The Effect of Various colI Factors on the Induction of Phage P22 by Ultraviolet Radiation

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The burst size of phage P22 in Salmonella typhimurium strain LT2 is 200 to 1000, whether a clear plaque mutant (1, 2) or a low multiplicity of wild-type (c⁺) phage is used. However, when vegetative phage growth is induced in strain LT2 lysogenized by c⁺ phage by exposing it to ultraviolet light from a low pressure germicidal lamp, the burst size is far smaller and usually less than 40. This is so even when the prophage is one of the non-excluding mutants already described (3) and the bacteria are super-infected with virulent (c₂) phage just before irradiation, despite the appearance of both c⁺ and c₂ phage in the burst. These observations suggested that the dose of u.v. radiation producing maximal induction damaged the bacteria to a degree that severely limited their capacity to support phage growth. Since strain LT2 not lysogenized by phage P22 becomes markedly more resistant to killing by u.v. radiation when it carries certain colicin I factors (4, 5), their effect on lysogenic strains was tested. Resistance to both killing and induction were found to be increased without affecting the burst size.

The strain of bacteria used was SR120, which is strain LT2 cured of a temperate B phage (6). This was lysogenized with c⁺P22, and the following colI factors then introduced by growth overnight in mixed culture with colI+ donor strains: Ia-CA53, -CT2, Ib-P9, -SI599, -CT4, -646, -1168. Each of these strains was incubated with shaking in Oxoid Nutrient Broth No 2 until the colony count was 1 to 2 × 10⁶/ml, diluted 1/100 in quarter-strength Ringer's solution and irradiated on a rocker in dim daylight. Samples were plated for plaques after incubation in broth at 37° for 20 min., using peptone agar (Oxoid Peptone 10 g., NaCl 5 g. and Oxoid Agar No 2 dissolved in distilled water, pH 7.2) with a streptomycin-resistant mutant of strain SR120 as indicator.

Comparison of the col- and col+ strains showed:

(1) All the col factors increased resistance to killing and induction to some extent. These included two factors, Ib-646 and -1168, which had been expected to leave resistance to killing unchanged, judging from their behaviour in strain tryD-10, a tryptophan-requiring mutant of strain LT2 (5) which still carries the B phage.

(2) For each strain, the optimal inducing dose was directly related to its resistance to killing. Thus, the optimal dose corresponded to a survival of 10 to 15%, whatever the absolute degree of resistance (Fig. 1).

(3) The maximum proportion of bacteria induced was either unaltered (about 65%) or decreased by about 10% by colI.

(4) The burst size was smaller, the larger the u.v. dose. With neither wild-type nor a non-excluding prophage was the burst size corresponding to a given survival altered by the presence of colI.

The behaviour of these strains varied markedly from one experiment to the next but, in general, a colI+ culture exposed to a given u.v. dose appeared to behave like a col- culture exposed to a smaller dose. That is, the presence of colI had the same
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effect as a decrease in intensity of the u.v. source, suggesting that coll produced a uniform increase in u.v. resistance of all cellular functions involved in survival and induction.

Fig. 1. The effect of u.v. radiation on three strains of Salmonella typhimurium, strain SR 120, lysogenized by wild-type phage P22. O, col-, col-; □, colla-CA53; △, collb-CT4. The colony counts (open symbols, dashed lines) and counts of induced bacteria (solid symbols, continuous lines) are expressed as percentages of the colony counts of the unirradiated cultures.

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