DNA Nanorobotics

Reem Mokhtar

DNA Nanorobotics

Book Chapter: Chandran, H., Gopalkrishnan, N., & Reif, J. (n.d.). DNA Nanorobotics.

Aim: design and fabrication of dynamic DNA nanostructures that perform specific tasks via a series of state changes (average system behavior)

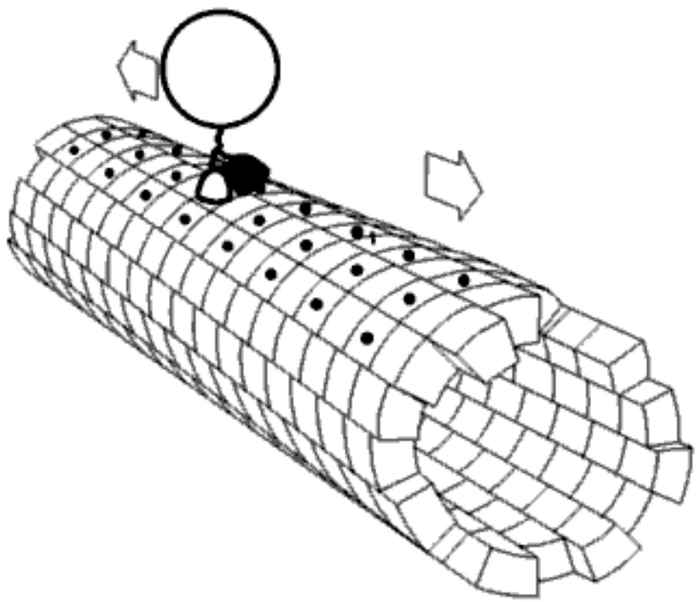
Challenges

1. Domain to sequence mapping in design (spurious interactions)
2. Fuel (spontaneous entropic effects)
3. Assembly + purification
4. Experimental design for validation

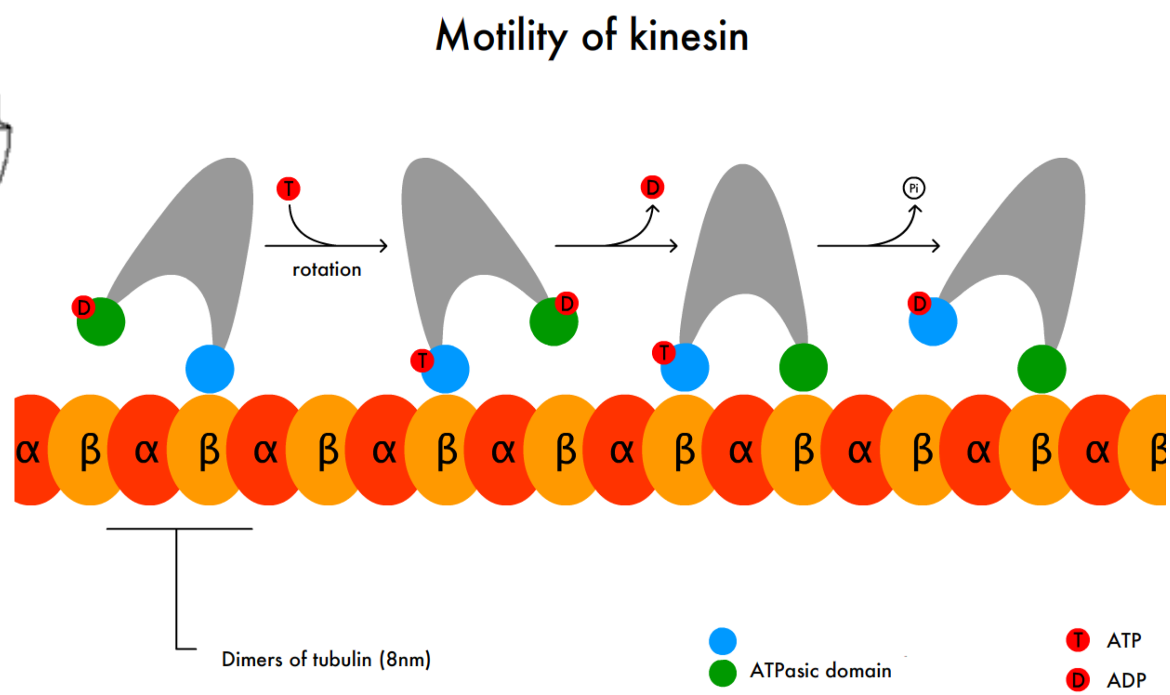
...each step is a challenge

Book Chapter: Chandran, H., Gopalkrishnan, N., & Reif, J. (n.d.). DNA Nanorobotics.

Examples in Nature –> Kinesins



ATPases (ATP → ADP → energy)



Yildiz, A. (2004). Kinesin Walks Hand-Over-Hand. *Science*, *303* (5658), 676–678. doi:10.1126/ science.1093753

Book Chapter: Chandran, H., Gopalkrishnan, N., & Reif, J. (n.d.). DNA Nanorobotics.

Examples in Nature –> Myosins

http://www.dnatube.com/video/389/A-Moving-Myosin-Motor-Protein

http://www.youtube.com/watch?v=gJ309LfHQ3M

Toyoshima, Y. Y., Kron, S. J., McNally, E. M., Niebling, K. R., Toyoshima, C., & Spudich, J. A. (1987). Myosin subfragment-1 is sufficient to move actin filaments in vitro.

Binds to actin → ATP hydrolysis → mechanical movement

Book Chapter: Chandran, H., Gopalkrishnan, N., & Reif, J. (n.d.). DNA Nanorobotics.

Why DNA?

Design

1. Predictable geometries can be achieved
2. Can predict dsDNA thermodynamics + geometry using software
3. Software-assisted design

Book Chapter: Chandran, H., Gopalkrishnan, N., & Reif, J. (n.d.). DNA Nanorobotics.

Why DNA?

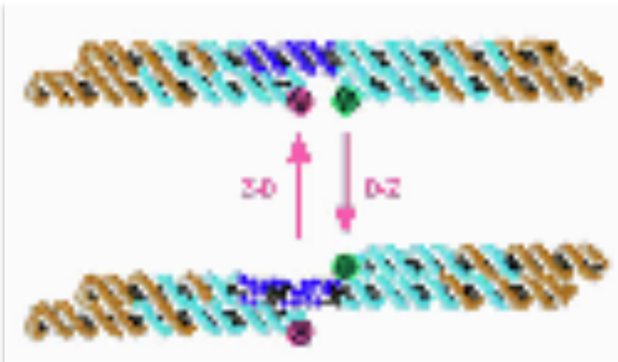
Experiments

1. Custom ssDNA synthesis
   → routine + inexpensive
2. Assembly simple
3. Characterization techniques (AFM, TEM, …)

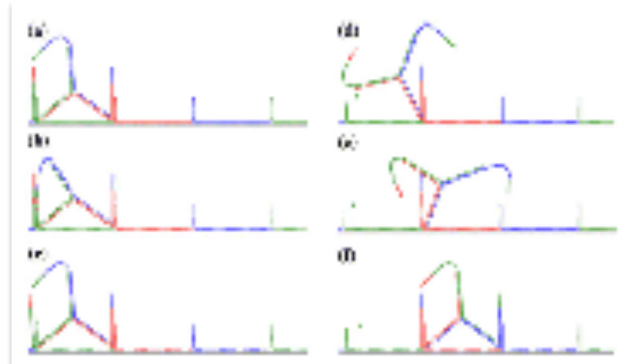
Book Chapter: Chandran, H., Gopalkrishnan, N., & Reif, J. (n.d.). DNA Nanorobotics.

Chapter Classification

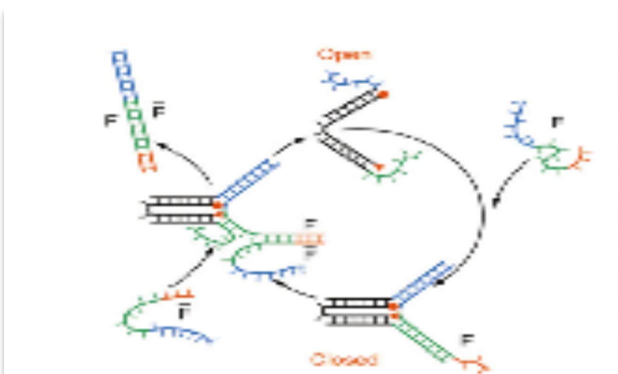
Switch conformation based on environment



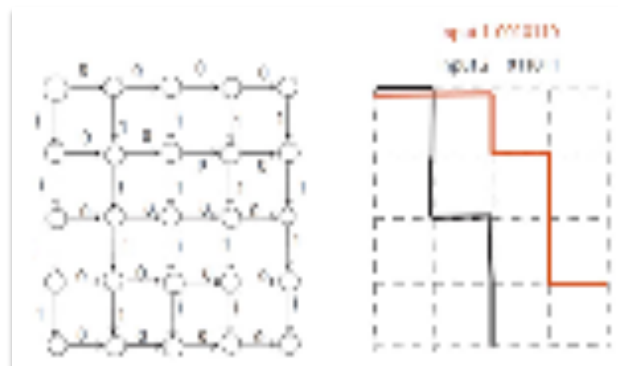
Powered by enzymatic reactions



Hybridization reactions



Programmable



Book Chapter: Chandran, H., Gopalkrishnan, N., & Reif, J. (n.d.). DNA Nanorobotics.