Transduction

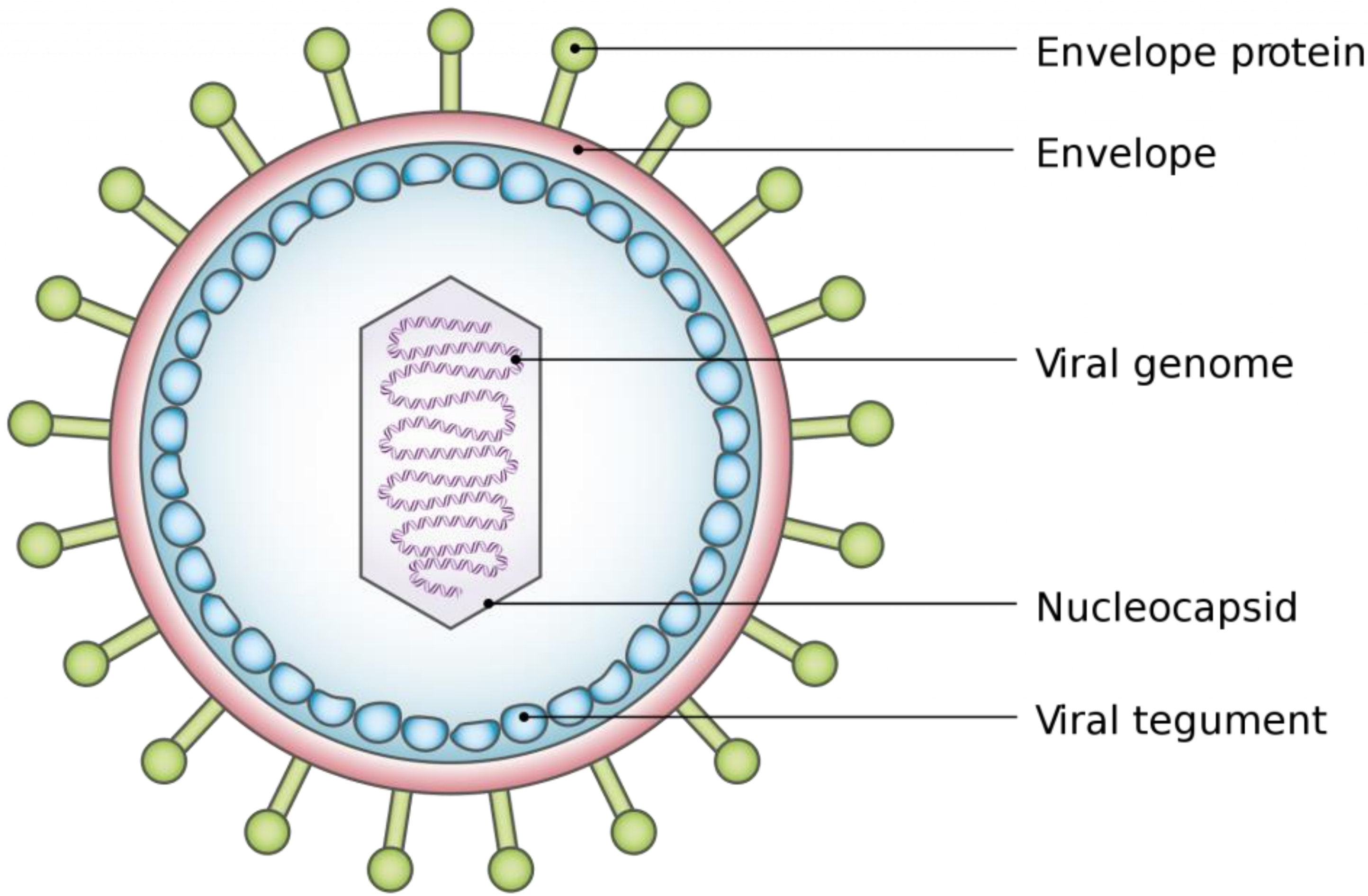
Introduction

- **Transduction** is the process by which **foreign DNA is introduced into a cell by a virus or viral vector.**
- Transduction **does not require physical contact** between the cell donating the DNA and the cell receiving the DNA which occurs in conjugation.
- It is also **DNase resistant** whereas **transformation is susceptible to DNase.**

- Transduction was discovered in 1952 in *Salmonella*.

- Transduction is a **common tool** used by molecular biologists to stably introduce a foreign gene into a host cell's genome (both bacterial and mammalian cells).

Viral structure



Mechanism

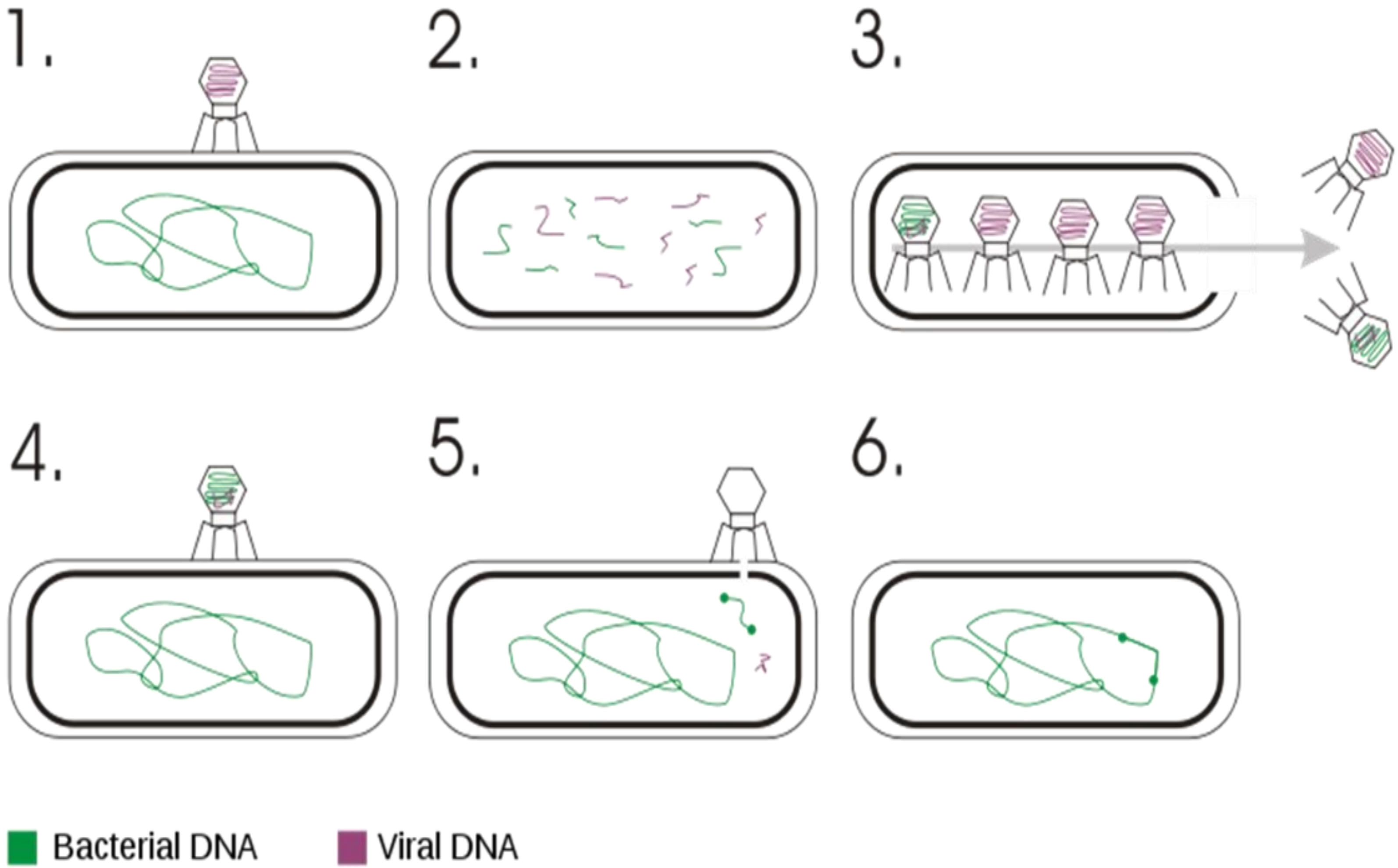
- When bacteriophages infect bacterial cells, they **take control** of replicational, transcriptional, and translation machinery of the host bacterial cell.
- **Thousands of copies** are made of different virus parts.
- Eventually they are assembled as **numerous virions**, or complete viral particles, including the viral DNA or RNA and the protein coat.

- During this assembly, **some parts of host (bacterial) DNA** also packed in new virions.

- These virions are then released as new **viruses**.

- When these viruses infect **new bacterial cell**, they transfer not only their own genetic material but also the genetic material **from previous host** which gets **integrated into genetic material of new host.**

- This is called **transduction**.


1.
2.
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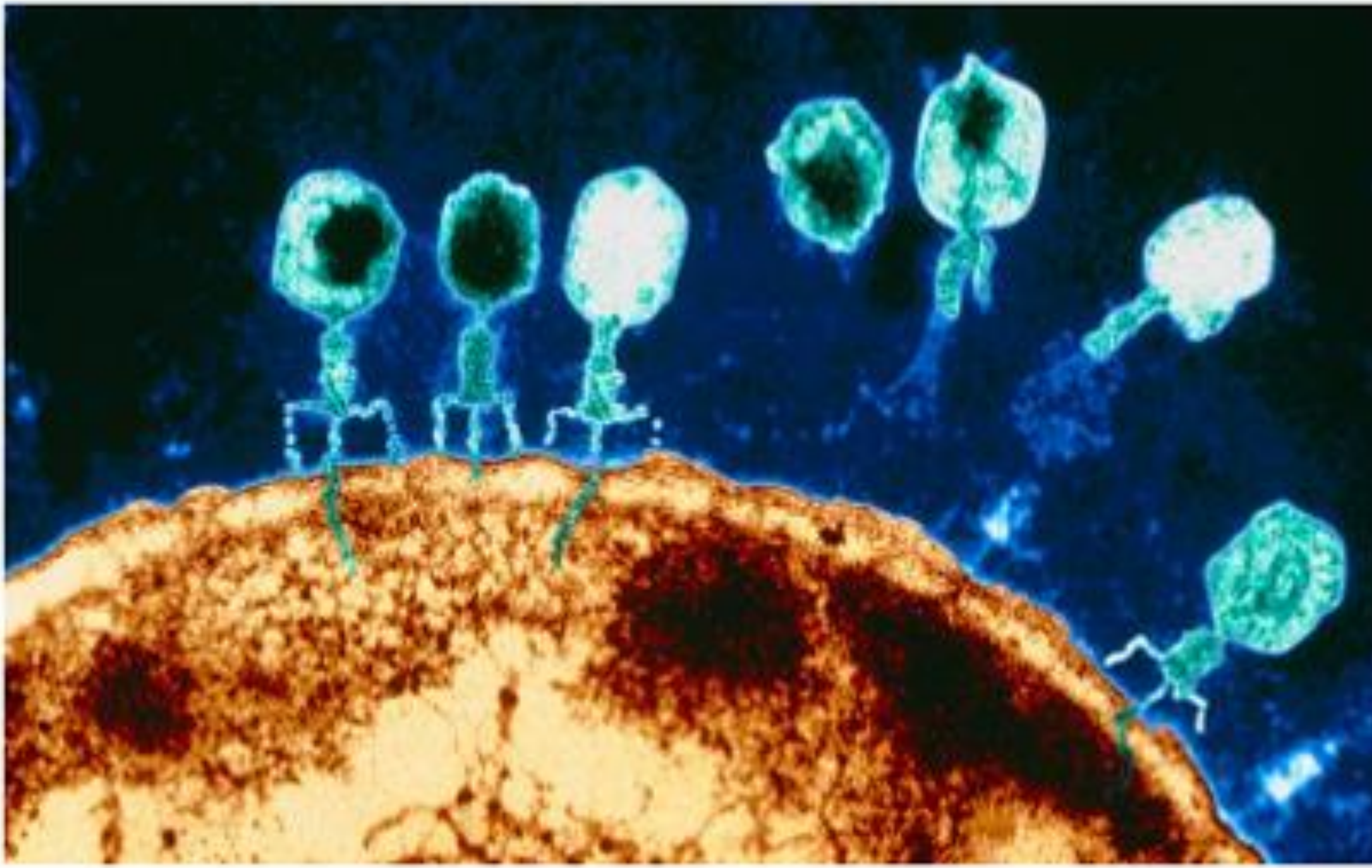
Bacterial DNA
Viral DNA



Bonin L, 26th Sept 2014 iWonder BBC News

Lytic and lysogenic (temperate) cycles

Transduction happens through either:

the **lytic cycle**

or

the **lysogenic cycle**

Lytic cycle

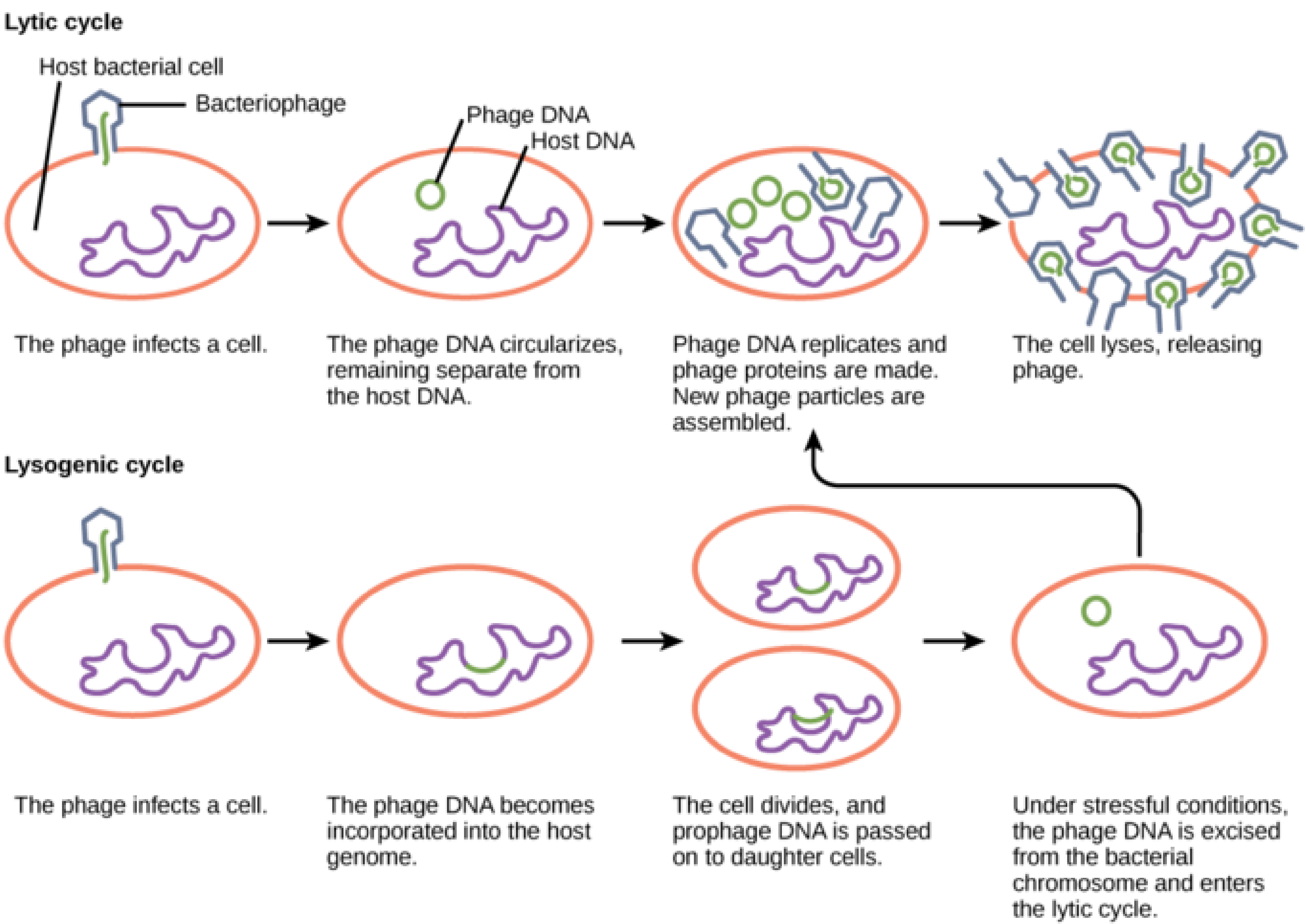
- When a **bacteriophage** attacks a bacterial cell it **takes control of whole bacterial machinery.**
- It is followed by **replication of its DNA** and **production of viral proteins.**
- Next step is **assembly of viral DNA and proteins** into **thousands** of phage particles called **virions**.
- Final step is **lysis of the cell** and the **release of phage particles.**

Lysogenic cycle

- If the lysogenic cycle is adopted, the **phage chromosome is integrated (by covalent bonds) into the bacterial chromosome**, where it **can stay dormant for thousands of generations.**

- In this phase, it is called a **prophage**.

- If the lysogen is **induced** by some factor (**UV light** for example), the phage genome is **excised** from the bacterial chromosome and **initiates the lytic cycle**.


Lytic cycle
Host bacterial cell
Bacteriophage
Phage DNA
Host DNA
The phage infects a cell.
The phage DNA circularizes, remaining separate from the host DNA.
Phage DNA replicates and phage proteins are made. New phage particles are assembled.
The cell lyses, releasing phage.
Lysogenic cycle
The phage infects a cell.
The phage DNA becomes incorporated into the host genome.
The cell divides, and prophage DNA is passed on to daughter cells.
Under stressful conditions, the phage DNA is excised from the bacterial chromosome and enters the lytic cycle.

Transduction can be either:

Generalized

or

Specialized

Generalized transduction

- Generalized transduction is the process by which **any bacterial DNA** may be transferred to another bacterium via a bacteriophage.

- It is a rare event; a very small percentage of phage particles happen to carry a donor bacterium's DNA, on the order of **1 phage in 10,000.**

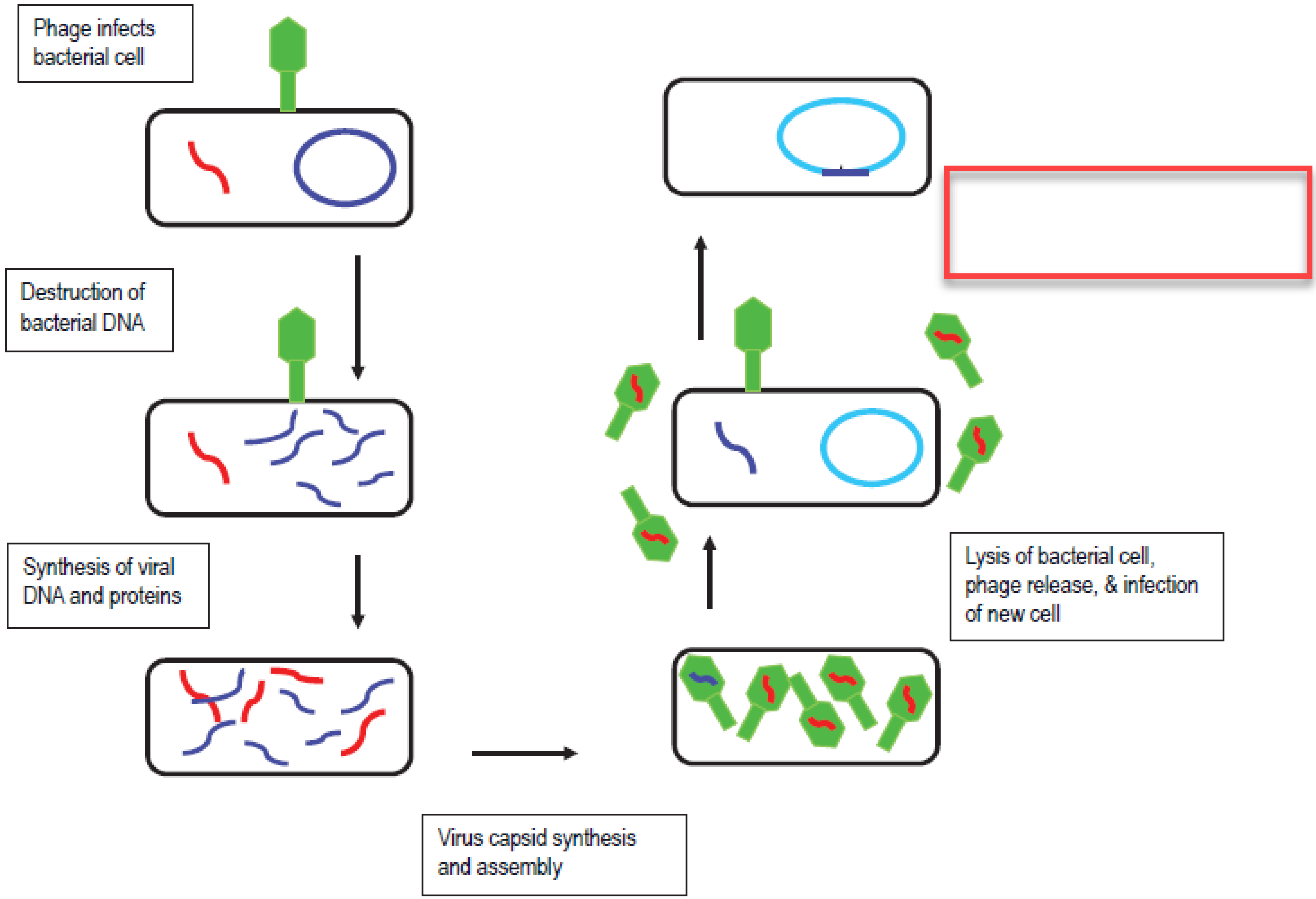
- In essence, this is the **packaging of bacterial DNA into a viral envelope.**

- It is relevant to **lytic cycle.**

- If bacteriophages undertake the **lytic cycle** of infection upon entering a bacterium, the virus will take control of the cell's machinery for use in replicating its own viral DNA.

- If by chance **bacterial chromosomal DNA is inserted into the** viral DNA of a virion, the **mistake will lead to generalized transduction**.

Generalized transduction



Courtesy of M. Mulks (MSU)

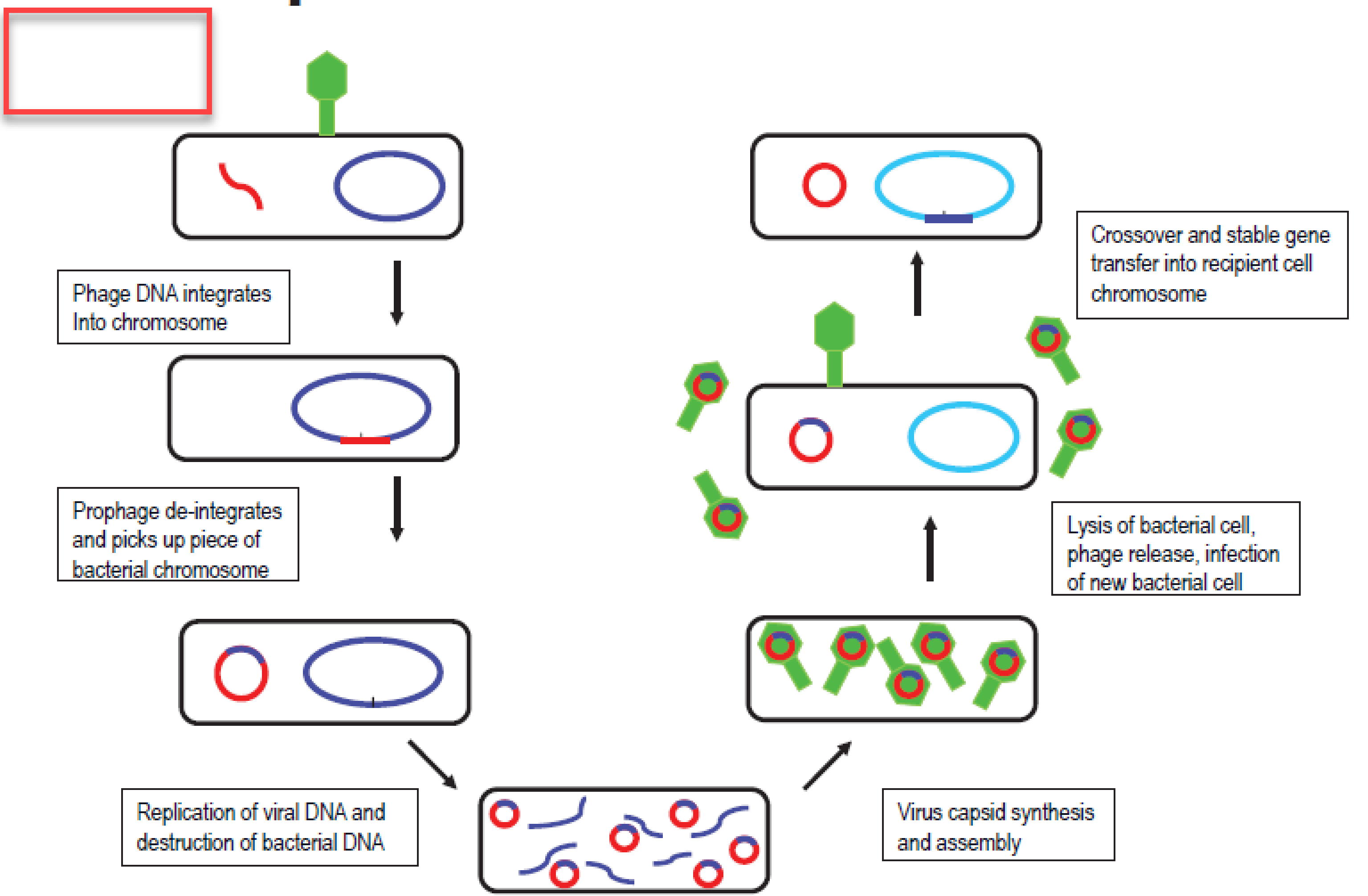
Specialized transduction

- Specialized transduction is **only relevant** to prophages or lysogenic cycle.
- Specialized transduction is the process by which a **restricted set of bacterial genes** is transferred to another bacterium.
- The genes that get transferred (donor genes) depend on **where the phage genome is located on the chromosome.**
- Specialized transduction occurs when the **prophage excises imprecisely from the chromosome so that bacterial genes lying adjacent to the prophage are included in the excised DNA.**

- The excised DNA is then **packaged into a new virus particle**, which then delivers the DNA to a new bacterium.

- An example of specialized transduction is **λ phage** in *Escherichia coli.*

Specialized transduction



Courtesy of M. Mulks (MSU)


Thank You!