20.109
Synthetic Biology Module
Lecture #5

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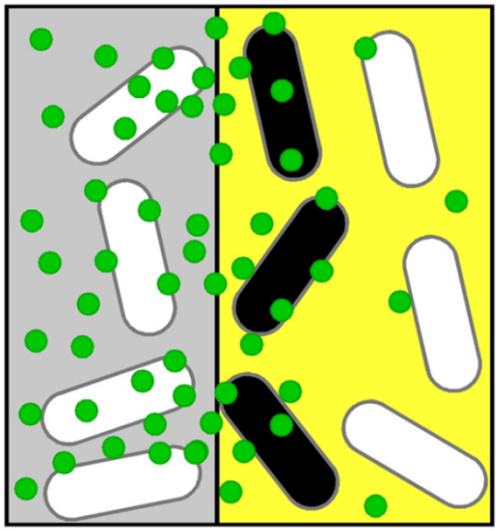
CSAIL

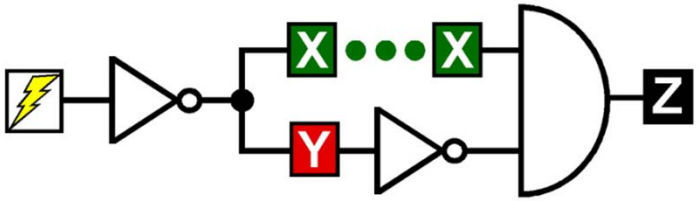
Genetic Edge Detection Algorithm

- Pseudocode:

```
IF NOT (light)
    produce signal
IF signal AND NOT (NOT light)
    produce pigment
```



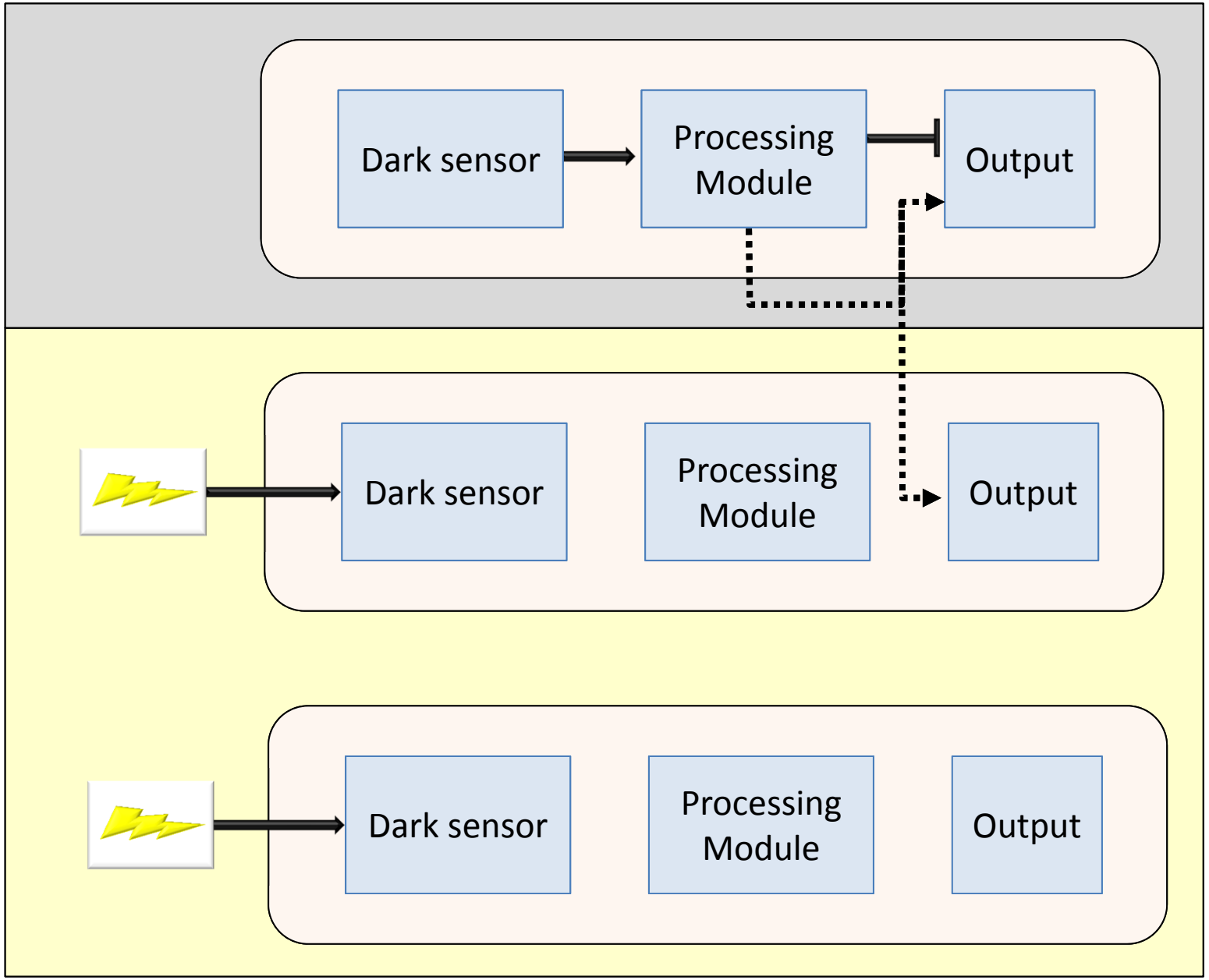
- Produce signal – generate diffusible communication signal
- Produce pigment – produce black pigment



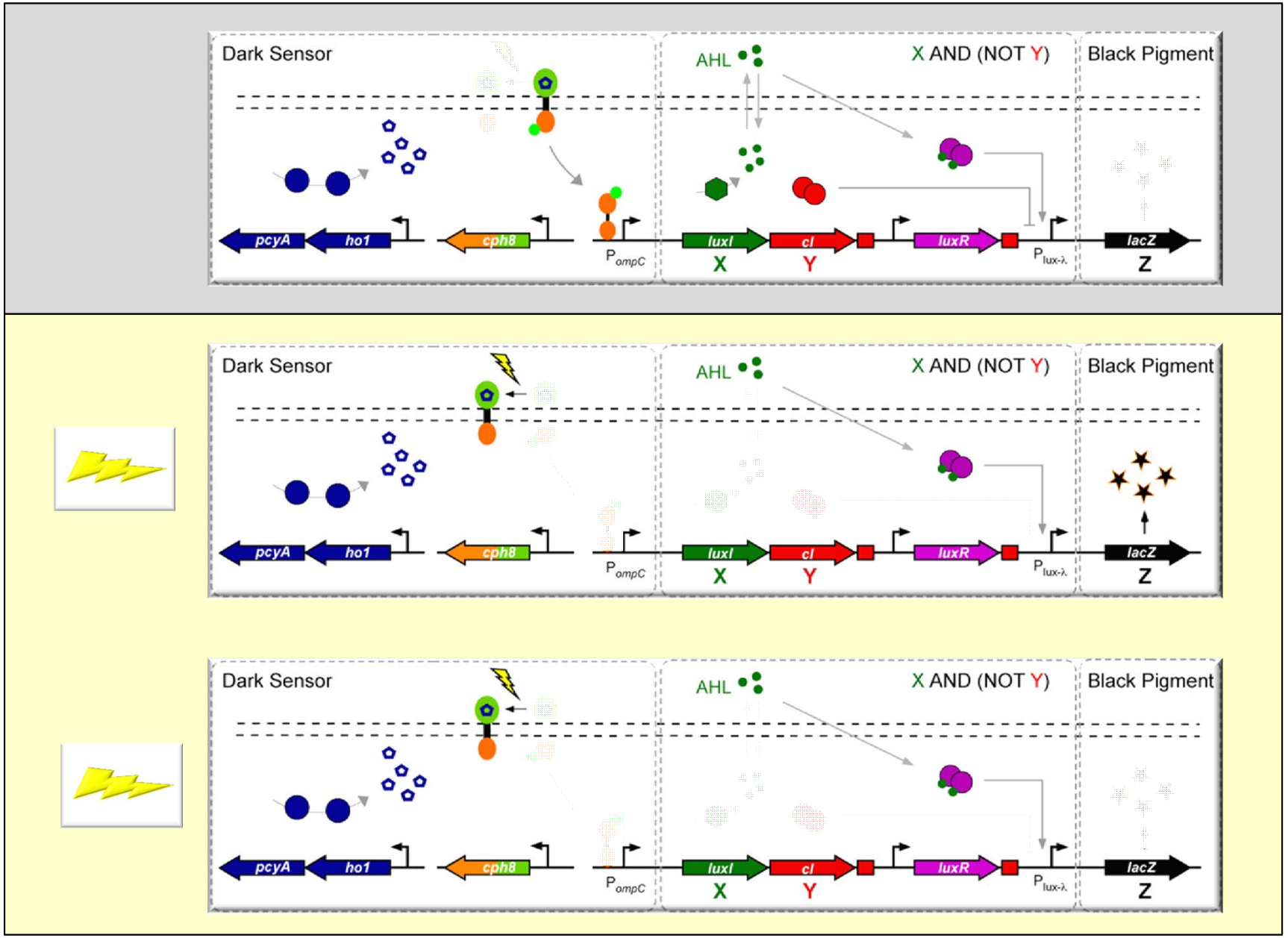
X	Y	Z
0	0	0
1	0	1
0	1	0
1	1	0

A synthetic genetic edge detection program. Tabor JJ, Salis HM, Simpson ZB, Chevalier AA, Levskaya A, Marcotte EM, Voigt CA, Ellington AD. **Cell.** 2009 Jun 26;137(7):1273. Figure 1B, 1C

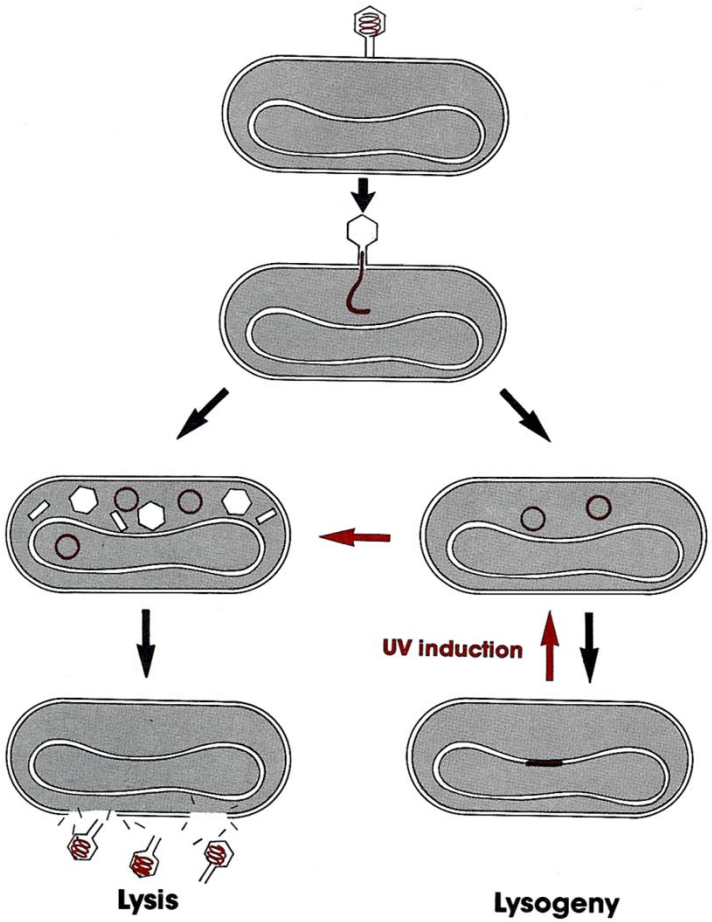
Abstract operation of the system



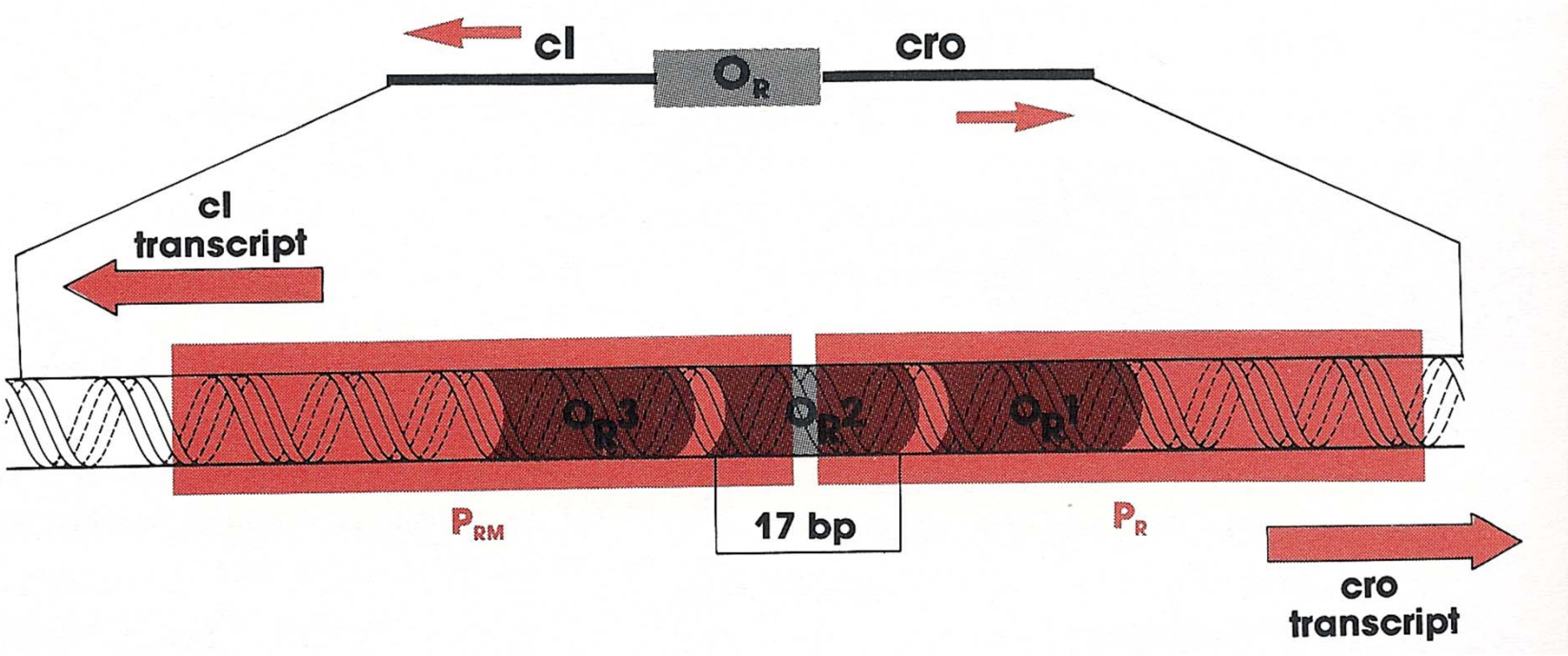
Detailed operation of the system



Bacteriophage λ: Lysis/Lysogeny



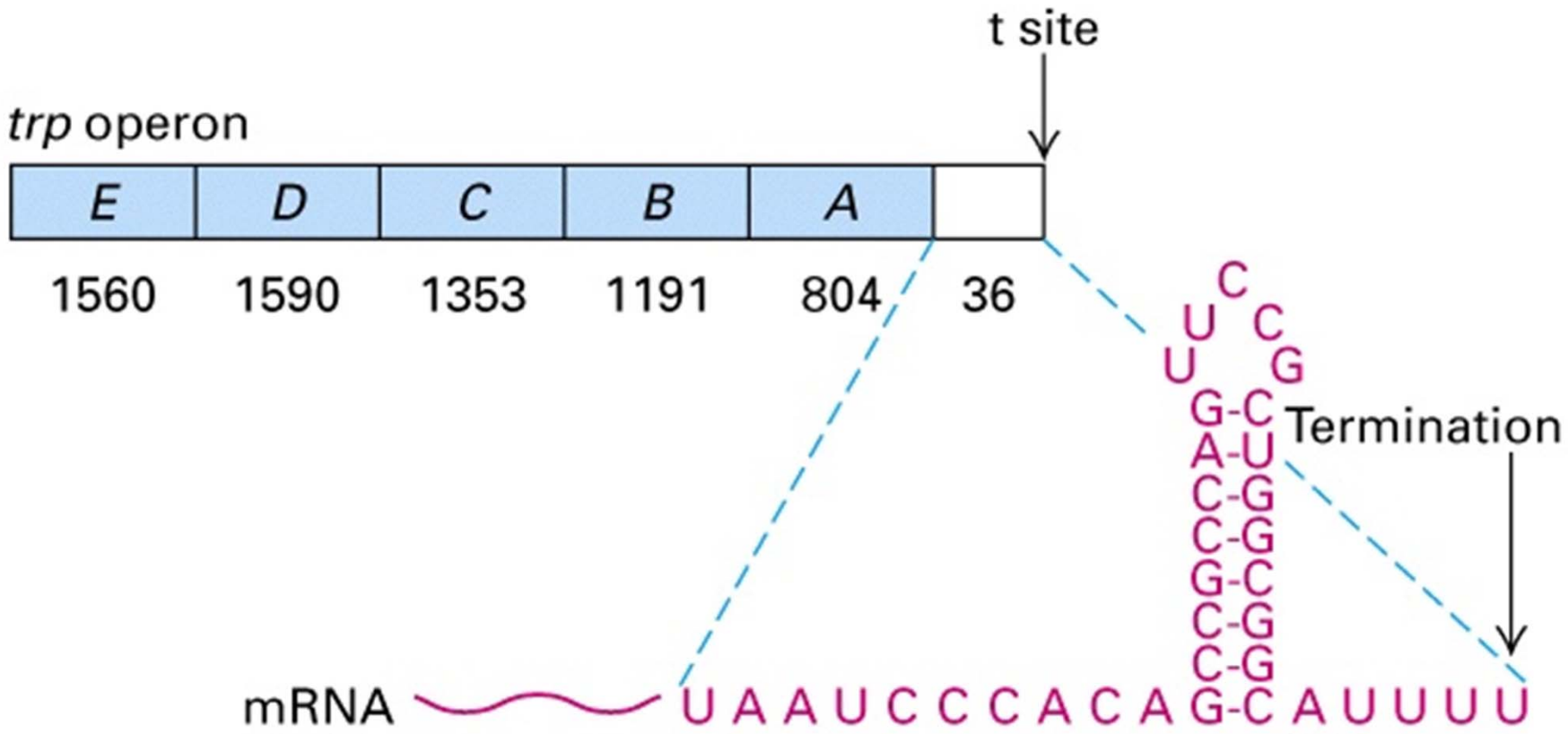
P_R and P_{RM} Promoters



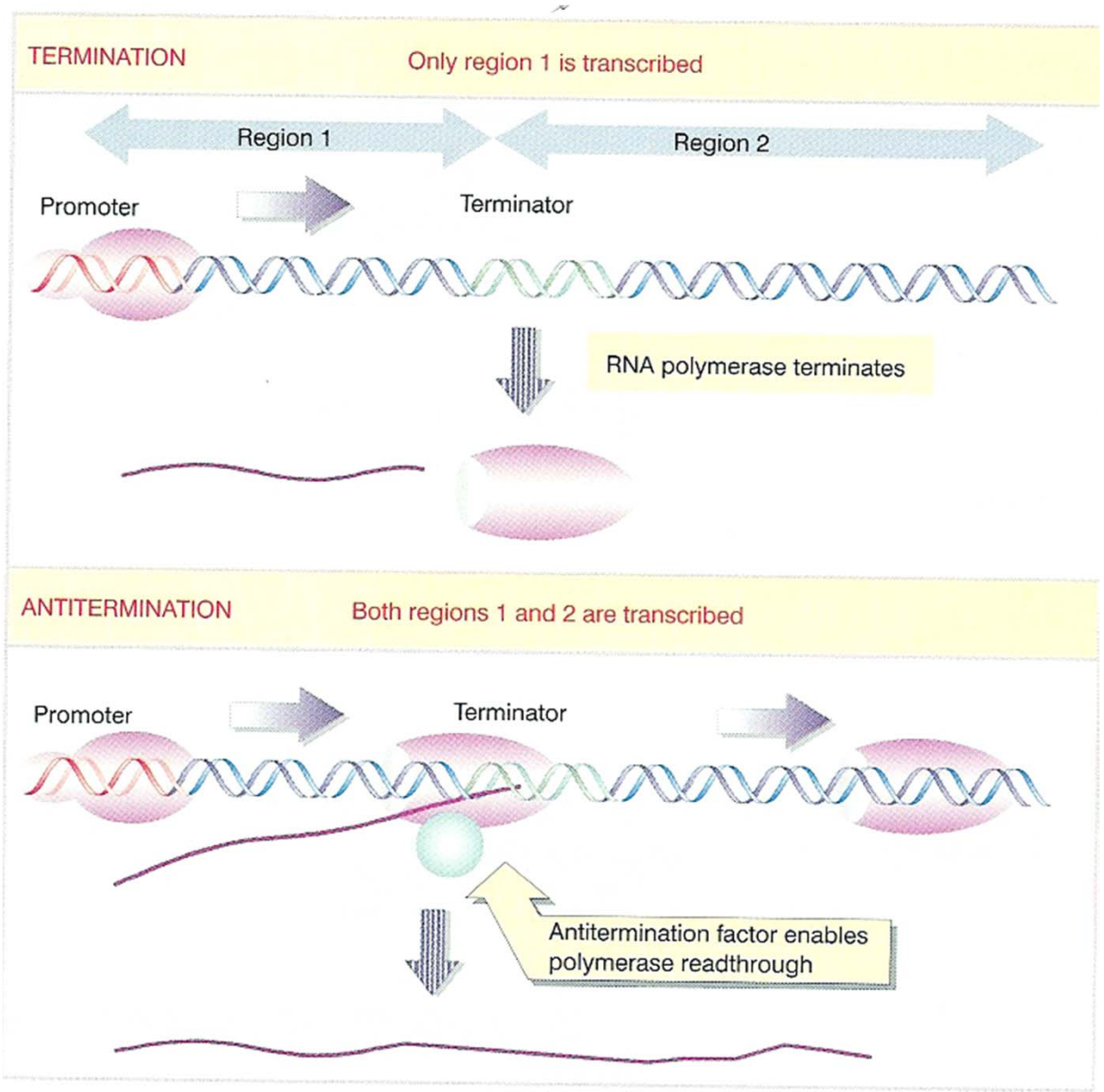
Gene regulation mechanisms in λ

- Transcription
  - Repression
  - Activation
  - Termination / anti-termination
- Translation
  - Ribosome binding site
  - mRNA decay
  - anti-sense mRNA

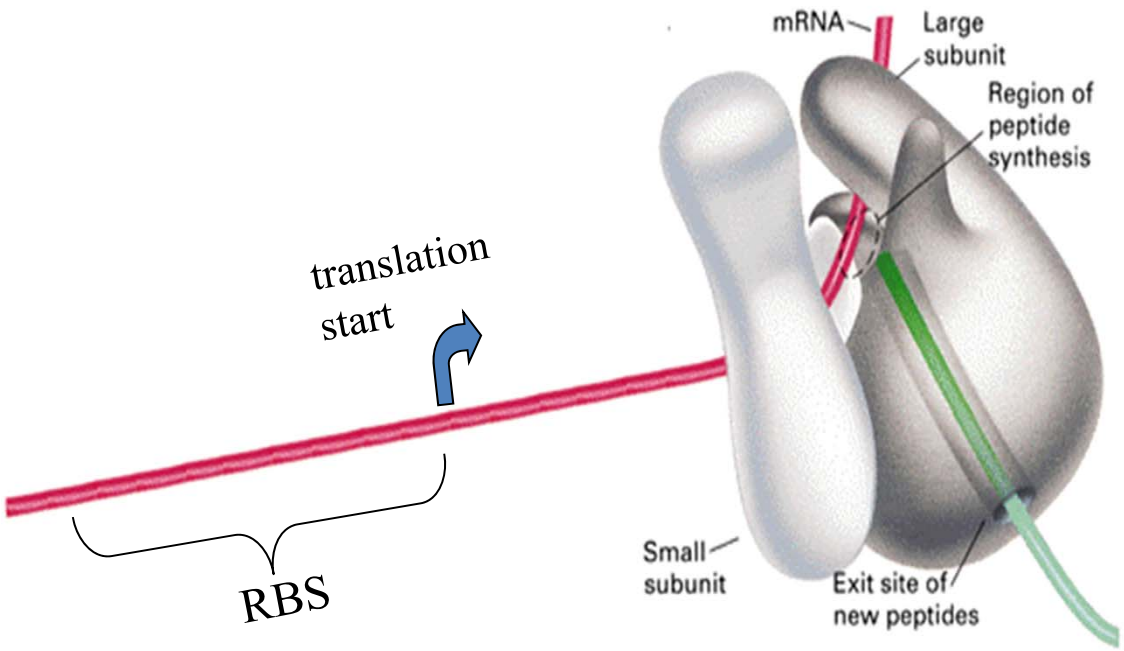
Rho-independent termination



Antitermination



Translation Initiation with RBS




```
RBS-1: ATTAAAGAGGAGAAATTAAGCATG    strong
RBS-2:  TCACACAGGAAACCGGTTCGATG      ¦
RBS-3:   TCACACAGGAAAGGCCTCGATG      ¦
RBS-4:    TCACACAGGACGGCCGGATG      weak
```

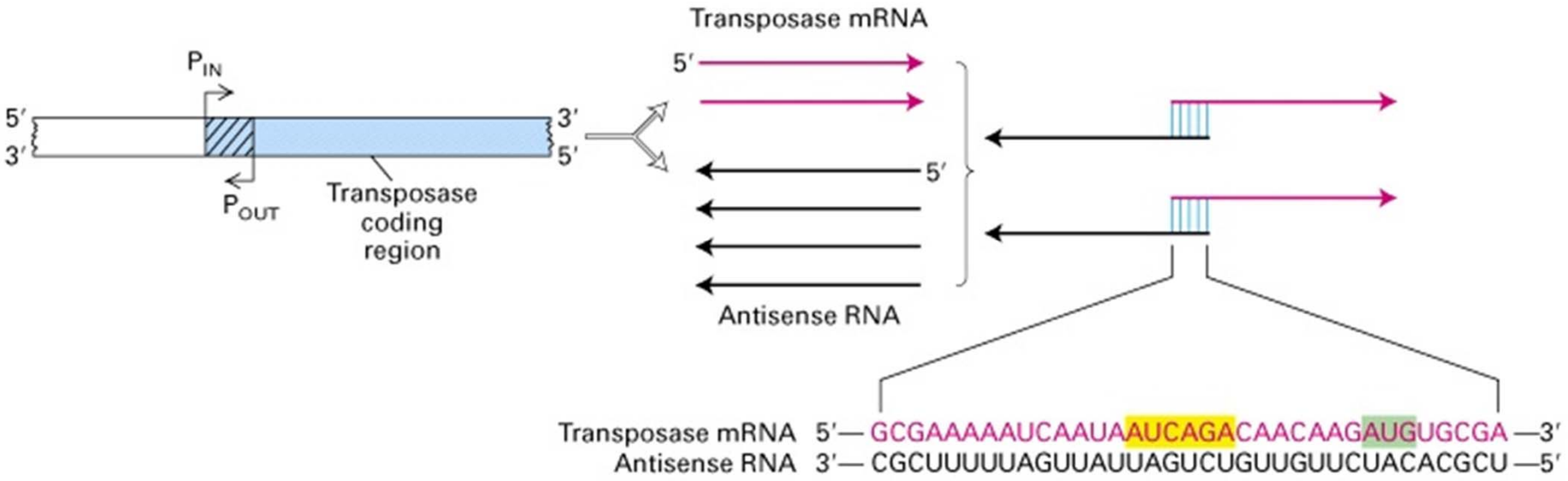
The stability of cytoplasmic mRNAs varies

TABLE 11-1 Half-Lives of Messenger RNAs

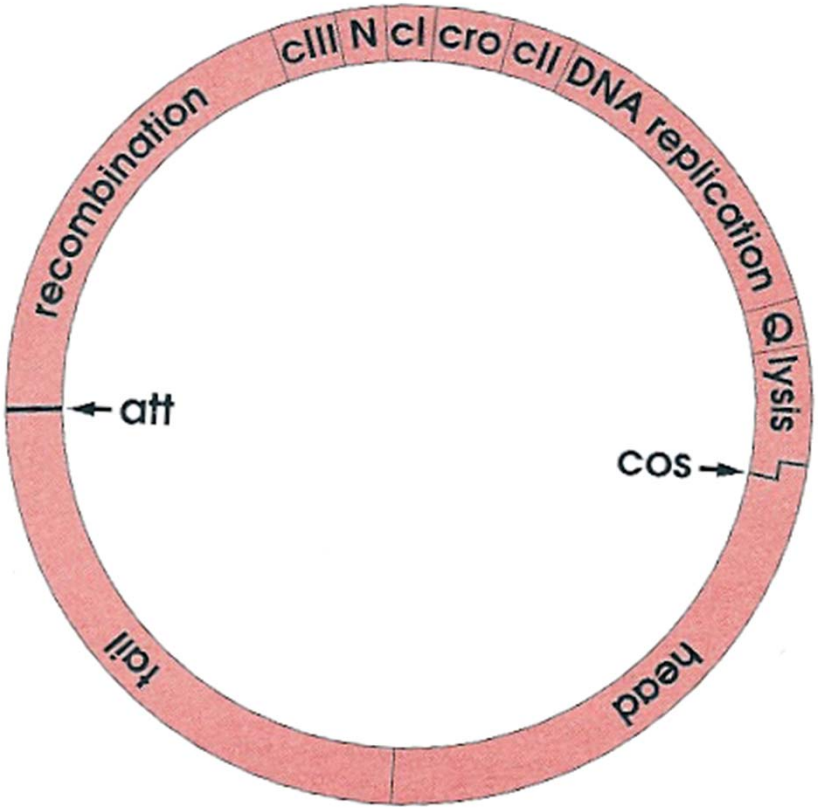
Cell	Cell Generation Time	mRNA Half-Lives*	
		Average	Range Known for Individual Cases
Escherichia coli	20–60 min	3–5 min	2–10 min
Saccharomyces cerevisiae (yeast)	3 h	22 min	4–40 min
Cultured human or rodent cells	16–24 h	10 h	30 min or less (histone and *c-myc* mRNAs) 0.3–24 h (specific mRNAs of cultured cells)

*For information on specific mRNA half-lives for *E. coli*, see A. Hirashima, G. Childs, and M. Inouye, 1973, *J. Mol. Biol.* **119**: 373; for yeast, see L.-L. Chia and C. McLaughlin, 1979, *Mol. Gen. Genet.* **170**:137; and for mammalian cells, see M. M. Harpold, M. Wilson, and J. E. Darnell, 1981, *Mol. Cell Biol.* **1**:188.

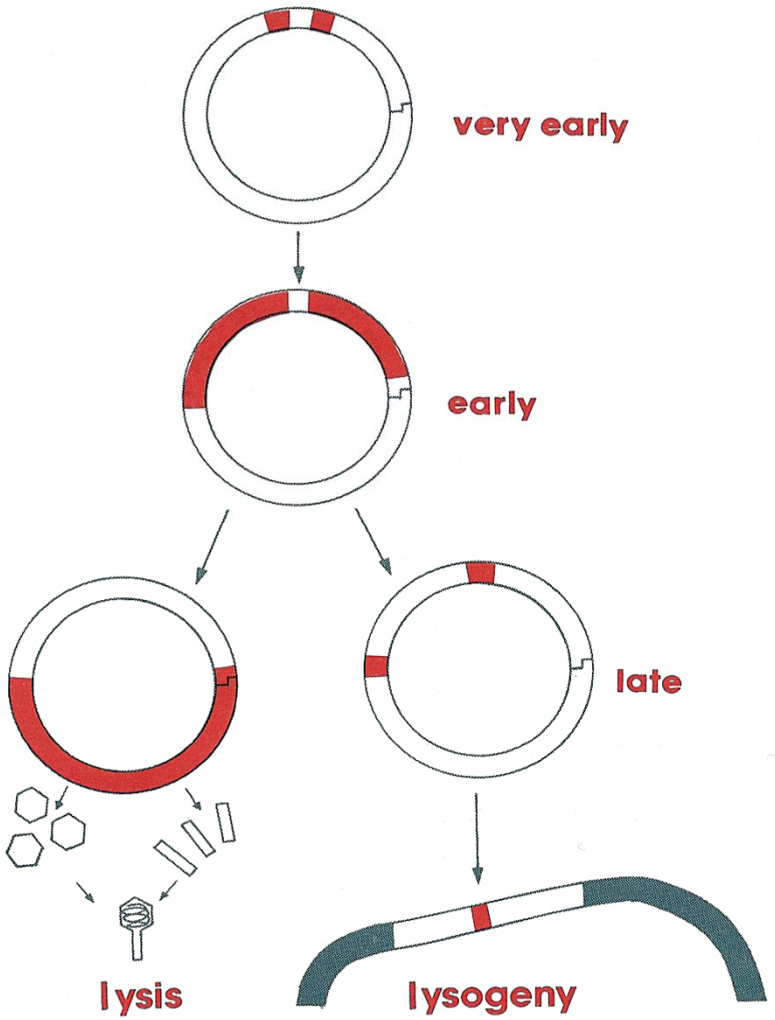
Antisense RNA regulates translation of transposase mRNA in bacteria



The λ Genetic Map

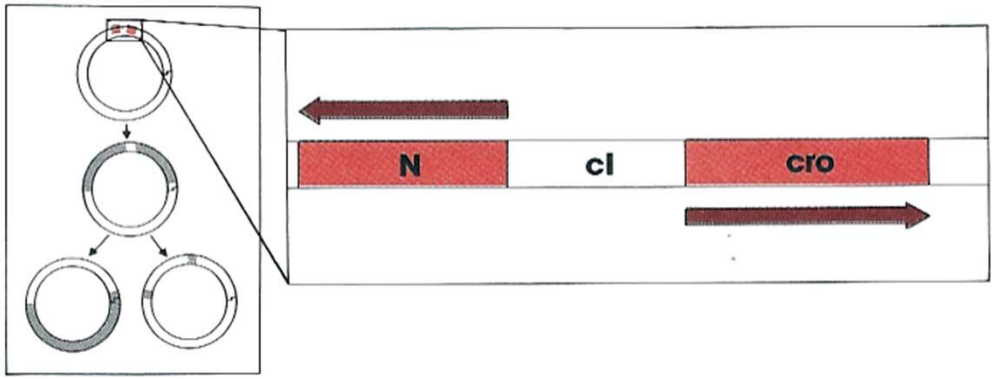


Patterns of Gene Expression

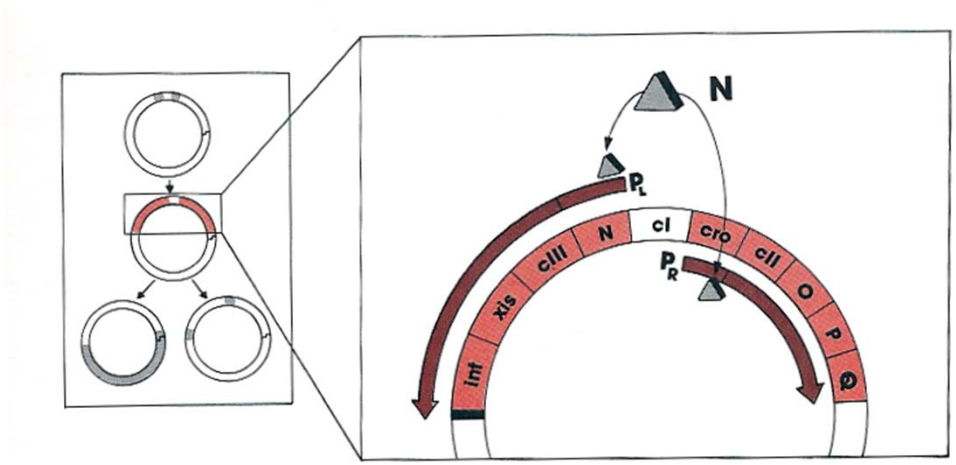


Very Early and Early Transcription

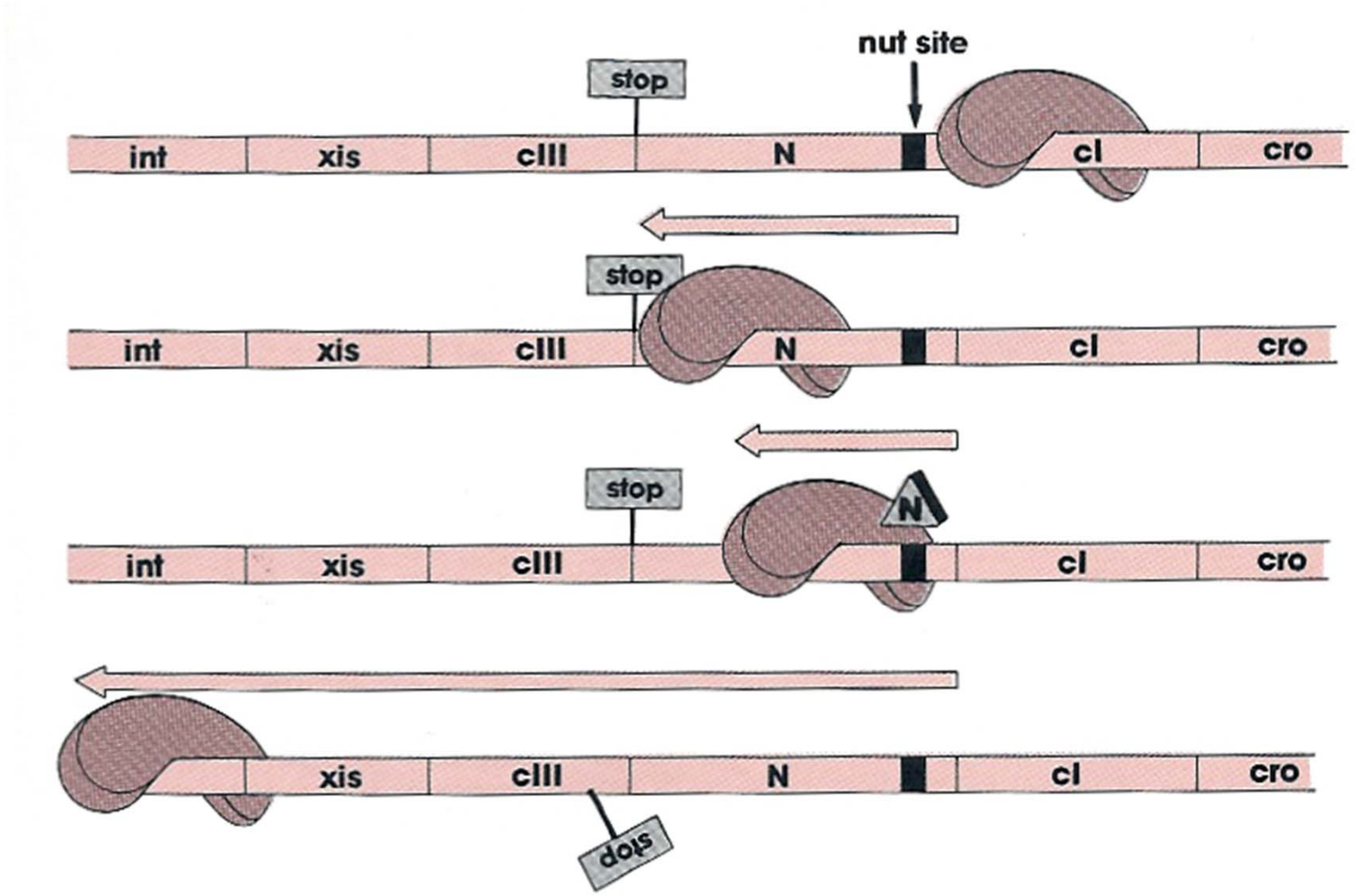
Very early



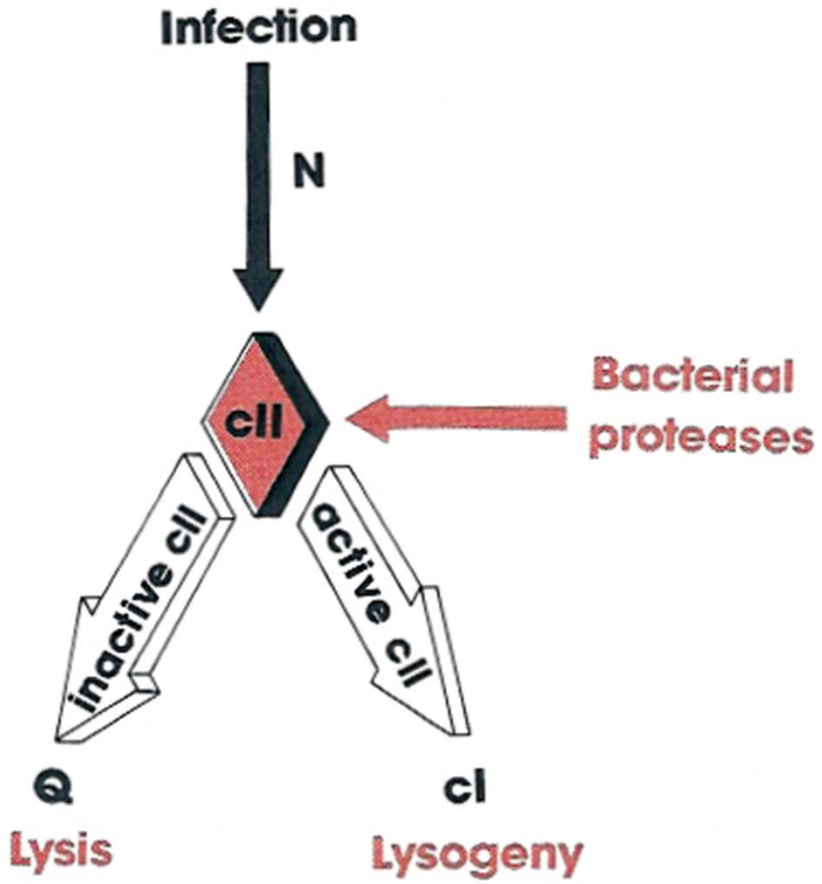
Early



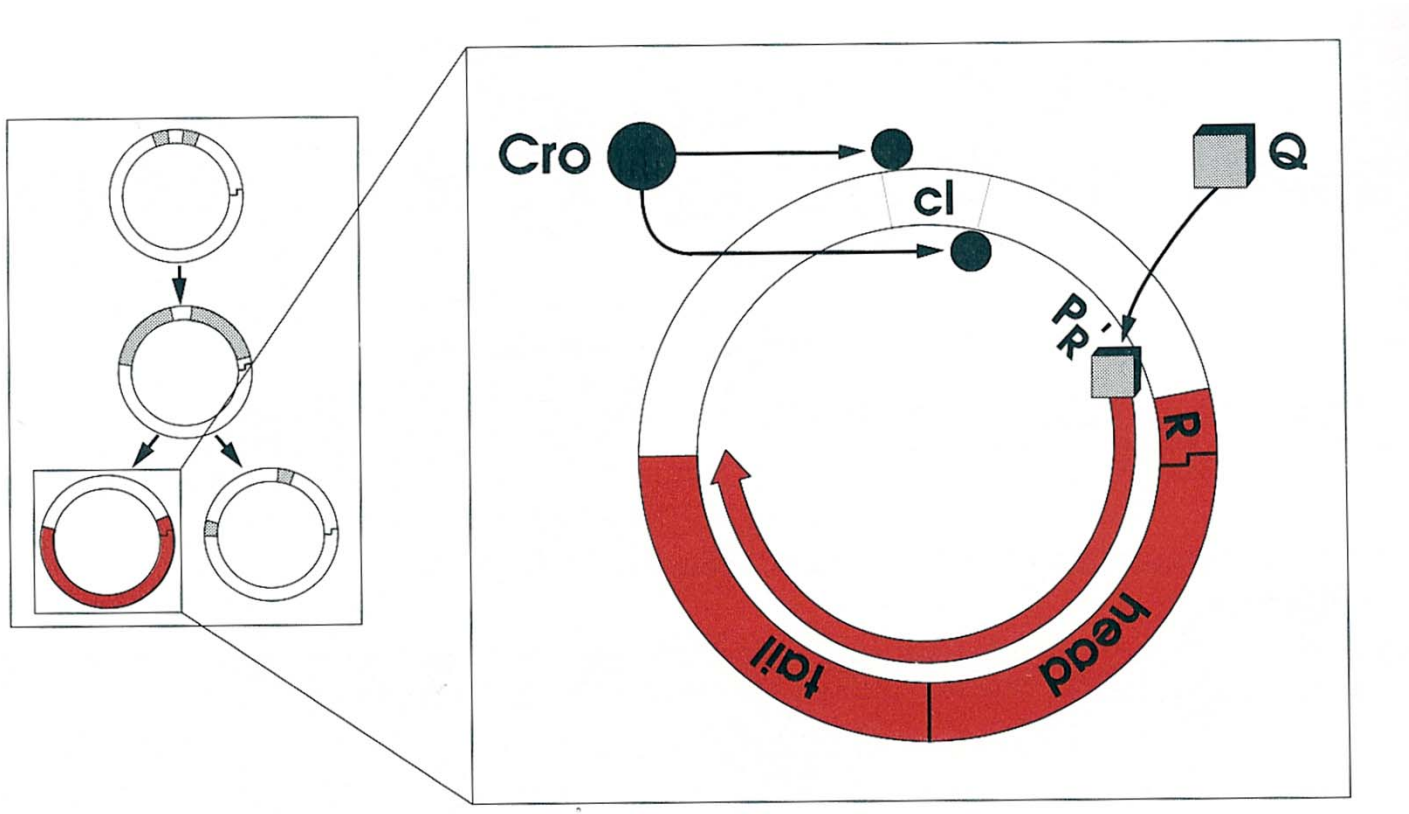
Protein N Anti-Termination



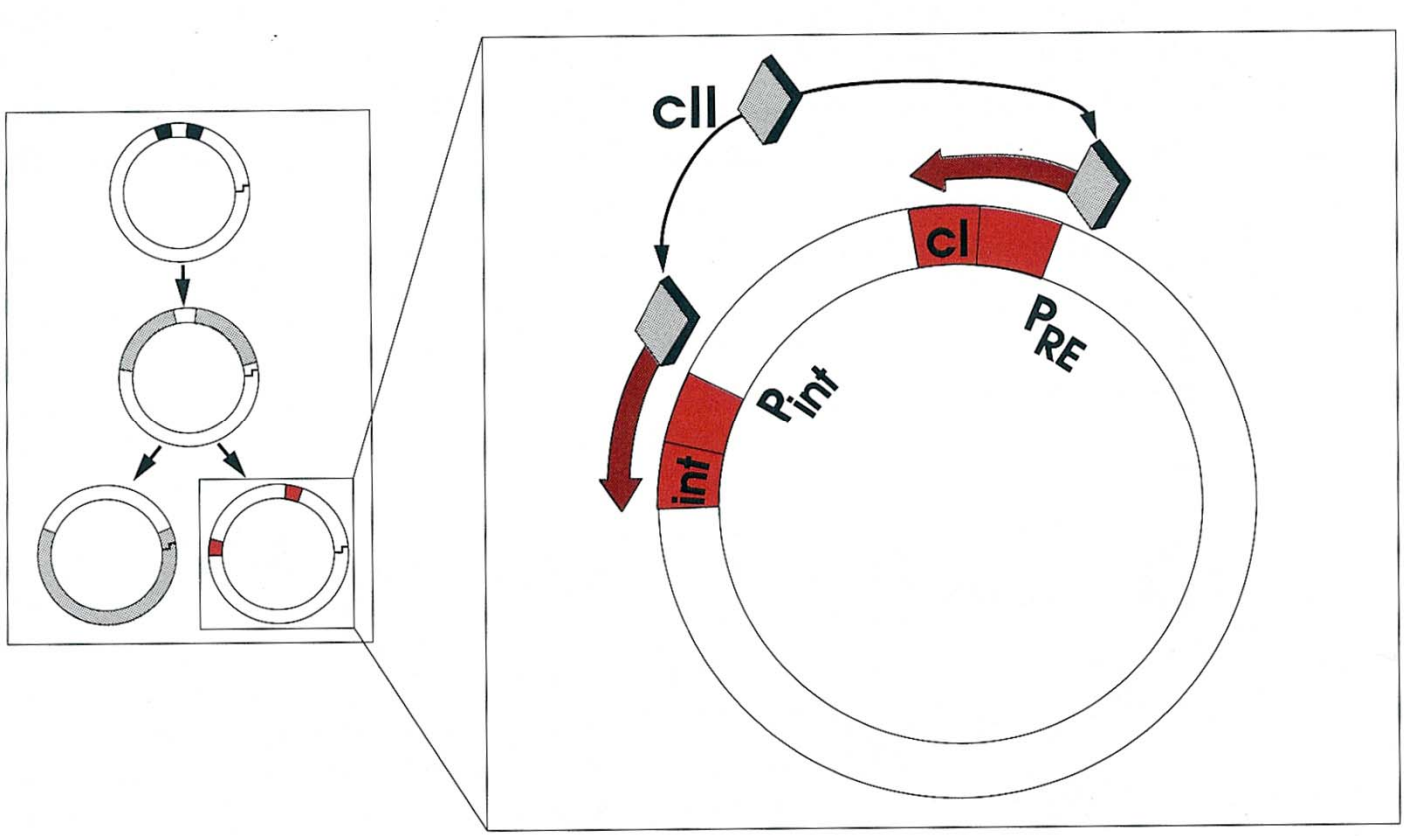
The Decision



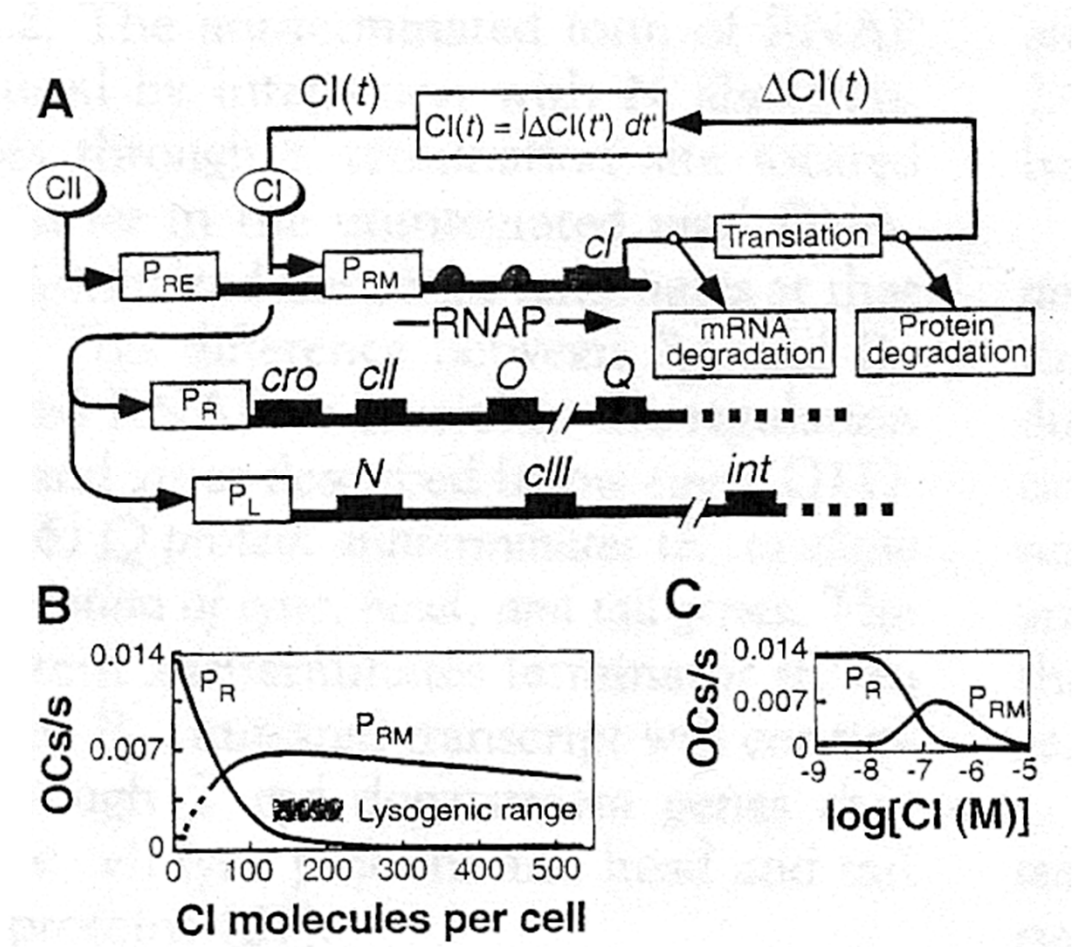
Late Lytic



Late Lysogenic



Setting the Switch with CII



The Entire λ Circuit