Slide 1:
In this lecture I will discuss the different stages of a bacteriophage infection cycle.

Slide 2:
The infection cycle involves 6 different stages, starting with the attachment of the phage to the bacterial surface. Next, the phage injects its DNA by penetrating the bacterial cell wall. The phage DNA is replicated and phage structural proteins are synthesized in the following 2 stages. Afterwards, the phage compounds are assembled and the newly formed mature phage particles lyse its host cell. The virions are released in the environment and can infect new bacterial targets. In the upcoming slides, these different stages of the infection cycle will be discussed in further detail.

Slide 3:
The infection cycle starts with the attachment of the phage to bacterial surface receptors on the cell wall. Possible targets are lipopolysaccharides, teichoic acids, proteins and flagella. The attachment is controlled by the phage tail structure. Phages with a contractile tail interact with bacterial surface receptors via receptor-binding proteins on the baseplate, while phages with a non-contractile tail interact via their tail fibers. Non-contractile long tailed phages interact directly. Non-contractile short tailed phages interact with a primary host receptor followed by an enzymatical degradation of this receptor enabling the tail fibers to make contact with a secondary receptor on the cell surface.

Slide 4:
Upon attachment, the phage DNA is injected into the bacterial cell via penetration. Similar as for attachment, this stage depends on the tail structure of the phage. Contractile tailed phages first change the conformation of the baseplate resulting in a contraction of the sheat. The receptor-binding proteins locally digest the external polysaccharides and a tail glycosidase disrupts the peptidoglycan layer. These actions enable the internal tail tube to penetrate the cell envelope and to inject the phage genome. Non-contractile long tailed phages penetrate the outer membrane with their tail tip, followed by enzymatic degradation of the peptidoglycan layer. Next, the base plate will change its conformation and the phage genome can be injected. Non-contractile short tailed phages first rearrange their tail proteins to locally cleave the peptidoglycan layer, resulting in injection of the phage genome.

Slide 5:
In the third stage of the infection cycle, the injected phage DNA is replicated. Prior to DNA replication, the host metabolism is redirected towards phage production. The host RNA polymerase, transcription factors and ribosomes are used to express the early genes of the phage genome producing among others a repair enzyme to reconstruct the bacterial cell wall and viral DNA polymerases and proteins required for DNA replication. Furthermore a DNAse for the degradation of host DNA into precursor molecules is expressed. The produced early proteins also regulate the viral gene expression, for example the activation of late gene transcription. Next, the DNA is replicated which means that the phage DNA is copied. Multiple methods can be applied for replication according to the preference of the infecting phage. One example is the rolling circle replication in which one strand of the circular dsDNA is nicked and the 3’ end is elongated using the unnicked DNA strand as template. The 5’ end is displaced. The displaced strand is complemented and the replicated DNA circularizes again.

Slide 6:
When multiple copies of the phage genome are present, the late genes are expressed synthesizing structural proteins required to assemble new phage particles. Capsid proteins, matrix elements, envelope proteins and tail structures are some examples of these late proteins.

Slide 7:
In the maturation stage, the synthesized phage elements are assembled into mature virions. The capsid proteins assemble into heads and the phage genome is linearized and packaged. The tail and accessory structures are attached to this phage capsid.

Slide 8:
The newly formed phage particles are now ready to be released from its host. Therefore, they produce a murein hydrolase or a lysin to attack and break down the host peptidoglycan layer. Furthermore, a holine or another membrane protein can make a lesion in the cytoplasmic membrane. These actions make the bacterial cell wall weak resulting in the burst of the host cell. This is called ‘lysis’ and is the final stage of the phage infection cycle. The phage particles are released into the extracellular environment and are capable of infecting new host cells.