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An Overview on Microbial Genetics

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Letter

Microorganisms were generally ignored by the first geneticists because they're small in size and were thought to lack variable traits and therefore the amphimixis necessary for a mixing of genes from different organisms. After it had been discovered that microorganisms have many various physical and physiological characteristics that are amenable to review, they became objects of great interest to geneticists due to their small size and therefore the incontrovertible fact that they reproduce far more rapidly than larger organisms. Bacteria became important model organisms in genetic analysis, and lots of discoveries of general interest in genetics arose from their study. Bacterial genetics is that the center of cloning technology.

Conjugation

Conjugation is that the process by which a donor bacterium transfers a replica of a plasmid to a recipient bacterium, through a pilus. the method requires cell-to-cell contact. The donor cell (F+) features a conjugative plasmid, an extra-chromosomal piece of dsDNA that codes for the proteins necessary to form a threadlike filament referred to as a pilus. The pilus is employed to bind to the recipient (F-) cell, bringing it in close proximity to the donor cell. It's believed that a channel is then opened between the 2 cells, allowing a ssDNA copy of the plasmid to enter the recipient cells. Both cells then make the complementary copy to the ssDNA, leading to two F+ cells capable of conjugation.

Transformation

The process of transformation also allows a bacterial cell to accumulate new genes, but it doesn't require cell-to-cell contact. During this process the new genes are acquired directly from the environment. Typically the method requires a donor cell that at some point lysed and released naked DNA to the environment. The recipient cell is one that's capable of taking over the DNA from the environment and incorporating it into its own genome, where the cell is described as being competent.

There are mechanical and chemical means of encouraging a cell to select up DNA from the environment, but natural competence is decided genetically. The method typically occurs at the top of exponential phase of growth or beginning of the stationary phase, within the presence of high cell density and limited nutrients. Under these conditions specific proteins are manufactured including DNA-binding proteins (DNA translocase), endonucleases, and transmembrane channel proteins. Gram negative cells also make a cell membrane autolysin, to move the DNA across the outer membrane.

Random pieces of DNA bind to receptors on the surface of the cell and are then transported into the cell by the DNA translocase, through the transmembrane channel, an outsized structure often involving numerous different proteins. An endonuclease are often wont to degrade one strand of dsDNA, if only ss DNA may pass into the cell, or to cleave the DNA fragment into smaller sizes. Once inside the cell, the DNA must be incorporated into the bacterial chromosome by RecA (see Molecular Recombination below), for the genes to be expressed.

Transduction

Transduction involves the utilization of an epidemic, a bacteriophage, to act as a conduit for shuttling bacteria genes from one cell to a different, thus negating the need for cell-to-cell contact. There are two differing types of transduction: generalized transduction and specialized transduction.

Generalized Transduction

In generalized transduction, a bacterial host cell is infected with either a virulent or a temperate bacteriophage engaging within the lytic cycle of replication. After the primary three steps of replication (absorption, penetration, and synthesis), the virus enters into the assembly stage, during which fully formed virions are made. During this stage, random pieces of bacterial DNA are mistakenly packaged into a phage head, leading to the assembly of a transducing particle. While these particles aren't capable of infecting a cell within the conventional sense, they will bind to a replacement bacterial host cell and inject their DNA inside. If the DNA (from the primary bacterial host cell) is incorporated into the recipient's chromosome, the genes are often expressed.

Specialized Transduction

Specialized transduction can only occur with temperate bacteriophage, since it involves the lysogenic cycle of replication. The bacteriophage randomly attaches to a bacterial host cell, injecting viral DNA inside. The DNA integrates into the chromosome of the host cell, forming a prophage. At some point induction occurs, where the prophage is excised from the bacterial chrosomsome. In specialized transduction, the excision is incorrectly performed and some of bacterial genes immediately adjacent to the viral genes are excised too. Since this DNA is employed because the template for the synthesis stage, all copies are going to be a hybrid of viral and bacterial DNA, and every one resulting virions will contain both viral and bacterial DNA.

Once the cell is lysed, the virions are released to infect other bacterial host cells. Each virion will attach to the host cell and inject within the DNA hybrid, which might be incorporated into the host chromosome, if a prophage is made. At now the second bacterial host cell can contain its own DNA, DNA from the previous bacterial host cell, and viral DNA.

Molecular Recombination

In each of the cases of HGT, the method is merely successful if the genes are often expressed by the altered cell. In conjugation, the genes are located on a plasmid, under the control of promoters on the plasmid. In transformation and transduction, where naked DNA is gaining access to the cell, the DNA could easily be weakened by the cell with no genetic expression occurring. So as for the genes to be expressed, the DNA must be recombined with the recipient's chromosome.

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