BIOENG 455 Test 1

29/9/08

1) $p = \rho k_B T (1 + B_2 \rho + B_3 \rho^2)$

Because 1 is dimensionless, so must $B_2\rho$ and $B_3\rho^2$.

$\Rightarrow [B_2] = \frac{1}{[\rho]} = \text{Volume} = L^3$

NB ρ is a number density not a mass density.

$[B_3] = \frac{1}{[\rho]^2} = L^6$

2) Induced entropic forces: Hydrophobic effect
Depletion Force
Fluctuation-Induced Forces

Membrane-Mediated Forces: Capillary Force
Depletion Force
curvature Force
Fluctuation-induced Force

3) $\langle R_{ee}^2 \rangle = Na^2 + \left\langle \sum_{i \neq j} \underline{r}_i \cdot \underline{r}_j \right\rangle$

a) $\underline{r}_i \cdot \underline{r}_j$ represents correlations or interactions between monomers.

b) Yes. If monomers attract each other, the term could be negative.

4) consider a real polymer:

$N = 10^5$ monomers

$a = 0.5$ nm

$\sqrt{\langle \vec{R_{ee}^2} \rangle} = 273.9$ nm

a) By definition: $l_k = \frac{\langle R_{ee}^2 \rangle}{L_o}$

$$n_k = \frac{L_o}{l_k}$$

one $L_o = 10^5 \times 0.5$ nm $= 5\,10^4$ nm

$\Rightarrow l_k = \frac{(273.9\ \text{nm})^2}{5\,10^4\ \text{nm}} = 1.5$ nm

b) $n_k = \frac{5\,10^4\ \text{nm}}{1.5\ \text{nm}} = 33,324$

5) -

6) 1) Monomers carry information
2) They spontaneously fold into a 3D shape
3) ∴ nm- covalently self-assemble into 1d, 2d, 3d aggregates.
4) They respond to their environment by changing shape.

#7 $\langle x^2 \rangle = 6DT$

Take $\langle x^2 \rangle \sim a_0 \sim 0.7\,nm^2$

$D \sim 1\,\mu m^2/sec$

$\Rightarrow T \sim \frac{0.7\,nm^2}{6 \cdot 10^6\,nm^2/sec} = 117\,ns$