

Lecture 13

Bacteriophage and bacterial genetics

Bacteriophage are viruses that infect bacteria and the ones that infect E.coli can be either *virulent* or *temperate*:

- Virulent phage do not integrate their DNA into the cell and usually just kill it. Virulent phage include the "T" series phage T1, T2, T3 etc.
- Temperate phage integrate their DNA into the host DNA causing a permanently infected state. Examples of temperate phage are phage λ and $\phi 80$.

Different phage have different forms of genetic material such as dsDNA (double stranded), ssDNA, and RNA. It can be either circular or linear.

Examining bacteriophage

To demonstrate the effect of phage on bacteria we use agar plates covered in a bacterial lawn. When phage infect the bacteria they cause holes in the lawn called *plaques*, these holes are where the phage have successfully propagated and can be *turbid* or *clear* depending on which cycle is used.

Bacteriophage anatomy = different phage have different morphologies; the T4 phage has a head that contains the DNA, a tail with a base plate, and also tail fibers. The λ phage is very similar except for it lacks tail fibers.

Lytic vs. Lysogenic cycles:

Lytic cycle = the phage attaches to the cell wall of the bacteria and injects DNA into the cell. The DNA forms into a circle and recruits the host machinery to produce more and more phage components. Eventually the cell wall ruptures and all the new phage come out after being assembled and having DNA packaged into them. Once this has occurred the cell is considered to have been *lysed*.

Lysogenic cycle = begins similarly to the lytic cycle by attaching to the cell wall of the bacteria, injecting nucleic acid, and circularising. It then starts to differ because the C1 gene produces a repressor protein that binds to its transcription factor and blocks the lytic pathway. Then the *int* gene produces *integrase* which allows recombination with the host DNA and eventually integration into it. The attachment points are called *attP*

(for prophage) and *attB* (for bacteria), and they are complementary. The integrated phage is known as a *prophage* and the bacteria housing it is called the *lysogen*.

Superinfection:

- Lysogens are immune to superinfection from phage of the same type. This is because the excess C1 protein floating around will bind to any more phage DNA that enters the cell and cause it to be lost.
- This means it is almost beneficial to be lysogenic if you are the bacteria.

The choice between lytic and lysogenic cycles:

The choice of the phage to enter the lytic or lysogenic cycle comes down to the physiological condition of the bacteria. If the bacteria is healthy enough to sustain the phage it will enter the lysogenic cycle and use the bacteria's machinery. However, if the bacteria is lacking in nutrients and unhealthy the phage will go down the lytic pathway since there is no point sticking around.

Transferring between cycle (prophage induction):

The process of transferring from one cycle to another revolves around the C1 protein and can be induced through exposure to UV light which damages the bacteria. When the bacterium is in trouble it produces an enzyme called *protease* which degrades the C1 protein causing the phage to enter into the lytic cycle. The lambda DNA gets out of the bacterial DNA by expressing a gene called *xis* (the reverse of *int*) which use E.coli machinery to complete the task.

Conjugation (the joining of two bacteria - bacterial sex) can also lead to prophage induction. This is because phage DNA is replicated and transferred through a *conjugal bridge*. If there is no C1 in the partner cell, then the balance will be tipped and the E.coli will enter the lytic cycle. Prophage induction that is induced through conjugation is called *zygotic induction*. **Conjugation between two lysogens will not result in zygotic induction** because C1 is present in both.

Host specificity:

- Phage has proteins that specifically interact with proteins on its host. These allow it to determine whether it is a good host or not. The *recognition mechanism* is a protein-protein interaction.