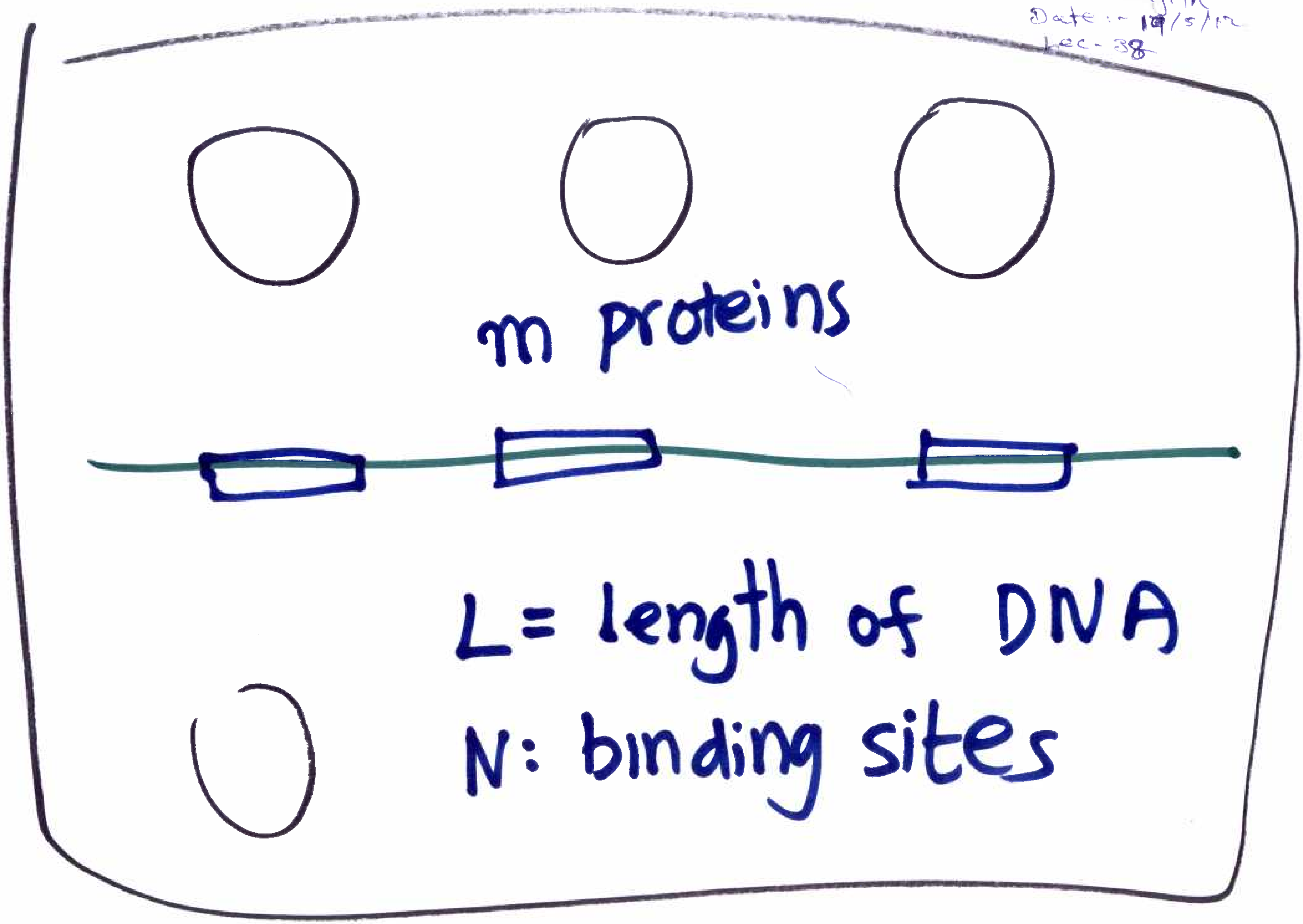
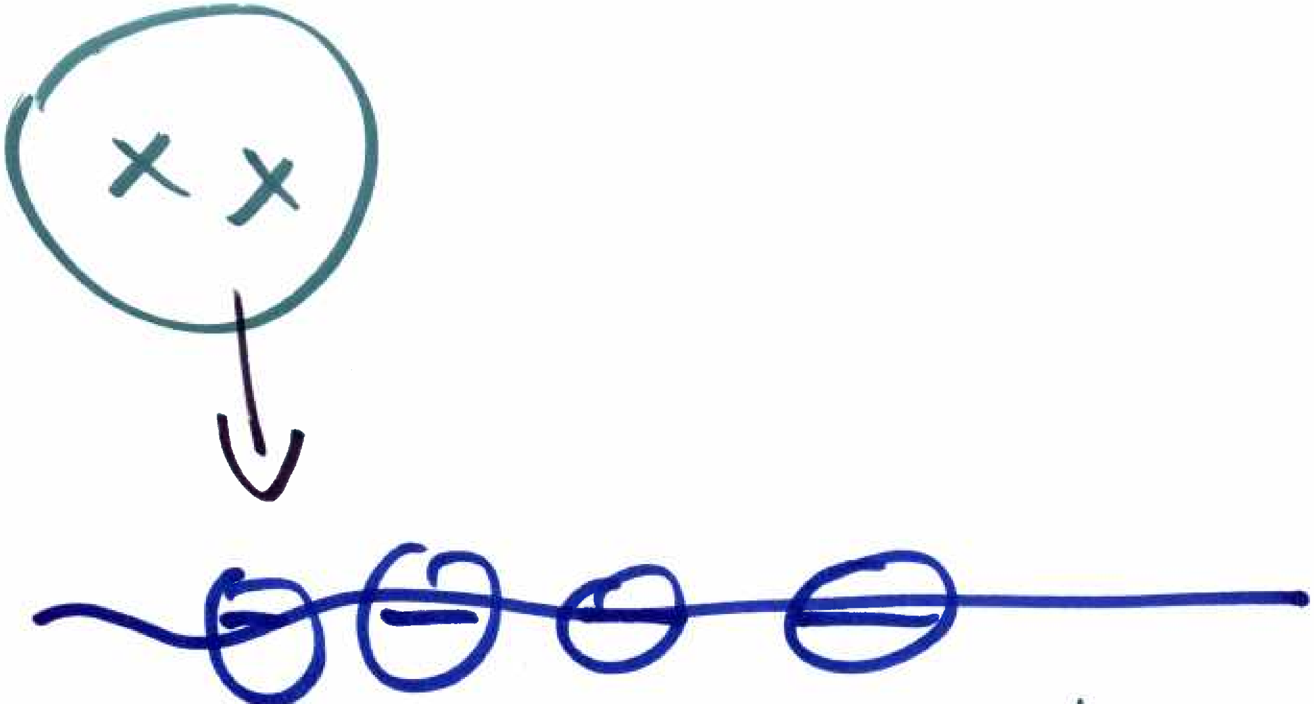
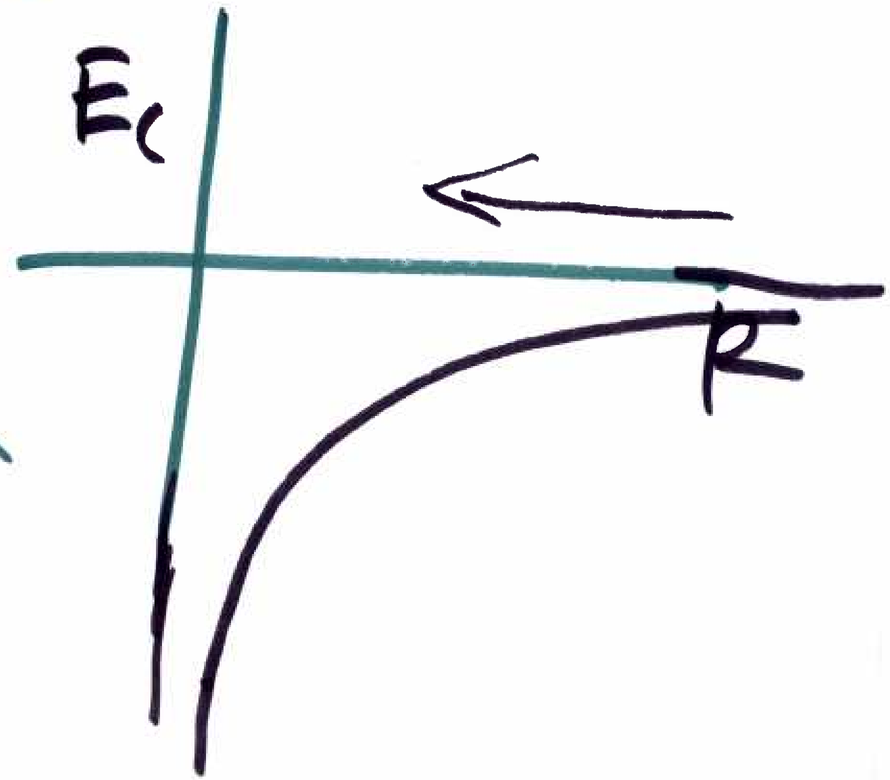
Prof. Ranjith
Date :- 19/5/12
Lec - 38



If there are N binding sites & m proteins, at equilibrium, how many of the proteins will be bound on to the DNA?



$$E_c = \frac{-q^2}{4\pi K R}$$



$$-\epsilon \, k_B T$$

=

Energy gained when 1 protein binds to DNA

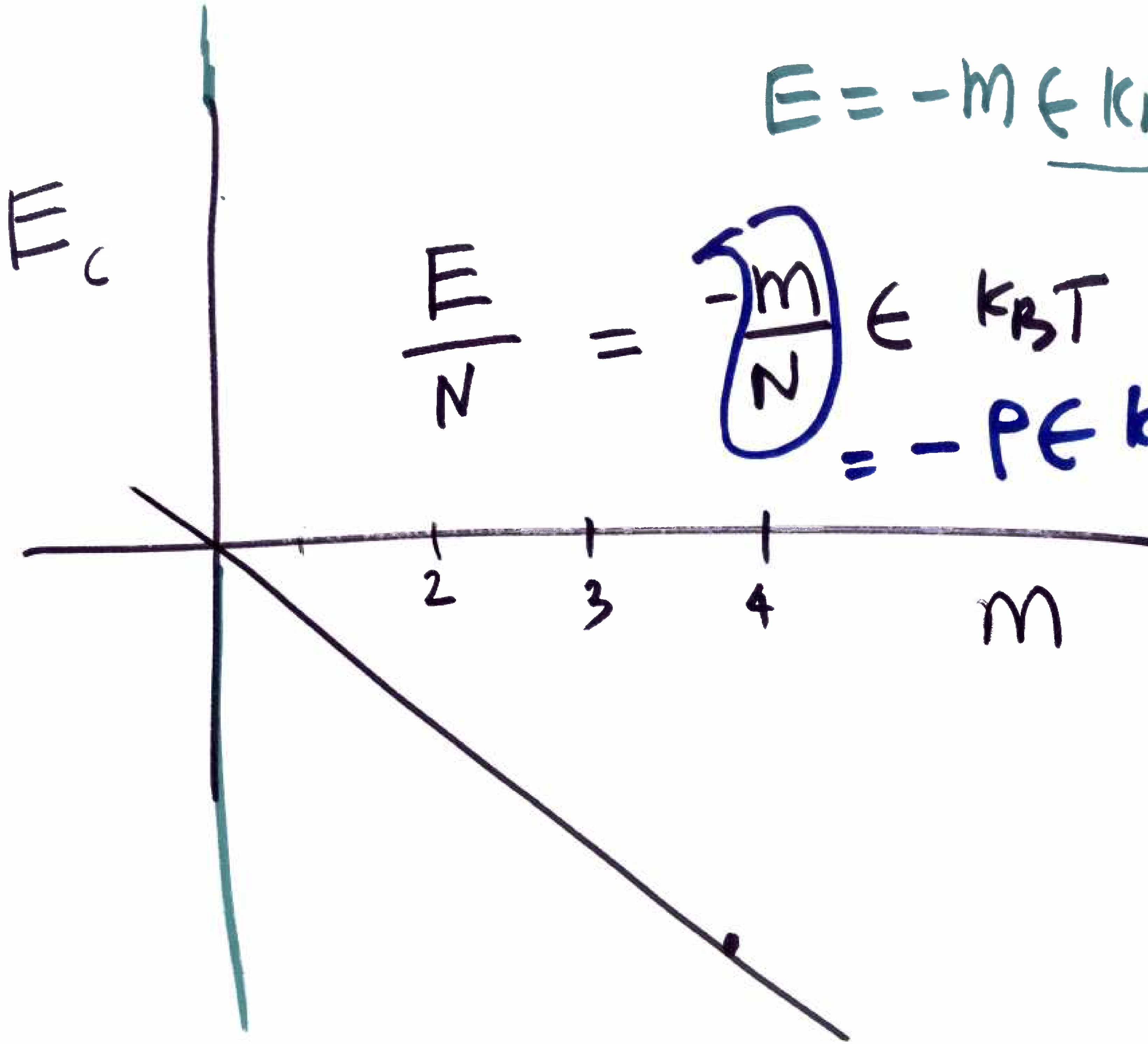
$1: \quad -\epsilon\, k_B T$

$2: \quad -2\epsilon\, k_B T$

$m: \quad -m\epsilon\, k_B T$

$$E = -m\,\epsilon\, k_B T$$

$$\frac{E}{N} = -\frac{m}{N}\,\epsilon\, k_B T = -p\,\epsilon\, k_B T$$

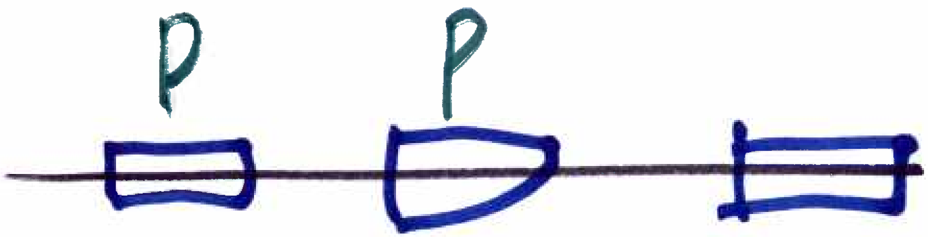


$$F = E - TS$$

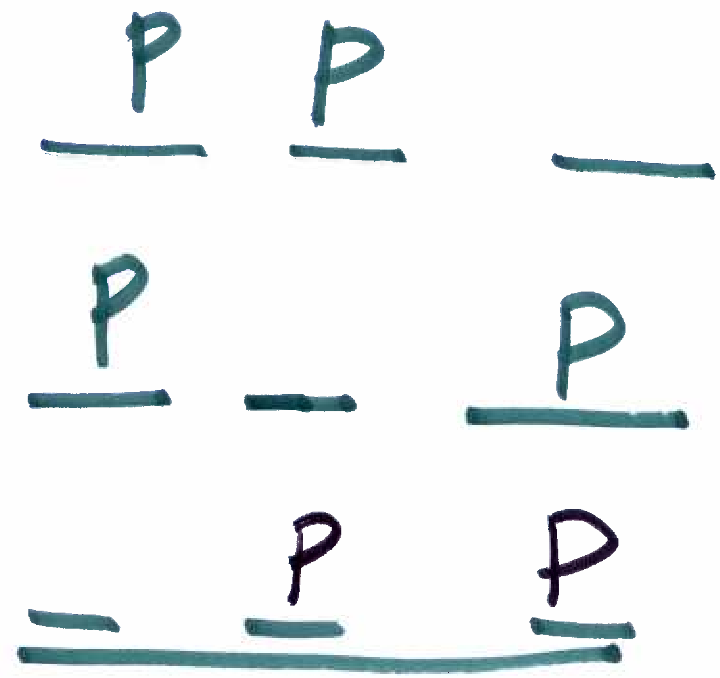
$$G = H - TS$$

$$S = k_B \ln \Omega$$

3 binding sites & 2 protiens



$\Omega = 3$



P P _ _

P _ P _

P _ _ P

_ P _ P

_ P P _

_ _ P P

_

$\Omega = 6$

P P P P

$$\Omega = 1$$

$$k_B \ln \Omega = 0$$

$$ {}^{N}C_{m} = \frac{N!}{m!\,(N-m)!} $$

$$\ln\left[\frac{N!}{m!\,(N-m)!}\right]$$

$$\ln N! - \ln\left(m!\,(N-m)!\right)$$

$$\ln N! - \ln m! - \ln(N-m)!$$

$$\ln N! \simeq N\ln N - N$$

$$N\ln N - N - (m\ln m - m)$$

$$-((N-m)\ln(N-m))$$

$$\boxed{\frac{m}{N} = P}$$

$$\frac{m}{N} = \rho$$

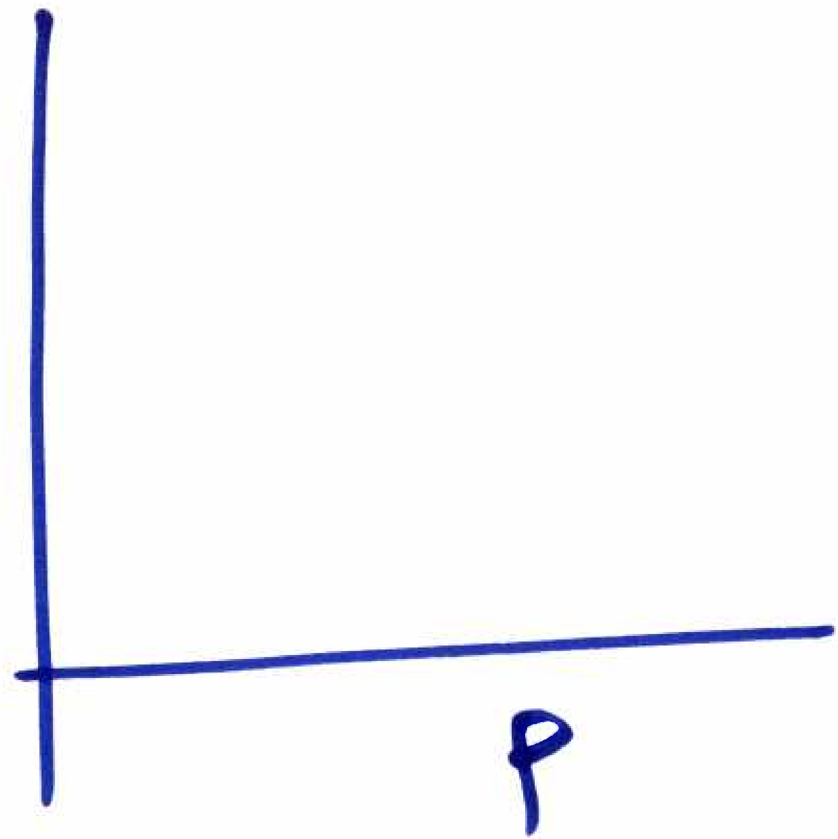
fraction of sites that is occupied by proteins

$$F(\rho)$$

$$\frac{\partial F}{\partial \rho} = 0$$

$$\frac{F}{N k_B T}$$

$$\frac{F}{N k_B T}$$



$$E = -N\rho k_B T$$

$$S = \rho \ln \rho + (1-\rho)\ln(1-\rho)$$

$$\underbrace{\overbrace{\left(\frac{F}{N k_B T}\right)}^{\bar{F}}}_{\bar{F}^0} = -\rho\epsilon + \rho\ln\rho + (1-\rho)\ln(1-\rho)$$

$$\frac{\partial \bar{F}}{\partial \rho} = -\epsilon + \frac{\rho}{\rho} + \ln\rho - \frac{1-\rho}{1-\rho} - \ln(1-\rho)$$

$$\frac{\partial \bar{F}}{\partial \rho} = -\epsilon + \ln \rho - \ln(1-\rho) = 0$$

$$\epsilon = \ln \rho - \ln(1-\rho)$$

$$\epsilon = \ln\left(\frac{\rho}{1-\rho}\right)$$

$$e^{\epsilon} = \frac{p}{1-p}$$

$$\epsilon = 0$$

$$p = \frac{e^{\epsilon}}{1+e^{\epsilon}} = \frac{1}{1+1}$$

$$= \frac{1}{2}$$

$$E = -\epsilon \, k_B T$$

If ~~σ~~ $\epsilon = \infty$

$$E = -\infty$$

$$P = \frac{e^{\infty}}{1+e^{\infty}} = 1$$

$$\epsilon = -\infty$$

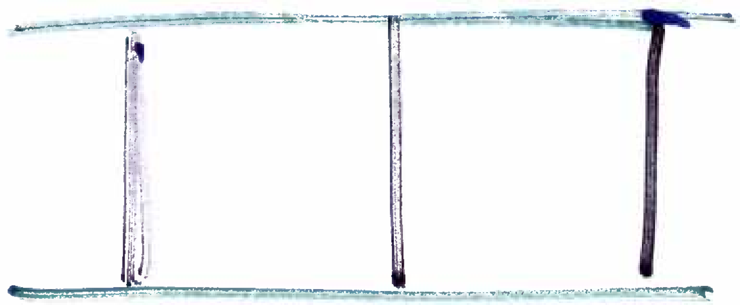
$$E = -\epsilon k_B T = \infty k_B T$$

$$P = \frac{e^{-\infty}}{1 + e^{-\infty}} = \frac{0}{1} = \underline{\underline{0}}$$

$$F = E - TS$$

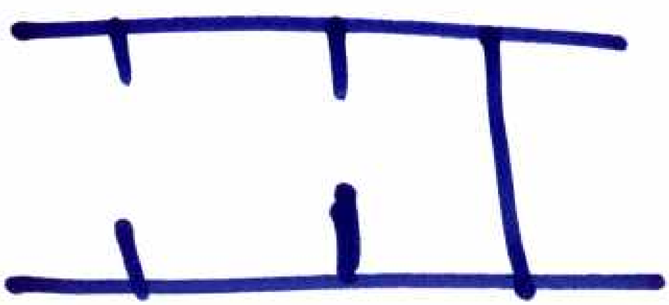
$E = h$

Case 1:

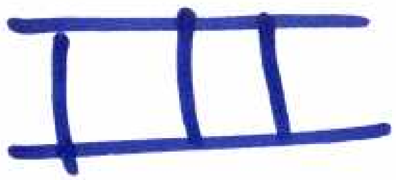


$= 3h$

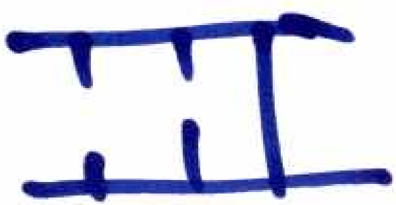
Case 2:

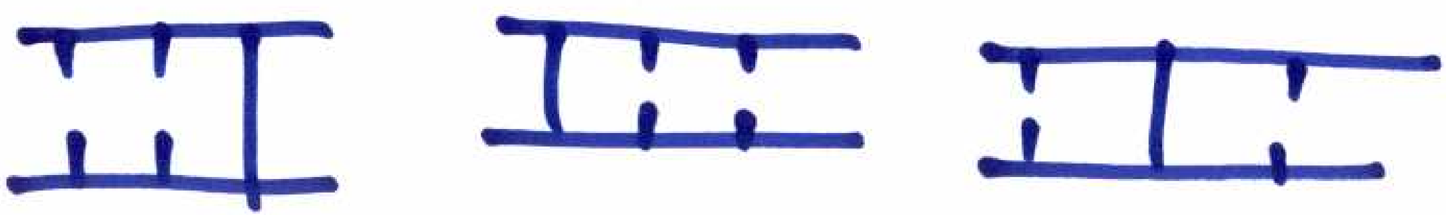


$= h$

①  $\epsilon = 3h$

h: energy per bp contact

②  $\epsilon = h$ | $S = k_B \ln 3$



① 3bp intact $\Omega = 1$

$$S = k_B \ln \Omega = 0$$

$$F = E - TS = n k_B T$$

① $F = 3h k_B T - 0$

② $F = h k_B T - k_B T$

$T = 100K$ | $h = -100$

$T = 1000K$