Induction of P1 Prophage and Superinfection by Bacteriophage T1

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Induction of the resident prophage did not permit restricted phage T1 to replicate freely in P1-lysogenic hosts. A few induced cells did become infectible.

When restricted T1 phage infects P1 lysogenic bacteria, only a small fraction of the cells (yielder cells) produce progeny phage; a minority of these progeny are host-modified so that they can infect P1 lysogens with high efficiency (4). Christensen (1) suggested that the yielders represent those cells in which activation of the prophage occurs either before or after the T1 infection.

Drexler (2) estimated that the number of T1-yielding cells is about 10 times the number of cells that undergo spontaneous prophage activation at any time. Thus, prior prophage activation is not necessary for a cell to be a yielder cell. In this paper, we show that prior induction of the prophage is also not sufficient to produce a yielder cell.

In the thymine-requiring *Escherichia coli* strain B3(P1b), the prophage is irreversibly induced by thymine starvation, although P1b production does not occur unless thymine is restored after the induction (5). Log-phase B3(P1b) cells were grown in complete medium (salts mixture plus 1% glucose, 1% neutralized Casamino Acids, and 10 μ g of thymine per ml). The bacteria were harvested, washed, resuspended in induction medium (the same medium lacking thymine), and incubated with aeration at 37 C. In different experiments, induction periods ranging from 30 to 140 min were allowed. In some cases, samples of the induced cells were then supplemented with thymine (10 μ g/ml) for an additional 10 min at 37 C. The bacteria were then harvested, washed, resuspended in 5×10^{-4} M $MgCl_2$, and infected with T1.B at a multiplicity of approximately 0.1. After 10 min at 37 C, samples were diluted into complete medium at 37 C for 5 min. The cells were then assayed, before lysis, for total T1 infectious centers, modified T1 infectious centers, and unattached T1.

The induction efficiency always approached 100%. Although induction resulted in a consider-

able increase in the number of cells producing T1, these yielders were never more than a few per cent of the induced cells. As in the infection of uninduced B(P1) cells (4), only a fraction of the yielders produced some modified T1. Typical results are shown in Table 1. Variations in the induction time had little or no effect on the results.

P1 prophage is not readily inducible by ultraviolet (UV) light. However, some induction does occur; at the optimum UV dose, about 10% of the Sh(P1) cells register as infectious centers.

We subjected P1 lysogens to various inducing doses of UV and tested their capacity to yield modified T1 after T1.B infection. (The measurement of cells yielding modified T1 is technically easier than the measurement of total T1 yielders.) The infection was carried out either immediately after UV treatment or after a period of post-irradiation incubation in growth medium.

In no case was there any evidence that the UV treatment increased the proportion of cells in the population yielding modified T1, although the number of induced cells exceeded the number of yielders in the nonirradiated controls.

Goldberg and Bryan (3) studied the infection of *Bacillus* strains carrying the defective phage PBSX by phage SP-10(C). Only a few per cent of the cells became infectible by SP-10(C) when the defective prophage was induced.

Induction of an interfering prophage, then, is not sufficient to allow the unrestricted growth of an unrelated superinfecting phage.

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TABLE 1. *Effect of induction of P1b in E. coli B3(P1b) on acceptance and modification of T1.B*

Determination	Expt 1	Expt 2	Expt 3
Thymine starvation.....	None	90 min	90 min
Thymine restoration.....	None	None	10 min
P1 infectious centers/cell.....	ca. 10^{-3}	0.82	1.0
T1.B added.....	1.7×10^7	1.7×10^7	1.7×10^7
T1 infectious centers			
On B (a).....	1.3×10^5	2.4×10^6	1.8×10^6
On B after chloroform treatment (b).....	1.3×10^5	1.9×10^6	10^6
On cells yielding T1 (a-b).....	$\ll 10^{5a}$	ca. 5×10^5	8×10^5
On Sh(P1) (cells yielding modified T1).....	ca. 5×10^2	1.4×10^4	2.7×10^4

^a From the results of Lederberg (4), we would expect this value to be about three times the number of cells yielding modified T1 or 10^3 to 2×10^3 .

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