Receptor for Phage $\phi 80$ on *Escherichia coli* K12

Phage $\phi 80$ showed very strange behavior towards various derivatives of *Escherichia coli* K12. The results obtained are summarized in Table 1.

Table 1. The Behavior of K12 Strains for Phage $\phi 80$

"Sensitive"	"Resistant"
K12 wild (F^-, prototroph, λ^+, S^s)	C600 (F^+, TLB_1^-, Lac^-, λ^-, S^r,$T^r_{1,5}$)
58-161 (F^+, M^- , λ^+, S^s)	W1177 (F^-, TLB_1^-, Lac^-, λ^+, S^r,$T^r_{1,5}$)
W-3100 (F^-, prototroph, λ^+, S^s)	W678 (F^-, TLB_1^-, Lac^-, λ^+, S^r,$T^r_{1,5}$)
W-3110 (F^-, prototroph, λ^-, S^s)	P678 (F^-, TLB_1^-, Lac^-, λ^-, S^r, A_z^r, $T^r_{1,5}$)
Hfr H (Hfr, B_1^-, λ^-, S^s)	112-12 (F^-, C^-, H^-, λ^-, S^s, $T^r_{1,5}$)
Y70 S (F^-, TLB_1^-, Lac^-, λ^+, S^s)	

F: compatibility factor. M, T, L, B_1, C, H: auxotrophic markers for methionine, threonine, leucine, thiamine, cystein, histidine. Lac: fermentation of lactose. S , A_z , $T_{1,5}$: resistance to streptomycin, azide, phage T_1 and T_5. λ^+: lysogenic for phage λ.

First this phage attacks K12 independently of λ and the F factor. Second, strains carrying $T^r_{1,5}$ marker are mostly resistant to phage $\phi 80$.

Strains 58-161 F^+ and W-1177 F^- were used in Lederberg's classical cross experiments. The former is originally sensitive to $\phi 80$ but the latter is resistant. Strain 58-161 is an auxotrophic mutant; F^+, M^-, T^+, L^+, B_1^+, Lac^+, S^s, $T^s_{1,5}$, $\phi 80^s$. Strain W-1177 is a complementary auxotrophic mutant; F^-, M^+, T^-, L^-, B_1^-, Lac^-, S^r, $T^r_{1,5}$, $\phi 80^r$. An attempt to determine the gene locus controlling the receptor for this phage was made by cross experiments on these strains. Recombinants were selected on synthetic media supplemented with 100 μg/ml of streptomycin. From the data shown in Table 2, the genetic factor seems to be located between Lac and T-L. The locus controlling the $T_{1,5}$-receptor is also probably located here.

Table 2. The Segregation of Non-selective Characters (Lac and $T_{1,5}$) in Recombinants between 58-161 × W-1177

Parents	Recombinants			
58-161/F^+ × W-1177/F^- (TLB_1^+,M^-) (TLB_1^-,M^+)	$Lac^+ \phi 80^r$	$Lac^+ \phi 80^s$	$Lac^- \phi 80^r$	$Lac^- \phi 80^s$
$Lac^+ \phi 80^r$ × $Lac^- \phi 80^s$	67 (37.8%)	5 (2.8%)	52 (29.3%)	53 (29.9%)
$Lac^+ \phi 80^s$ × $Lac^- \phi 80^r$	2 (2.0%)	37 (37.0%)	31 (31.0%)	30 (30.0%)

From these results it seems that these two loci ($T^{r/s}_{1,5}$ and $\phi 80^{r/s}$) are closely linked to each other or are even identical.

To study this an investigation was made of whether the $T^s_{1,5} \rightarrow T^r_{1,5}$ mutation followed by a $\phi 80^s \rightarrow \phi 80^r$ mutation. $T^s_{1,5}$ strains were all sensitive to $\phi 80$, but $T^r_{1,5}$ mutants selected from these $T^s_{1,5}$ strains were all also resistant to $\phi 80$. The $\phi 80^s \rightarrow \phi 80^r$ mutation was followed, as might have been expected, by a $T^s_{1,5} \rightarrow T^r_{1,5}$ mutation (Table 3).

Table 3. The Cross-resistance Interrelationship between $\phi 80$ and T1, T5

	K12	K12/$\phi 80$	K12/$T_{1,5}$	K12/T_1-Tryp
$\phi 80$	+	—	—	—
T_1	+	—	—	—
T_5	+	—	—	+

+: sensitive , —: resistance

Recently Yanofsky *et al.* (1959)[1] have described T^r_1 *tryp*** mutants, which are rare among T^r_1 isolates in strain K12. All the ten T^r_1 *tryp*⁻ mutants isolated by Yura (Virus Institute, Kyoto Univ.) and the author were also resistant to phage $\phi 80$. Though these *tryp* deletion mutants were found to carry the various *tryp* region deletion (Yura, personal communication), all were resistant to T_1 as well as $\phi 80$ but were sensitive to T_5.

T_1 *tryp* is independent region upon $T_{1,5}$ marker on the K12 chromosome. However, from the fact that all the variety of T^r_1 strains are always also the $\phi 80^r$ strain, it is clear that the T_1 phage receptor gene is not only the same as the receptor gene for $\phi 80$ phage but also the receptor site on the cellular surface for both phages is common. This receptor site may be controlled by two different genes in the $T_{1,5}$ and T_1 *tryp* regions.

Finally it is very interesting that one of the genes controlling the adsorption of this phage is closely linked with the *tryp* region, because the *tryp* locus is itself also closely linked to this $\phi 80$ prophage locus on the K-12 chromosome, as will be described elsewhere.

REFERENCE

1) Yanofsky, C. and Lennox, E. S. (1959). Transduction and recombination study of linkage relationships among the genes controlling tryptophan synthesis in *Escherichia coli*. *Virology* **8**, 425-447.

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** *tryp*: auxotrophic marker for tryptophan.