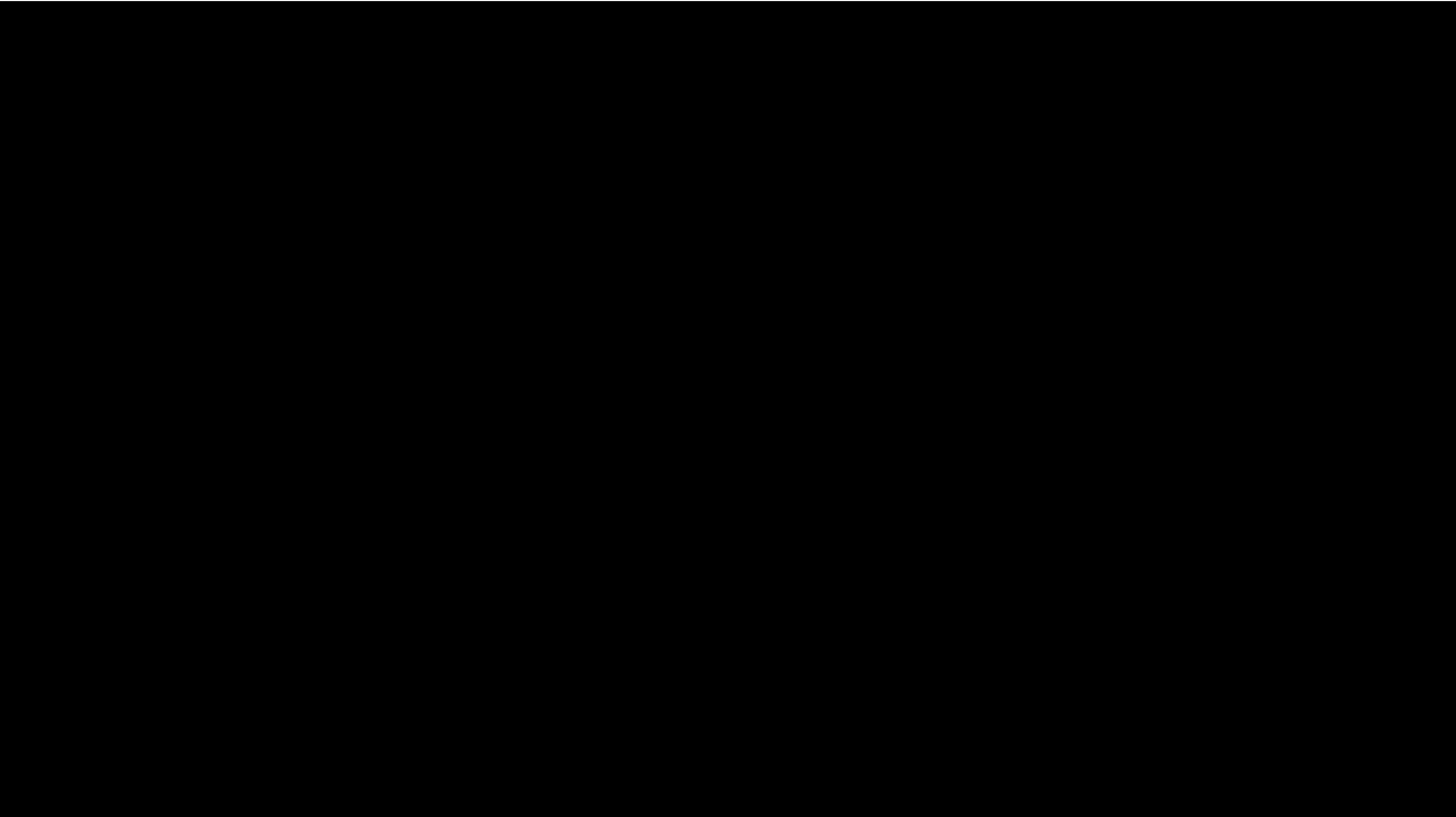
Viral Reproduction: Bacteriophages

Lytic Cycle and/or **Lysogenic Cycles**



Viral Reproduction: Bacteriophages

Bonus Animation...Super Cool



Viral Reproduction: Animal Viruses

- Viral reproduction in animal cells is not as well understood as those for the bacteriophages.
- The details of each step have yet to be worked out.
- In addition the variation in animal virus replication is immense.

General Steps

1. Viral adsorption

2. Viral entry

3. Viral movement

4. Viral release

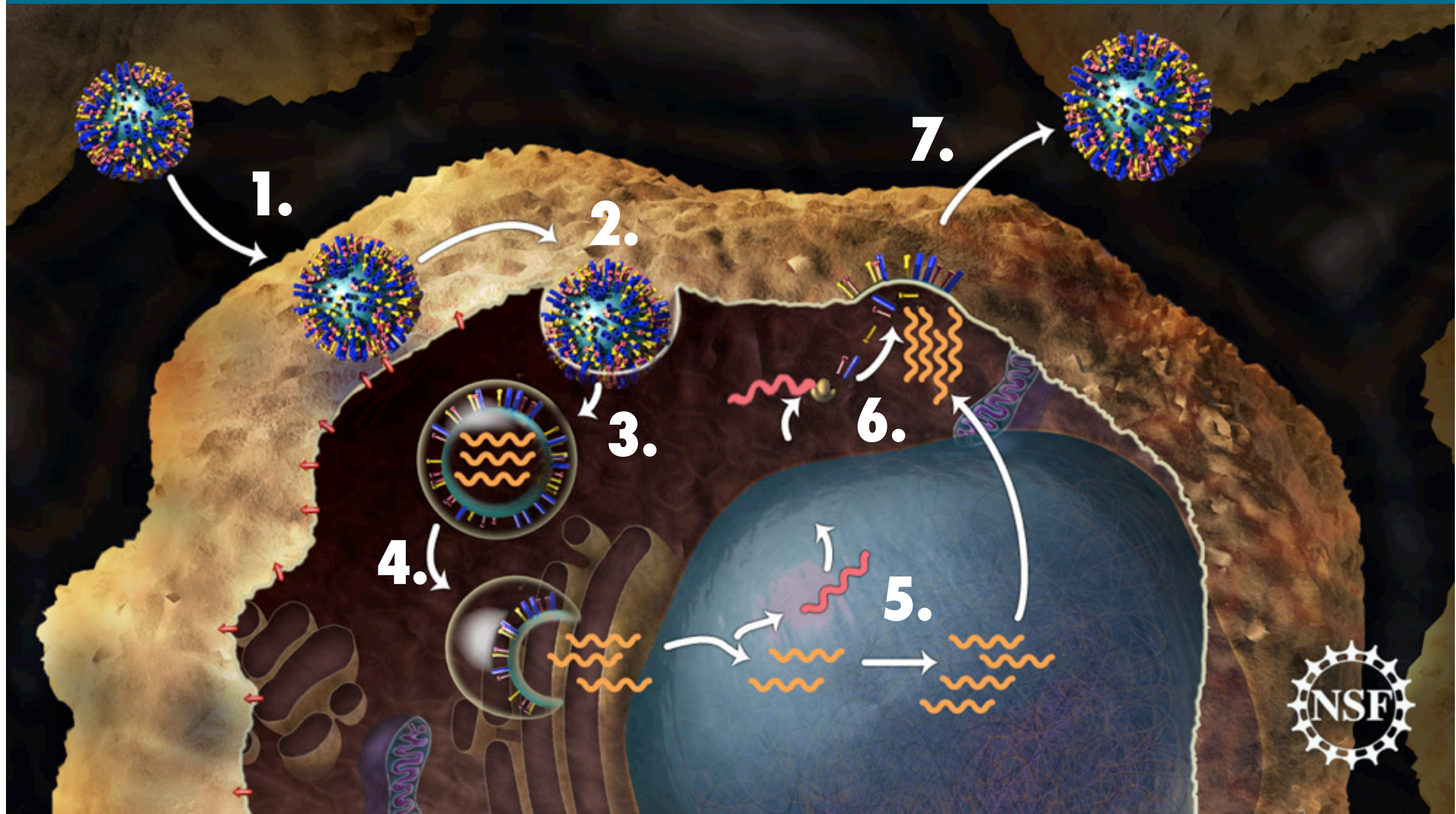
5. Viral replication

6. Viral Assembly

7. Viral release from cell

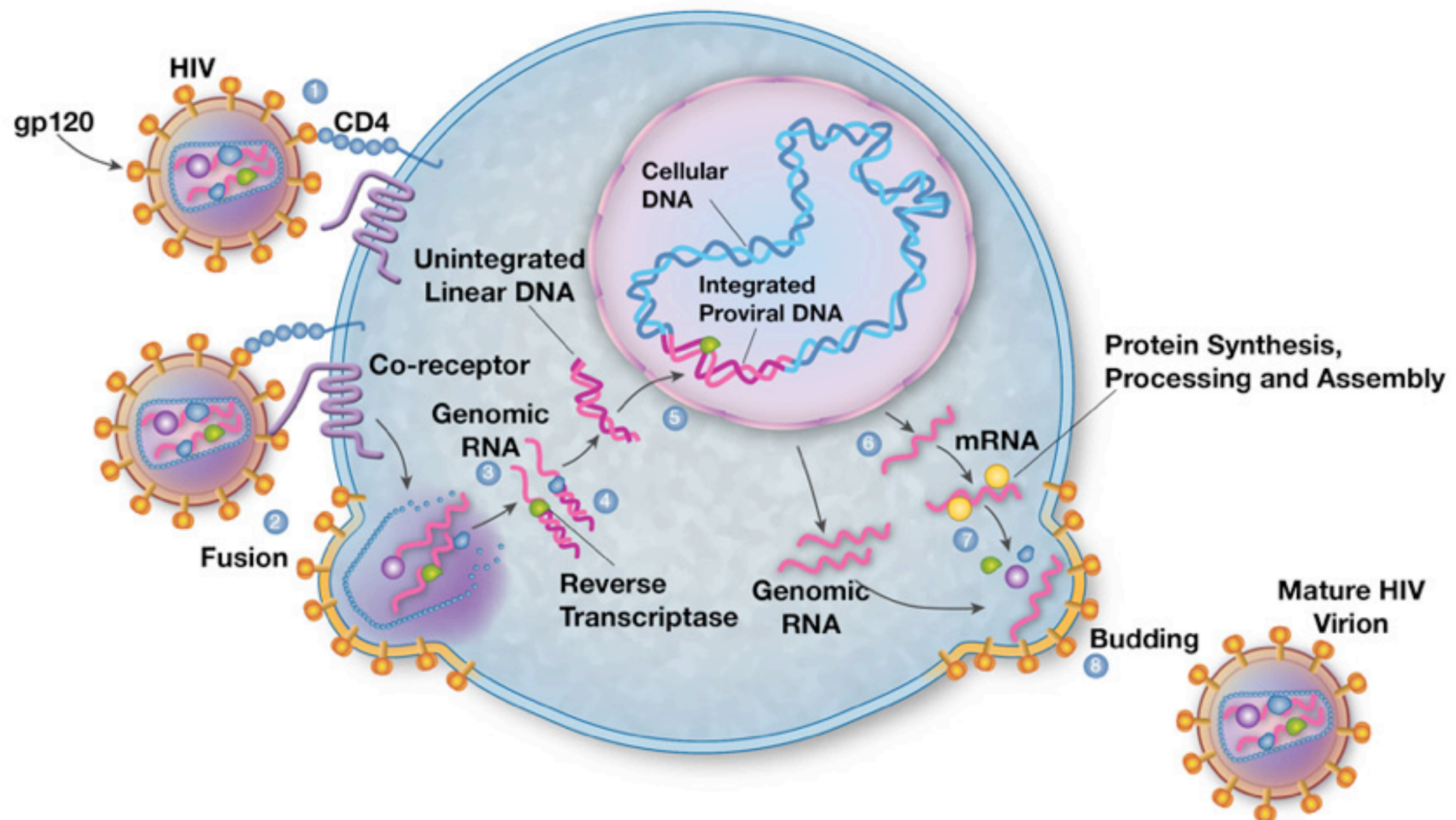
see
next
slide

Viral Reproduction: General Animal Viruses



Viral Reproduction: Animal (Retrovirus)

HIV Replication Cycle



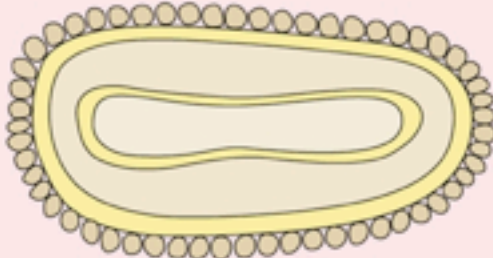














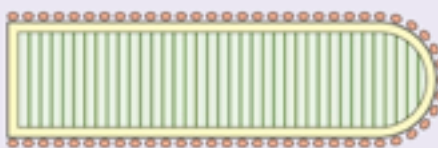
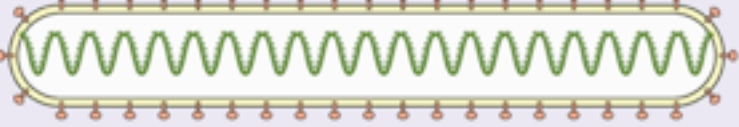




Viral Reproduction: HIV

- An example retroviral replication



Animal Virus Classification

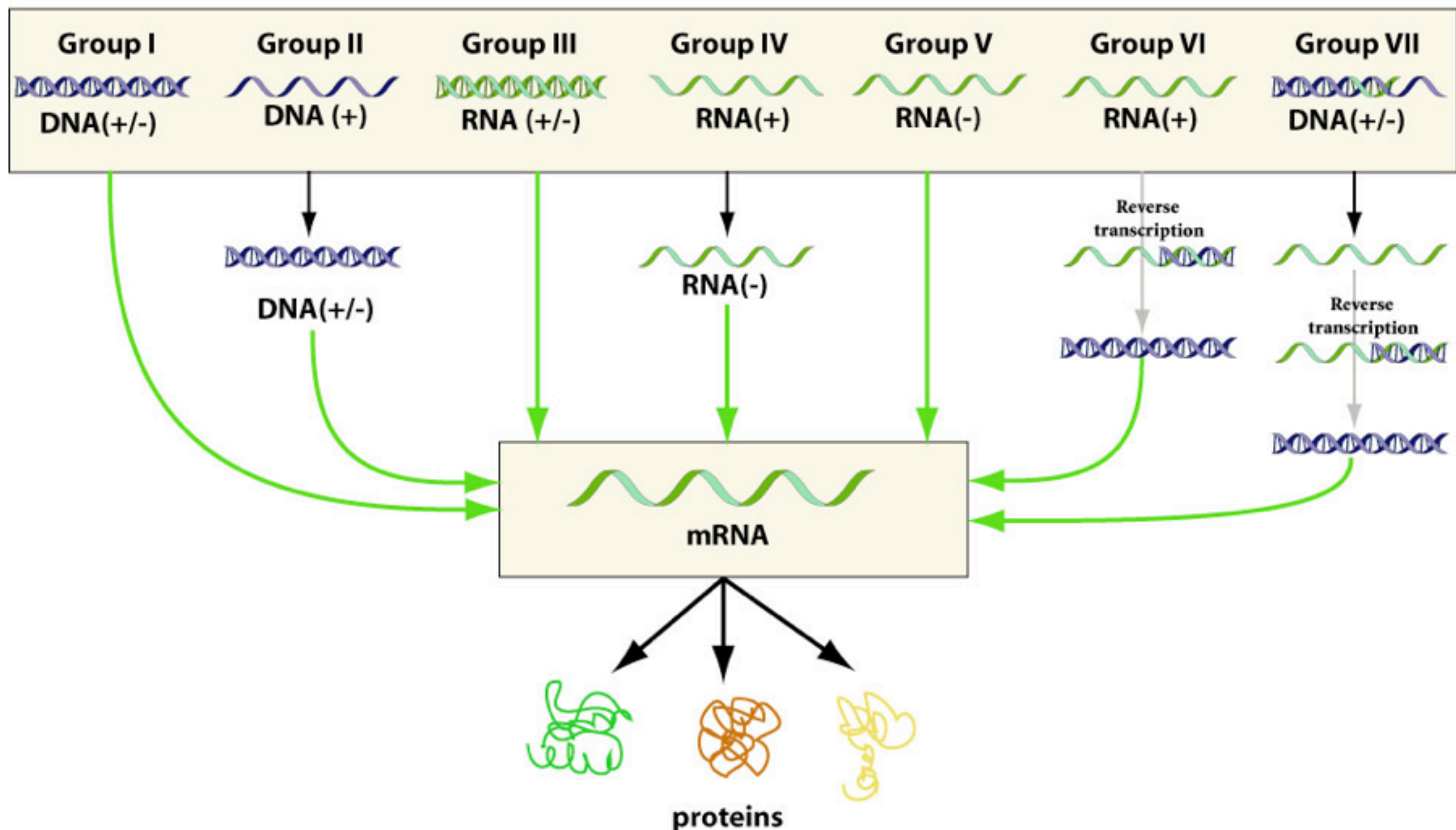
- Comparing animal virus genomes is one common way to classify animal virus

	Enveloped	Nonenveloped
DNA	<p>dsDNA</p>  <p><i>Poxviridae, Chordopoxvirinae</i></p>  <p><i>Herpesviridae</i></p>  <p><i>Hepadnaviridae</i></p>	<p>dsDNA</p>  <p><i>Adenoviridae</i></p>  <p><i>Papovaviridae</i></p> <p>ssDNA</p>  <p><i>Parvoviridae</i></p>
RNA	<p>ssRNA</p>  <p><i>Coronaviridae</i></p>  <p><i>Paramyxoviridae</i></p>  <p><i>Bunyaviridae</i></p>  <p><i>Toroviridae</i></p>  <p><i>Orthomyxoviridae</i></p>  <p><i>Arenaviridae</i></p>  <p><i>Togaviridae</i></p>  <p><i>Flaviviridae</i></p>  <p><i>Retroviridae</i></p>  <p><i>Rhabdoviridae</i></p>  <p><i>Filoviridae</i></p> <p>100 nm</p>	<p>dsRNA</p>  <p><i>Reoviridae</i></p>  <p><i>Birnaviridae</i></p> <p>ssRNA</p>  <p><i>Picornaviridae</i></p>  <p><i>Caliciviridae</i></p>

Animal Virus Classification

- Animal virus reproduction schemes based upon their genome

Genetic material present in the virion



Evolution of Viruses

- No clear explanation exists for the origin of viruses.
- There are three hypotheses for the origin of viruses.
 - 2 of the 3 have viruses evolving after cells evolved.
 - 1 has them evolving first the universal common ancestor.

Evolution of Viruses

- **Progressive Hypothesis.**
 - *Viruses evolved from mobile genetic elements, pieces of DNA gained mobility from genome to another.*
- **Regressive Hypothesis.**
 - *They may have descended from free living simple cells that adapted a parasitic replicating strategy*
- **Virus First Hypothesis.**
 - *Perhaps viruses were simple replicating precursors to the very first cell(s)*

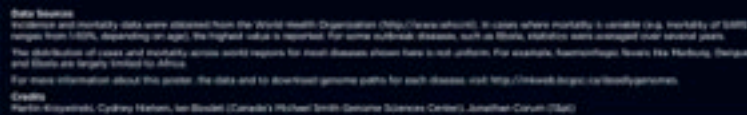
Side Bar: Viral Pathogens

- Viruses cause disease in animals, plants, crops, livestock and they play a role in certain cancers
- Viruses can damage or kill cells either of which lead to disease or death or the organisms

Viral Pathogens: The Flu



GENOME STRUCTURE AND SIZE OF HARMFUL BACTERIA AND VIRUSES



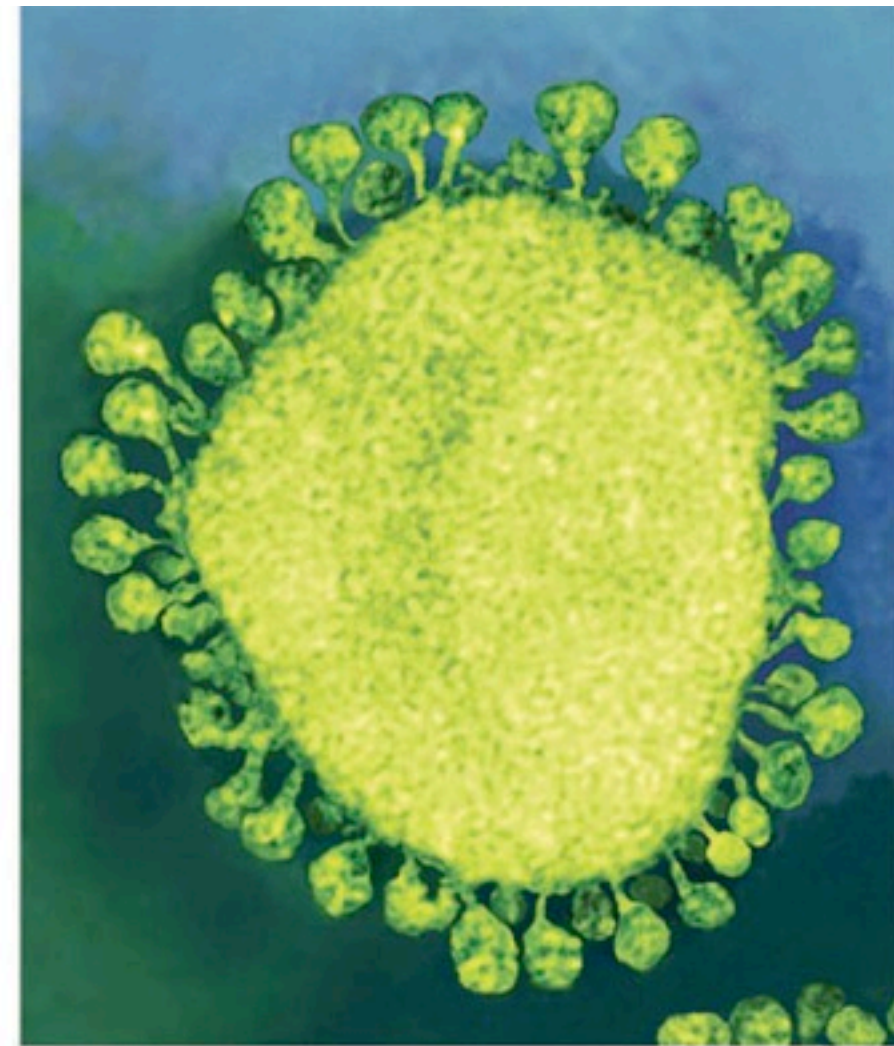
Emerging Viruses

- Viruses that suddenly appear or suddenly catch the medical communities attention because of its effects
- Extending its territory through globalization plays a huge role
- Also results from a virus expanding its host range

- Severe acute respiratory syndrome (SARS)
 - Recently appeared in China



(a) Young ballet students in Hong Kong wear face masks to protect themselves from the virus causing SARS.



(b) The SARS-causing agent is a coronavirus like this one (colorized TEM), so named for the "corona" of glycoprotein spikes protruding from the envelope.

Figure 18.11 A, B

Vaccines & Antiviral Drugs

- Antiviral drugs are specific to the virus.
- Antiviral drugs do not destroy the virus
 - *recall antibiotics destroy bacteria*
- Antiviral drugs inhibit the development of new viruses
- Currently we have antiviral drugs for HIV, the flu, hepatitis and herpes, to name a few.

Vaccines & Antiviral Drugs

- Antiviral drugs attack the virus at different stages of its life cycle.
- Antiviral drugs are difficult to develop because the virus hides inside normal cells and the drug must target the virus without harming the host cells.
- In addition mutation rates and variation are both very high among viruses.
- Some vaccines have proved effective but do nothing once the viral infection has set in