

Emmy Noether



Google doodle: 23 March 2015
(her 133rd birthday)

- Mathematician and Theoretical Physicist
- Einstein called her “the most significant” mathematician

Emmy Noether



- Explained why energy is conserved.
- Explained **all** possible conservation laws: why they exist (e.g. Conservation of linear and angular momentum)

Work = Process of putting in energy, or taking away energy

Kinetic energy = Energy due to motion

(No motion \longrightarrow No kinetic energy)

Potential energy = “Stored energy”

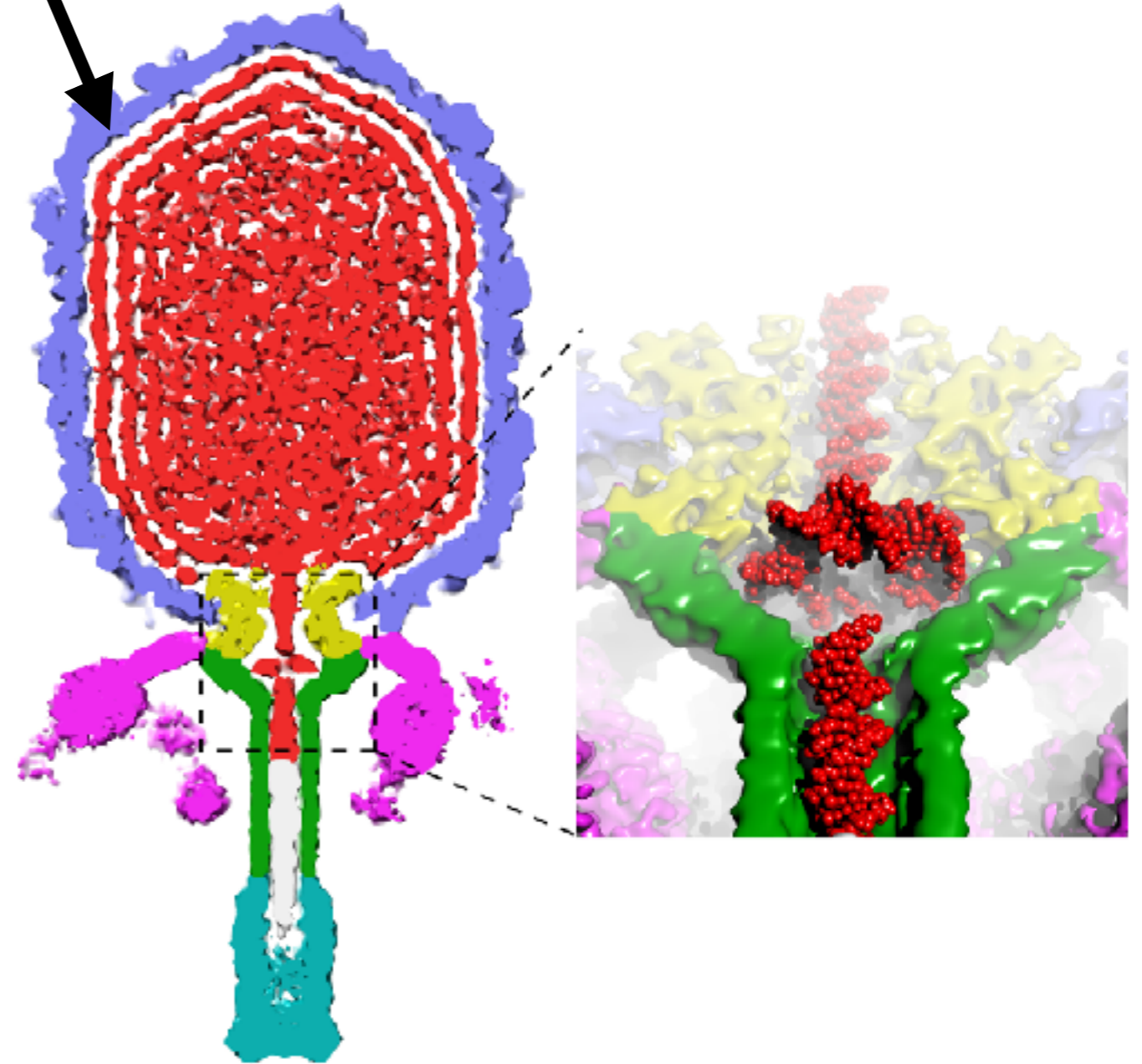
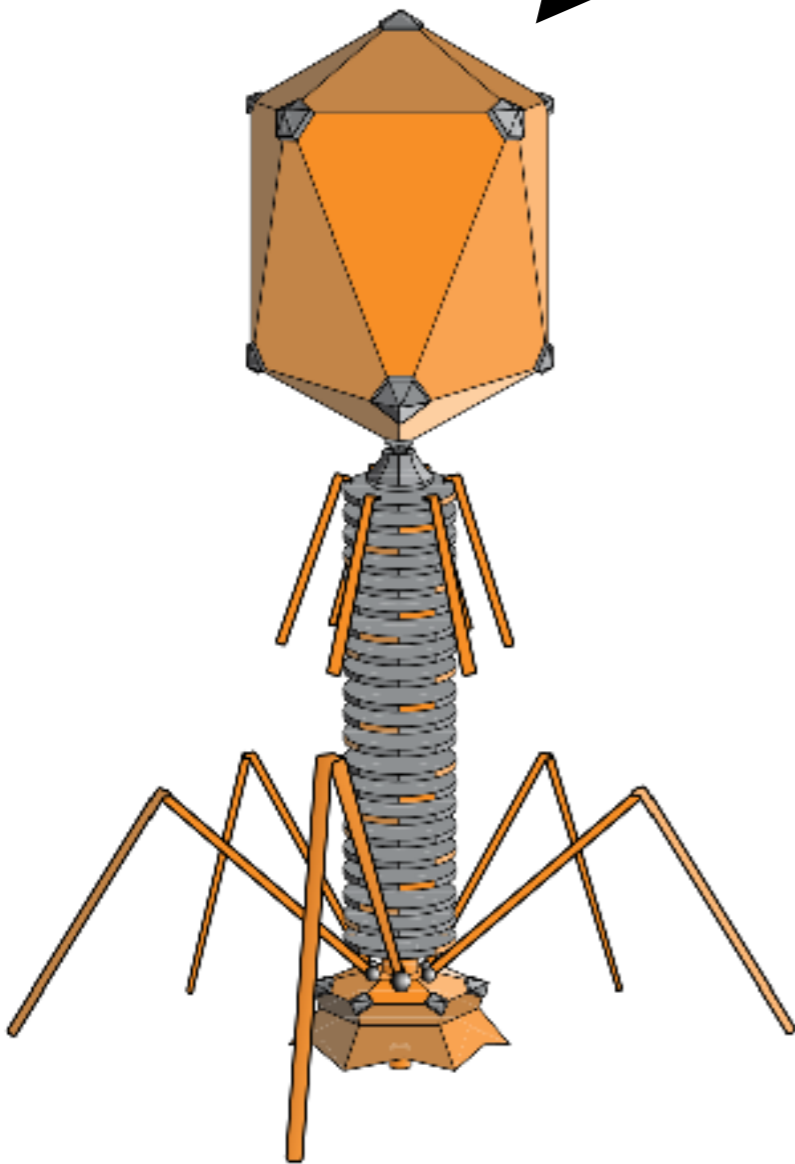
If you release the system, does it move?

If yes, then there is potential energy

Kinetic energy = Energy due to motion

Bacteriophage $\phi 29$: Virus that infects bacteria

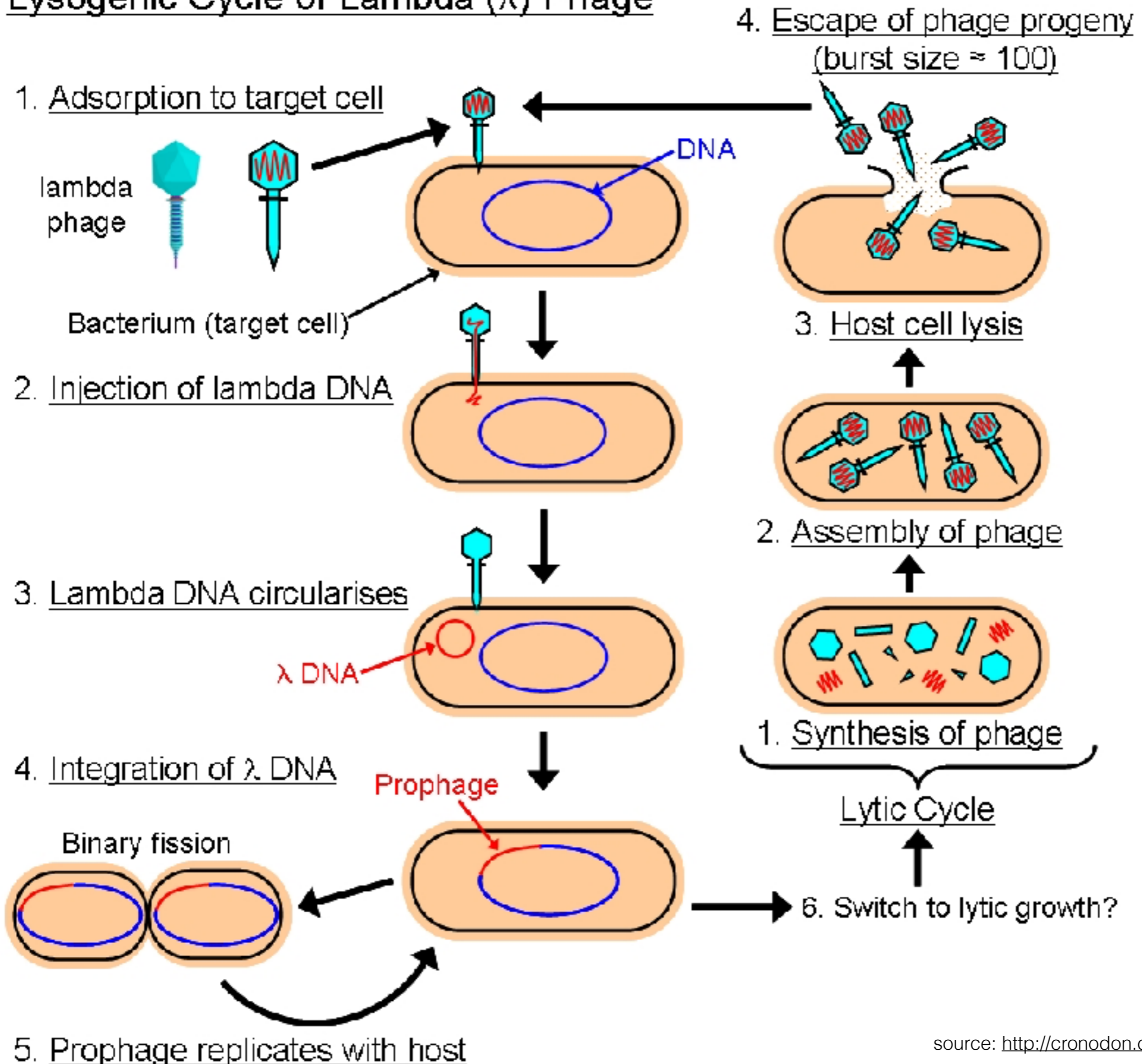
viral DNA packaged
in here



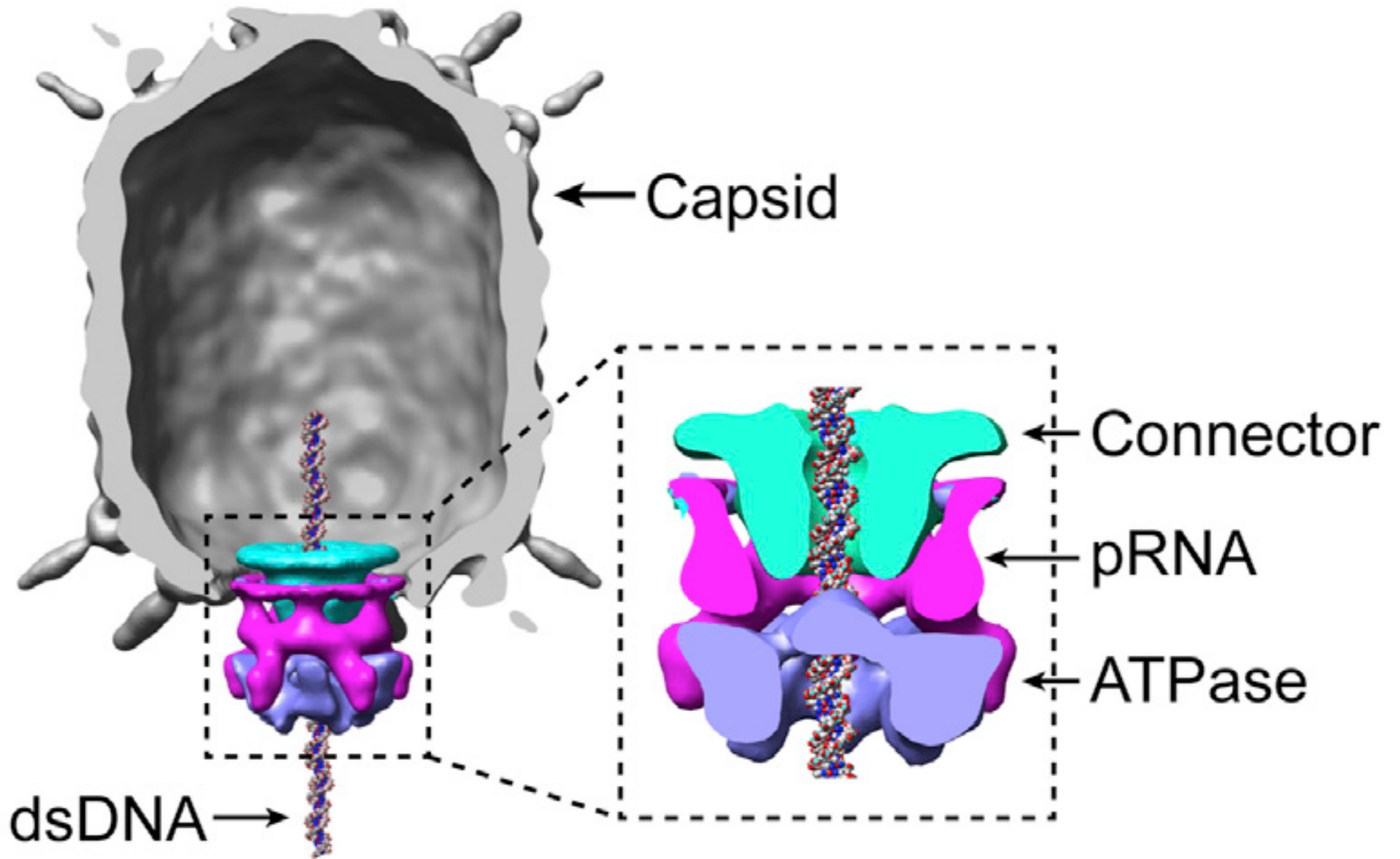
The bacteriophage's DNA is:

- Double stranded
- 20,000 base pairs (bps)
(distance between base pairs ~ 0.3 nm)
(note: Bohr radius ~ 0.05 nm)
- radius of the capsid (capsule) is ~ 40 nm
(treating it as a sphere)

Lysogenic Cycle of Lambda (λ) Phage

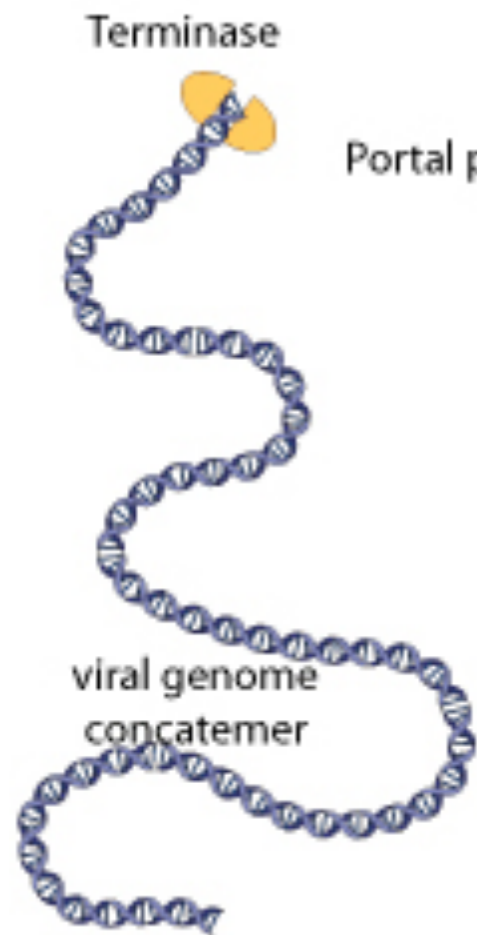


Motor protein packs DNA into the viral capsule

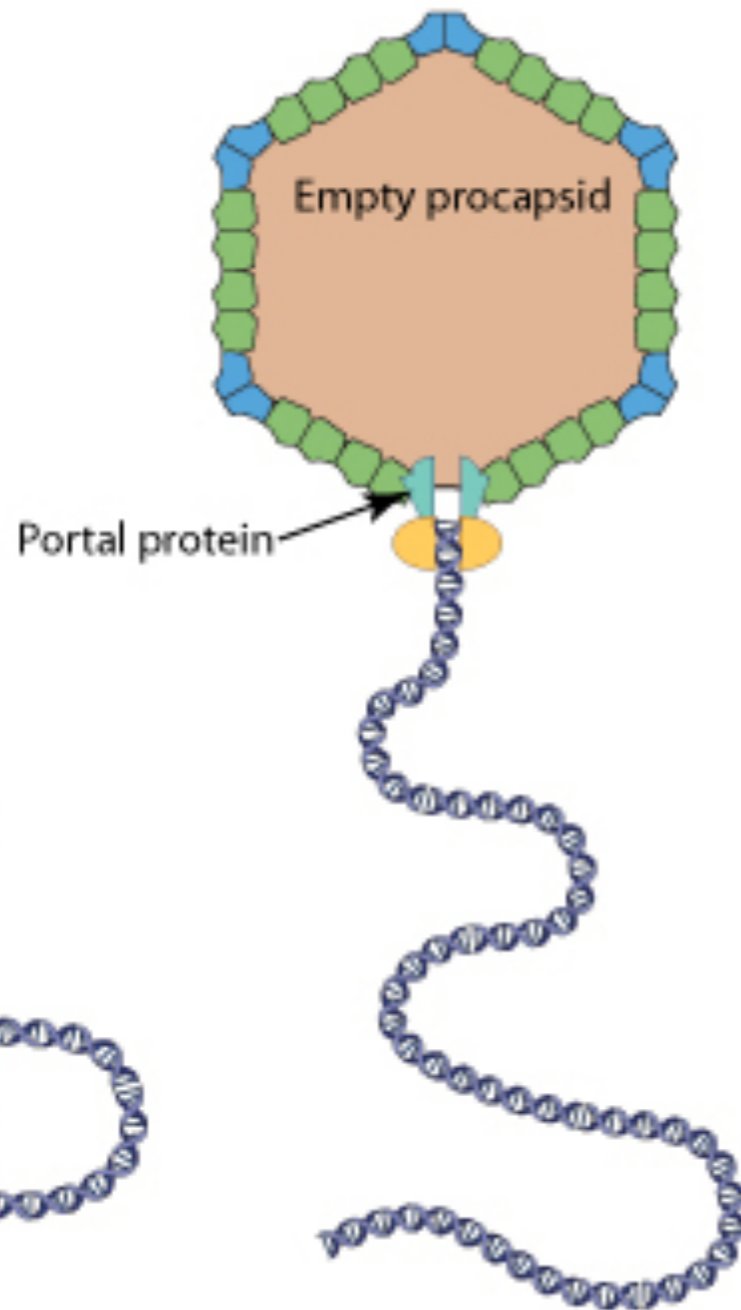


Schematic diagram of genome packaging in dsDNA viruses

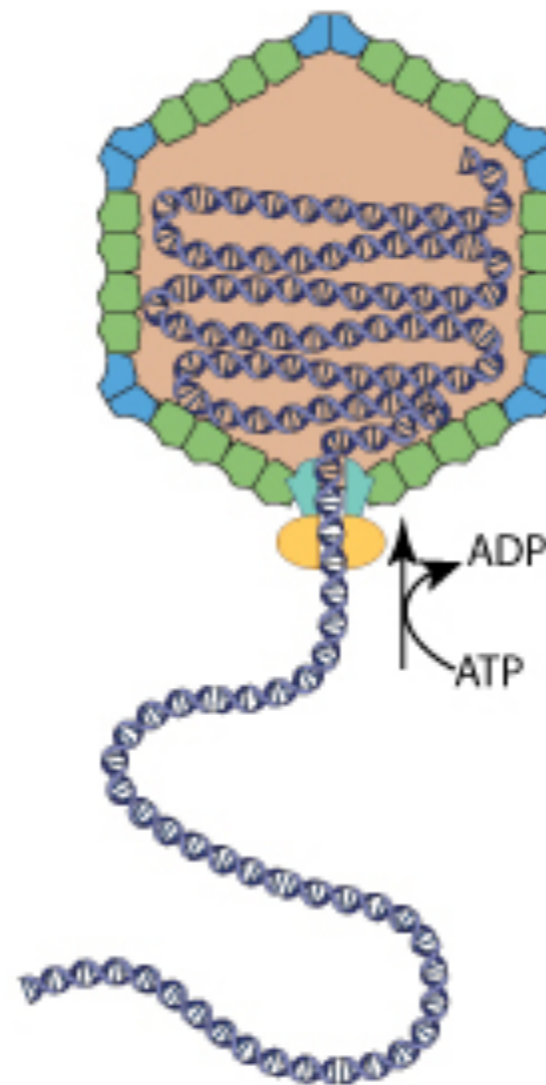
1. Terminase binds viral genome



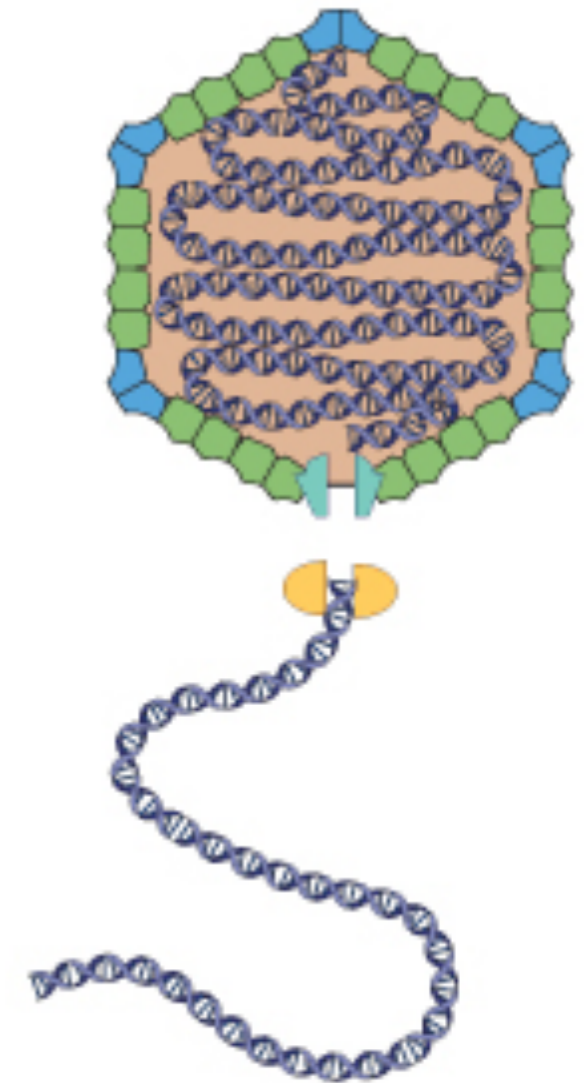
2. Terminase-DNA binds procapsid portal



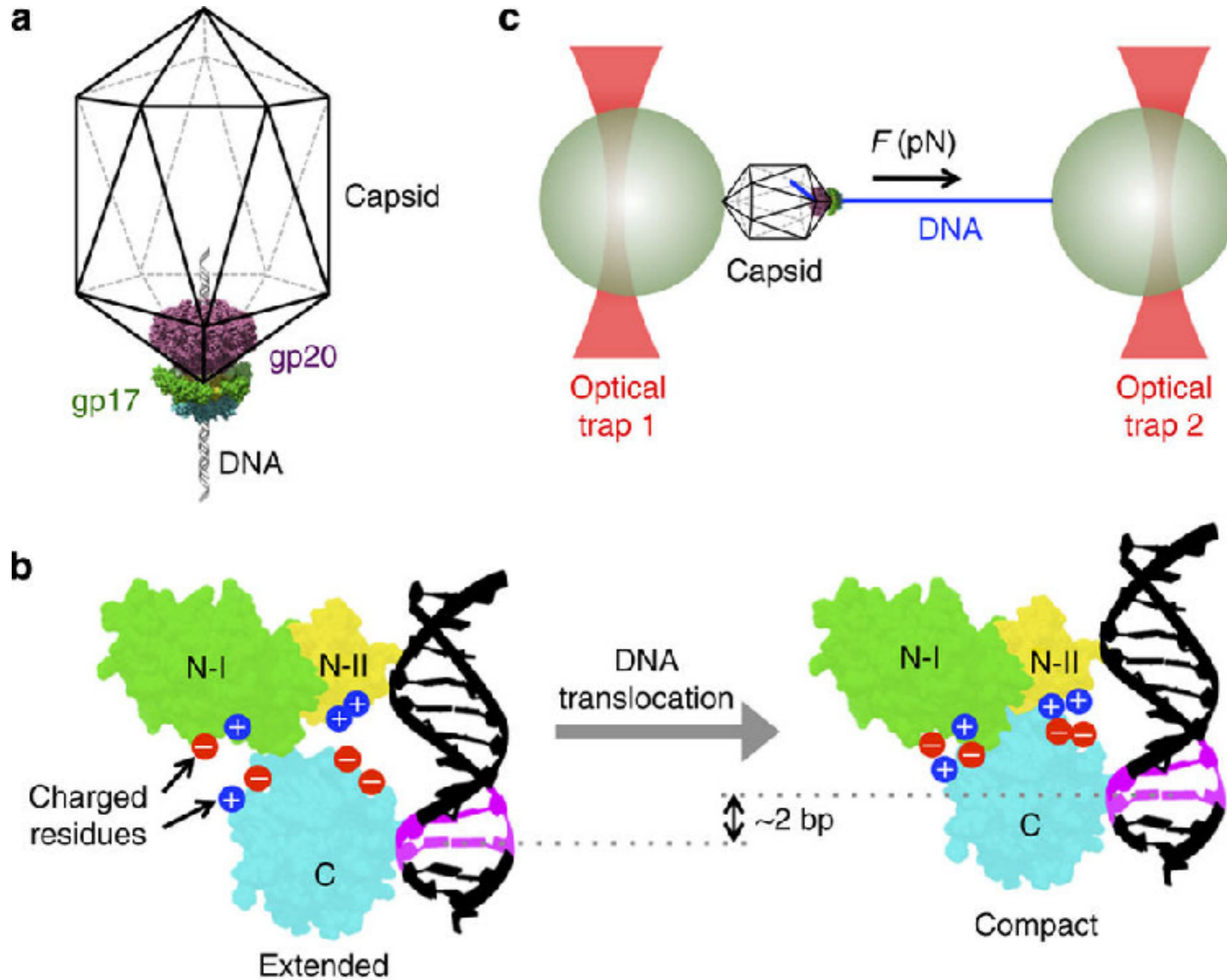
3. DNA translocation



3. contamer cleavage and packaging completion

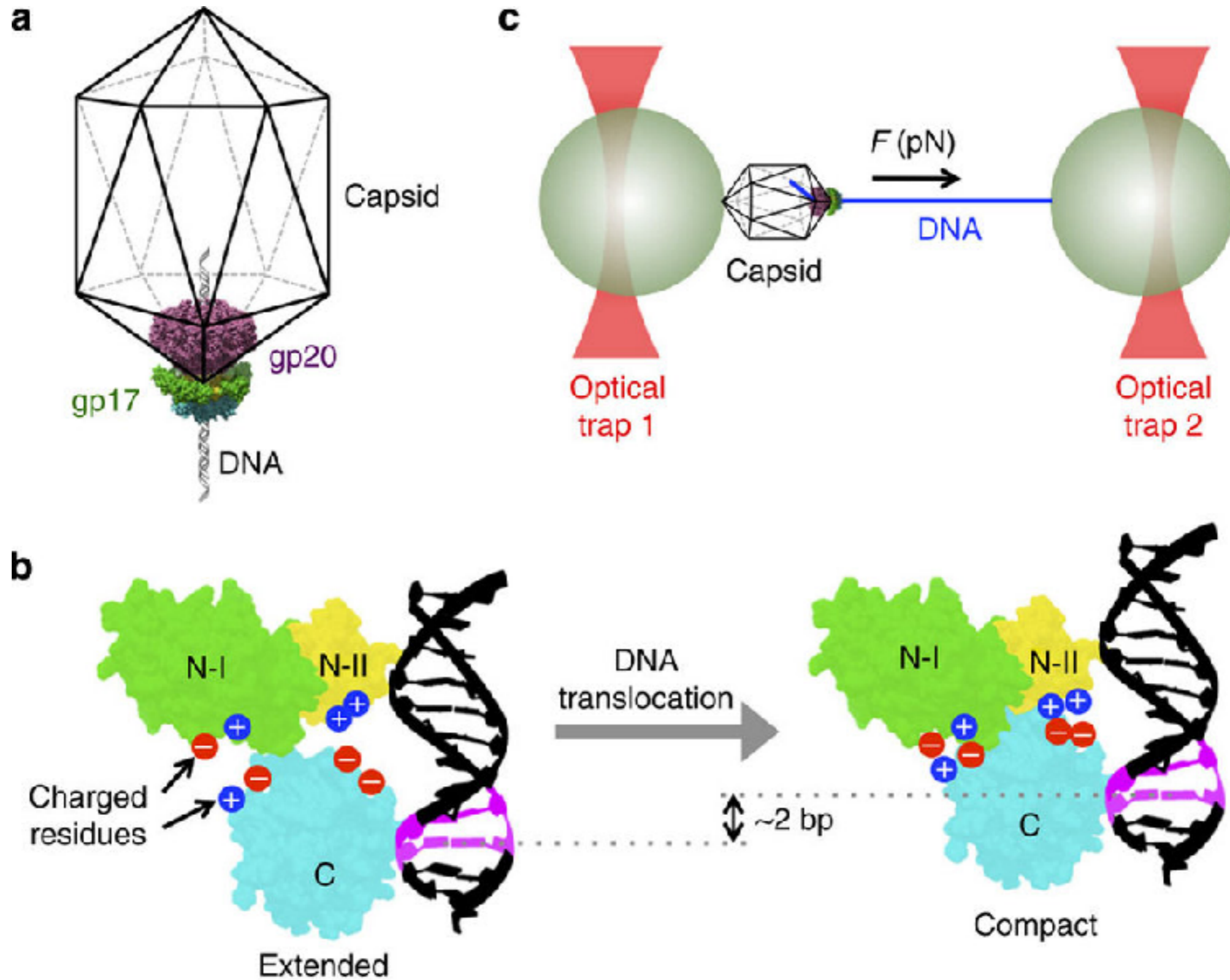


Experiment to measure force on the DNA



A. D. Migliori et al.
Nature Communications (2014)

Work done by packing motor $\approx 10^5 k_B T \approx 4.1 \times 10^5 \text{ pN} \cdot \text{nm}$



A. D. Migliori et al.
Nature Communications (2014)

How much work is done by the motor in packaging DNA?

Main forces involved are:

1. Bend and coil the DNA: “Elastic force”
(can treat as a “spring” force)
2. Bend and coil the DNA: DNA is negatively charged
(each base contains negatively charged phosphate groups)