

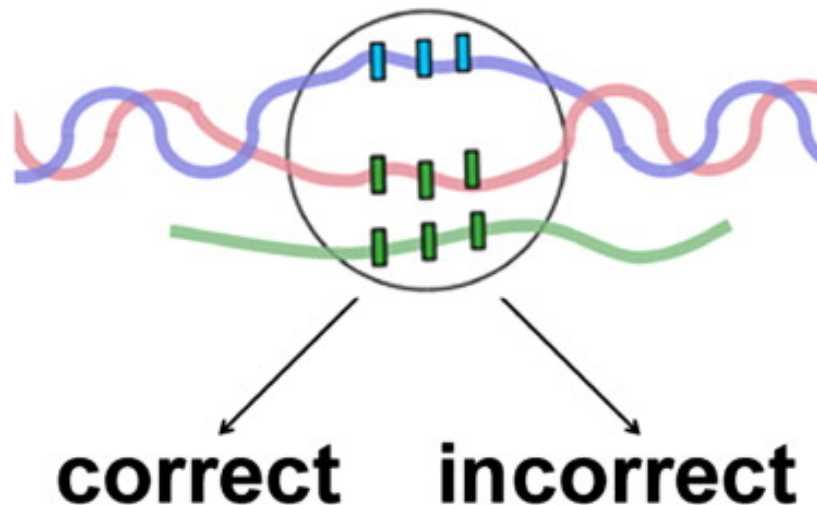
# RecA-Mediated Homology Search as a Nearly Optimal Signal Detection System

Yonatan Savir<sup>1</sup> and Tsvi Tlusty<sup>1,\*</sup>

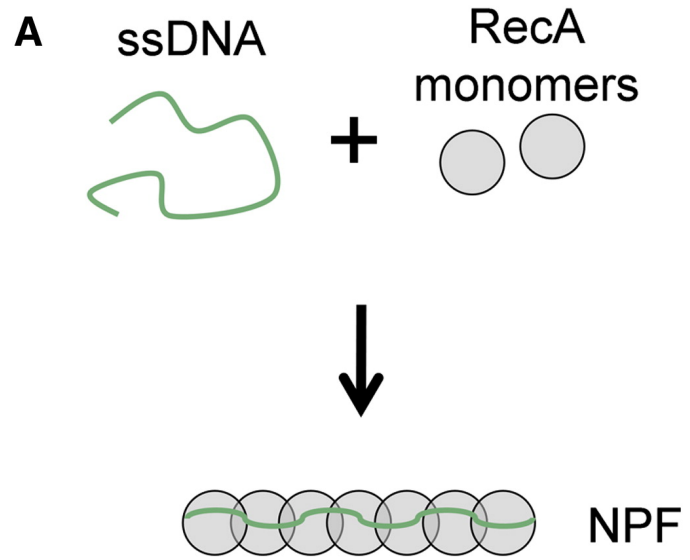
<sup>1</sup>Department of Physics of Complex Systems, Weizmann Institute of Science, Rehovot 76100, Israel

\*Correspondence: [tsvi.tlusty@weizmann.ac.il](mailto:tsvi.tlusty@weizmann.ac.il)

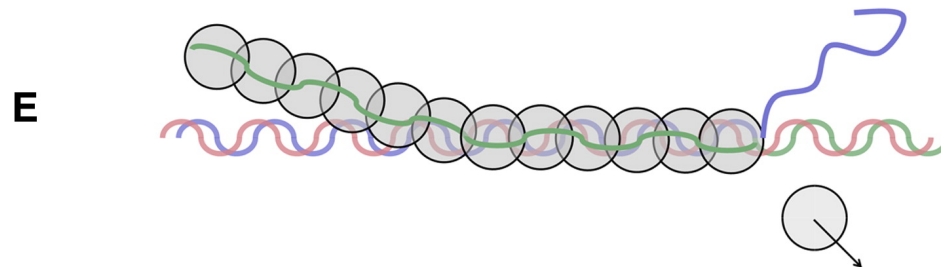
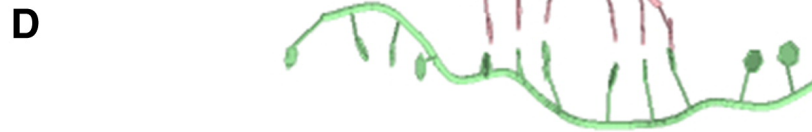
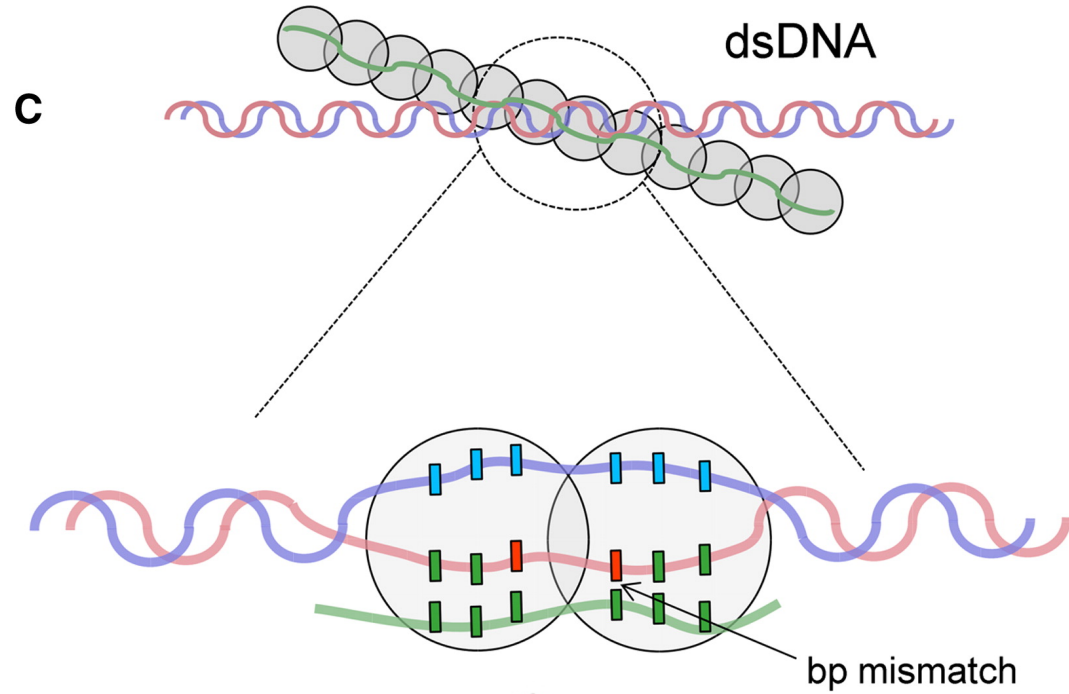
DOI 10.1016/j.molcel.2010.10.020



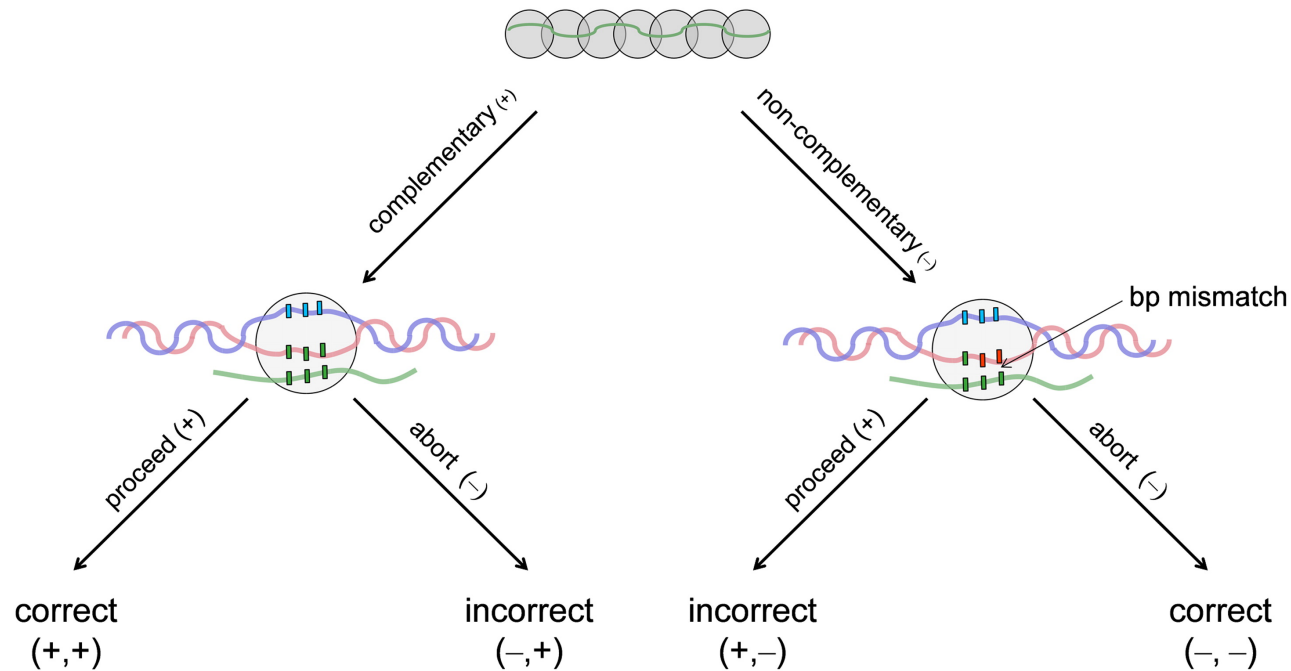
## Polymerization



## Homologous recognition and strand exchange



Input \ Output	Complementary Sequence (+)	Non-complementary Sequence (-)
Proceed with HR (+)	True Positive (+,+) $p_{+,+}; C_{+,+}$	False Positive (+,-) $p_{+,-}; C_{+,-}$
Abort HR (-)	False Negative (-,+) $p_{-,+}; C_{-,+}$	True Negative (-,-) $p_{-,-}; C_{-,-}$



Bayesian costs  $\sum_{i,j} C_{ij} p_{ij}$

$$C_b = -c_+ \cdot p_h(+)\cdot p_b(+)\cdot p_f(+ ) + c_- \cdot p_h(-)\cdot p_b(-)\cdot p_f(-)$$

where  $c_+ = C_{-,+} - C_{+,+}$  and  $c_- = C_{+,-} - C_{-,-}$

$p_h(+)$  · Probability to find correct homological strand

$p_b(+)$  Probability to bind

$p_f(+)$  Probability that complex is functional

$\Delta G_{\text{ext}}$   $\Delta G_b$  Free energy of extension (per triplet),  
and binding (per basepair)  
 $\Delta G_t$  Total Free Energy

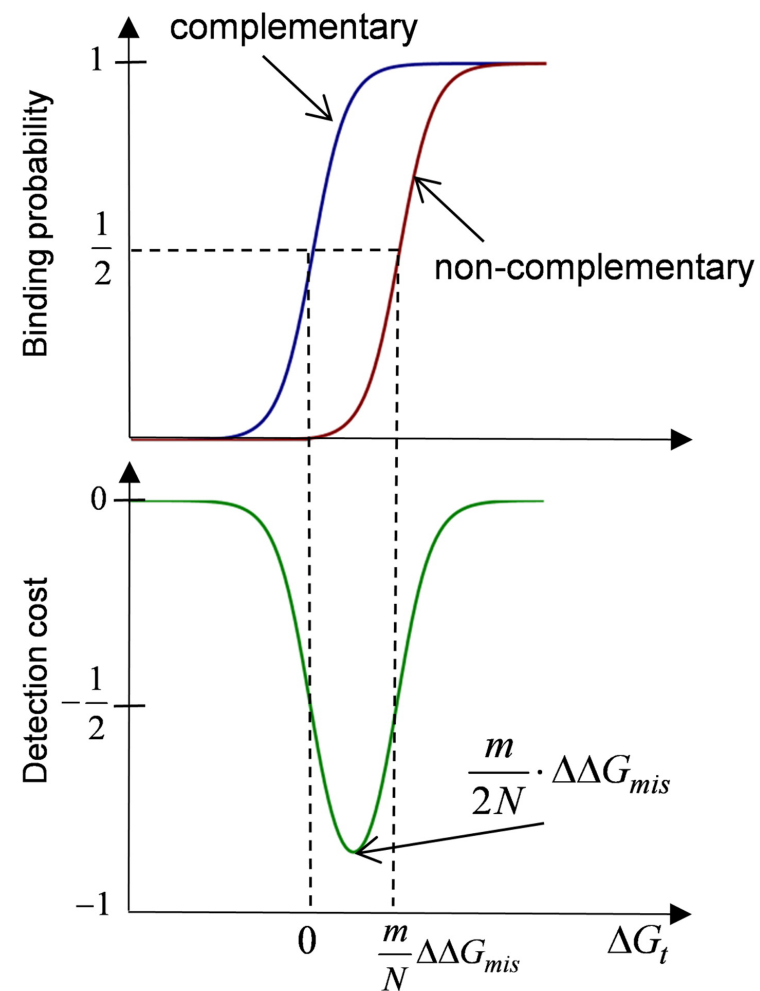
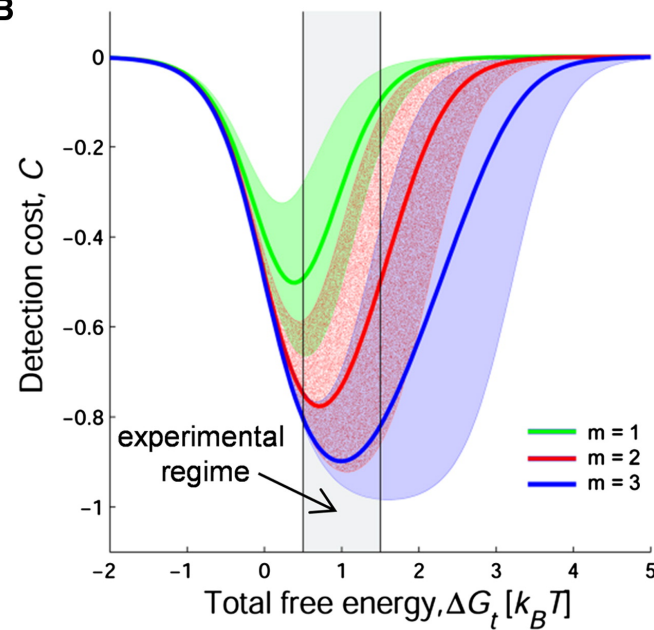
$$p_b(+)=1/[1+\exp(-N\cdot\Delta G_t)],$$

$$p_b(-)=1/[1+\exp(-N\cdot\Delta G_t+m\cdot\Delta\Delta G_{\text{mis}})]$$

Normalized Cost function using tolerance t

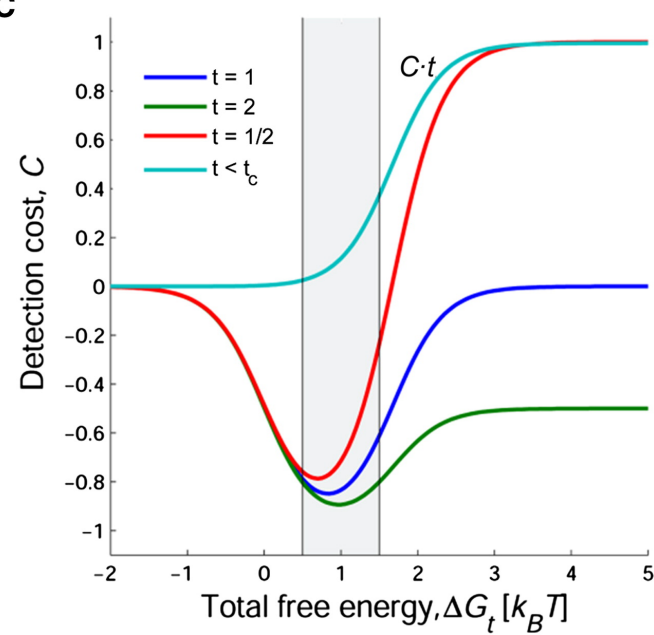
$$C=\frac{-1}{1+\exp(-N\cdot\Delta G_t)}+\frac{(1/t)}{1+\exp(-N\cdot\Delta G_t+m\cdot\Delta\Delta G_{\text{mis}})}.$$

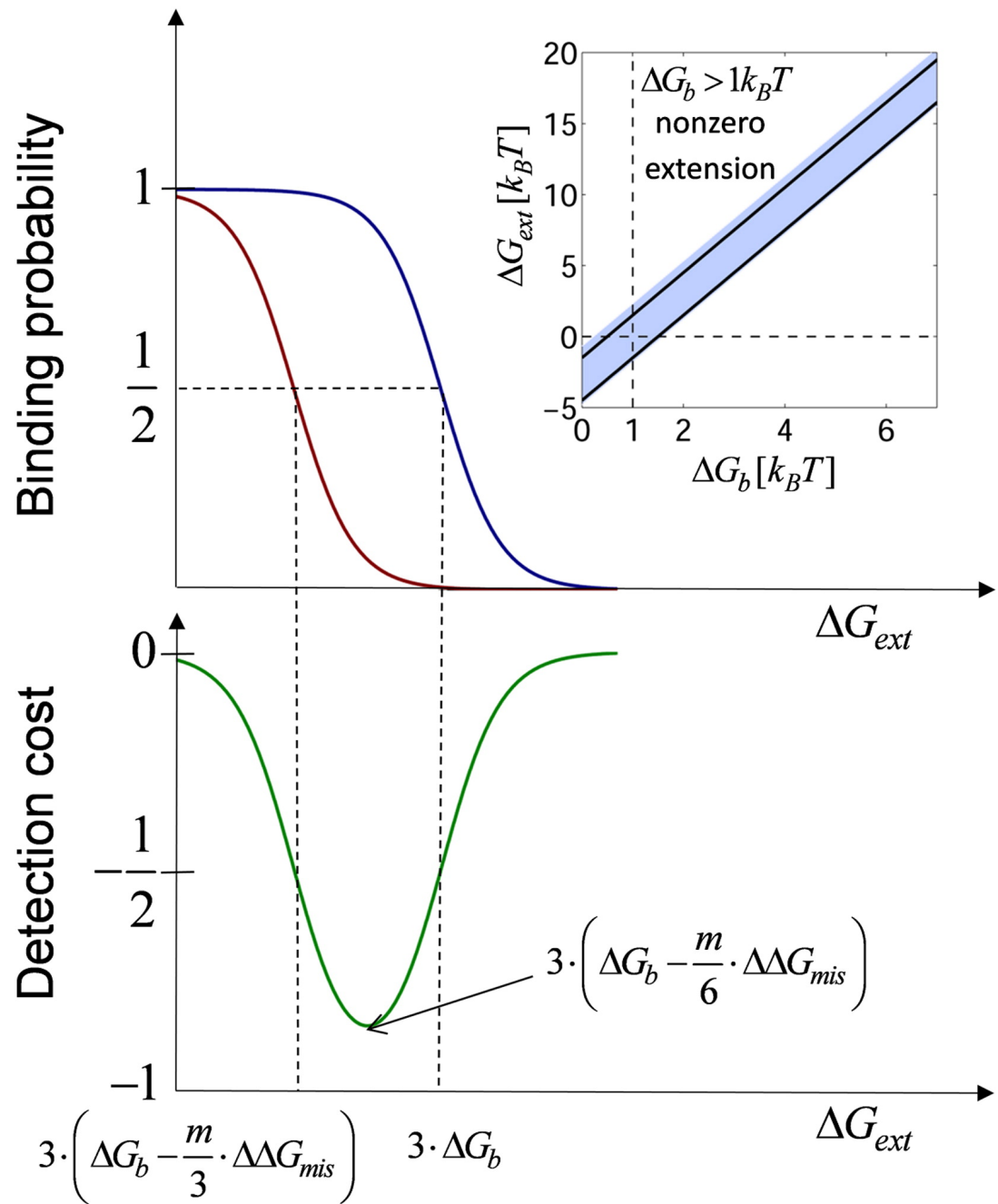
$$t=[c_+\cdot p_h(+)\cdot p_f(+)]/[c_-\cdot p_h(-)\cdot p_f(-)]$$

**A****B**

Optimal total free energy

$$\overline{\Delta G_t} = \frac{m}{2N} \cdot \Delta \Delta G_{mis}.$$

**C**



Optimal extension energy

$$\overline{\Delta G_{ext}} = 3 \left( \overline{\Delta G_b} - \frac{m}{6} \cdot \Delta \Delta G_{mis} \right)$$