Life cycle of viruses

- Plant viruses are more similar to animal viruses than they are to bacteriophages.
- Plant viruses may be enveloped or non-enveloped.
- Like many animal viruses, plant viruses can have either a DNA or RNA genome and be single stranded or double stranded.
- However, most plant viruses do not have a DNA genome; the majority have a +ssRNA genome, which acts like messenger RNA (mRNA).
- Only a minority of plant viruses have other types of genomes.
- Plant viruses may have a narrow or broad host range. For example, the citrus tristeza virus infects only a few plants of the Citrus genus, whereas the cucumber mosaic virus infects thousands of plants of various plant families.
- Most plant viruses are transmitted by contact between plants, or by fungi, nematodes, insects, or other arthropods that act as mechanical vectors.
- However, some viruses can only be transferred by a specific type of insect vector; for example, a particular virus might be transmitted by aphids but not whiteflies. In some cases, viruses may also enter healthy plants through wounds, as might occur due to pruning or weather damage.
- Viruses that infect plants are considered biotrophic parasites, which means that they can establish an infection without killing the host, similar to what is observed in the lysogenic life cycles of bacteriophages.
- Viral infection can be asymptomatic (latent) or can lead to cell death (lytic infection).
- The life cycle begins with the penetration of the virus into the host cell.
- Next, the virus is uncoated within the cytoplasm of the cell when the capsid is removed.
- Depending on the type of nucleic acid, cellular components are used to replicate the viral genome and synthesize viral proteins for assembly of new virions.
- To establish a systemic infection, the virus must enter a part of the vascular system of the plant, such as the phloem.
- The time required for systemic infection may vary from a few days to a few weeks depending on the virus, the plant species, and the environmental conditions.
- The virus life cycle is complete when it is transmitted from an infected plant to a healthy plant.

The Life Cycle of Viruses with Prokaryote Hosts

The life cycle of bacteriophages.has been a good model for understanding how viruses affect the cells they infect, since similar processes have been observed for eukaryotic viruses, which can cause immediate death of the cell or establish a latent or chronic infection. Bacteriophages are the viruses that can infect the bacteria**. Virulent phages** typically lead to the death of the cell through cell lysis. **Temperate phages**, on the other hand, can become part of a host chromosome and are replicated with the cell genome until such time as they are induced to make newly assembled viruses, or **progeny viruses**.

The Lytic Cycle

During the **lytic cycle** of virulent phage, the bacteriophage takes over the cell, reproduces new phages, and destroys the cell.

T-even phage is a good example of a well-characterized class of virulent phages.

There are five stages in the bacteriophage lytic cycle (see Figure 1).

1. **Attachment** is the first stage in the infection process in which the phage interacts with specific bacterial surface receptors (e.g., lipopolysaccharides and OmpC protein on host surfaces). Most phages have a narrow host range and may infect one species of bacteria or one strain within a species. This unique recognition can be exploited for targeted treatment of bacterial infection by phage therapy or for phage typing to identify unique bacterial subspecies or strains.
2. The second stage of infection is entry or **penetration**. This occurs through contraction of the tail sheath, which acts like a hypodermic needle to inject the viral genome through the cell wall and membrane. The phage head and remaining components remain outside the bacteria.

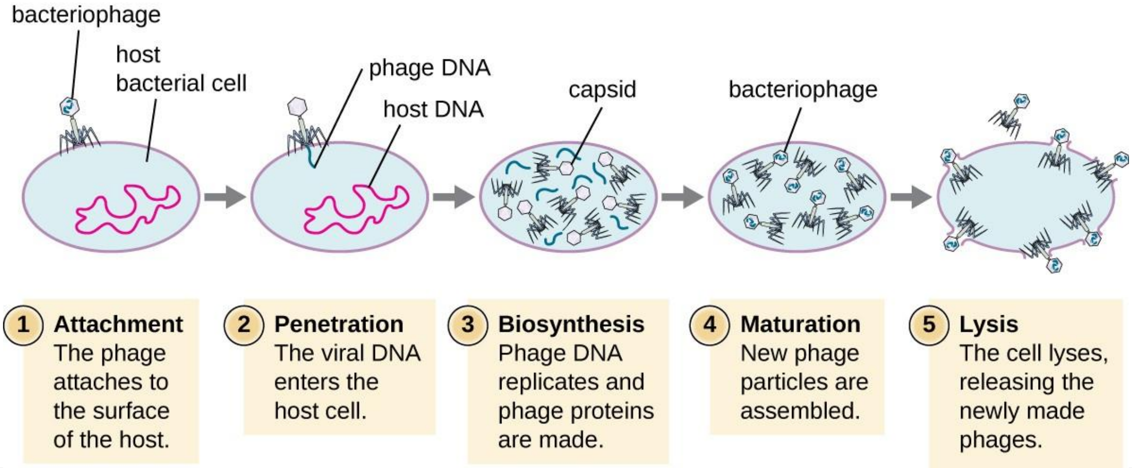

Figure 1. A virulent phage shows only the lytic cycle pictured here. In the lytic cycle, the phage replicates and lyses the host cell.

3. The third stage of infection is **biosynthesis** of new viral components. After entering the host cell, the virus synthesizes virus-encoded endonucleases to degrade the bacterial chromosome. It then hijacks the host cell to replicate, transcribe, and translate the necessary viral components (capsomeres, sheath, base plates, tail fibers, and viral enzymes) for the assembly of new viruses. Polymerase genes are usually expressed early in the cycle, while capsid and tail proteins are expressed later.
4. During the **maturation** phase, new virions are created. To liberate free phages, the bacterial cell wall is disrupted by phage proteins such as holin or lysozyme.
5. The final stage is release. Mature viruses burst out of the host cell in a process called **lysis** and the progeny viruses are liberated into the environment to infect new cells.

The Lysogenic Cycle

- In a **lysogenic cycle**, the phage genome also enters the cell through attachment and penetration.
- A prime example of a phage with this type of life cycle is the lambda phage.
- During the lysogenic cycle, instead of killing the host, the phage genome integrates into the bacterial chromosome and becomes part of the host.
- The integrated phage genome is called a **prophage**.
- A bacterial host with a prophage is called a **lysogen**.
- The process in which a bacterium is infected by a temperate phage is called **lysogeny**.
- It is typical of temperate phages to be latent or inactive within the cell.
- As the bacterium replicates its chromosome, it also replicates the phage's DNA and passes it on to new daughter cells during reproduction.
- The presence of the phage may alter the phenotype of the bacterium, since it can bring in extra genes (e.g., toxin genes that can increase bacterial virulence).
- This change in the host phenotype is called **lysogenic conversion** or **phage conversion**.
- Some bacteria, such as *Vibrio cholerae* and *Clostridium botulinum*, are less virulent in the absence of the prophage.
- The phages infecting these bacteria carry the toxin genes in their genome and enhance the virulence of the host when the toxin genes are expressed.

- In the case of *V. cholera*, phage encoded toxin can cause severe diarrhea; in *C. botulinum*, the toxin can cause paralysis.
- During lysogeny, the prophage will persist in the host chromosome until **induction**, which results in the excision of the viral genome from the host chromosome.
- After induction has occurred the temperate phage can proceed through a lytic cycle and then undergo lysogeny in a newly infected cell (Figure 2).

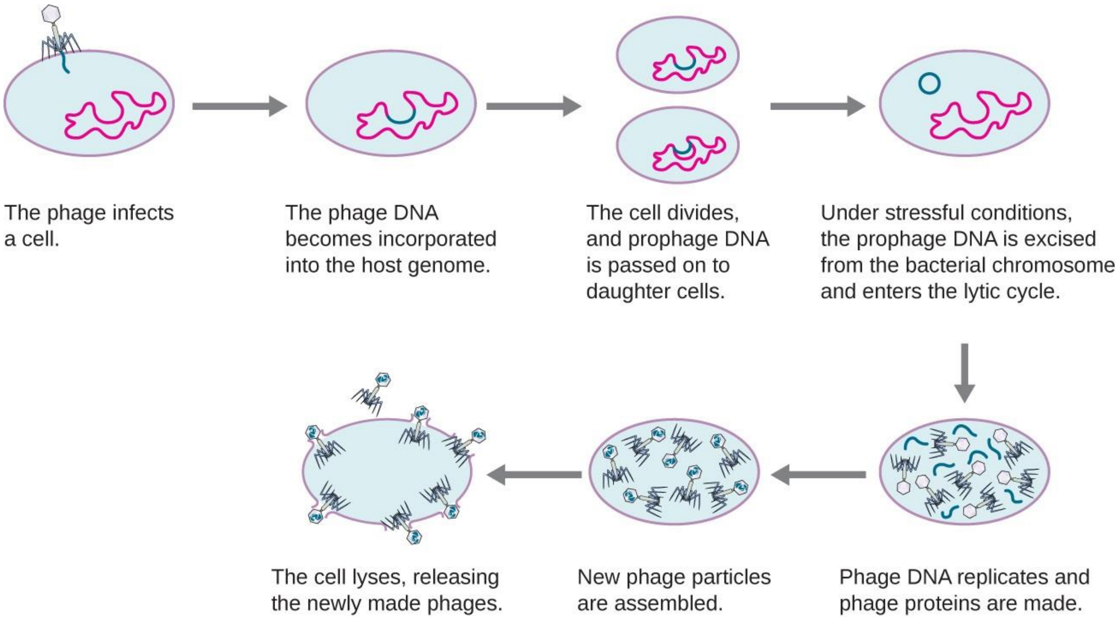

Figure 2. A temperate bacteriophage has both lytic and lysogenic cycles. In the lysogenic cycle, phage DNA is incorporated into the host genome, forming a prophage, which is passed on to subsequent generations of cells. Environmental stressors such as starvation or exposure to toxic chemicals may cause the prophage to be excised and enter the lytic cycle.