10.7A: The Lytic Life Cycle of Bacteriophages

Learning Objectives

1. Describe the steps involved in the lytic life cycle of bacteriophages.
2. Define the following:
   a. lytic bacteriophage
   b. eclipse period

As mentioned in an earlier section, bacteriophages are viruses that only infect bacteria (see Figure \(\PageIndex{1}\)) and Figure \(\PageIndex{2}\). Bacteriophages that replicate through the lytic life cycle are called lytic bacteriophages. After infecting bacteria with lytic bacteriophages in the lab, plaques can be seen on the petri plates. Plaques are small clear areas on the agar surface where the host bacteria have been lysed by lytic bacteriophages. The lytic life cycle is somewhat similar to the productive life cycle of animal viruses and consists of the following steps:
Plaques on an agar surface after infecting Escherichia coli with Coliphage T-4

Step 1: Adsorption

Attachment sites on the bacteriophage adsorb to receptor sites on the host bacterium (see Figure \(\PageIndex{1}\)). Most bacteriophages adsorb to the bacterial cell wall, although some are able to adsorb to flagella or pili. Specific strains of bacteriophages can only adsorb to specific strain of host bacteria. This is known as viral specificity.

Figure \(\PageIndex{1}\): Adsorption during the Lytic Life Cycle of a Lytic Bacteriophage. The bacteriophage binds to receptors on the bacterial cell wall.

Step 2: Penetration

In the case of bacteriophages that adsorb to the bacterial cell wall, a bacteriophage enzyme "drills" a hole in the bacterial wall and the bacteriophage injects its genome into the bacterial cytoplasm (Figure \(\PageIndex{2}\)). Some bacteriophages accomplish this by contracting a sheath which drives a hollow tube into the bacterium. This begins the eclipse period. The genomes of bacteriophages which adsorb to flagella or pili enter through these hollow organelles. In either case, only the phage genome enters the bacterium so there is no uncoating stage.
Figure \(\PageIndex{2}\): Penetration during the Lytic Life Cycle of a Lytic Bacteriophage. The bacteriophage injects its genome into the cytoplasm of the bacterium.

**Step 3: Replication**

Enzymes coded by the bacteriophage genome shut down the bacterium's macromolecular (protein, RNA, DNA) synthesis. The bacteriophage replicates its genome and uses the bacterium's metabolic machinery to synthesize bacteriophage enzymes and bacteriophage structural components (Figure \(\PageIndex{3}\)) and Figure \(\PageIndex{4}\)).

Figure \(\PageIndex{4}\): Late Replication during the Lytic Life Cycle of a Lytic Bacteriophage. The production of bacteriophage components and enzymes progresses.

**Step 4: Maturation**

The phage parts assemble around the genomes (Figure \(\PageIndex{5}\)).
Step 5: Release

Usually, a bacteriophage-coded lysozyme breaks down the bacterial peptidoglycan causing osmotic lysis and release of the intact bacteriophages (Figure \(\PageIndex{6}\)).

Step 6: Reinfection

From 50 to 200 bacteriophages may be produced per infected bacterium.
Adsorption of a Bacteriophage to the Cell Wall of the Bacterium. Attachment sites on the virus bind to corresponding receptors on the host cell wall.

Exercise: Think-Pair-Share Questions

1. Describe how a lytic bacteriophage might possibly play a role in horizontal gene transfer in bacteria.
2. As will be seen in lab, phage typing is a technique wherein unknown strains of a bacterium are identified by using known strains of bacteriophages. How can we use a bacteriophage to identify a bacterium?
3. We saw in the previous section that a single infected animal cell may produce 10,000-50,000 viruses yet an infected bacterium can only produce 50-200 bacteriophages. Explain this.

Concept Map for the Lytic Life Cycle of Bacteriophages

Summary

1. Bacteriophages that replicate through the lytic life cycle are called lytic bacteriophages,
2. Adsorption is the attachment sites on the phage adsorb to receptor sites on the host bacterium.
3. Specific strains of bacteriophages can only adsorb to specific strain of host bacteria (viral specificity).
4. In the case of bacteriophages that adsorb to the bacterial cell wall, a bacteriophage enzyme "drills" a hole in the bacterial wall and the bacteriophage injects its genome into the bacterial cytoplasm.
5. The bacteriophage replicates its genome and uses the bacterium's metabolic machinery to synthesize bacteriophage enzymes and bacteriophage structural components.
6. During maturation, the bacteriophage parts assemble around the phage genomes.
7. A phage-coded lysozyme breaks down the bacterial peptidoglycan causing osmotic lysis and release of the intact bacteriophages.

Contributors and Attributions

- Dr. Gary Kaiser (COMMUNITY COLLEGE OF BALTIMORE COUNTY, CATONSVILLE CAMPUS)