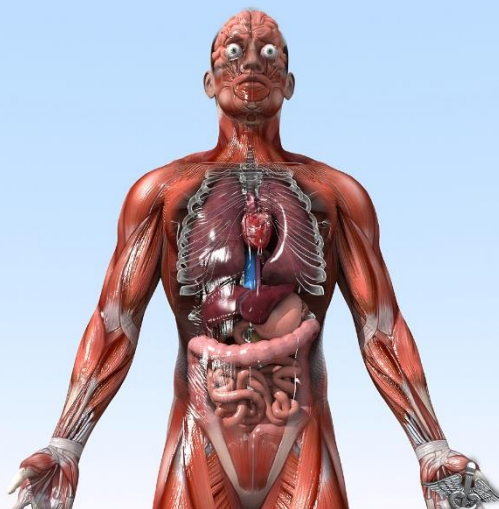
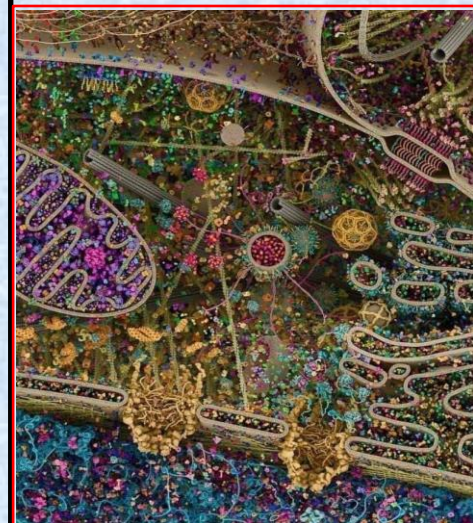


General Animal Biology

Zoo-109

علم الأحياء

109- حين



For Pre-Medical Students



Common First Year

السنة الأولى المشتركة - المسار الصحي

1444-H - 2023

Reference: Campbell, N. A. and Reece, J. B. (2014). *Biology (10th edition)*. Pearson Education. Inc. USA.

عمادة التعليم الإلكتروني والتعلم عن بعد
E-learning Deanship



King Saud University

جامعة الملك سعود

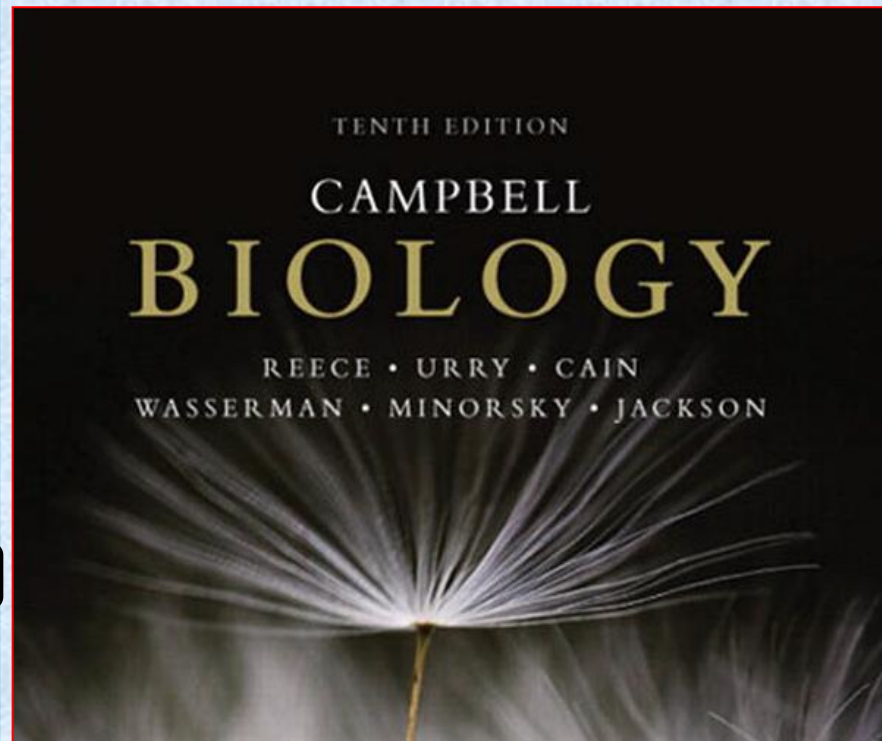
جامعة
الملك سعود
King Saud University



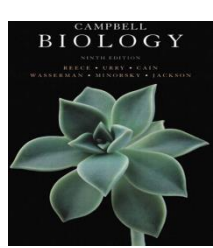
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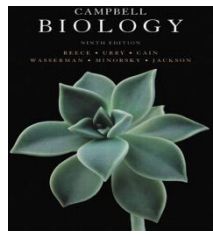
Viruses



Objectives



- Describe why viruses **are not considered as living organisms**.
- Describe the basic **structure of viruses**.
 - A virus consists of a **nucleic acid** surrounded by a **protein coat**.
 - *Viral Genomes.*
 - *Capsids and Envelopes.*
- Viruses replicate only in host cells.
- Replicative Cycles of Phages.
 - *The Lytic Cycle.*
 - *The Lysogenic Cycle.*
- Compare between the **lytic** and **lysogenic** cycles of virus replication.

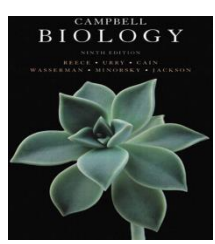


What are viruses?

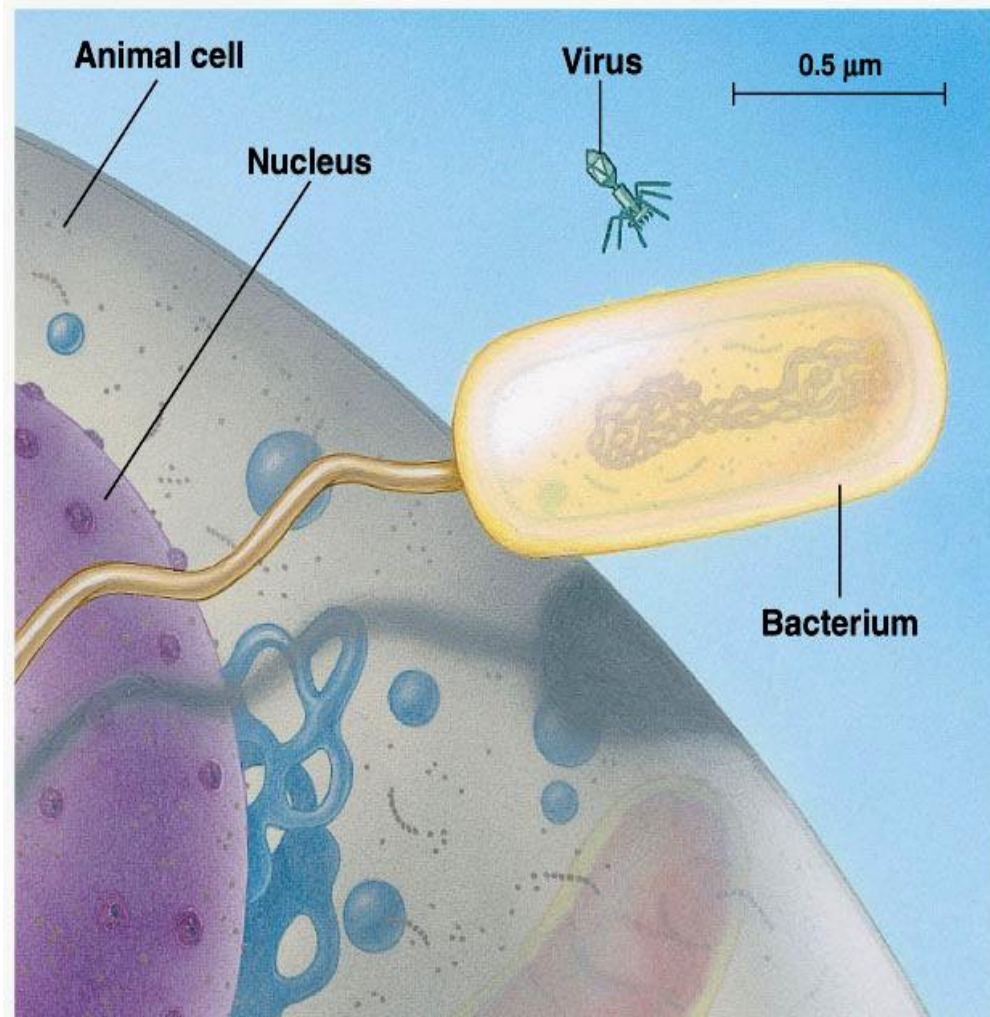


- At the boundary of life, between the macromolecules (which are not alive) and the prokaryotic cells (which are alive), lie the viruses and **bacteriophages** (phages).
- These creatures are **parasites** responsible for causing many diseases in living things (HIV in humans, as an example).
- Viruses are found everywhere.
- Viruses consist of a core of nucleic acid, either **DNA** or **RNA**, and a **protective coat of protein**.
- Viruses do not show any of the expected signs of life.
- **Viruses:**
 - **do not** respond to stimuli,
 - **do not** grow,
 - **do not** do any of the things we normally associate with life.
- Viruses **are not considered "living" organisms**. However, they do show one of the most important signs of life (**the ability to reproduce in a host cell**).



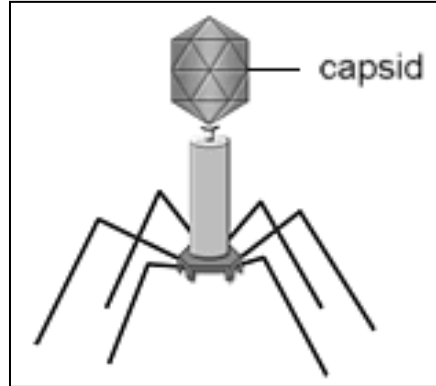
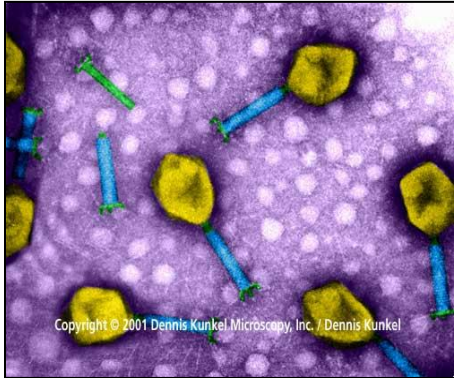


What are viruses?

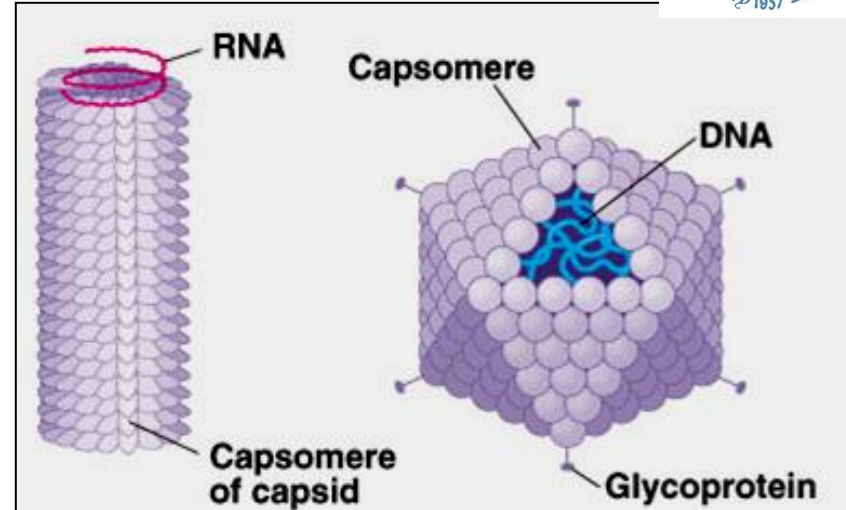


- Viruses are much smaller than bacteria.
- Virus is about **20nm** in diameter.
- Viruses are not cells.
- A virus is a genome **enclosed in a protective coat** **غطاء واقى** حامض نووي

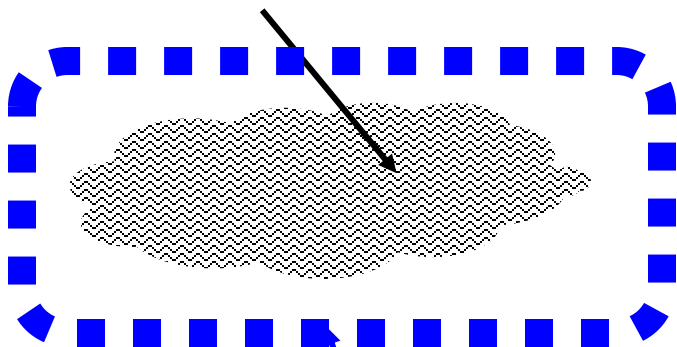
Virus is a genome enclosed in a protective coat



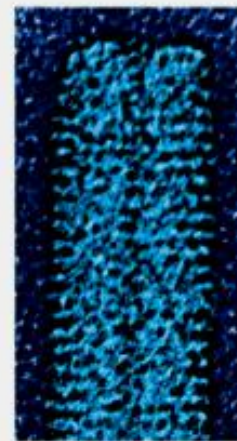
bacteriophages



Genome (DNA/RNA)

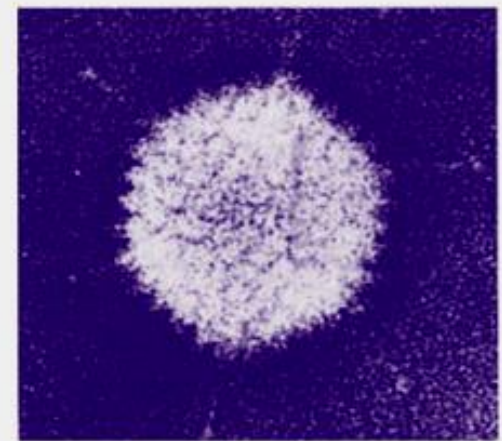


Protein coat (capsid)



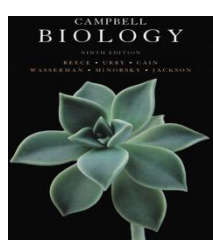
10 nm

(a) Tobacco mosaic virus



50 nm

(b) Adenoviruses

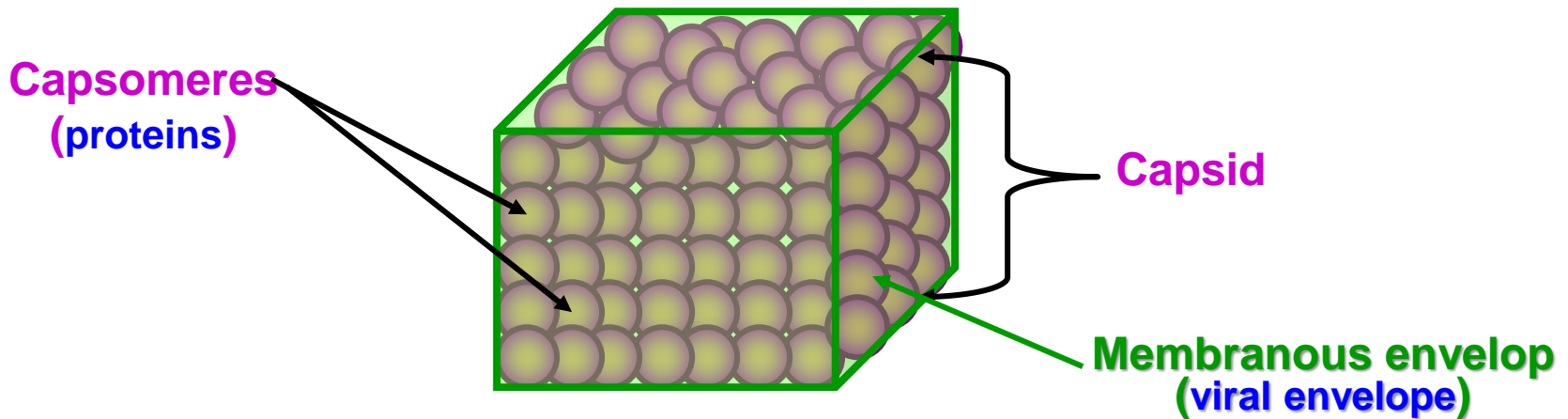


Viral Capsid and Envelope



A- Capsid الغلاف الفيروسي

- A protein shell that encloses the viral genome.
- It is rode-shaped, helical, polyhedral or more complex.
- **Capsomeres**: Are the protein units that form capsid.

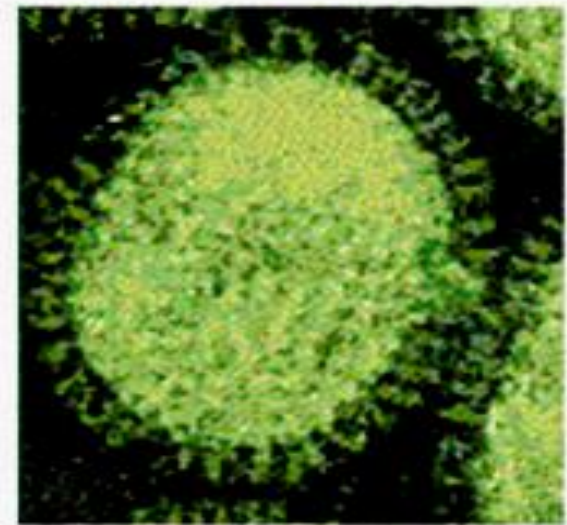
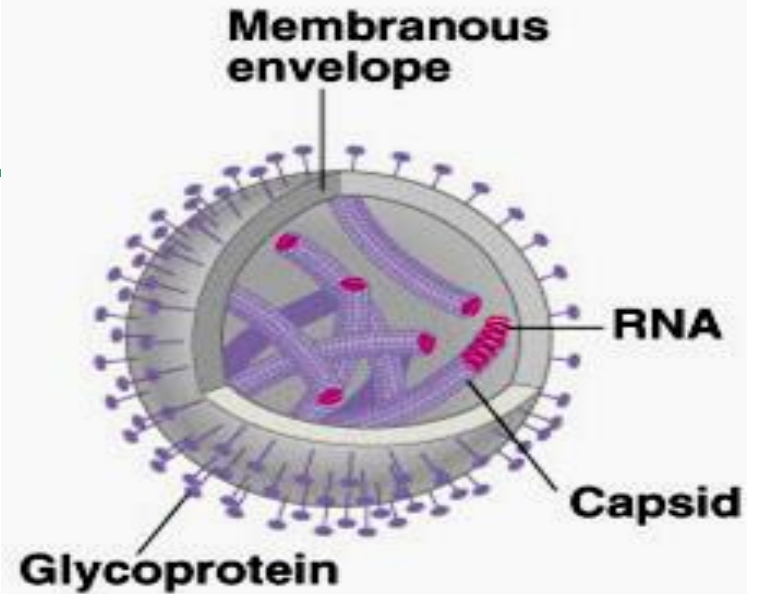


Sometimes further wrapped يُغَاف in a membranous envelope (Viral envelope الغطاء الفيروسي), eg. Influenza virus.

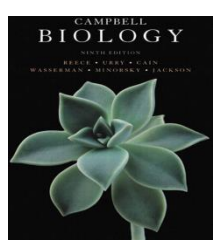


B- Envelope الغطاء الفيروسي

- Some viruses have **viral envelopes**, membranes cloaking their capsids.
- These envelopes are **derived from the membrane of the host cell**.



(c) Influenza viruses



Types of Viral Genome: (Hereditary material *المادة الوراثية*)



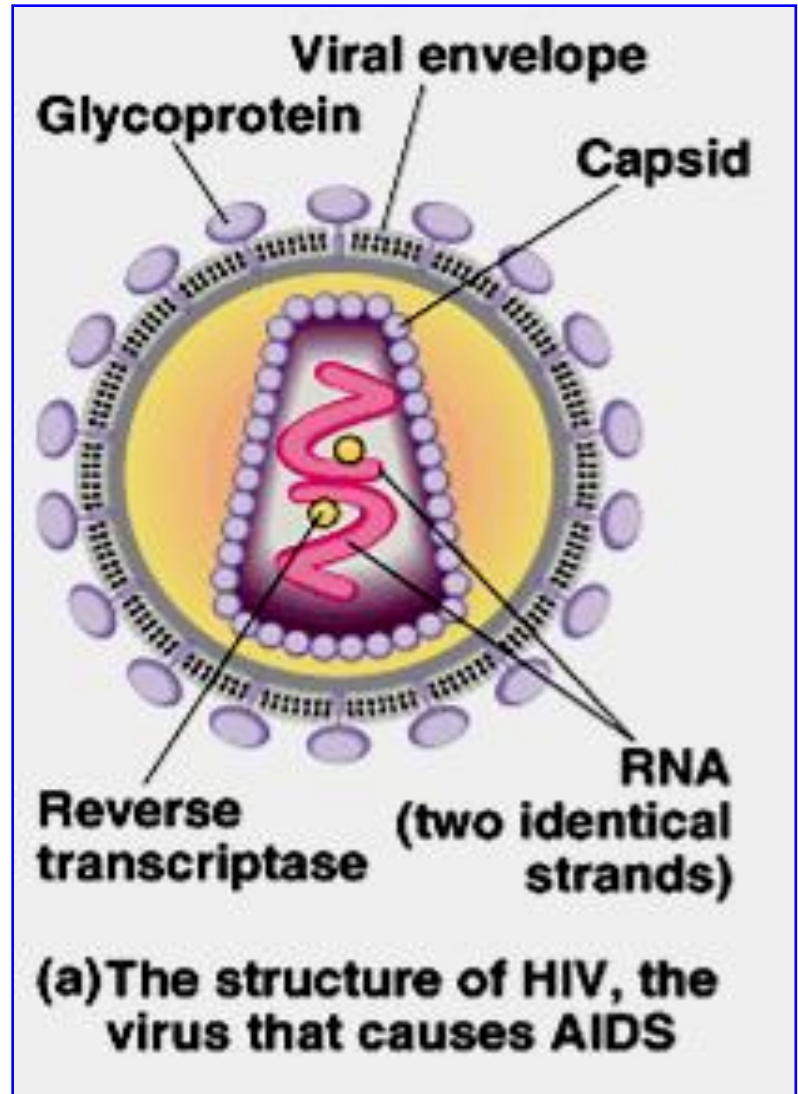
Viral genomes may consist of:

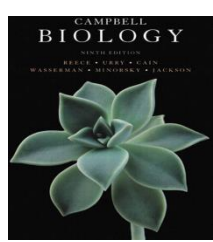
- **double-stranded DNA (dsDNA)**,
- **single-stranded DNA (ssDNA)**,
- **double-stranded RNA (dsRNA)**,
- **single-stranded RNA (ssRNA)**.

depending on the specific type of the virus.

The viral genome is usually organized as a single linear or circular molecule of nucleic acid.

The smallest viruses have only **four genes**, while the largest have **several hundred**.



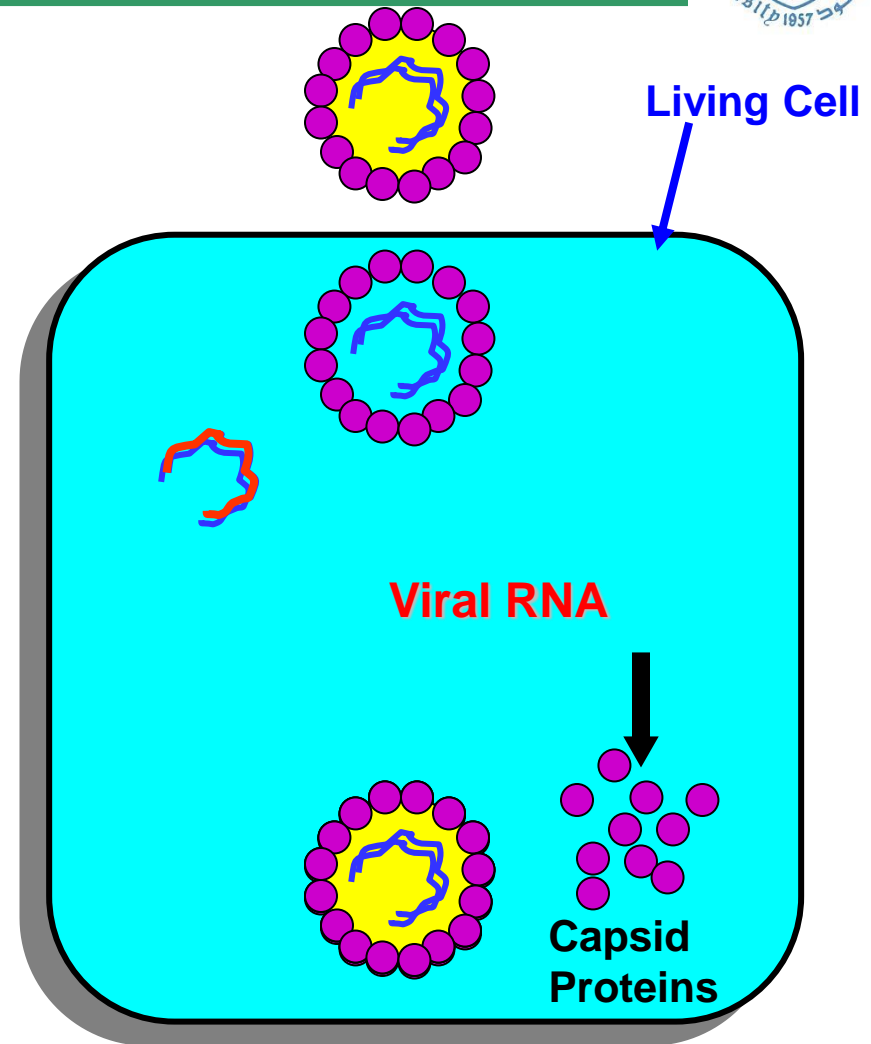


Virus-Reproduction within a living host cell

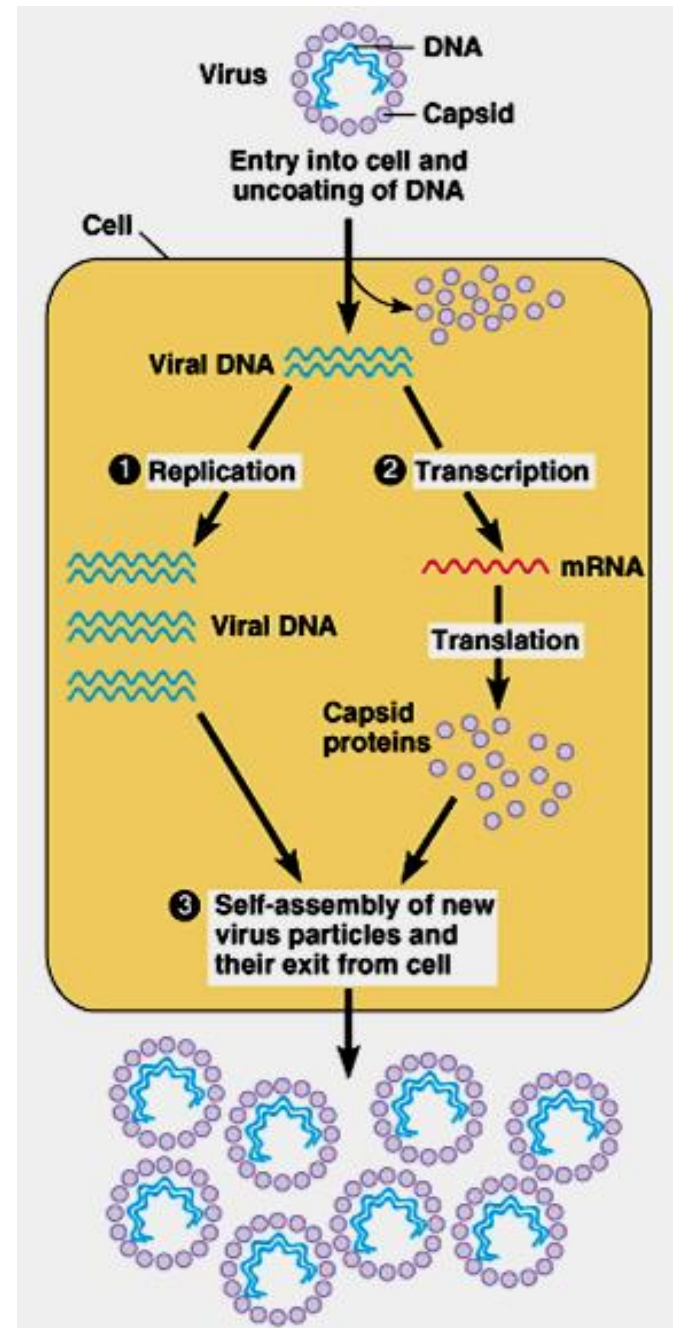


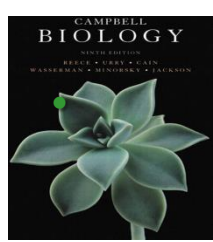
Obligate parasitism التطفل الإجباري

- 1- Enters the cell and releases its genome
- 2- Replicates using host nucleotides and enzymes
- 3- Produce a new capsid units using host cell resources.
- 4- The new viral DNA and proteins assemble to form new viruses



- A viral infection begins when the genome of the virus enters the host cell.
- Once inside, the viral genome commandeers its host, reprogramming the cell to copy viral nucleic acid and manufacture proteins.
- The nucleic acid molecules and capsomeres then self-assemble into viral particles and exit the cell.



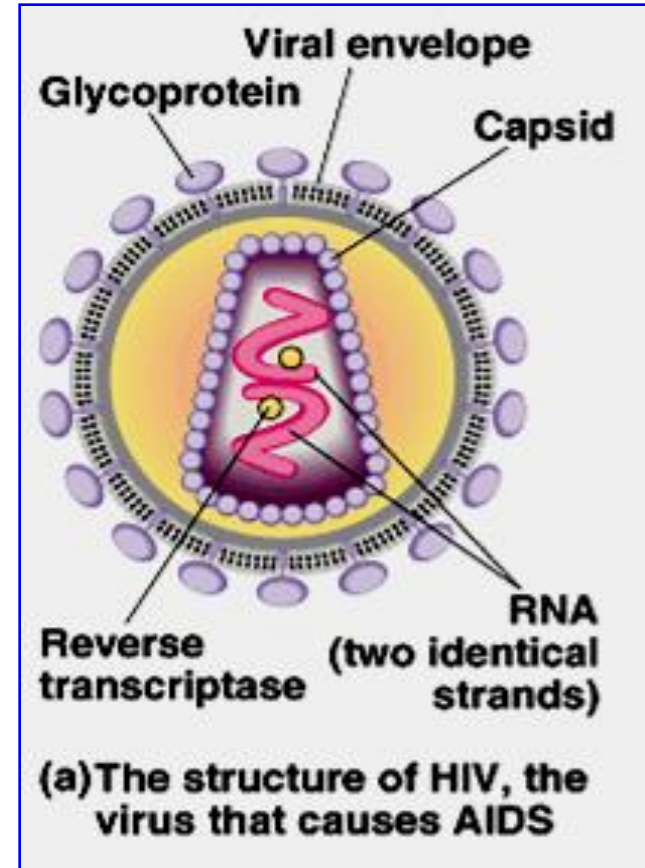


Human Immunodeficiency Virus (HIV), the virus that causes AIDS (Acquired Immuno-Deficiency Syndrome) is a retrovirus.



The retrovirus

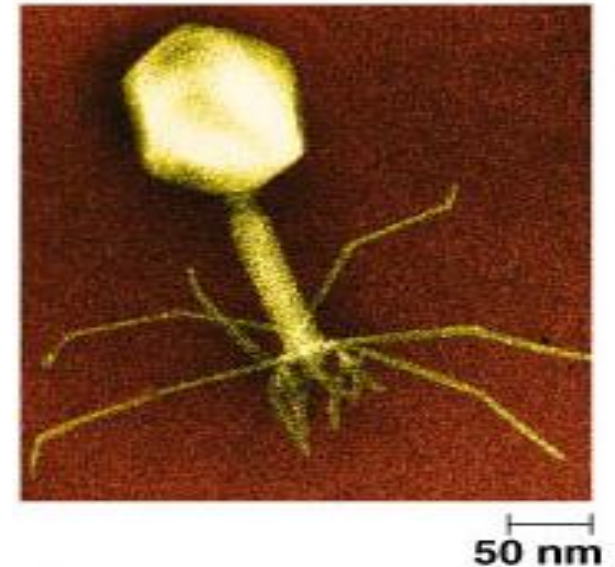
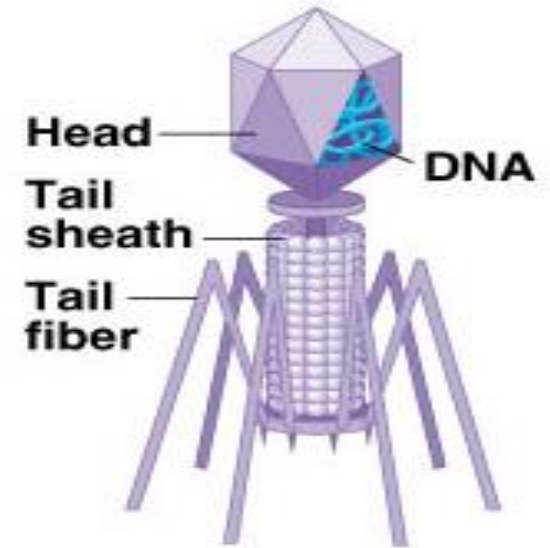
- A **retrovirus** is an **RNA virus** that is duplicated in a host cell using the **reverse transcriptase** enzymes to produce DNA from its RNA genome. The DNA is then incorporated into the host's genome by an **integrase** enzymes.
- This **viral particle** includes:
 - ✓ An **envelope** with glycoproteins,
 - ✓ A capsid containing **two identical RNA strands** as its genome
 - ✓ Two copies of **reverse transcriptase**.
- An example is the AIDS (HIV) virus.



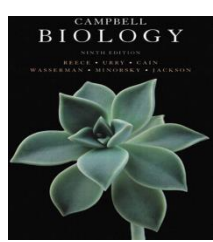
Bacteria infecting Viruses (bacteriophages)

Bacteriophages (صواعق البكتريا)

- Viruses that infect bacteria, are called **bacteriophages** or (**phages**).
- It has a 20-sided **capsid-head** that encloses their DNA and **protein tail** piece that attaches the phage to the host and injects the phage DNA inside.
- Phages reproduce by **Lytic Cycle** (دورة مميتة) and/or **Lysogenic cycle** (دورة غير مميتة).



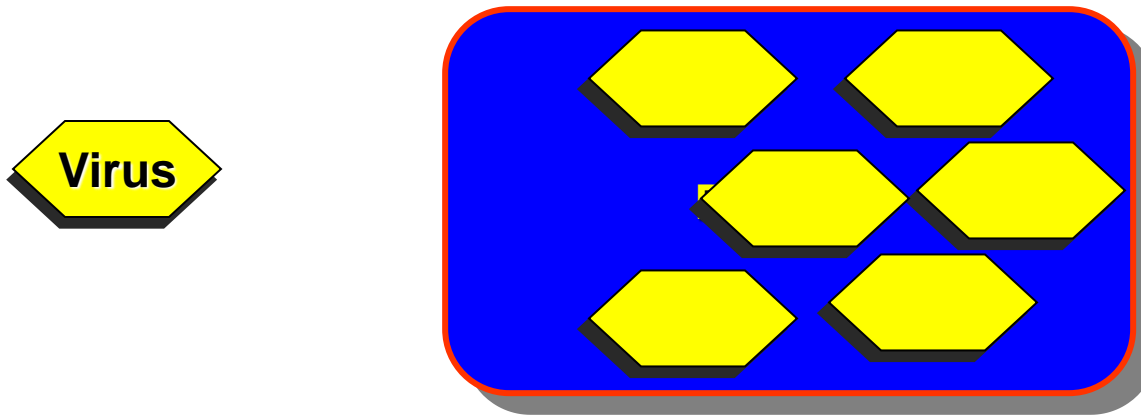
(d) Bacteriophage T4



Bacteriophages (on *E. coli*)



Phages reproductive cycles within bacteria (e.g: *Escherichia coli*)



1)- lytic cycle (الدورة التحللية) ,

The phage reproductive cycle results in the death of the host.

– In the last stage, the bacterium lyses (breaks open) and releases the phages produced within the cell to infect others.

- **Virulent phages** فيروسات قاتلة reproduce only by a lytic cycle.

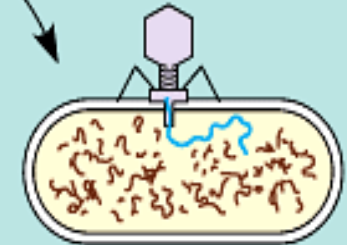
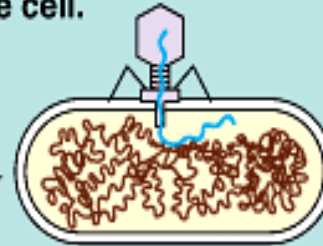
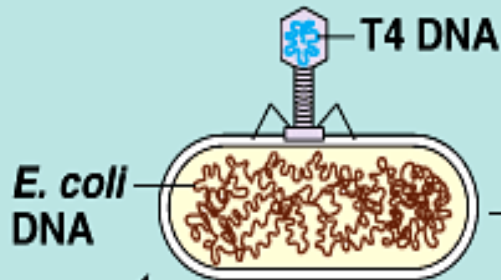
1 The T4 phage uses its tail fibers to stick to specific receptor sites on the outer surface of an *E. coli* cell.

2 The sheath of the tail contracts, thrusting a hollow core through the wall and membrane of the cell. The phage injects its DNA into the cell.

3 The empty capsid of the phage is left as a "ghost" outside the cell. The cell's DNA is hydrolyzed.

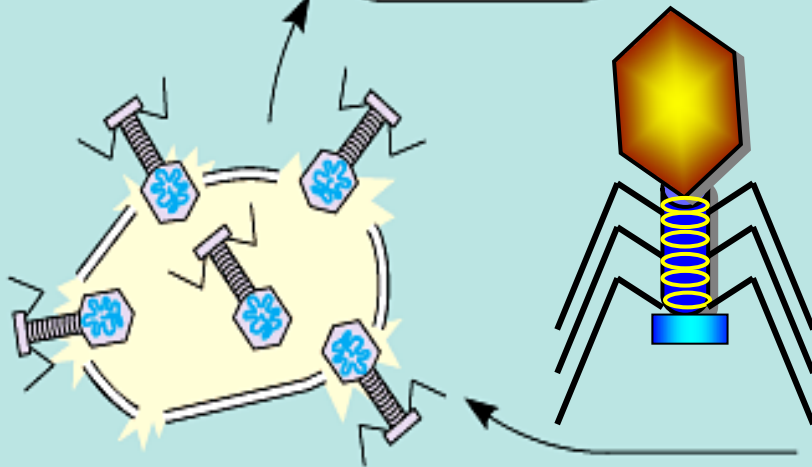
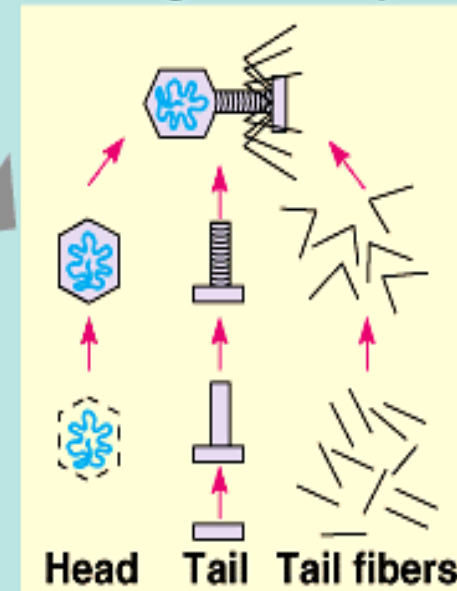
4 The cell's metabolic machinery, directed by phage DNA, produces phage proteins, and nucleotides from the cell's degraded DNA are used to make copies of the phage genome. The phage parts come together. Three separate sets of proteins assemble to form phage heads, tails, and tail fibers.

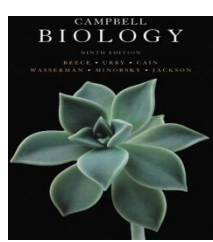
5 The phage then directs production of lysozyme, an enzyme that digests the bacterial cell wall. With a damaged wall, osmosis causes the cell to swell and finally to burst, releasing 100 to 200 phage particles.



Phage T4 (virulent viruses) فیروس ممیت

Phage assembly



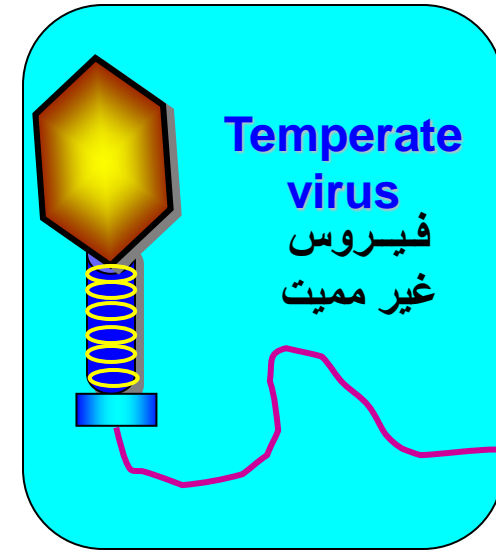


2)- lysogenic cycle (الدورة غير التحللية)



Phage lambda (λ)

The phage genome usually replicates without destroying the host cell.



- Phage lambda (λ) (Temperate phages) may use both **lytic** and **lysogenic** cycles.
- Within the host, the virus' circular DNA engages in either the **lytic** or **lysogenic** cycle.
- During a **lytic** cycle, the viral genome immediately turns the host cell into a virus-producing factory, and the cell soon lyses and releases its viral products.

2)- Lysogenic cycle (الدورة غير التحليلية)

Phage

The phage attaches to host cell and injects DNA.

Occasionally, a prophage exits the bacterial chromosome, initiating a lytic cycle.

Phage DNA

Bacterial chromosome

Many cell divisions produce a colony of bacteria infected with prophage.

Lytic cycle

Lysogenic cycle

The cell lyses, releasing phages.

Phage DNA circularizes

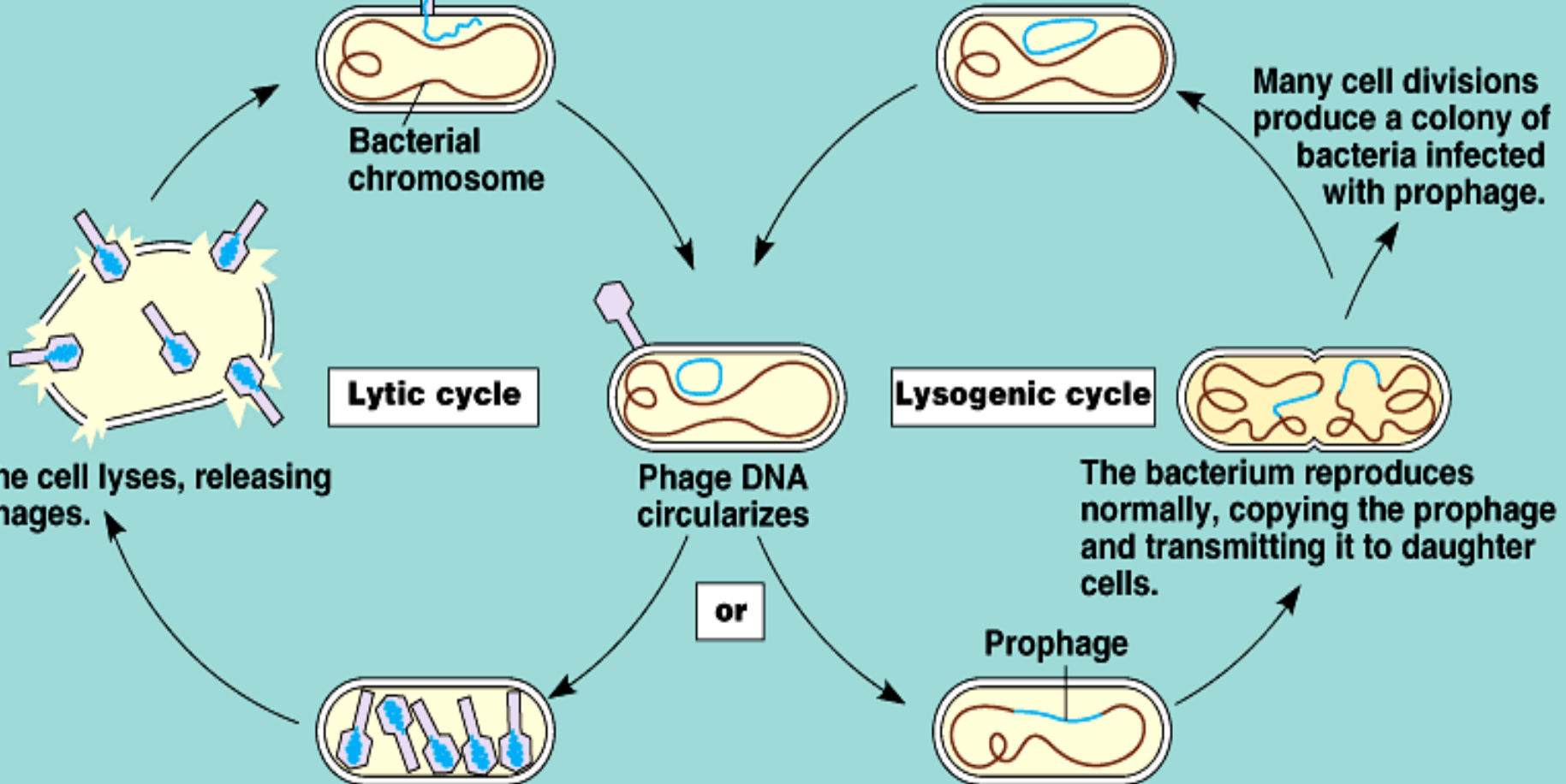
The bacterium reproduces normally, copying the prophage and transmitting it to daughter cells.

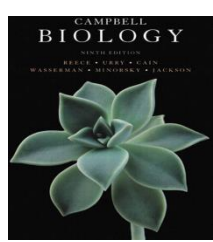
or

Prophage

New phage DNA and proteins are synthesized and assembled into phages.

Phage DNA integrates into the bacterial chromosome, becoming a prophage.

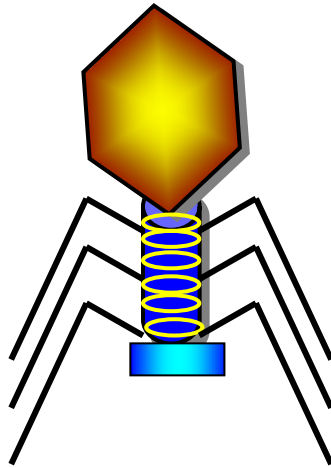




Summary



Phage T4

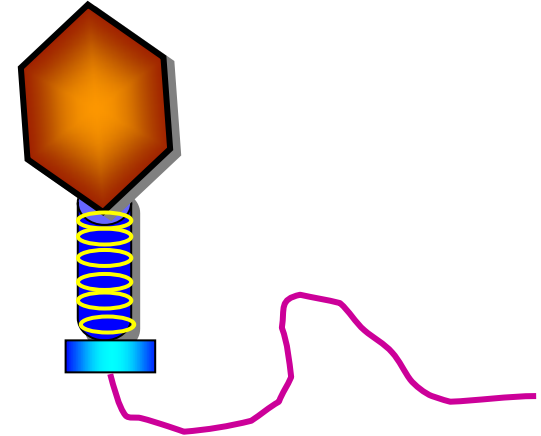


Many tail fibres
(virulent virus)

فيروس مميت

lytic cycle
(الدورة التحللية)

Phage lambda (λ)



Only 1 tail fibre

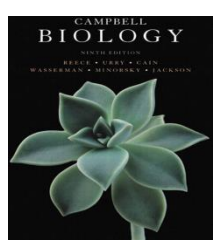
Temperate virus

فيروس غير مميت أحيانا

Lysogenic cycle
(الدورة غير التحللية)

and/or

lytic cycle
(الدورة التحللية)



Summary: Characters of viruses

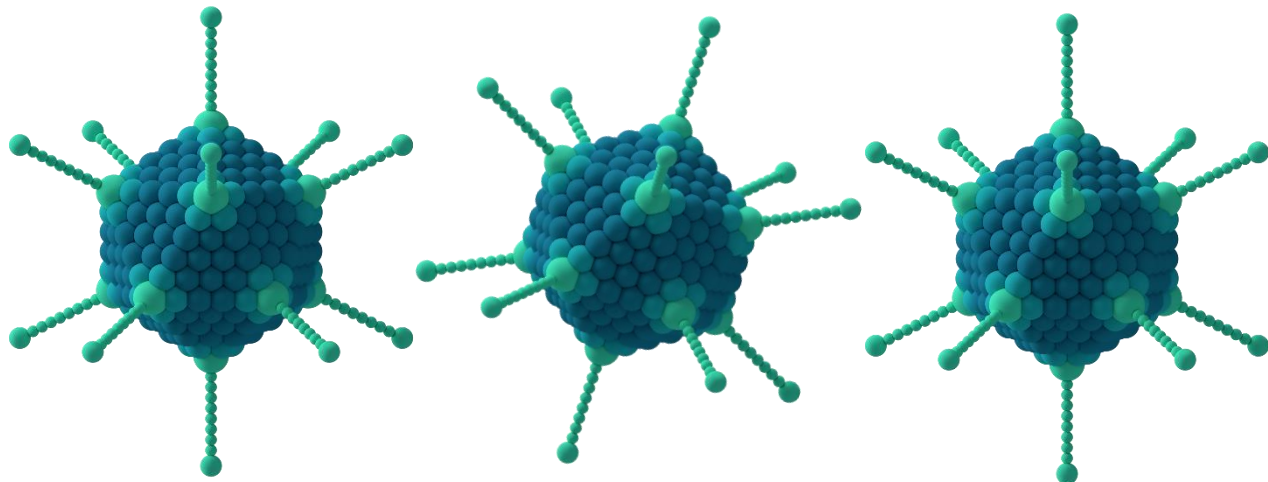


Most viruses of eukaryotes attack specific tissues. eg. **Human cold viruses** infect only the cells lining the upper respiratory tract, and **AIDS virus** binds only to certain white blood cells (**Immune system**).

- **DNA enclosed in a protein coat** (sometimes, membranous envelope also)
- **Can be crystallised** يتبلور
- They lack **يفتقد** enzymes for metabolism
- Have **no ribosomes** for making their own proteins
- Reproduce only within a living host cell (**obligate parasitism** تطفل إجباري).
- Each type of a virus infects a limited range of host cells (**host range** مدى الإصابة)

Viruses are host specific

- a protein on the surface of the virus has a shape that matches a molecule in the plasma membrane of its host, allowing the virus to recognize the host cell.



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General Animal Biology
(Zoo-109)

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Thank you very much

شكراً جزيلاً

Zoology Department