encoded protein synthesis uninduced before the beginning of the experiment, then $f_{-0}$ will approach zero.

Thus,

| $m = \Delta\mu$ | $D = 0.3\ h^{-1}$<br>$0.15\ gen^{-1}$ | $D = 0.67\ h^{-1}$<br>$0.12\ gen^{-1}$ |
|---|---|---|
| $R$ max ($f_{-0} = 0$) | $7.5 \times 10^{-4}\ gen^{-1}$ | $4.4 \times 10^{-4}\ gen^{-1}$ |
| $R$ if $f_{-0} = 0.002$ | $4.5 \times 10^{-4}\ gen^{-1}$ | $2.0 \times 10^{-4}\ gen^{-1}$ |
| $R$ if $f_{-0} = 0.003$ | $3.0 \times 10^{-4}\ gen^{-1}$ | $8.4 \times 10^{-5}\ gen^{-1}$ |
| $R$ if $f_{-0} = 0.0037$ | $2.0 \times 10^{-4}\ gen^{-1}$ | $0\ gen^{-1}$ |

To determine $P$, recall that $R = P\,\mu_+$ (eq. 14.10). A value for $\mu_+$ can be estimated from eq. 14.14b after some rearrangement to give

$$D = \mu_+ + \Delta\mu f_- \tag{14.40}$$

Values of $\mu_+$ and $\mu_-$ vary slightly during culture as a consequence of the assumption that $dN^t/dt = 0$.[†] An average value of $\mu_+$ is

$$\mu_+ = D - \Delta\mu/2 \tag{14.41}$$

$R$, in units of $gen^{-1}$, is changed to $h^{-1}$ by multiplying by $D/\ln 2$. Thus,

| $D$ | $\mu_+$ | $R_{max}$ | $P_{max}$ |
|---|---|---|---|
| $0.3\ h^{-1}$ | $0.267\ h^{-1}$ | $7.5 \times 10^{-4}\ gen^{-1}$ or $3.2 \times 10^{-4}\ h^{-1}$ | $1.2 \times 10^{-3}$ |
| $0.67\ h^{-1}$ | $0.615\ h^{-1}$ | $4.4 \times 10^{-4}\ gen^{-1}$ or $4.2 \times 10^{-4}\ h^{-1}$ | $0.7 \times 10^{-3}$ |

A change in the probability of segregational losses as a function of dilution rate corresponds to the copy number, which also changes with dilution rate. The pDW17 plasmid has an *average* copy number of about 40 to 50 in exponential growth in minimal medium.

Consider eq. 14.1, which predicts the probability of plasmid loss by random segregation:

$$P = 2^{(1-Z)} \tag{14.1}$$

for $Z = 40$ and $P = 1.8 \times 10^{-12}$, which is certainly less than the maximum value calculated in these experiments. Note from Example 14.1, however, that if the average copy number were distributed so that half the cells had 10 plasmids and half had 70, then the probability of plasmid loss would be $9.8 \times 10^{-4}$, which is very close to the maximum probabilities allowed by these experimental data.

[†]Physically, these changes in $\mu_+$ and $\mu_-$ could occur due to small changes in residual substrate concentration. This observation implies that the assumption of constant $\Delta\mu$ and $R$ used in integrating eq. 14.17 would fail if $\Delta\mu$ were very large.