

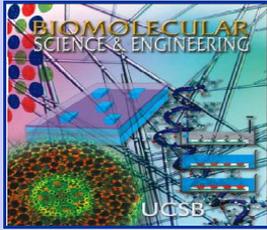
Functional Bio-Nano Materials

P. Pincus

Physics, Materials, Biomolecular Science & Engineering
UCSB

Nature synthesizes functional materials in an integrated and highly controlled manner. The study of this integrated system is the realm of the developing field of *SYSTEMS BIOLOGY*.

Biology celebrates diversity but, at the molecular/cellular levels, a few motifs are seen over and over. We provide some examples in the context of *functional materials*. Can X-ray/neutron scattering be adopted as a generic probe for these structures and their functions?

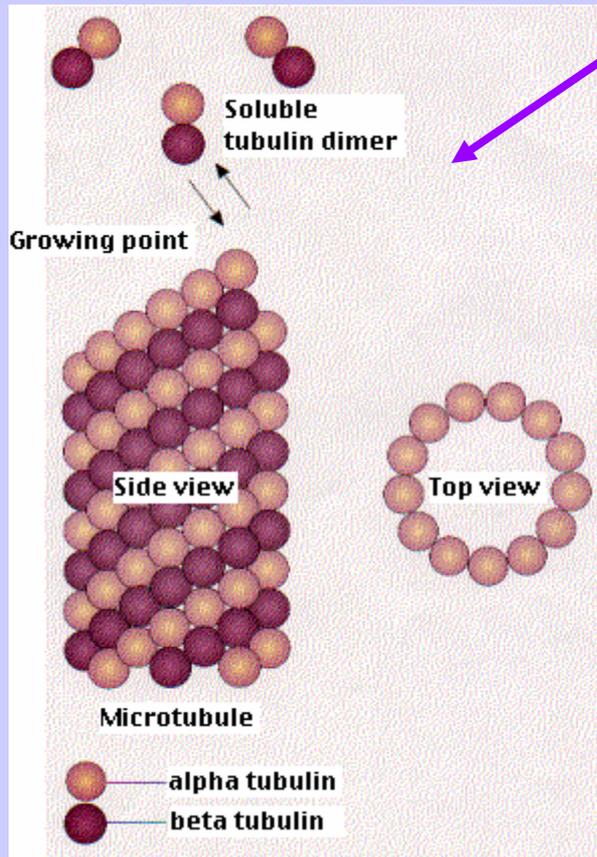


OUTLINE

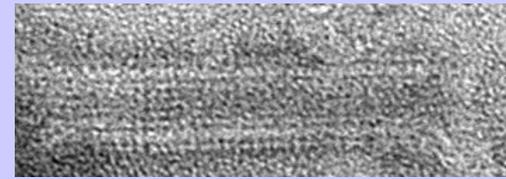


- Hierarchical Assembly
- Motor Driven Synthesis
- Programmed Assembly
- Functional (Smart) Materials

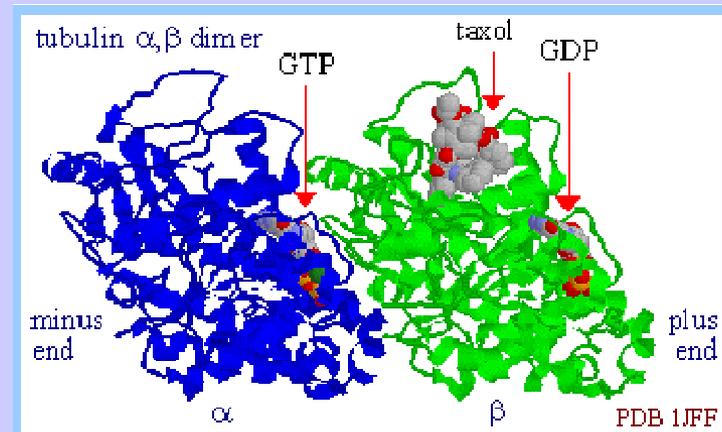
Hierarchical Assembly Microtubules



Microtubule



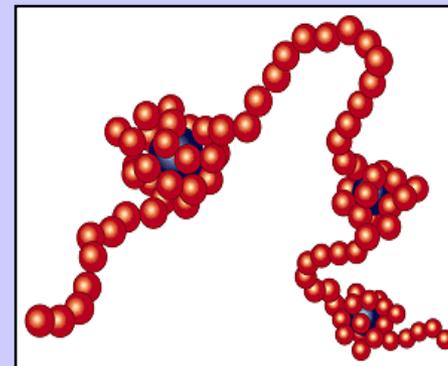
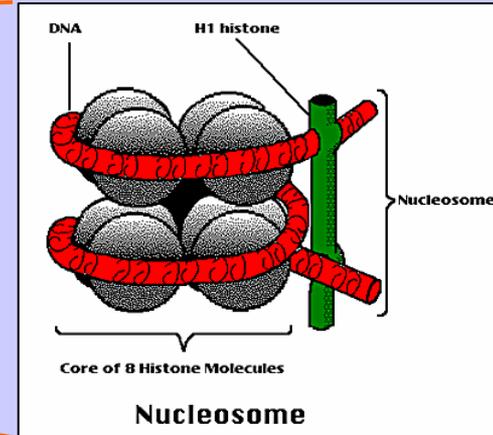
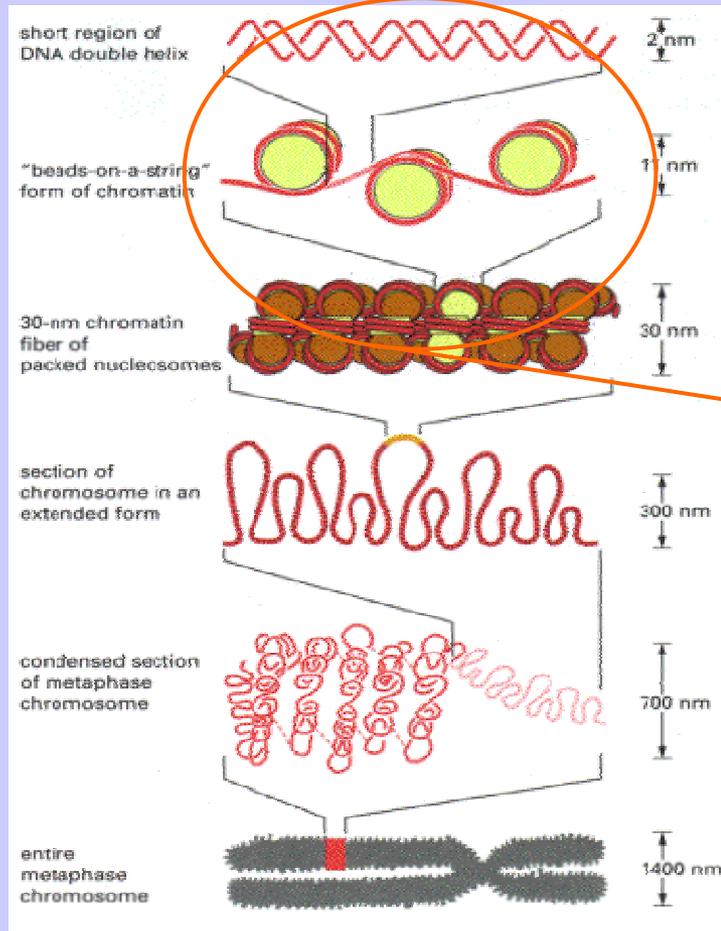
TEM Image (Raviv et al)



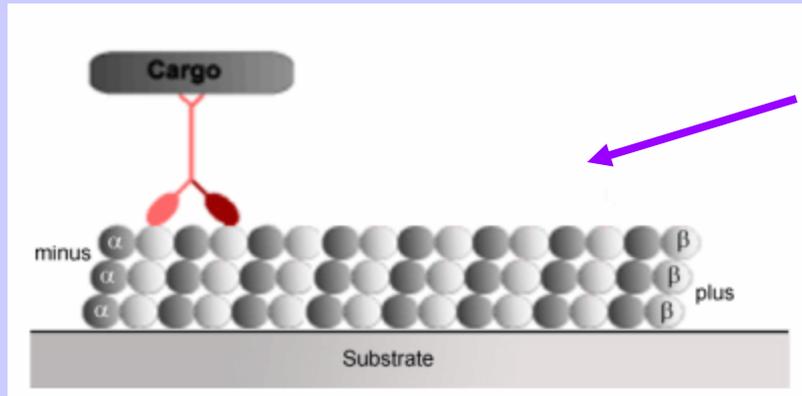
Tubulin Dimer



Hierarchical Assembly Chromatin

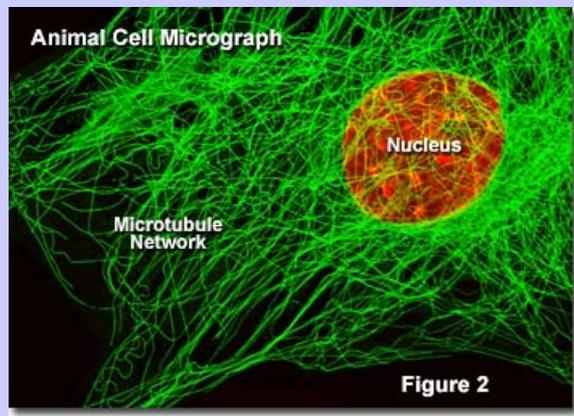
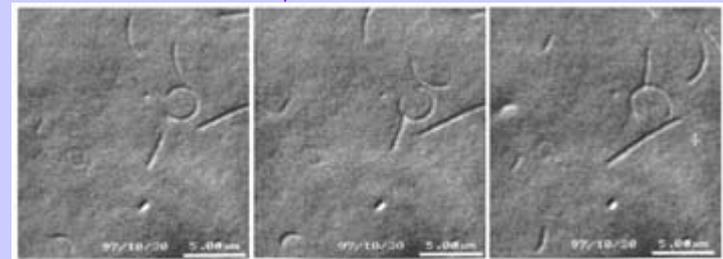


Motor Driven Synthesis



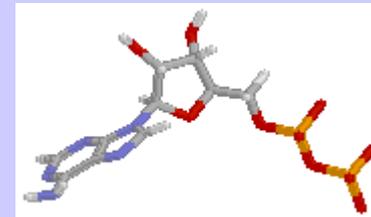
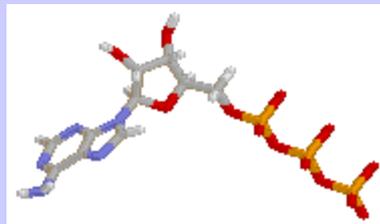
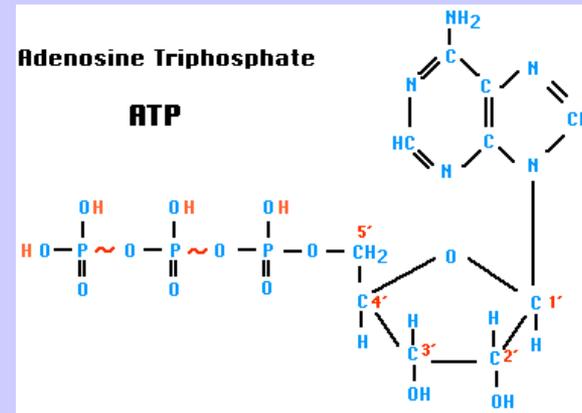
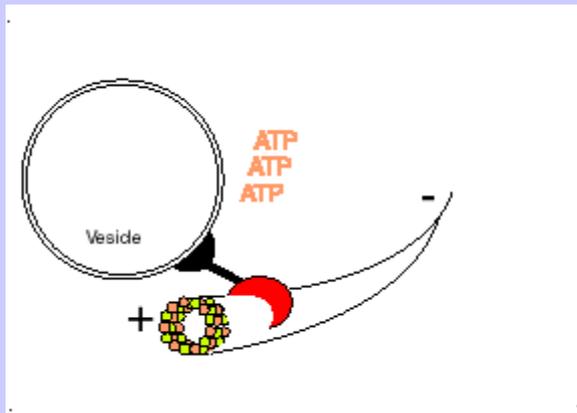
Kinesin walking on microtubule

Microtubules translating on glass slide



Non-Diffusive Transport

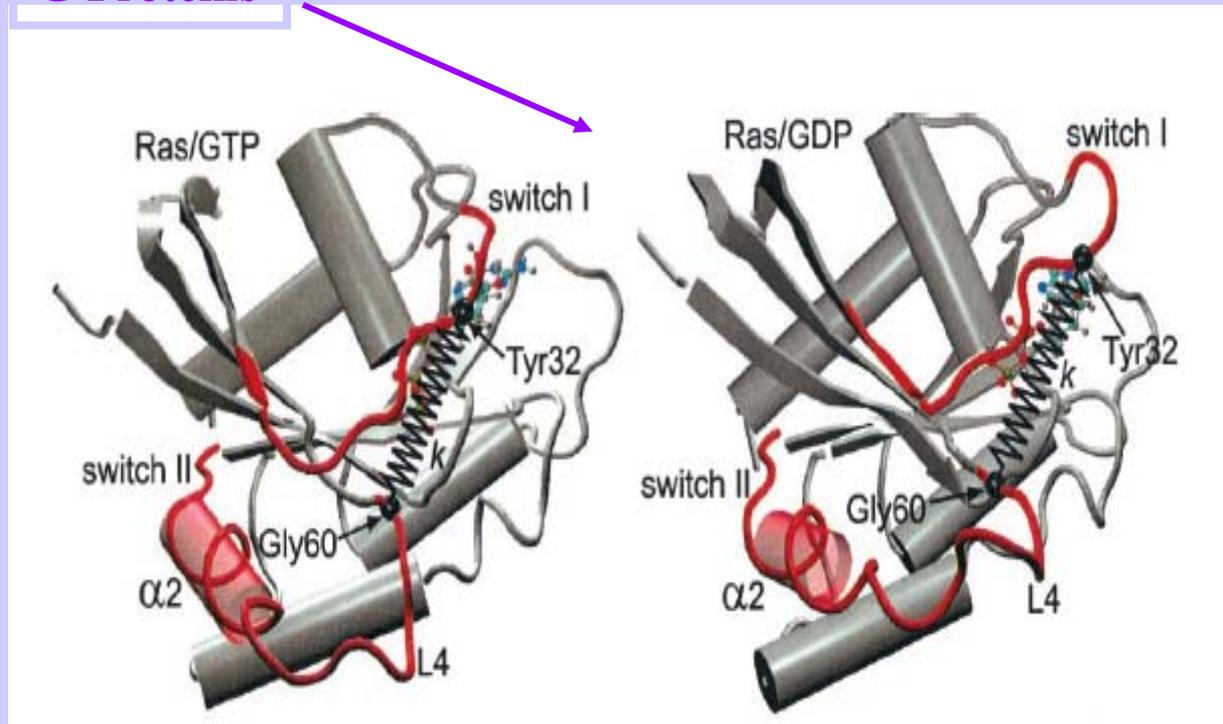
Power Source ATP Hydrolysis



ATP => ADP + 7 KCAL/MOLE

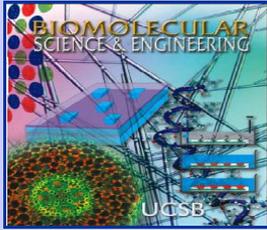
Functional (Smart) Materials

G Proteins



$GTP \Rightarrow GDP + \gamma \text{ Phosphate} + 1 \text{ kcal/mole}$

(Kosztin, Bruinsma, O'Lague, Schulten, PNAS 2002)



SOME QUESTIONS

- Is it possible for there to be a generic scattering technique to probe hierarchical assemblies, e.g. spallation source with broad spectrum?
- Can active dynamical processes, i.e. ATP hydrolysis driven systems, be studied (frequency, scattering vector range)?
- Do integrated functional systems require soft materials?
- Is it possible to construct artificial analogous devices?
- Hybrid structures, e.g. histones => charged electronically or optically active beads?
- Can hard materials be incorporated?
- In what applications would functional materials be useful and/or engender new classes of devices?