Viruses

The art of moving DNA around without sex

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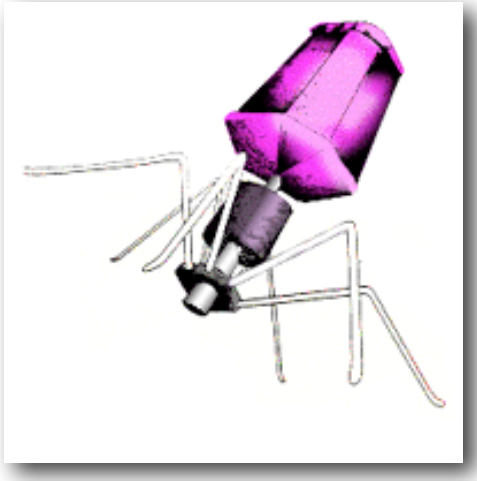
Viruses,
too small to see with a light microscope (EM works though)

- Viruses are found everywhere (1 oz of sewage can contain 1 billion viruses)
- Every organism in the world is targeted by viruses
- Viruses are small (around 50nm, light is wavelenngth is 600nm) and relatively simple
- Viruses consist of a core of nucleic acid, either DNA or RNA, and a protective coat of protein molecules and sometimes lipids



Is it alive?

Viruses do not

- Grow
- Have homeostasis
- Metabolize

Viruses do

- Infect cells and use the cell to make more viruses
- Cause disease in many organisms

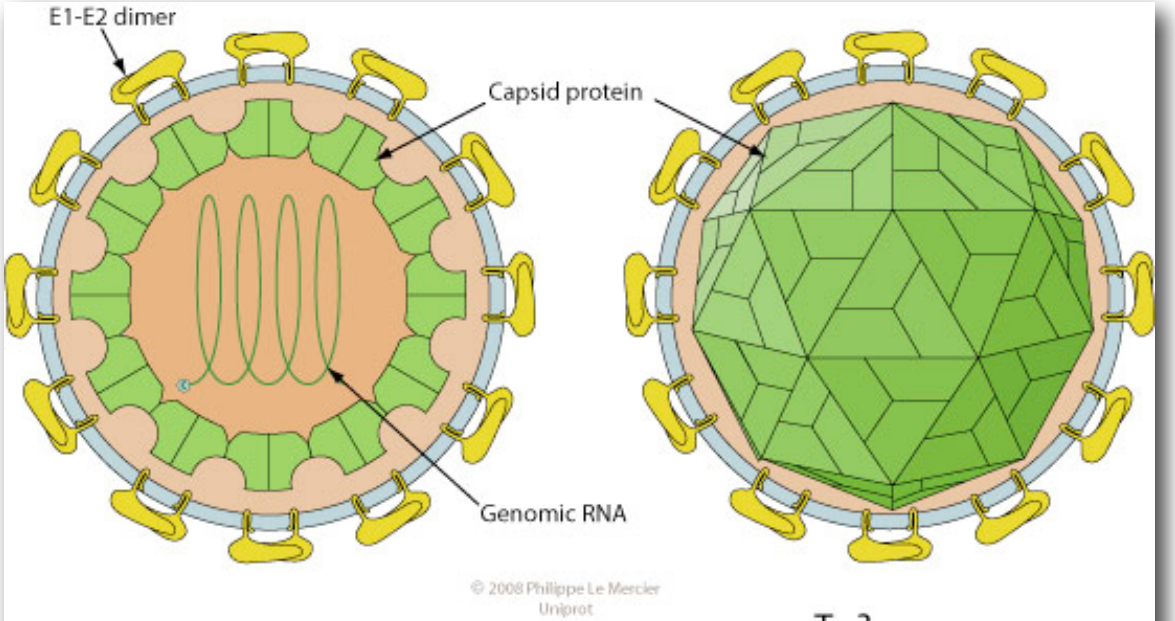
Virion (a virus particle)

Nucleic Acid – RNA or DNA (either single or double stranded)

Capsid – protein coat that surrounds the DNA or RNA in a virus

Lipid Membrane – a membrane around the capsid in many kinds of viruses; helps the virus enter cells ("enveloped" viruses; without the membrane, the virus is "naked")

- Made of proteins, lipids, and glycoproteins



RNA or DNA? Either
Single stranded or Double Stranded? Either

Viruses with RNA

- Human immunodeficiency virus (HIV)
- Influenza viruses
- Rabies Virus

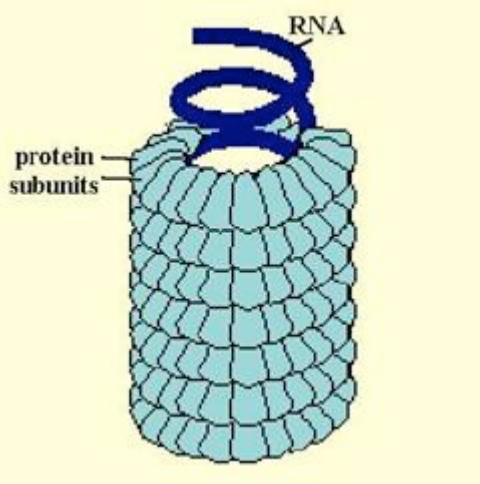
Viruses with DNA

- HPV
- Herpes-type viruses (including chickenpox)
- Eppstein Bar Virus (mononucleosis)
- Smallpox

Virus Shapes

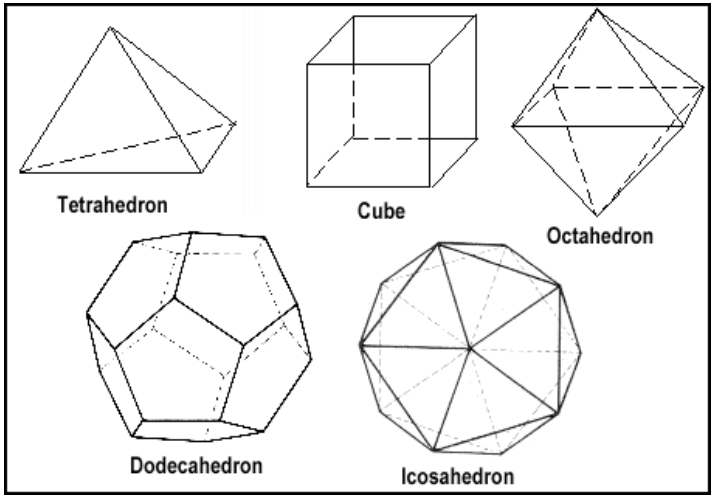
Helical

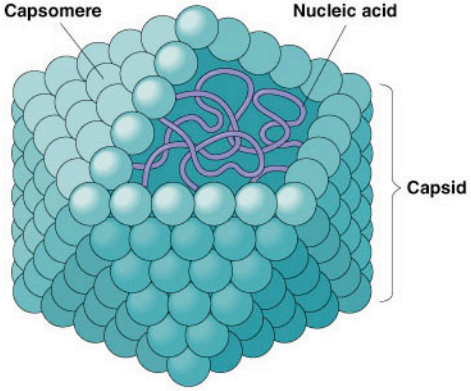
Rodlike with capsid proteins winding around the core in a spiral



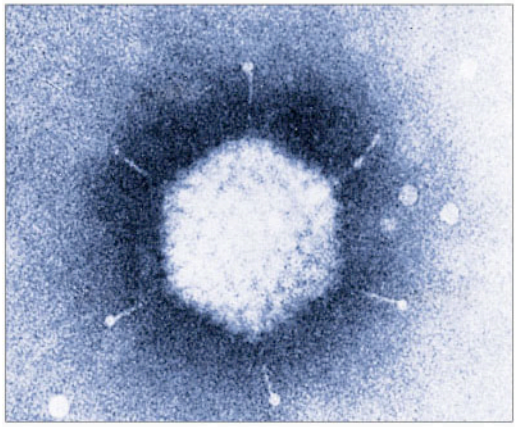
Polyhedral

Has many sides
Most polyhedral capsids have 20 sides and 12 corners





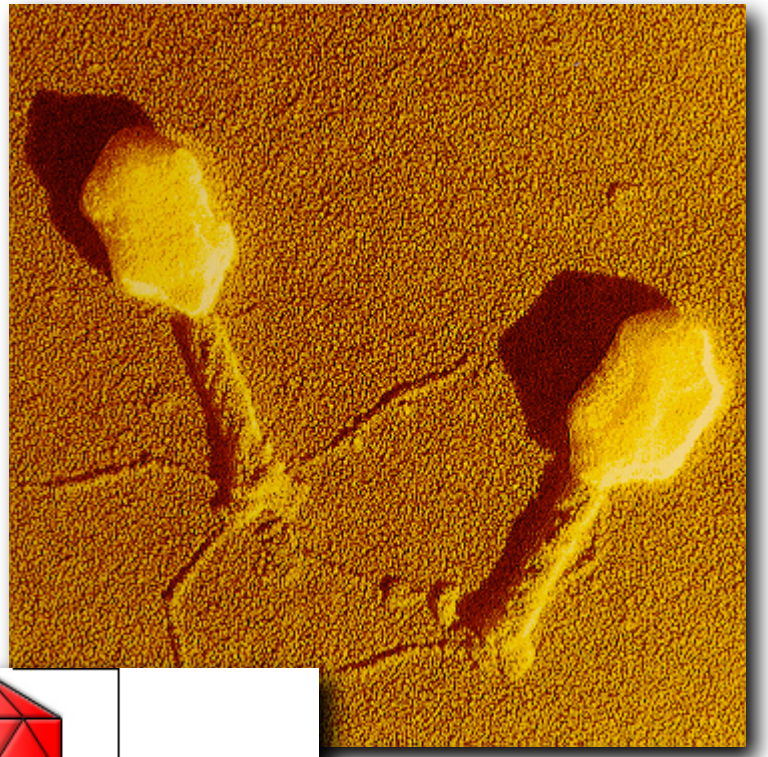
(a) A polyhedral virus

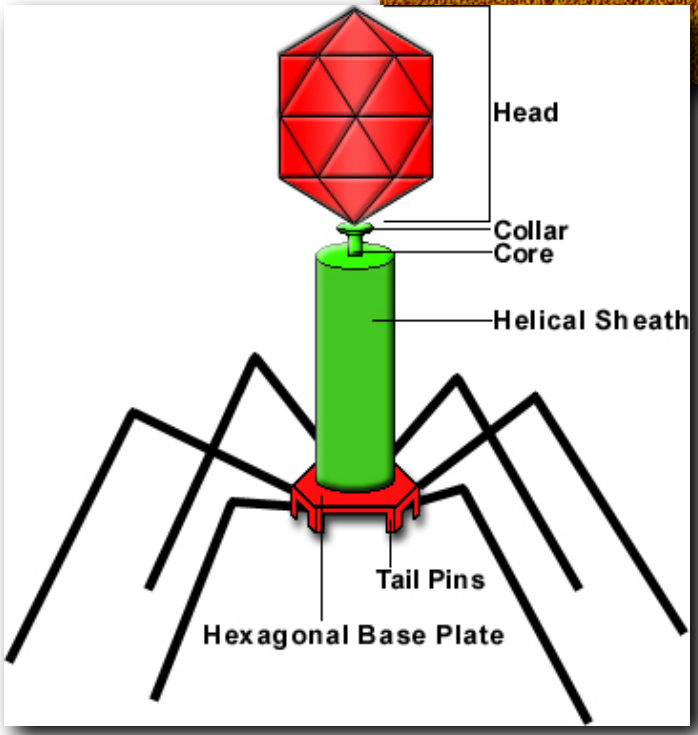


(b) A *Mastadenovirus*

Or a combo

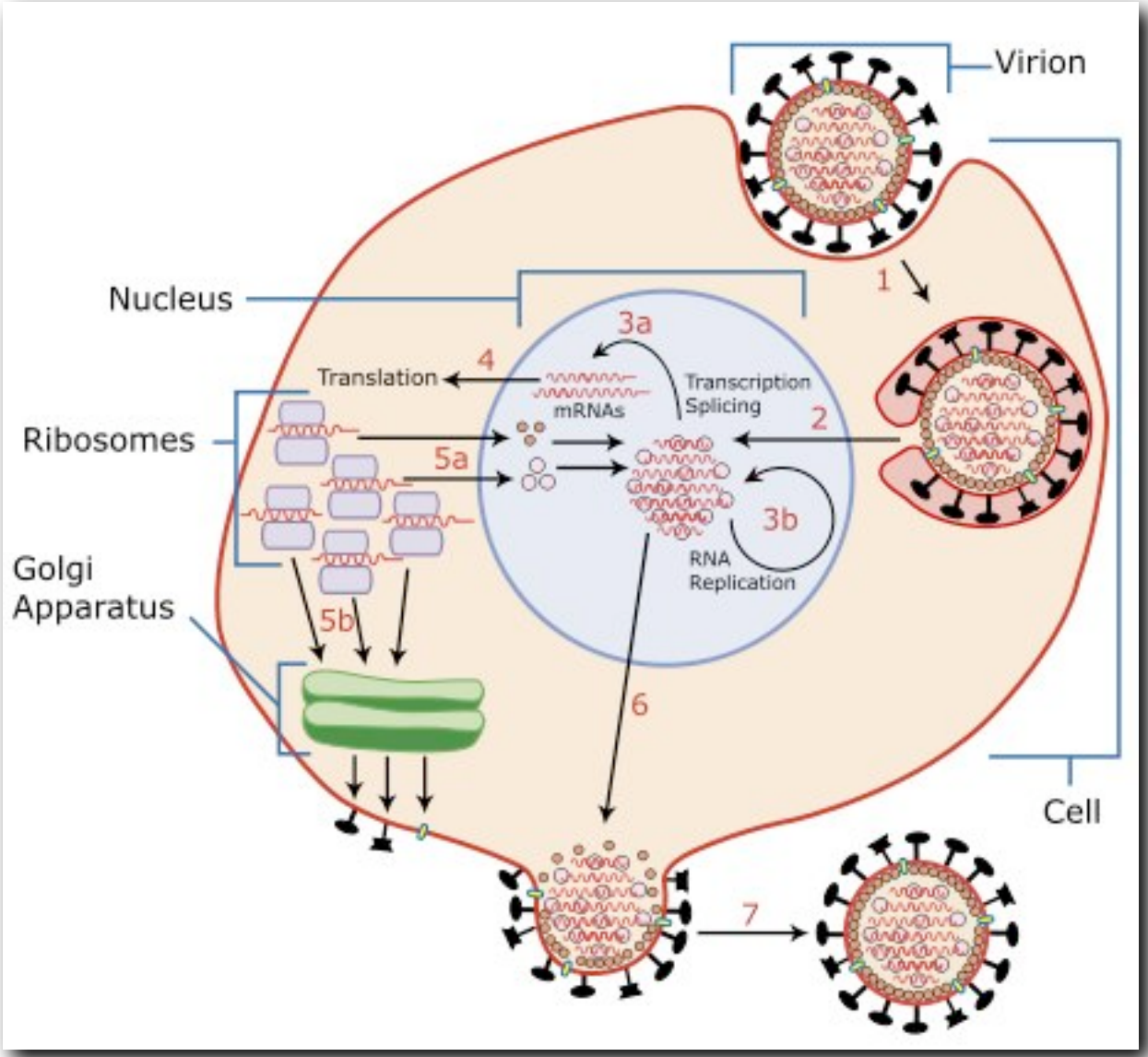
Polyhedral capsid attached to a helical tail.



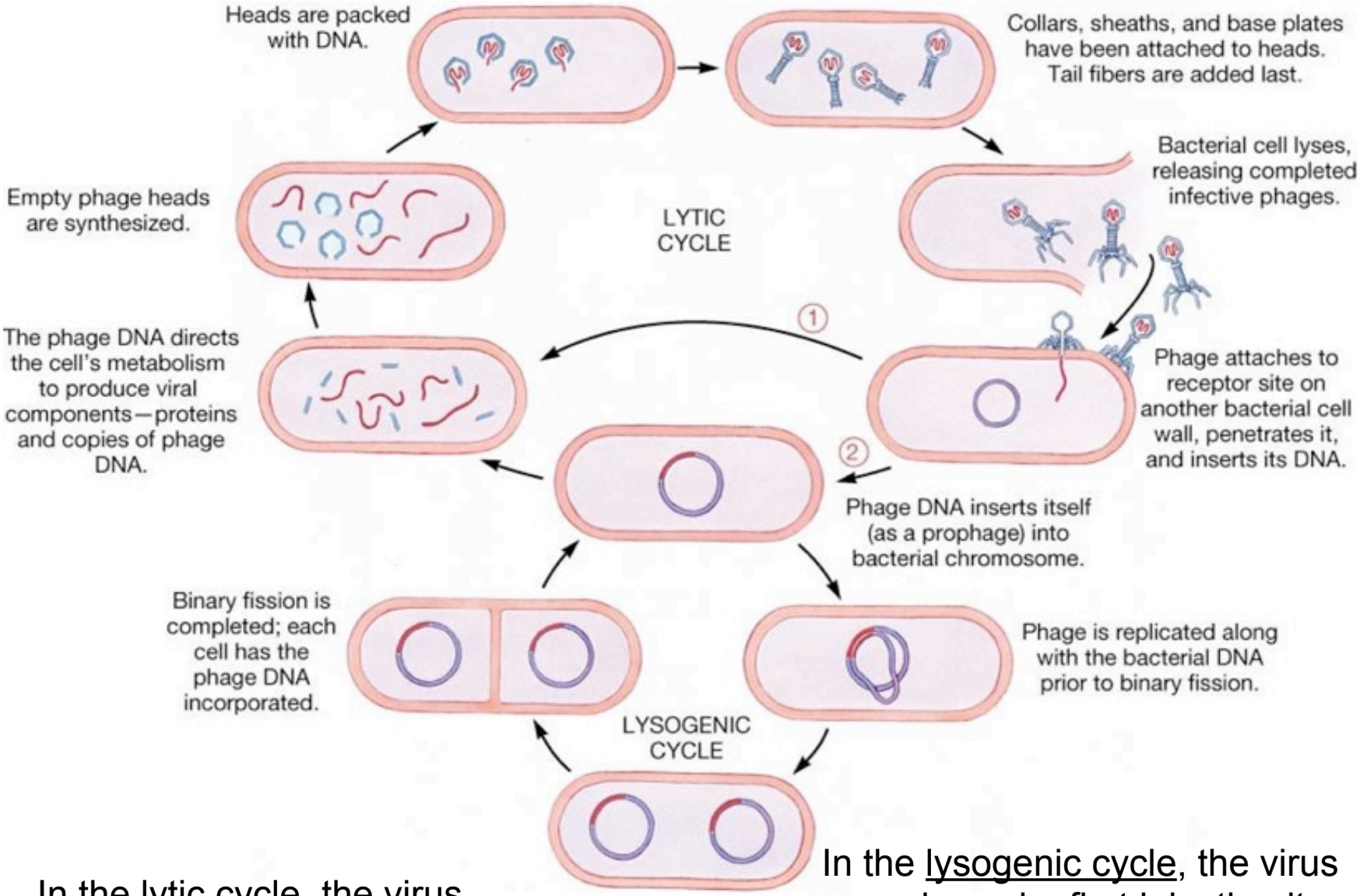


Bacteriophage T4
(attacks bacteria)

Generalized Viral life cycle



Viral lifestyles



In the lytic cycle, the virus reproduces itself using the host cell's machinery.

In the lysogenic cycle, the virus reproduces by first injecting its genetic material, indicated by the red line, into the host cell's genetic instructions.

We’re still alive!

Ebola
Swine Flu
HIV/AIDS
West Nile Virus
SARS
Rubella
Polio
Measles
Chicken Pox
Small Pox

Just to name a few.....

Small Pox and Cow pox

Small pox
Infects humans
30% of infections are lethal

Cox pox (vaccinia)
Infects cows, can infect humans, very low lethality

Coxpox provided immunity against smallpox

Basis of the virtual eradication of smallpox

Still the common strategy for vaccination (inactivated/attenuated virus for inoculation)

Jeste

1770s

Jenner

Cox pox inoculation (the original vaccination)

The vaccination debate has been going on for a long time already

Good things viruses have given us:

1/ The strongest promoters in the word
2/ Reverse transcriptase
3/ The first proto-oncogenes
4/ Vehicles for gene therapy
5/ The first vaccination strategy
6/ Vehicles for cloning DNA

Viruses and cancer

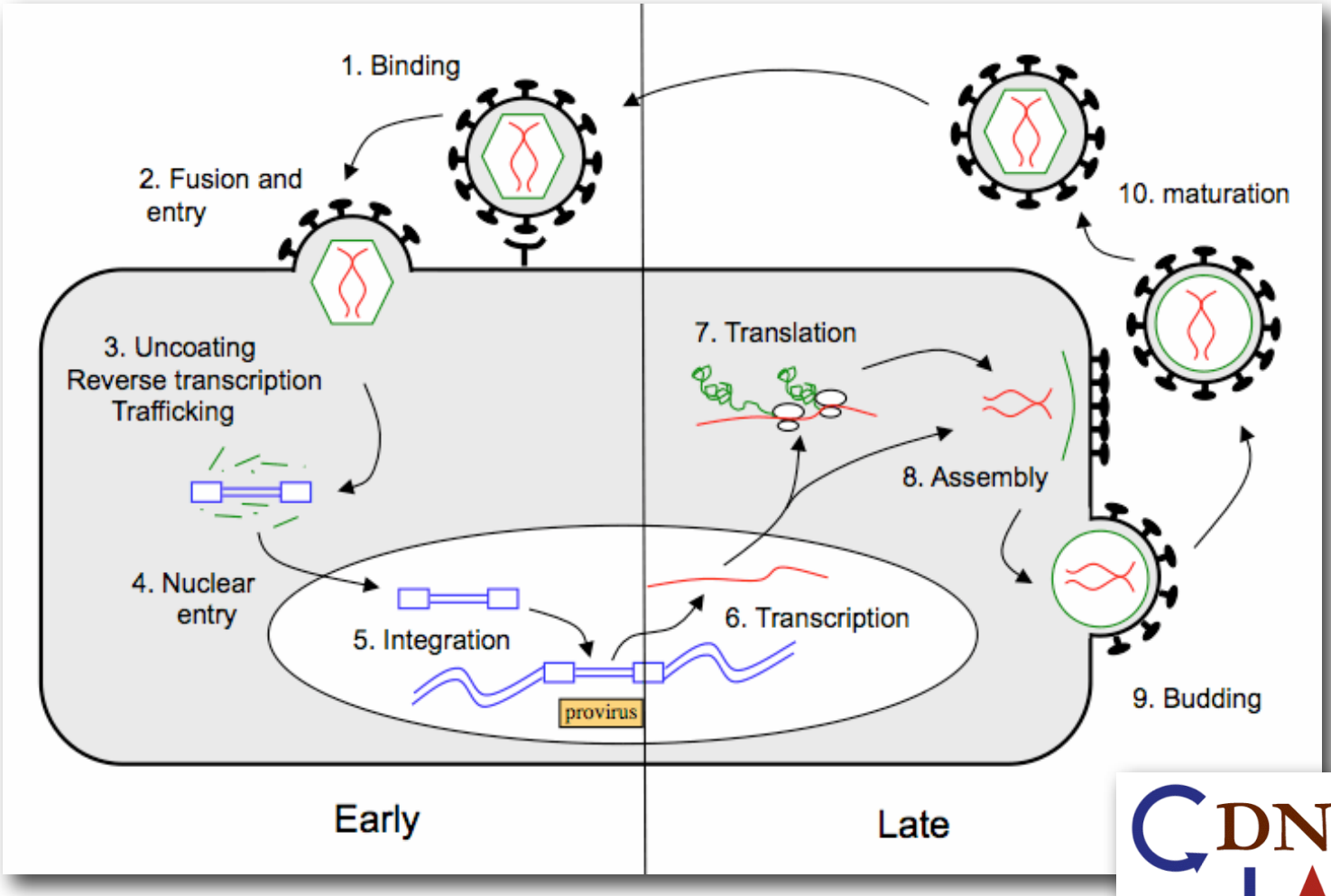
Mechanism

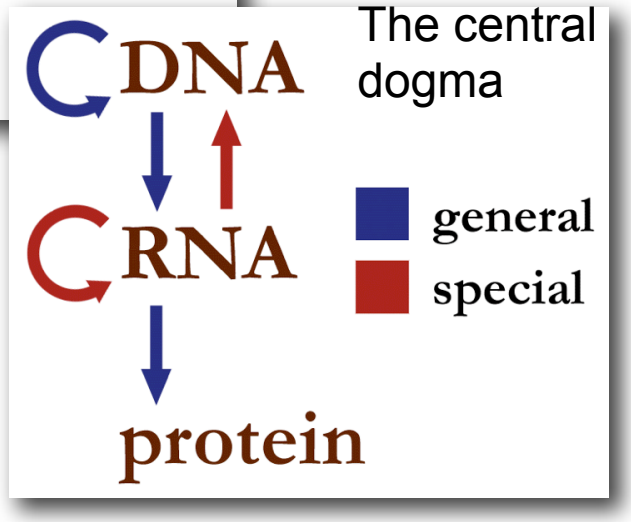
1/ Virus carries some sort of “GO” signal
Transduced proto-oncogne
Normal part of the viral genome (HPV and cervical cancer)

2/ Insertional mutagenesis
Proviral integration causes a mutation either inactivating a “STOP” signal, or activating a “GO” signal

3/ Loss of immunity undermines the normal ability of the body to fight virus-induced cancer (e.g. kaposi sarcoma in AIDS patients)

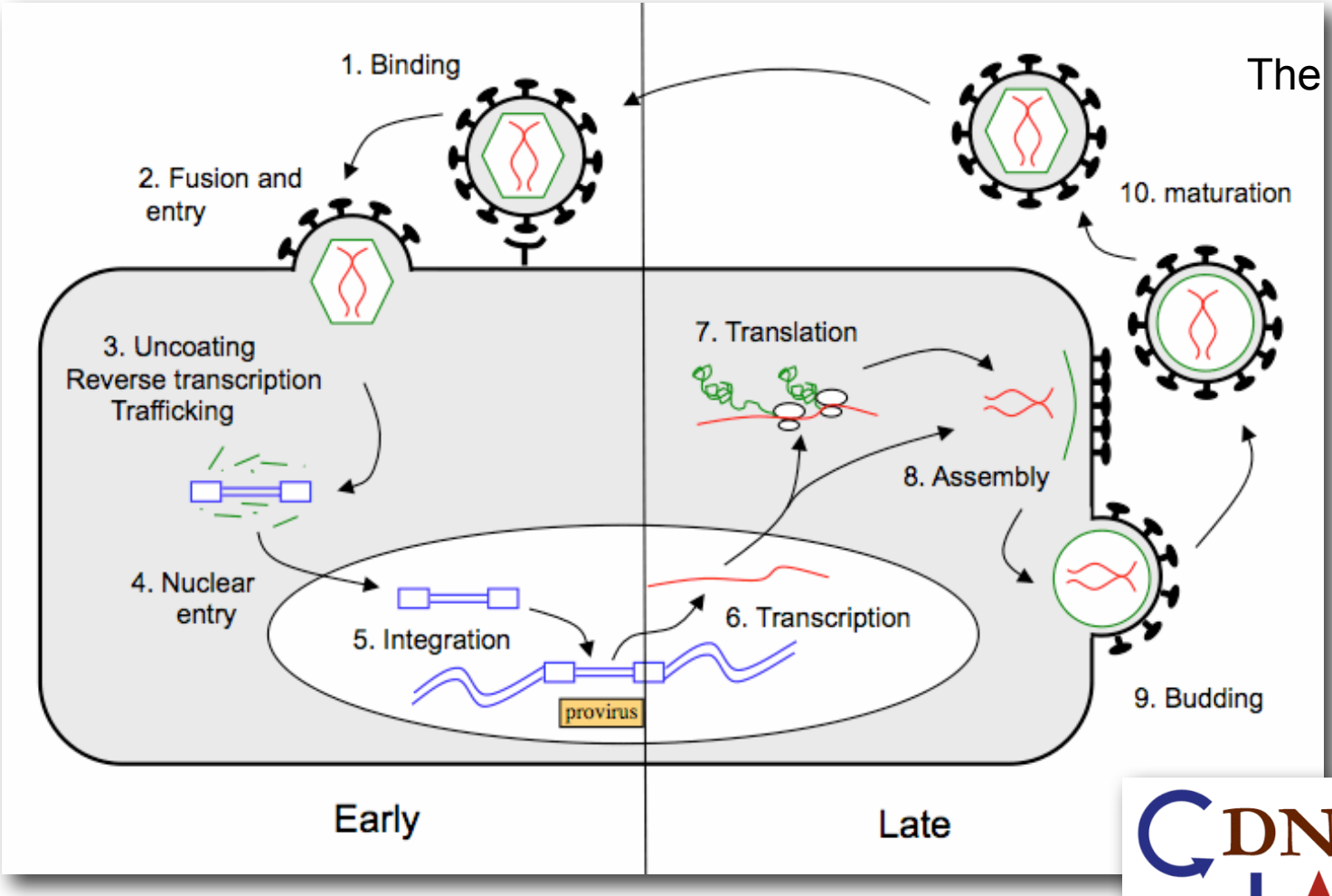
The life of a retrovirus



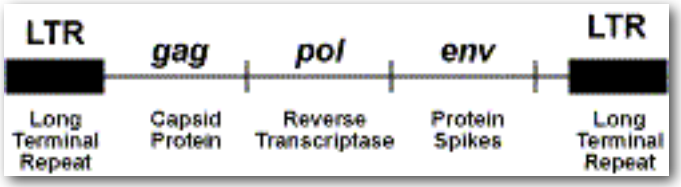


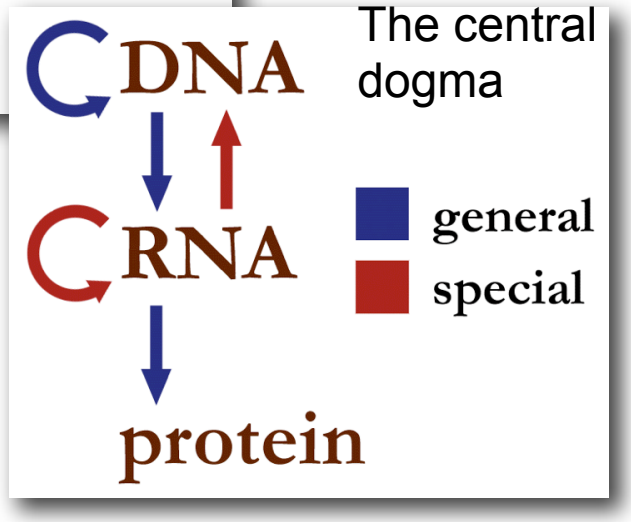
RNA to DNA: Reverse transcription
RNA-dependent DNA polymerase/Reverse transcriptase

The life of a retrovirus



RNA to DNA: Reverse transcription



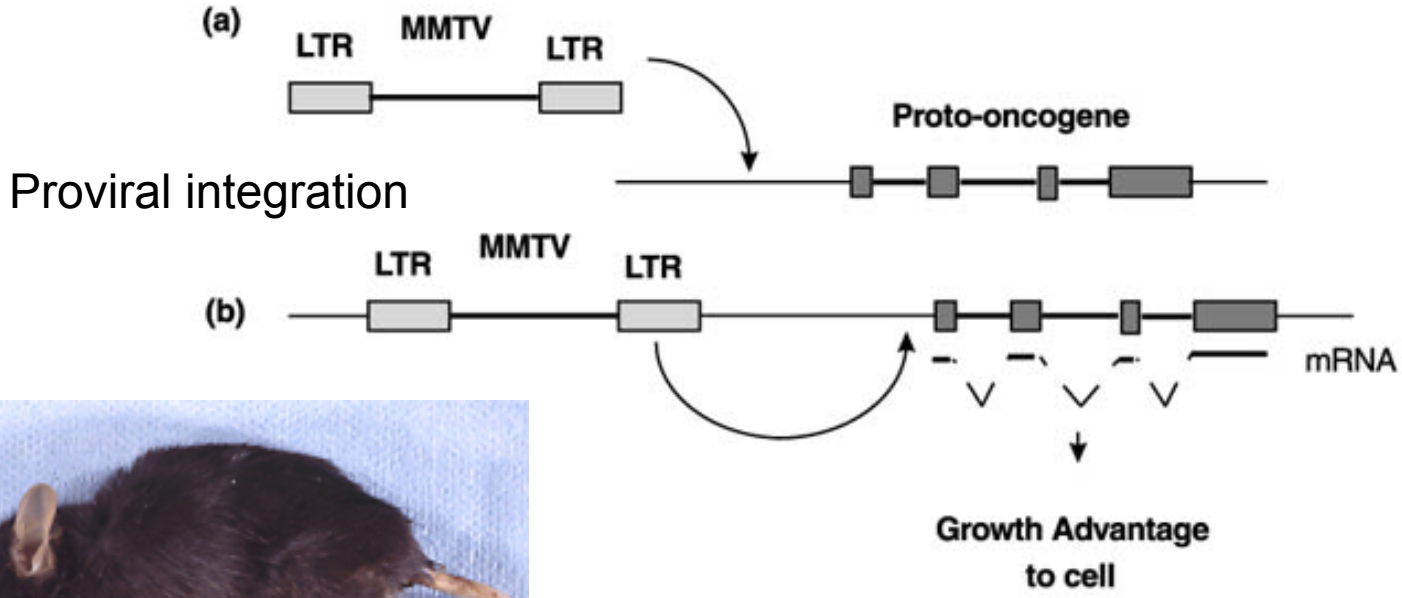


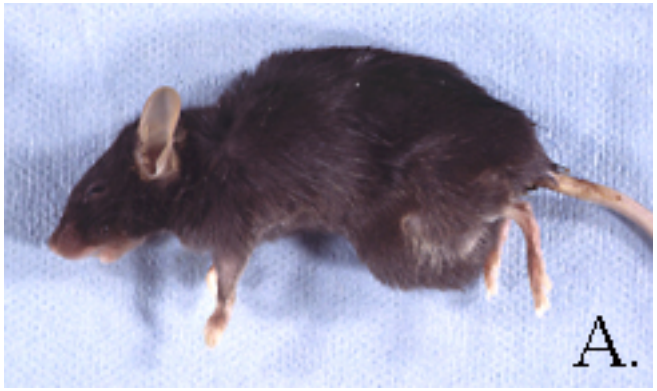
Proviral Insertional mutagenesis

MMTV (mouse Mammary Tumor Virus), a retrovirus

Present in milk of infected mothers
Establishes widespread infections/proviral integrations in the pups
When nursing adults, the infected animals produce virus in their milk etc. etc.

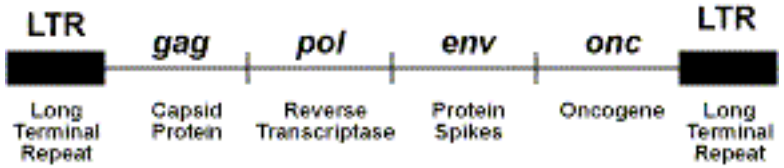
Human homologs founds in a high proportion of tumors, real impact still unclear





These “GO” genes play important roles in human cancers

Incorporate an activated GO signal (oncogene transduction)

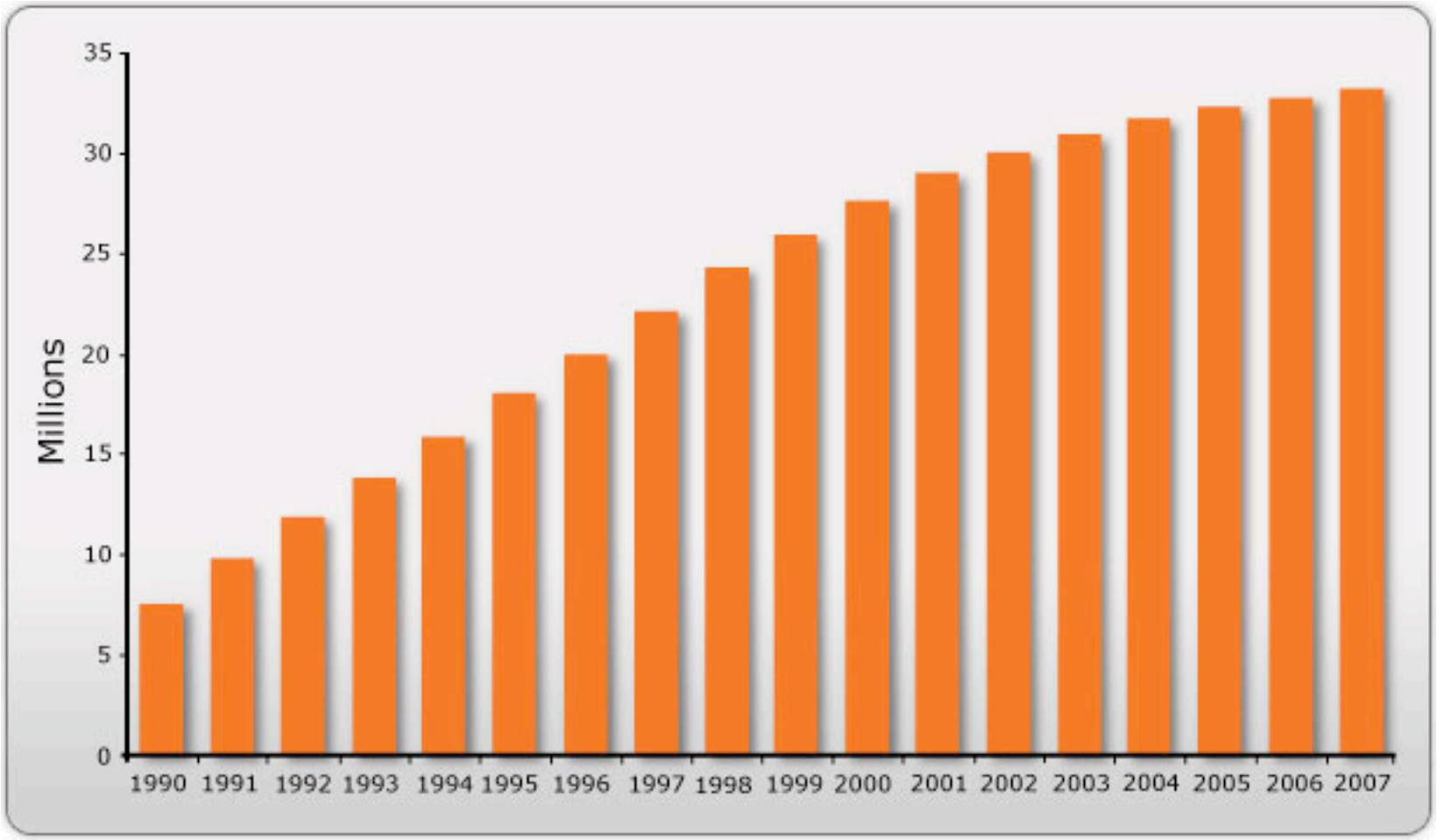


- **Growth factor receptors** - One example is epidermal growth factor receptor which promotes wound healing by stimulating cell growth. Some factors function as transmembrane protein kinases that are activated by an extracellular signal. An example is ***v-erbB*** found in the Avian erythroblastosis virus that infects chicken.
- **Protein kinases** - These proteins alter the function of other proteins by phosphorylating specific amino acid residues. The ***v-src*** from the Rous Sarcoma virus which infects chickens is an example.
- **G-proteins** - These proteins bind the nucleotide GTP, and also exhibit GTPase activity. The ***v-H-ras*** oncogene of the Harvey murine sarcoma virus which infects rats is an example.
- **Transcription factors** - These proteins function by binding to DNA and activating transcription. An example is the ***v-jun*** oncogene of the Avian sarcoma virus that infects chickens.

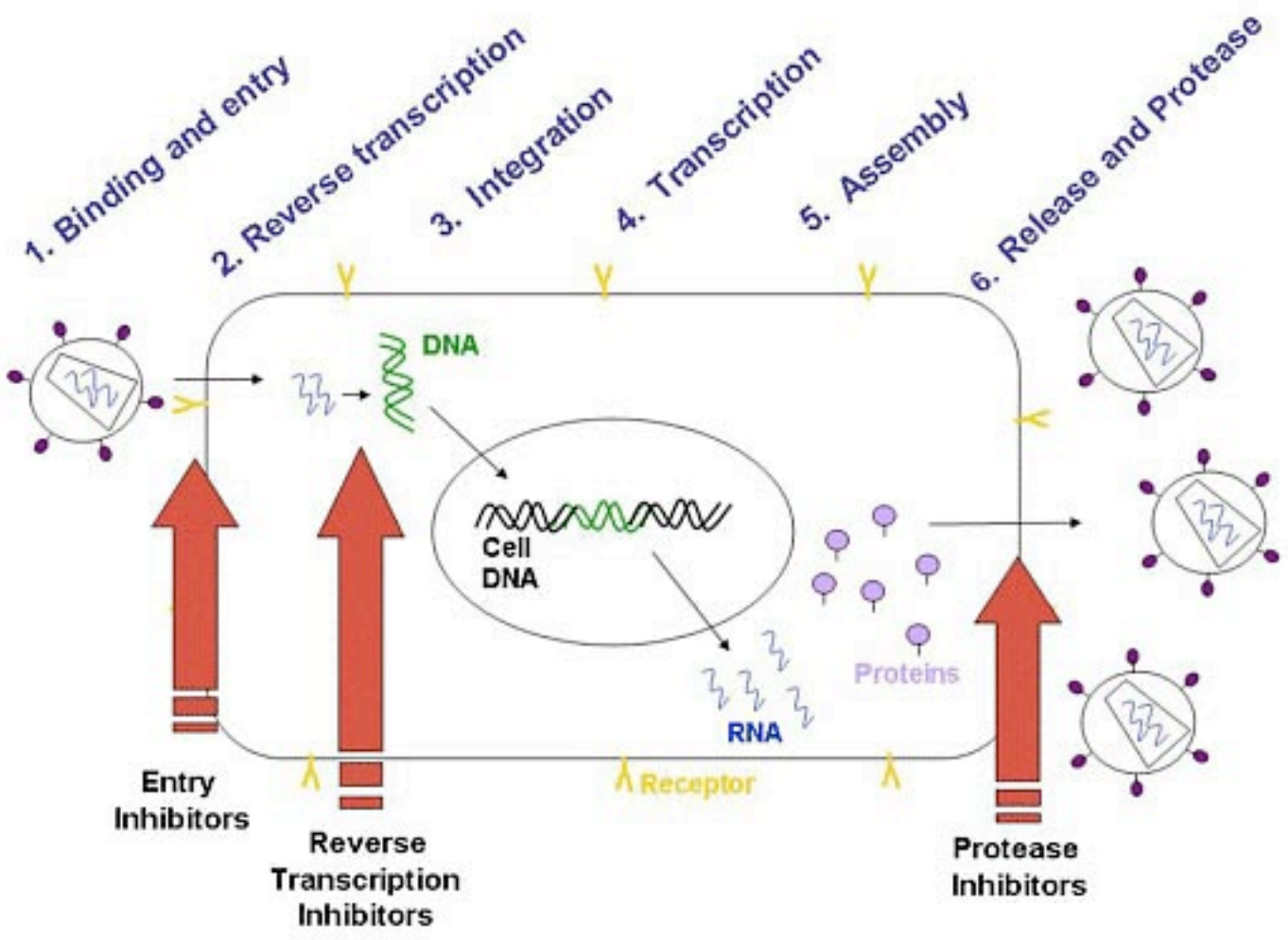
Human Immunodeficiency Virus (HIV)

Acquired Immuno Deficiency Syndrome (AIDS)

Worldwide AIDS infections

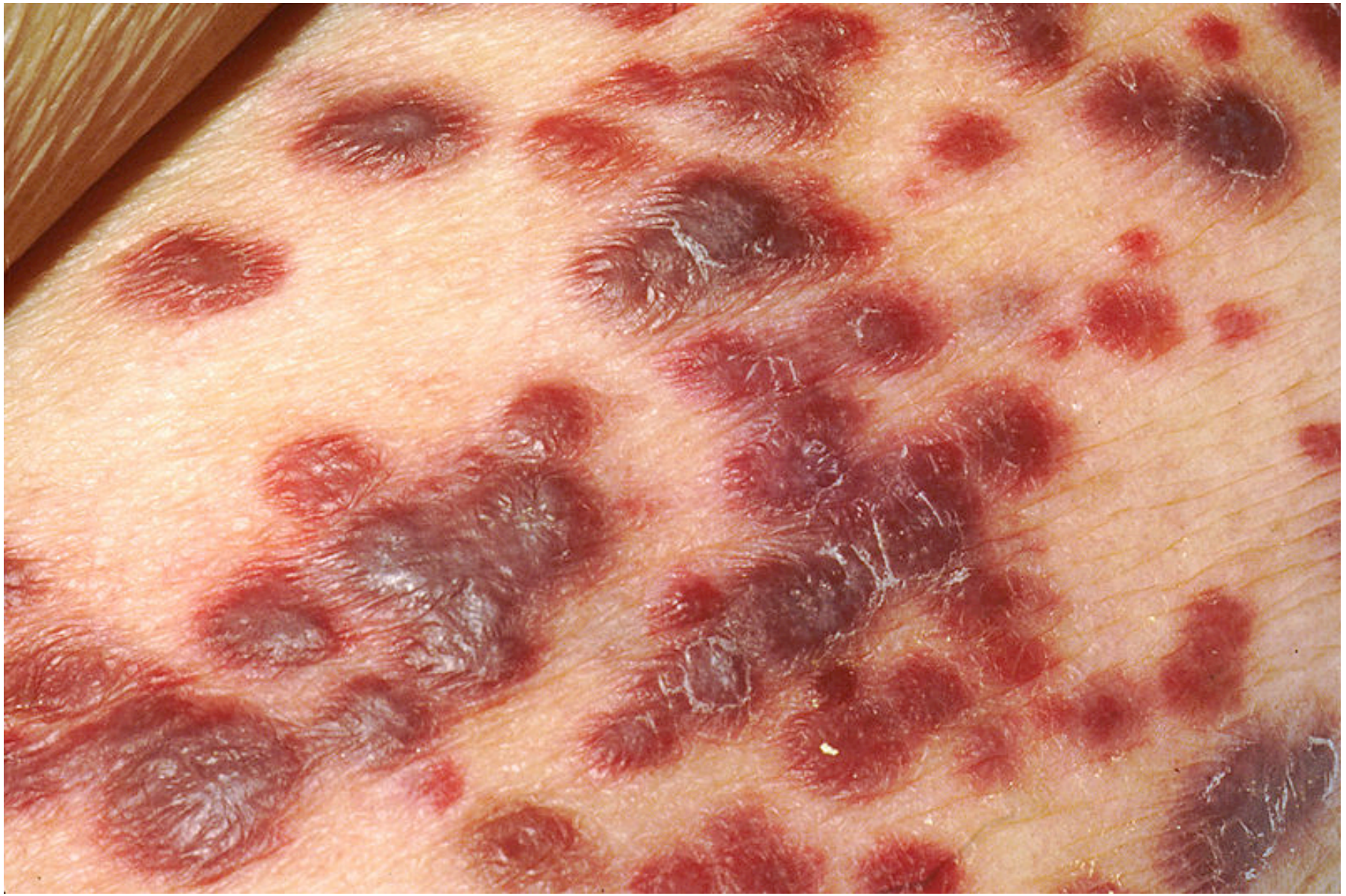


HIV life cycle, attacks T-Cells, suppresses the immune response and leaves the path open to other (opportunistic) infections



No functional immunization

Immune suppression by HIV infection leads to Kaposi Sarcoma, caused by a Herpes virus (HHV8)



Cold sores and Chicken pox

Both are caused by Herpes-type viruses. These viruses hide out in nerves while inactive.

Cold sores come back now and then. So does chicken pox. Adult chicken pox: shingles

HPV/RPV gone wild

Immune system abnormal