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William Shih's Lecture Part 2:
Nanofabrication via DNA single stranded bricks

Teaching Tools were prepared by Karen Cheng and William Shih.

Contents

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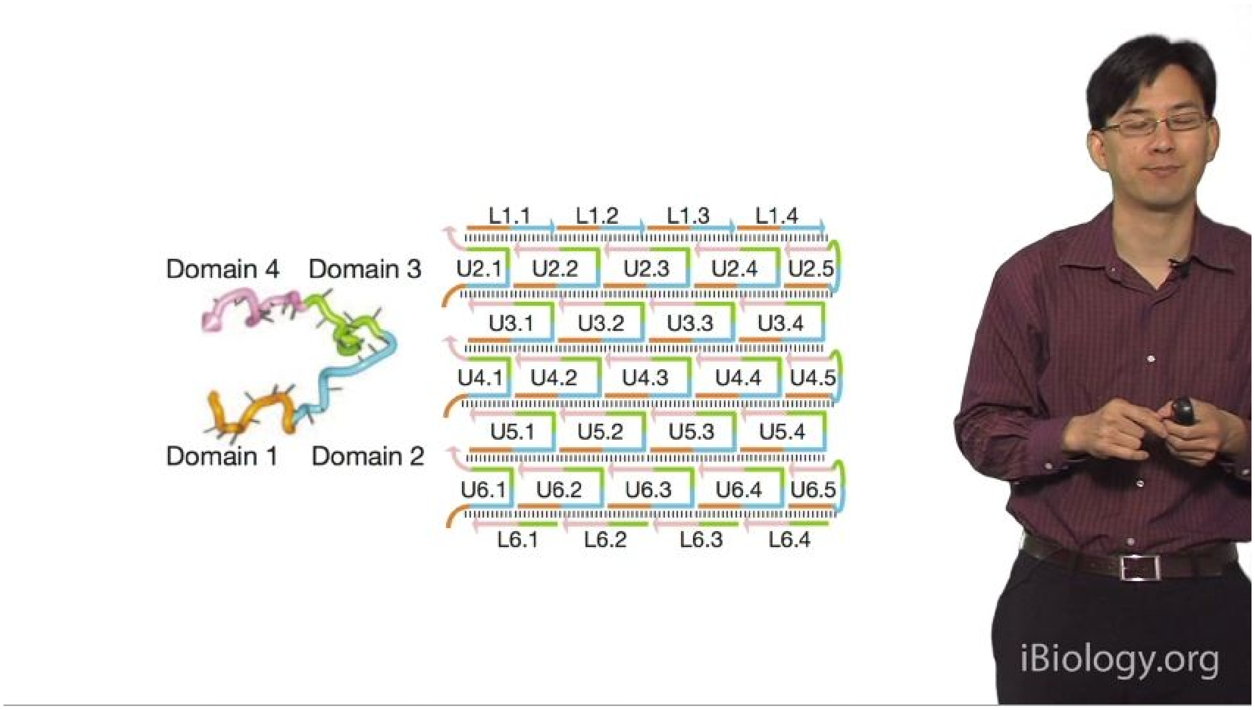
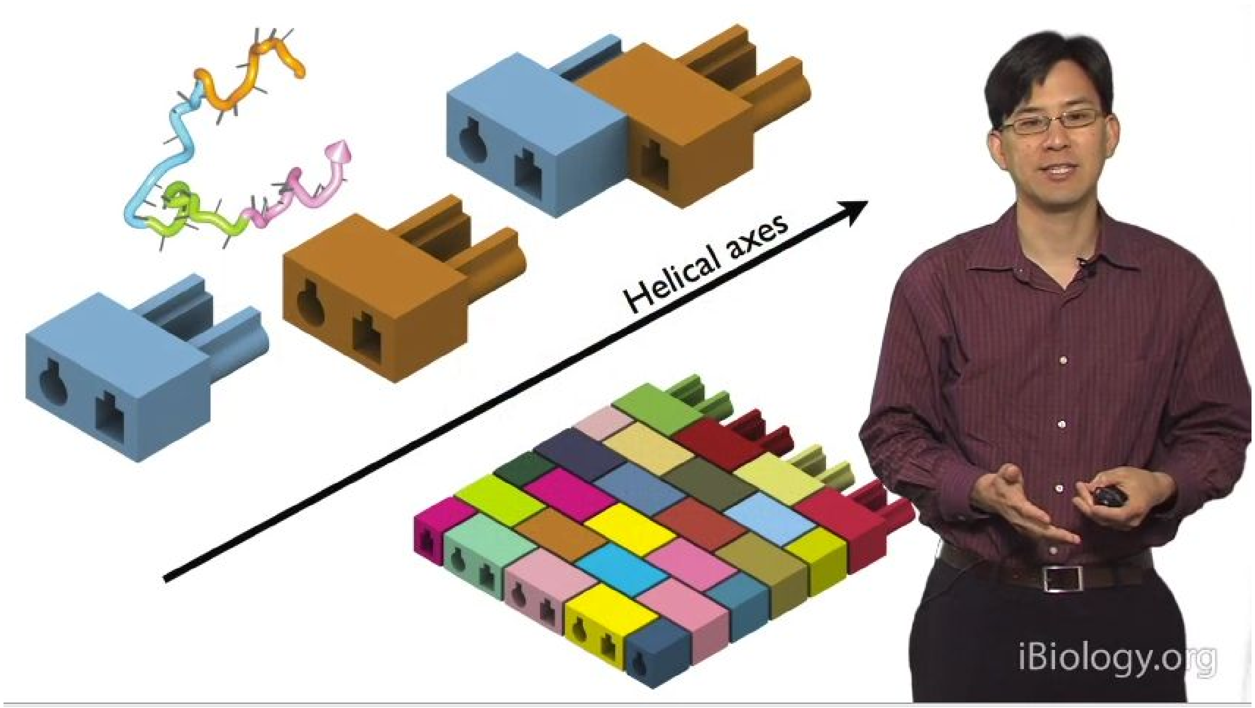
1. Keywords and Terms

DNA single stranded bricks, DNA single stranded tiles (SST), molecular canvas

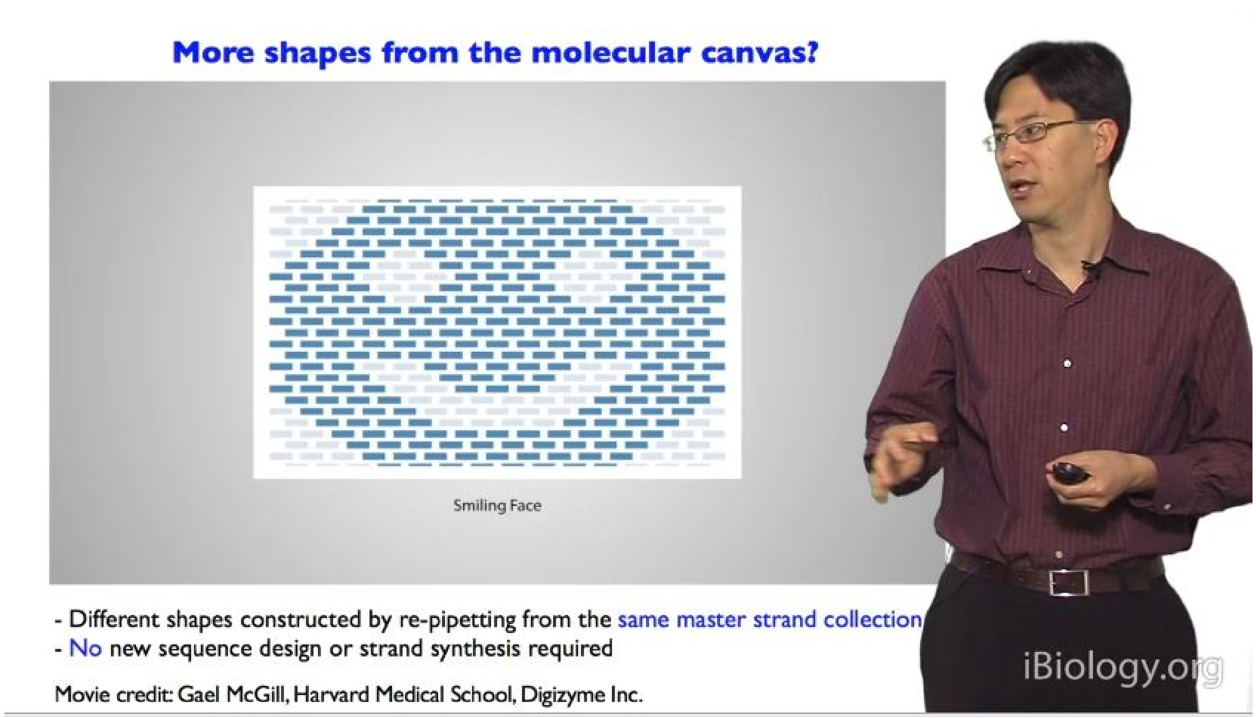
2. Lecture Notes



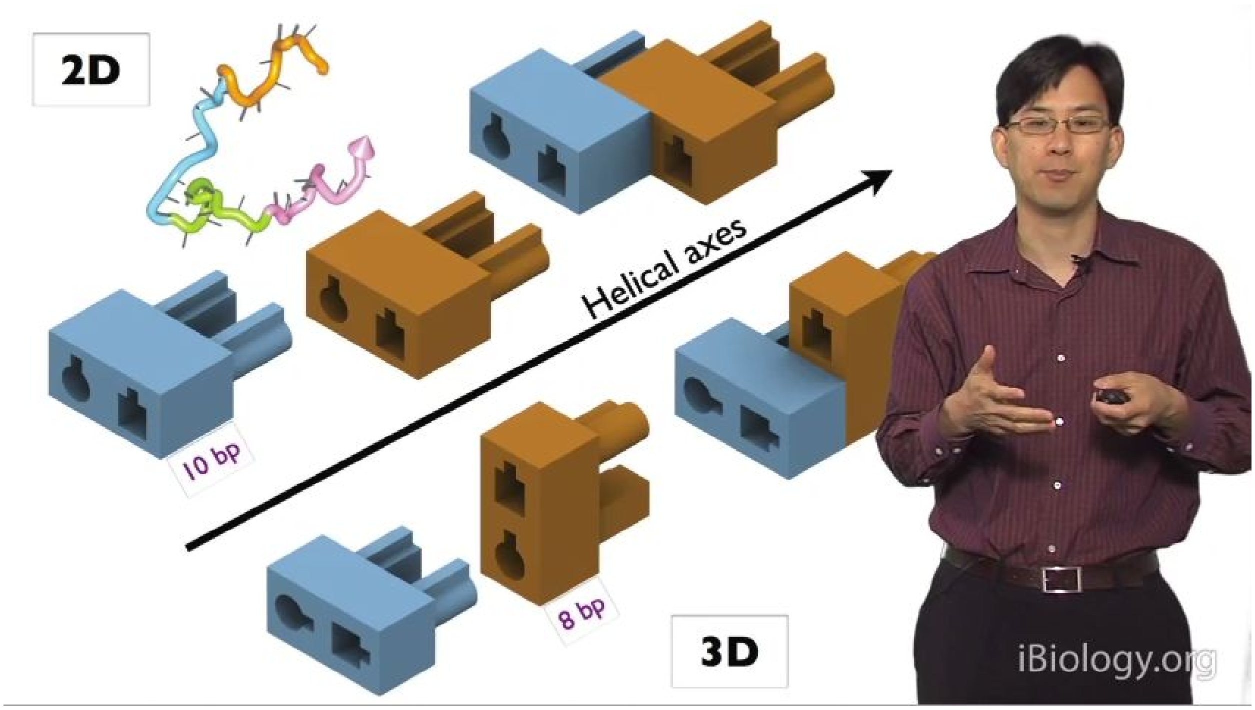
3:40 min
Tiles assemble together based on designed compatibilities between one domain of tile A and another domain from tile B.
Each tile in this tapestry has a unique DNA sequence.
Can achieve the complexity of DNA origami.



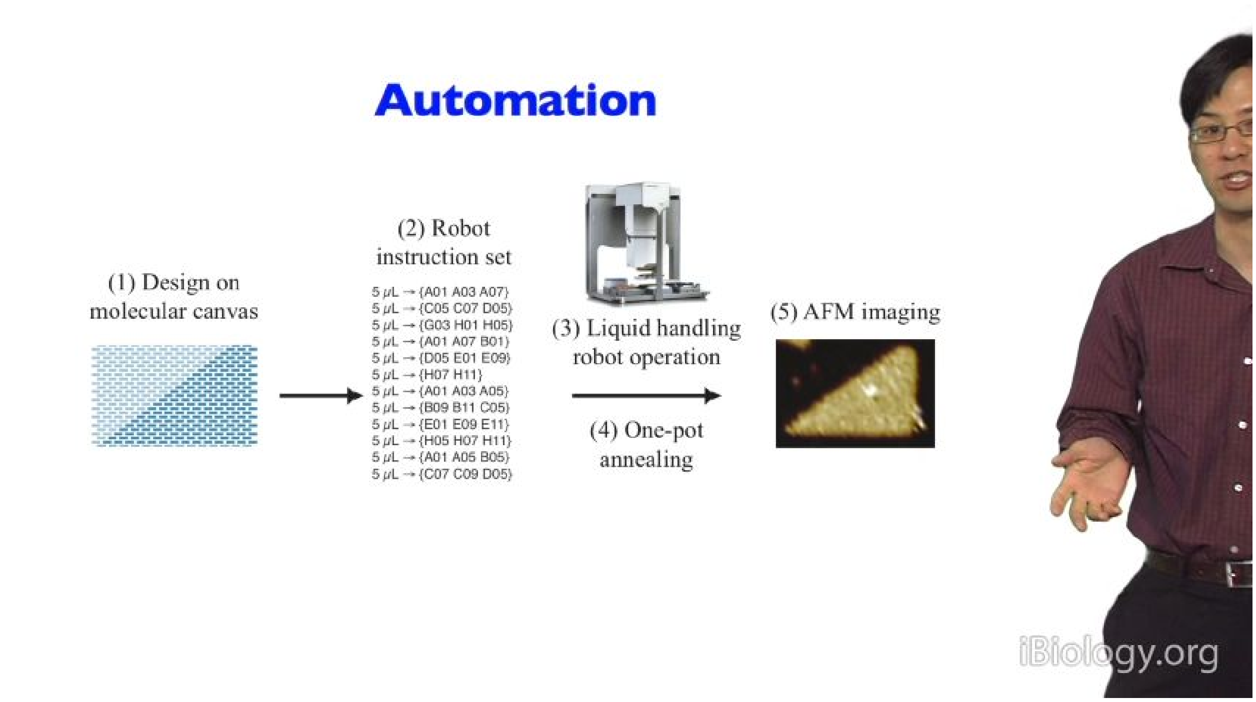
4:46 min
Single strand DNA bricks:
Lego analogy



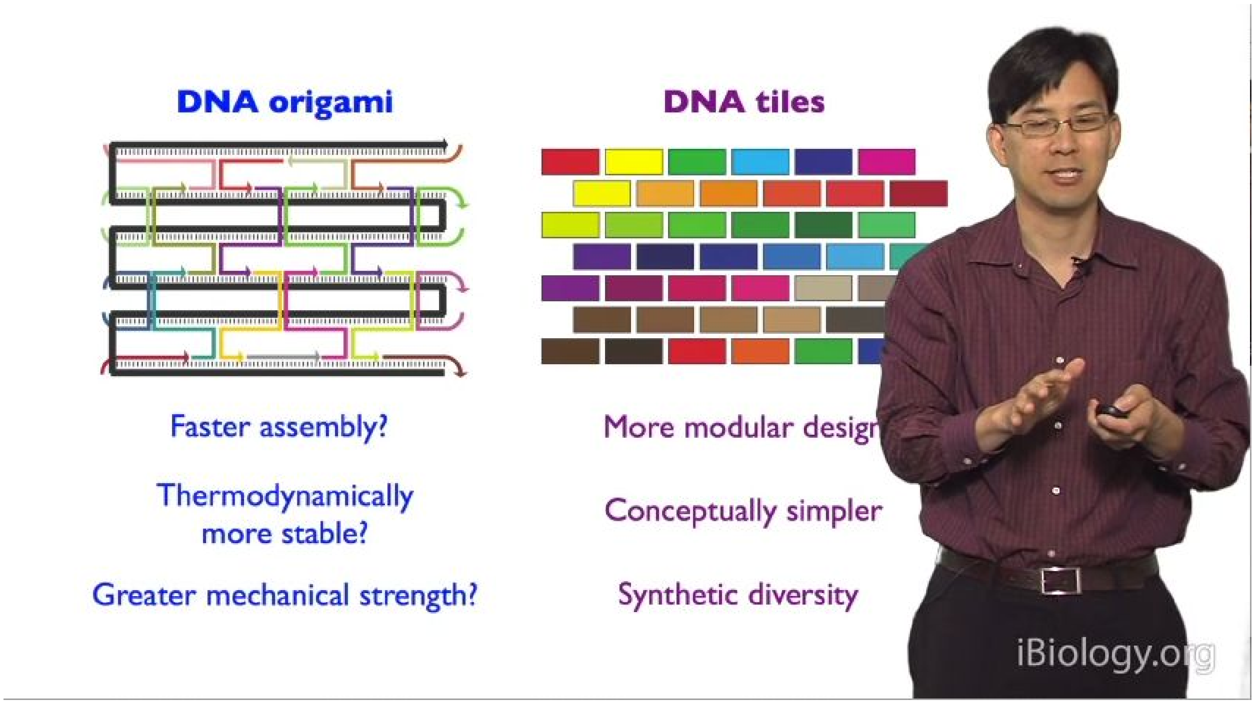
7:30 min
Different shapes can be constructed by re-pipetting different subsets from a master strand collection.



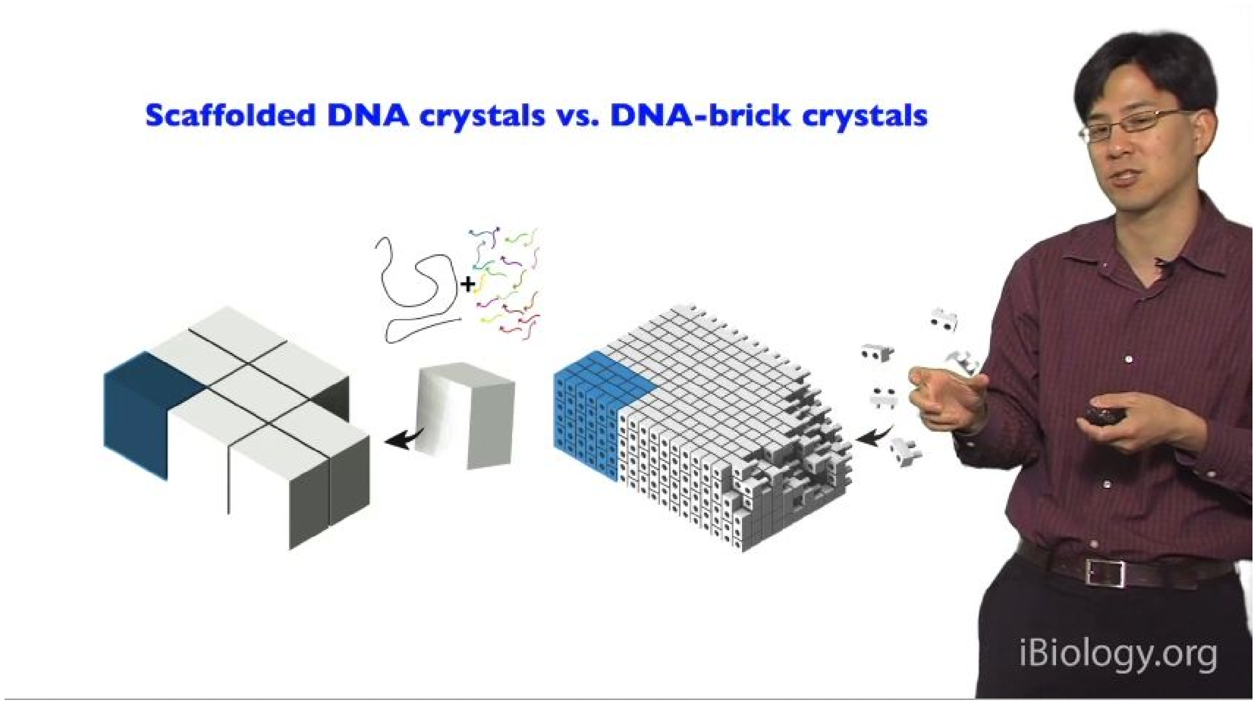
11:38 min
DNA tiles can be brought into three-dimensions by simple design principles. Stereospecific interactions between different length DNA tiles create different 3D shapes



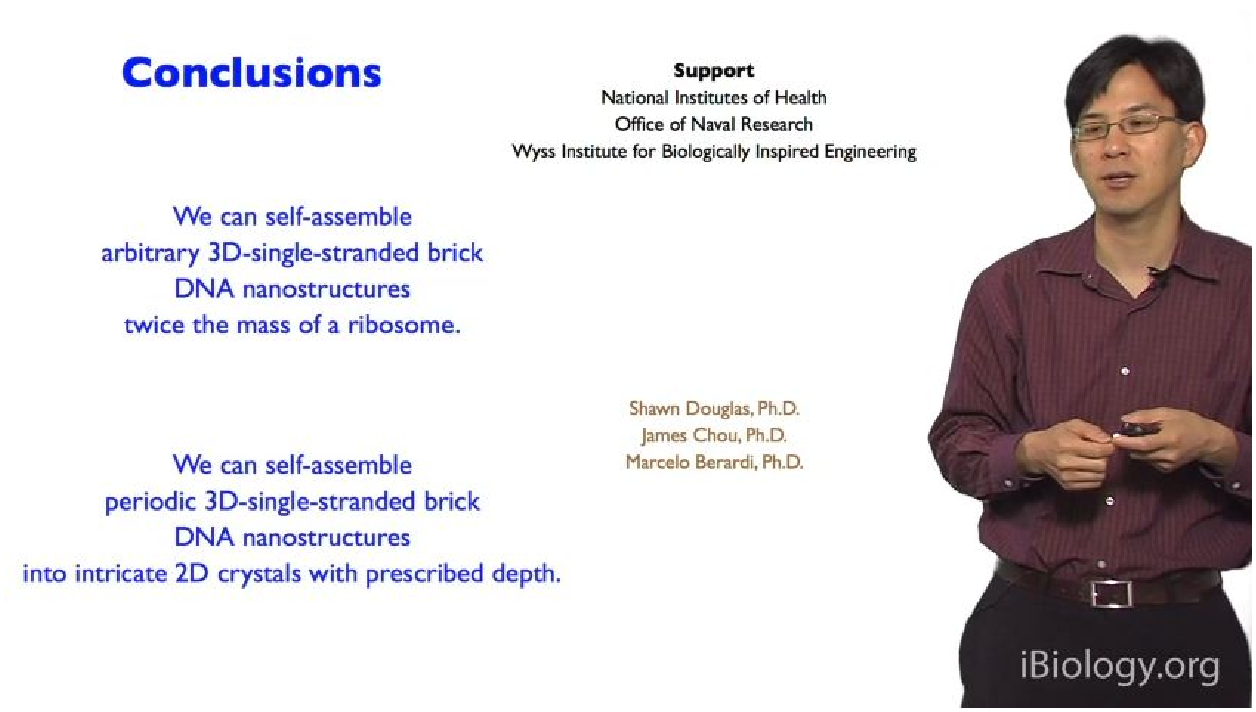
21:29 min
Work flow for automation of DNA tiles



23:08 min
Unique features of DNA origami vs. DNA tiles



32:07 min
DNA brick crystals form more easily than scaffolded DNA origami crystals



32:41 min

3. Review Questions

1. **What are DNA single stranded tiles?**
2. **True/False: DNA single stranded tiles assemble into DNA brick lattices.**
3. **Are DNA origami or DNA bricks more useful for creating periodic structures?**
4. **What are applications of different designs of DNA bricks?**

4. Answers to Review Questions

1. **The 42 nt single stranded tile (SST) motif consists of four domains made of DNA composed of concatenated sticky ends and binds to four neighboring SST during assembly into DNA bricks.**
2. **True**
3. **DNA bricks, because each DNA tile acts as a modular "Lego" piece.**
4. **Creating a unit cell for protein crystallography, creating a virus-like nanotube, patterning nanoparticles onto a DNA molecular canvas.**

5. Discussion Questions

1. **Why does nucleation of DNA tile formation potentially dictate the success of complex structure formation?**
2. **What are reasons that DNA brick crystals form more easily than scaffolded DNA origami crystals?**

6. Answers to Discussion Questions

1. **Shih explains that the DNA bricks are designed so that nucleation of DNA tiles is very slow and the growth is very fast. This design principle acts as a way to control "population growth" so that there isn't an excess of partially seeded DNA tiles formed where the building blocks could potentially run out if nucleation was fast.**

2. For DNA origami crystals, preforming the unit cells (i.e. the long scaffold strand) could make it hard to have reversible assembly. Thermodynamically, molecular contacts formed in the preformed unit cell are more favorable than disassembly so reversibility is rare.

For DNA brick crystals, the three-dimensional growth is occurring as individual tiles add onto the growing structure. Because these tiles are so short, it is more thermodynamically neutral for the tiles to assemble/disassemble so that reversibility is easier.

7. Paper for Journal Club

Derr et al. Tug-of-War in Motor Protein Ensembles Revealed with a Programmable DNA Origami Scaffold (2012) Science, 338: 662-665.

Key words: dynein, kinesin, processivity, DNA origami, chassis, synthetic cargo

1. **Describe how Derr et al. used DNA origami to design a synthetic cargo that could be attached selectively to kinesin or dynein motor proteins.**
2. **How do the motile properties of dynein and kinesin cargo transport differ according to the single molecule chassis-motor assays (see Figure 2)?**
3. **How does the mixed-motor photocleavable chassis experiments support a tug-of-war model for opposite-polarity motor proteins (see Figure 4)?**
4. **Are you convinced that this engineered chassis-motor protein complex accurately recapitulates motor-protein directed microtubule transport?**