Quadrant II – Transcript and Related Material

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Paper Title: Microbial Genetics

Unit: 2: Gene Transfer Mechanisms

Module Name: Transduction: Lysogenic Cycle

Module No: 11

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Notes:

Lysogenic Cycle

Lysogenic cycle is the phase of a temperate virus's life cycle in which it establishes and maintains lysogeny. In this cycle, viral genome becomes associated with the host genome.

Temperate phages, unlike virulent phages, often reproduce in synchrony with the host genome to yield a clone of virus-infected cells. This relationship is called as lysogeny, and bacteria which harbor the phage are called lysogenic bacteria or lysogens. The latent form of the phage genome within the lysogen is called as the prophage.

A temperate phage may induce a change in the phenotype of its host cell that is not directly related to the completion of its life cycle. Such a change is called as lysogenic conversion. eg. *Corynebacterium diphtheriae,* the cause of diphtheria, is infected with phage beta the genome of which encodes diphtheria toxin, responsible for the symptoms of the disease.

A prophage can exist in a dormant state for a long time during which no new bacteriophages are made. When a bacterium containing a lysogenic prophage divides to produce two daughter cells, the prophage's genetic material is copied along with the bacterial chromosome. Therefore, both daughter cells inherit the prophage. However, lysogeny is reversible, and the prophage can be induced to become active again and lyse its host.

Lysogenic cycle is best studied in Lambda phage which is a double-stranded DNA phage with icosahedral head and a non contractile tail that infects the K12 strain of *E. coli.* It has 40 genes involved in head synthesis, tail synthesis, lysogeny, DNA replication and cell lysis.

The cascade of events leading to either lysogeny or the lytic cycle involves a number of regulatory proteins that function as repressors or activators or both. Two regulatory proteins are of particular importance: the lambda repressor (product of the *cI* gene) and the Cro protein (product of the *cro* gene). The lambda repressor promotes lysogeny, and the Cro protein promotes the lytic cycle. In essence, the decision to pursue lysogeny or to pursue a lytic cycle is the result of a race between the production of these two proteins. If lambda repressor prevails, the production of Cro protein is inhibited and lysogeny occurs; if the Cro protein prevails, the production of lambda repressor is inhibited and the lytic cycle occurs. This is because the lambda repressor prevents transcription of viral genes, while Cro ensures viral gene expression.

An importantl step in prophage formation is the insertion or integration of the lambda genome into the *E. coli* chromosome. This is catalyzed by the enzyme integrase, the product of the *int* gene, taking place at the attachment site (*att*) on host chromosome . A homologous *att* site is found on the phage genome helping in base pairing with each other . The bacterial *att* site is located between the galactose (*gal*) and biotin (*bio*) operons. Circular lambda genome becomes a linear stretch of DNA located between the host operons. The prophage can remain integrated indefinitely, being replicated as the bacterial genome is replicated.

Several environmental factors like UV light, low nutrient conditions or chemical mutagens like mitomycin C can lower repressor levels. As lambda repressor levels decline, the Cro protein levels increase and trigger induction. Induction leads to destruction of infected cells and release of new phages—that is, induction initiates the lytic cycle. The prophage becomes active and makes an excisionase protein coded by *xis* gene that causes the integrase to reverse integration, free the prophage, and initiate a lytic cycle. When this happens, it promotes the synthesis of new phages and eventually lyses the host cell.

Steps involved in Lysogenic cycle

- ✓ **Adsorption and Penetration**
- ✓ **Integration of viral DNA with host DNA**
- ✓ **Entry of prophage into dormant stage**
- ✓ **Division of infected cells by binary fission**
- ✓ **Transition or induction from lysogenic to lytic cycle**

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