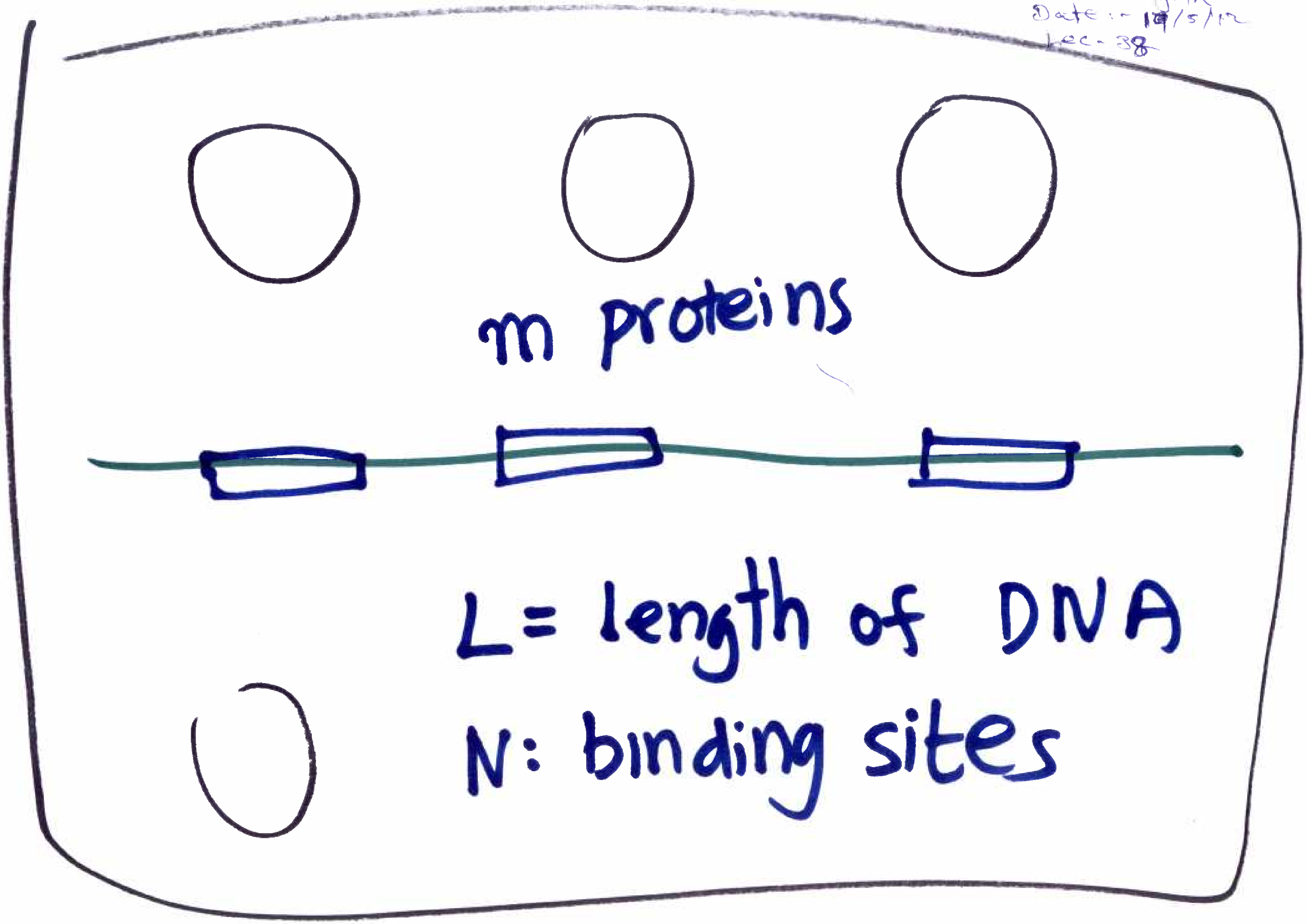
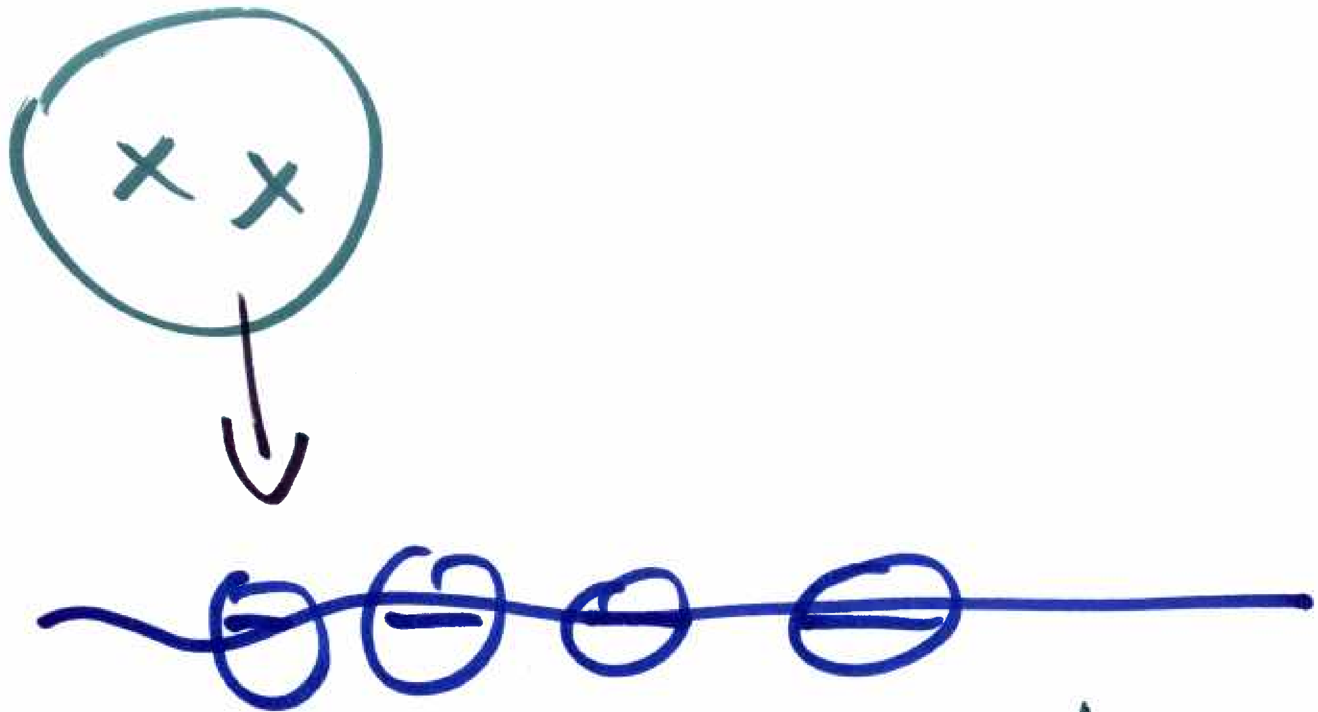
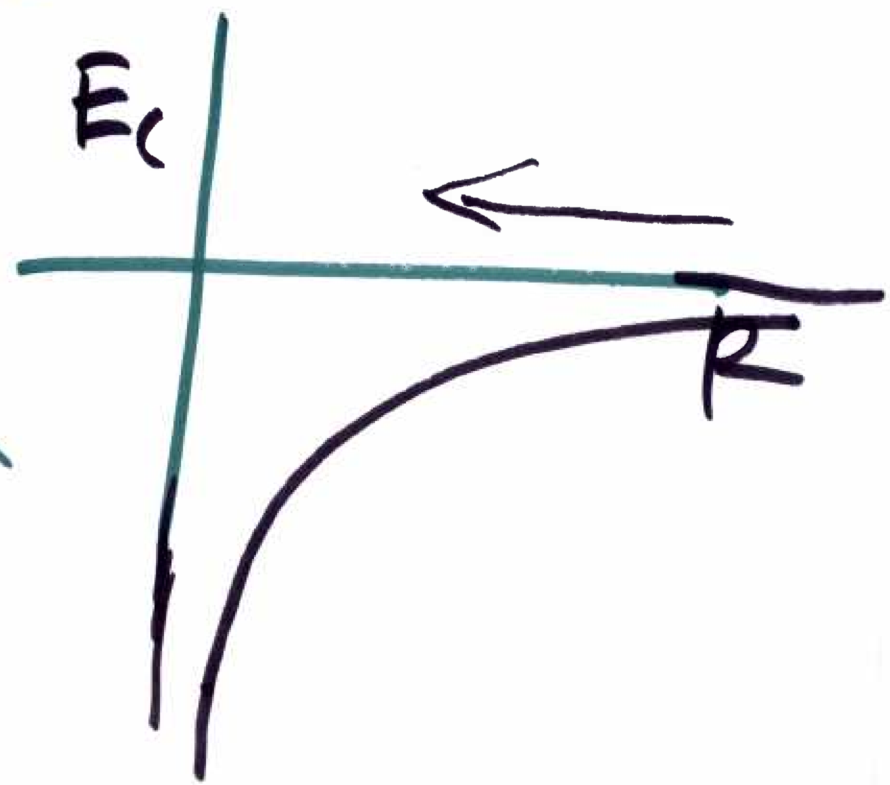
Prof. Ranjith
Date :- 19/5/12
Lec - 38



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



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



$$-\epsilon\ k_BT$$

$$= \underbrace{\qquad\qquad}_{\text{Energy gained when 1 protein binds to DNA}}$$

Energy gained when 1 protein binds to DNA

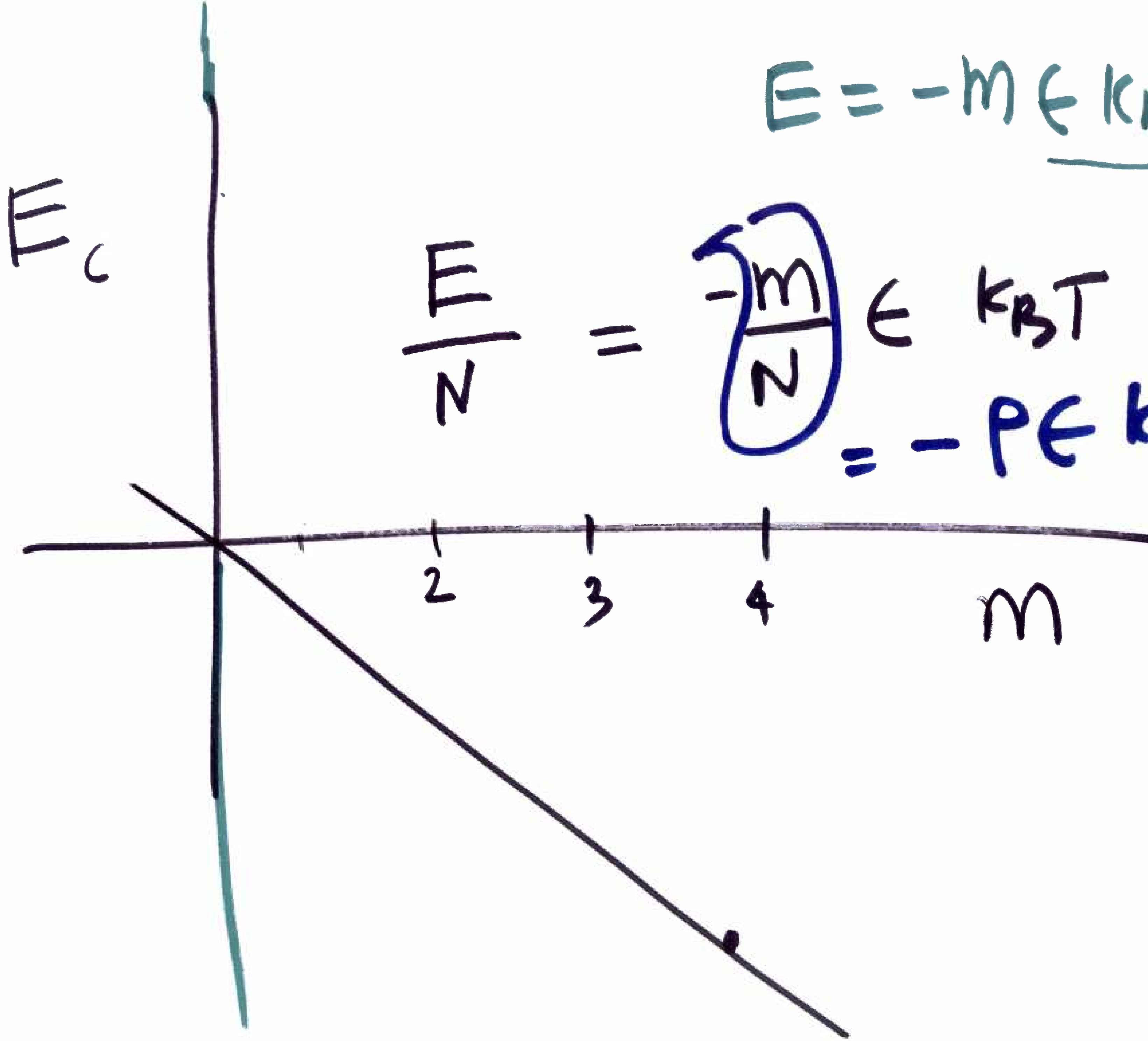
1 : $-\epsilon k_B T$

2 : $-2\epsilon k_B T$

m : $-m\epsilon k_B T$

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

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

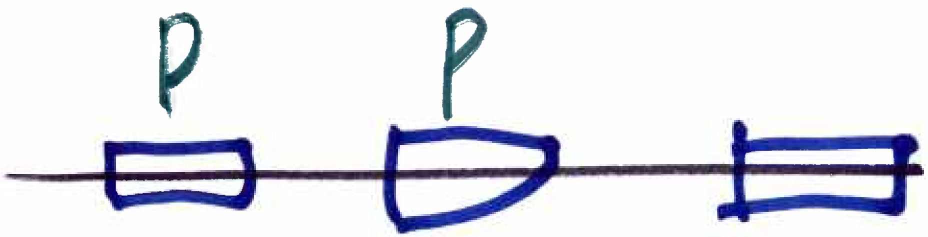


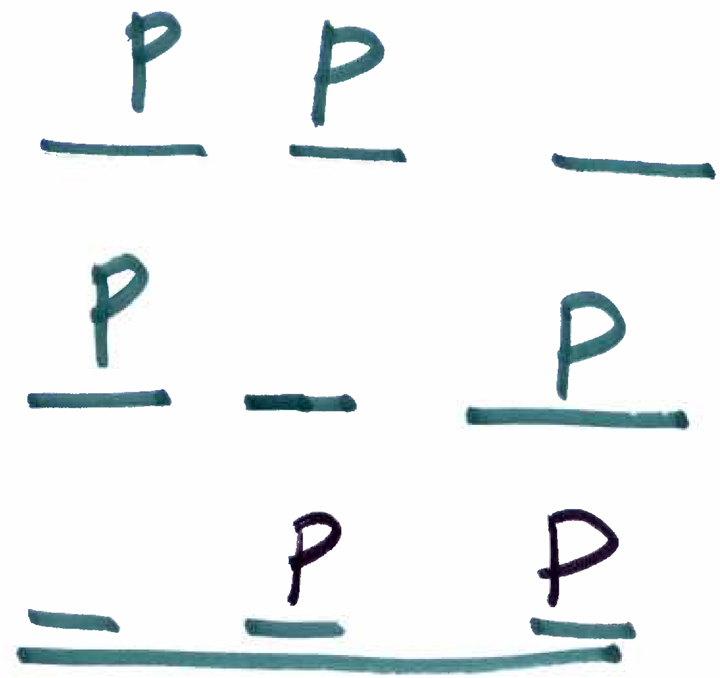
$$F = E - TS$$

$$G = H - TS$$

$$S = k_B \ln \Omega$$

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

$$\Omega = 1$$

$$k_B \ln \Omega = 0$$

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

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

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

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

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

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

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

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

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

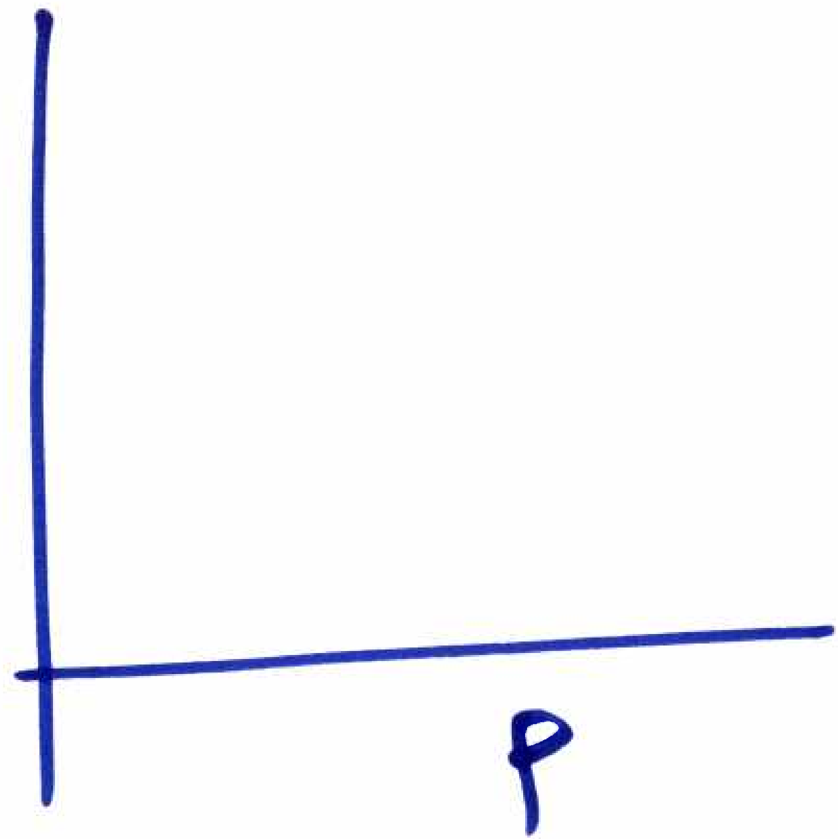
fraction of sites that is occupied by proteins

$$F(\rho)$$

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

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

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



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

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