Bacteria

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Describe the structure of a bacterial chromosome including the arrangement of DNA within bacterial cells.

Bacterial chromosome

- Found in nucleoid
- Double-stranded and not associated with histones
- Contains an origin of replication (Ori C) and genes organised into operons
- Folded into 50 or so loops, known as loop domains, bound to central protein scaffolds , and are further supercoiled independently and complexed with DNA-binding proteins

Plasmids

- Smaller, double-stranded, circular, extra-chromosomal DNA
- Contains an origin of replication (ori) --> replicates independently of the chromosome
- Carries genes that are not essential for survival or reproduction but are beneficial under stressful conditions
- Can have more than one plasmid in bacteria cell

Describe the process of binary fission, transformation, transduction and conjugation in bacteria and explain the role of F plasmids in bacterial conjugation. (Knowledge of Hfr is not required.)

Binary fission

1. The bacterial DNA attaches itself to the mesosome, a highly folded region of the cell membrane. Replication of DNA starts at the origin (Ori C) that is attached to the cell wall.
2. New DNA is constructed using the original as a template in a semi-conservative manner, bidirectionally. This process is assisted by DNA gyrase which removes the positive supercoiling. DNA replication ends at the termination sequence located opposite Ori C.
3. The bacteria cell grows and elongates. The bacterial chromosomes separate and the cell membrane invaginates. New cell wall layers are secreted in between the membrane layers.

Transformation

Transformation is the uptake by the cell of a DNA molecule from the surrounding environment and the incorporation of this molecule into the recipient chromosome an a heritable form.

Transduction

Transduction is the transfer of bacterial DNA from one cell to another by means of a phage particle. This is due to errors made during the viral lifecycle. The virus containing these genes then injects them into another bacterium, completing the transfer.

Generalised transduction

1. Towards the end of the phage lyre cycle, fragments of the host DNA or plasmids can be packaged into the new phage particles.
2. The resultant virus particle injects the DNA into another bacterium but does not initiate another lytic cycle.
3. In the second cell, some of this acquired DNA may replace homologous regions of its own chromosome.
    - Because any random DNA fragment maybe packaged into the viral particle, any segment of the bacterial DNA may be transferred this way.

Specialised transduction

1. During the phage lysogenic phase, the phage's DNA is integrated into a very specific area in the host's chromosome.
2. When the viral DNA excises itself during the lytic phase, some bacterial DNA that is next to the viral integration site is excised along with it.
3. When the resulting virus infects another cell, it will pass the bacterial DNA into the cell along with its own. If the infected cell survives, it will contain a new piece of bacterial DNA, which can undergo recombination.
    - Because the viral DNA integrates at a specific location, when it excises, the bacterial DNA removed will be those near to the prophage. Therefore the DNA transferred to the second cell is about the same.

Conjugation