



**SUPERCOL**

# DNA Origami

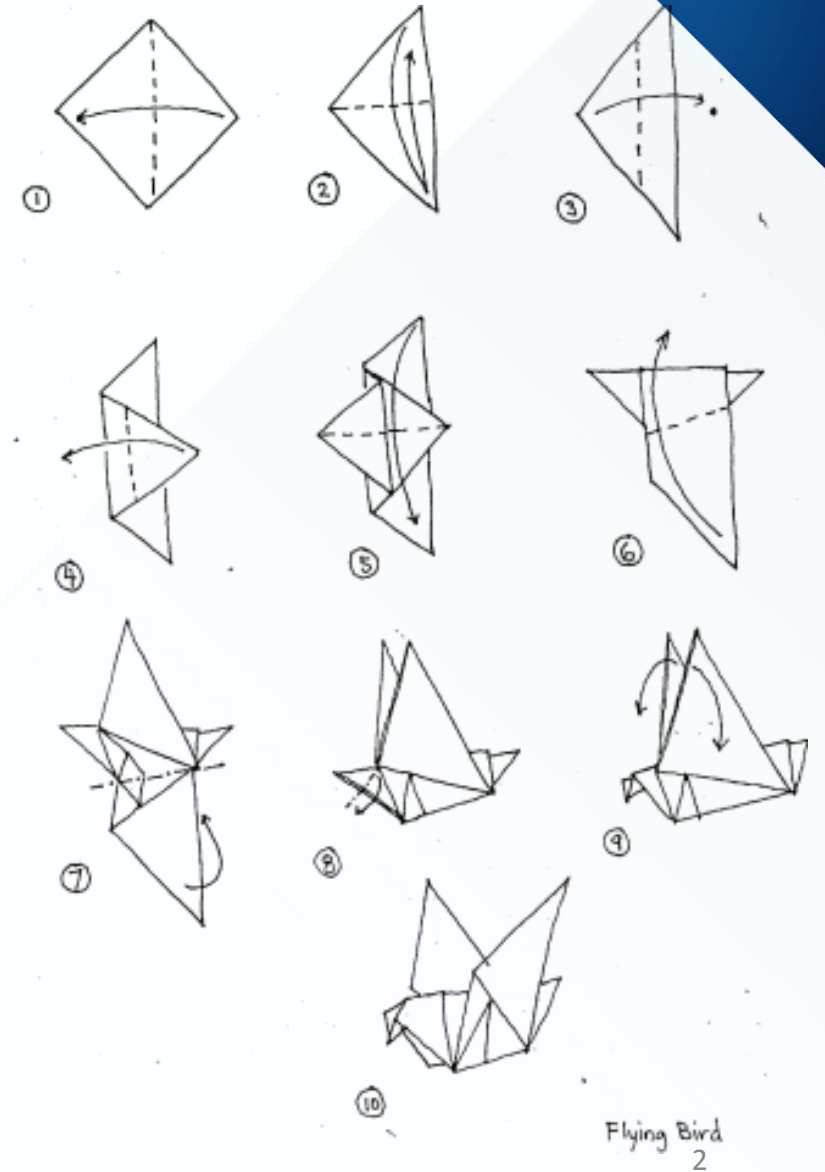
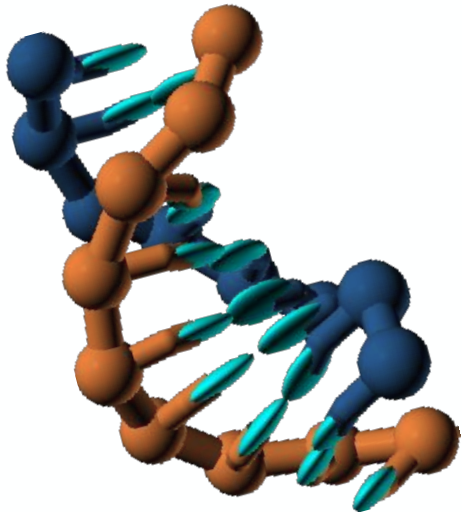
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PhD Seminars, Roma, 09 / 11 / 2022



# Overview

- Self-Assembly
- DNA Introduction
- Origami?
- Summary
- quantitative single-molecule counting?

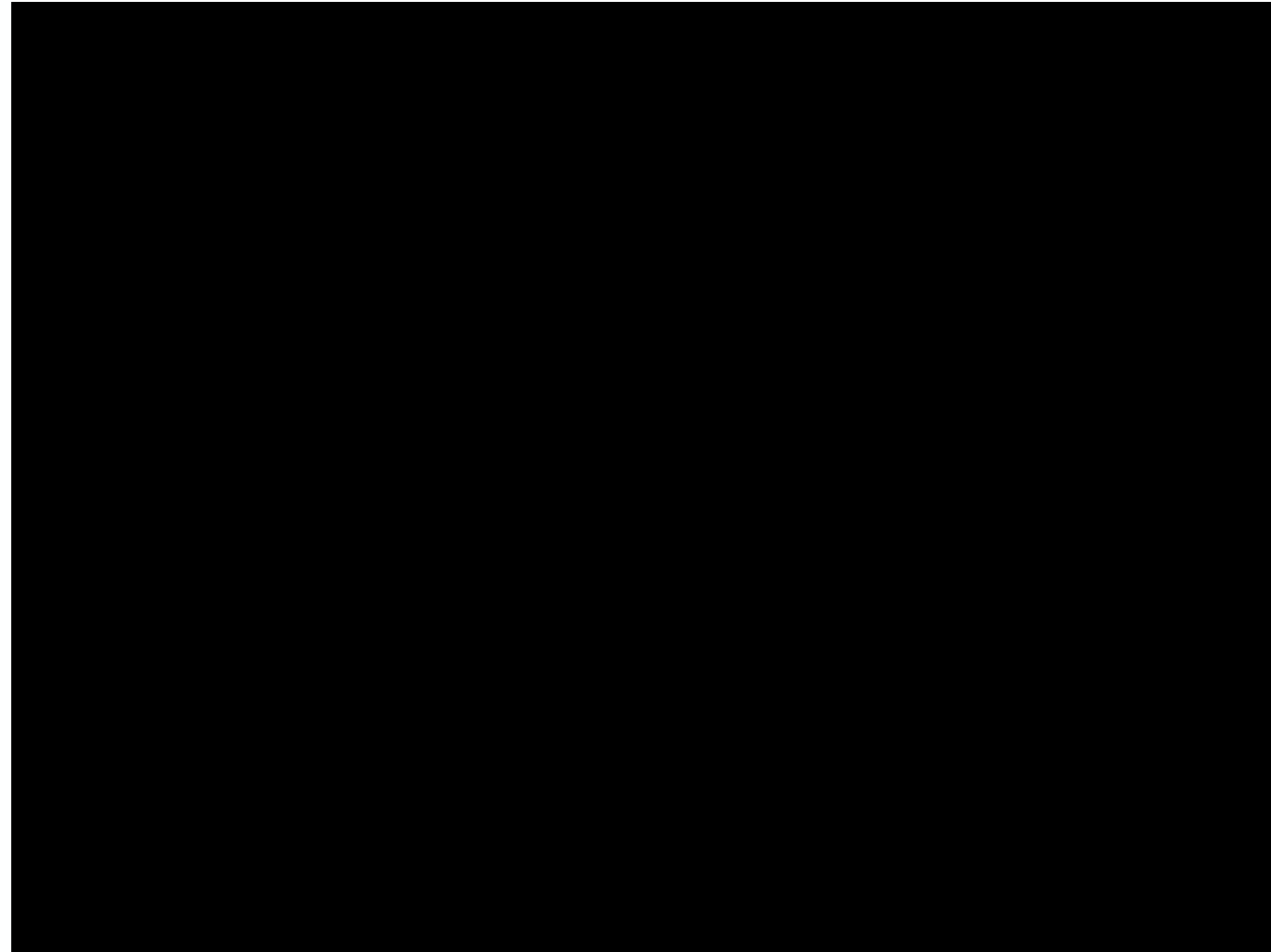
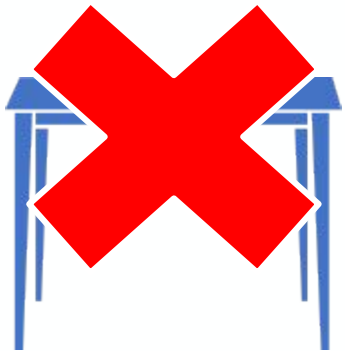




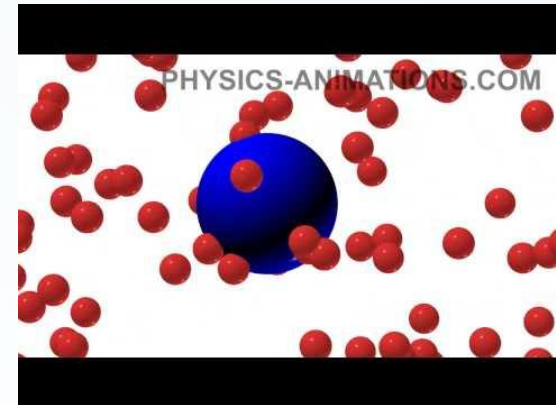
# Self-Assembly



## Secondary Structures

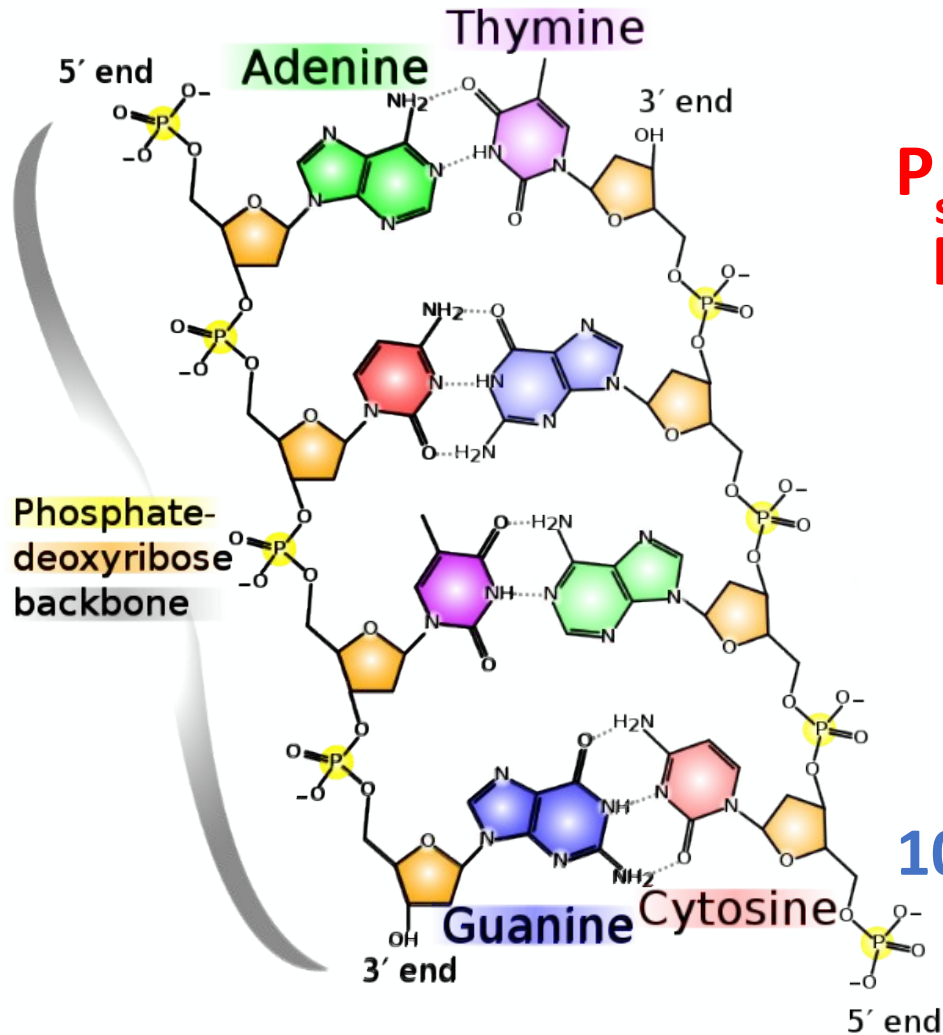


## Brownian motion





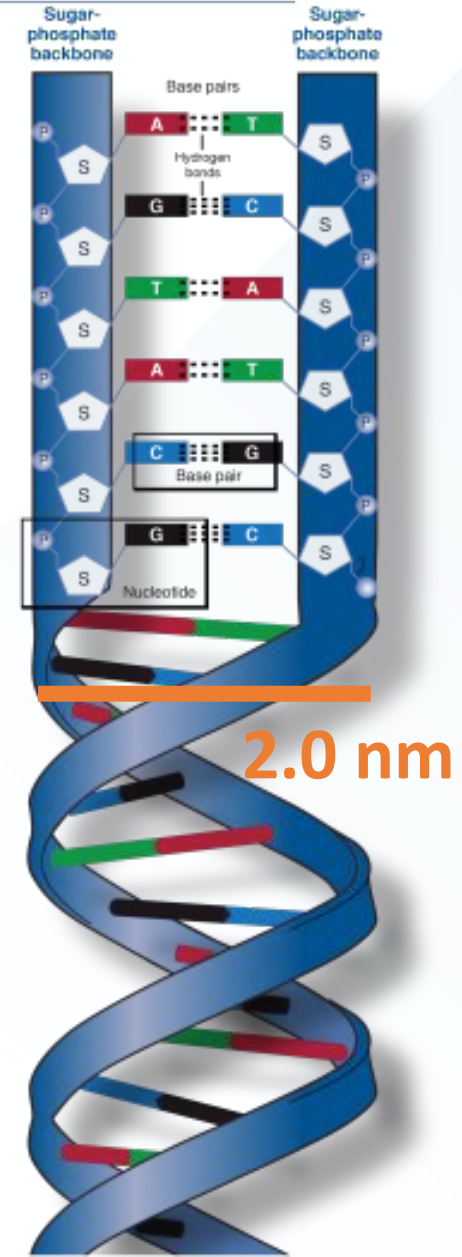
# DNA Introduction



B-DNA

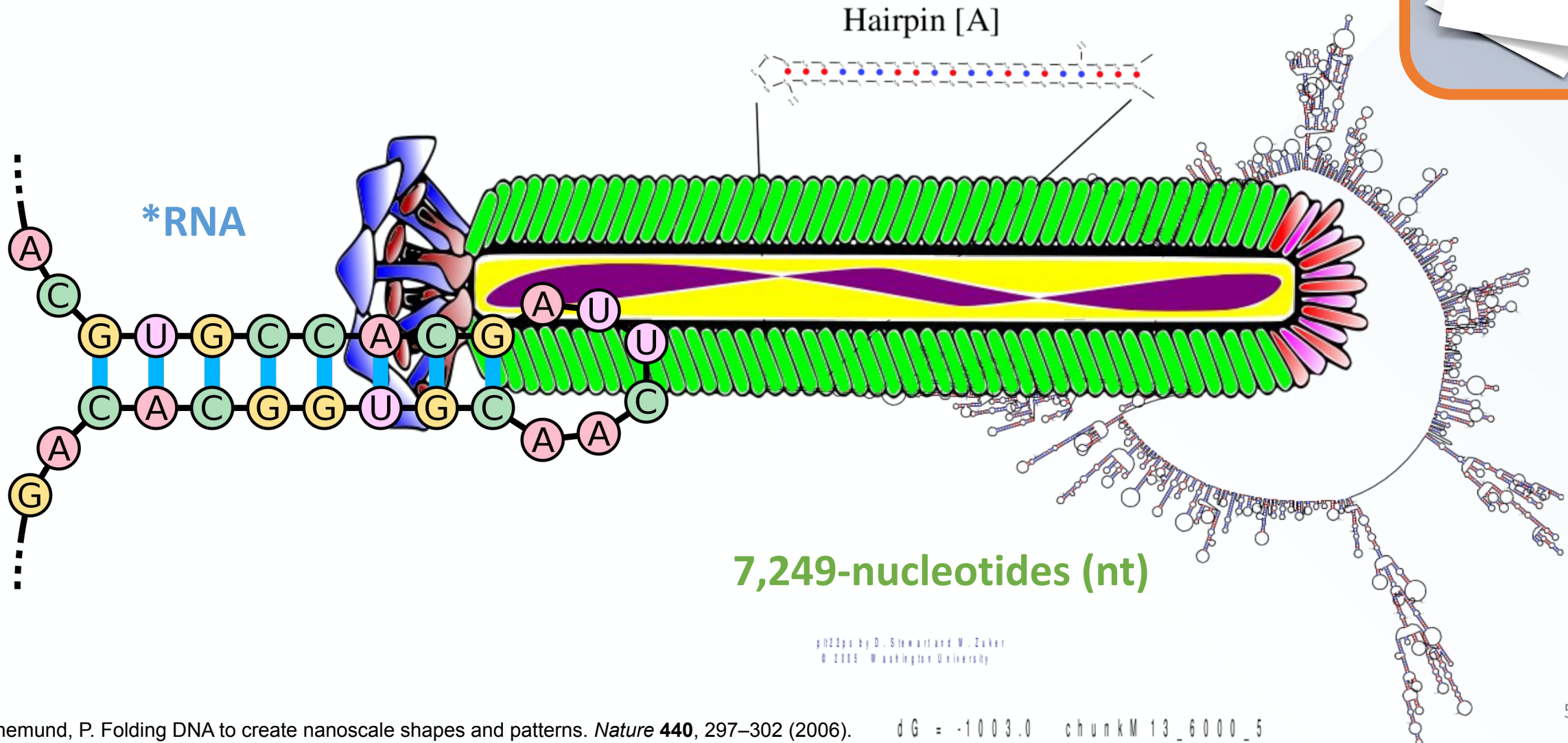
$P_{ssDNA} \sim 2 \text{ nm}$   
 $P_{dsDNA} \sim 50 \text{ nm}$

3.4 nm/turn  
 10.5 bases/turn



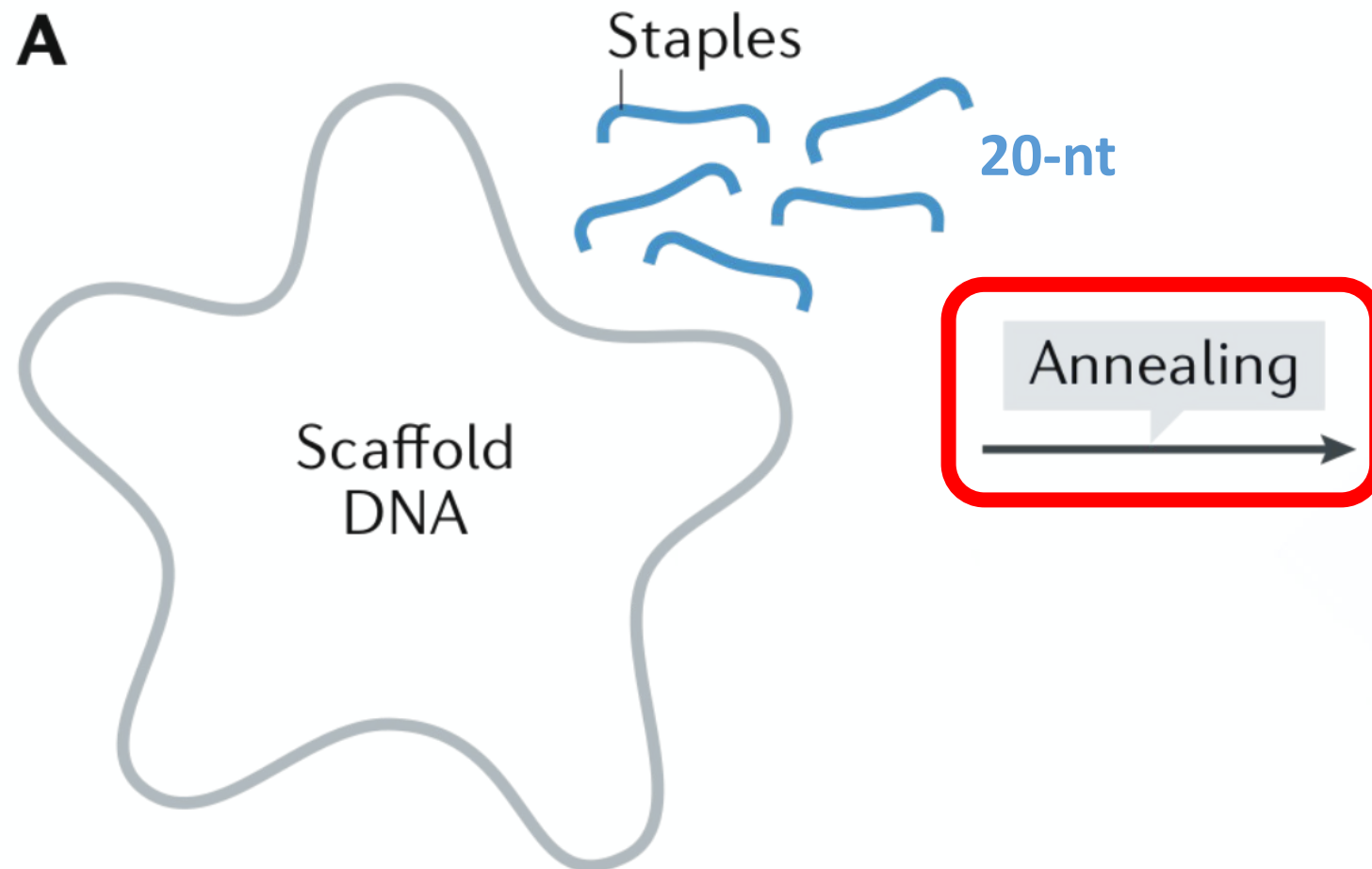


# Scaffold Strand - M13mp18 Virus

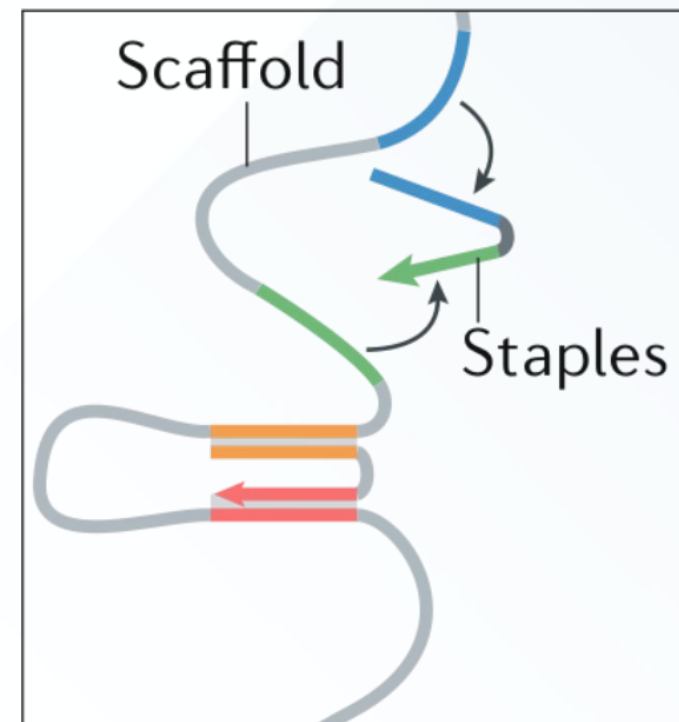


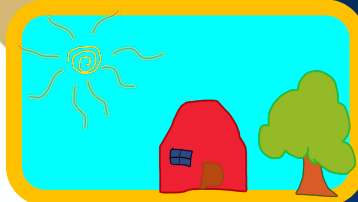
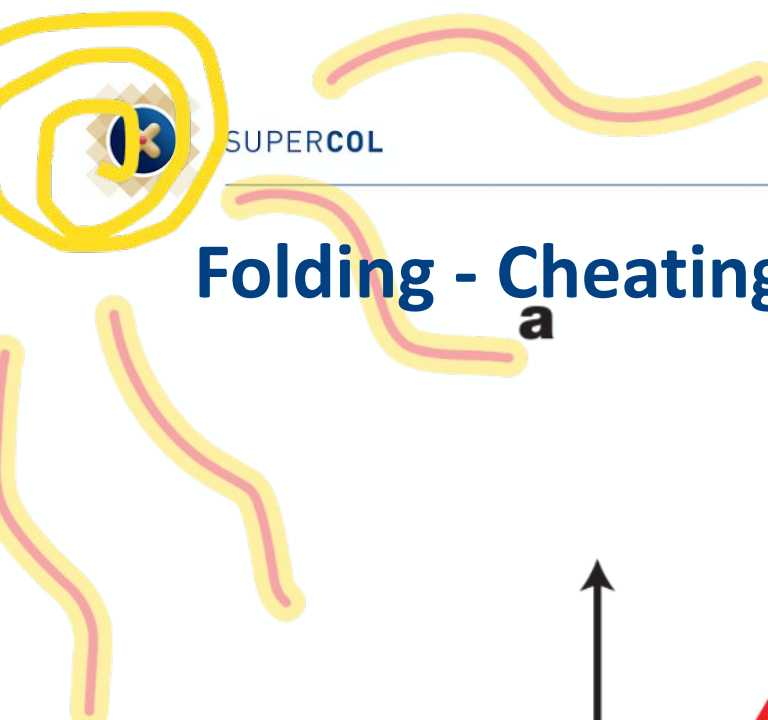
# Folding - Cheating ?????!?!!

**A**

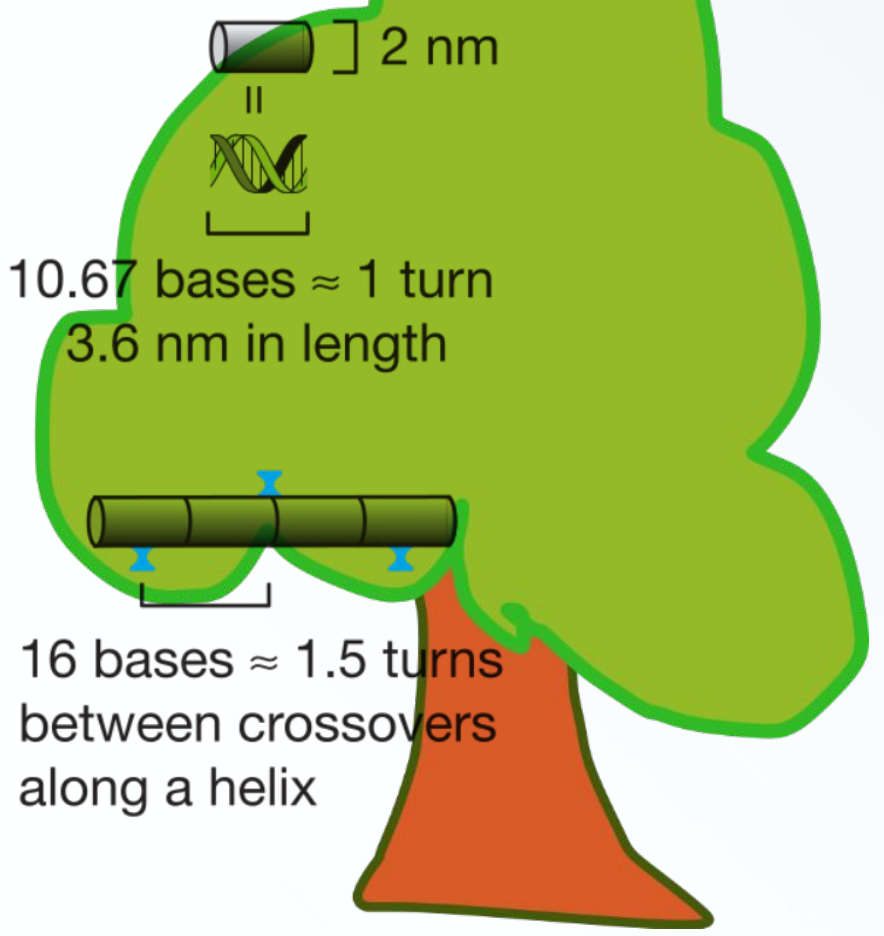
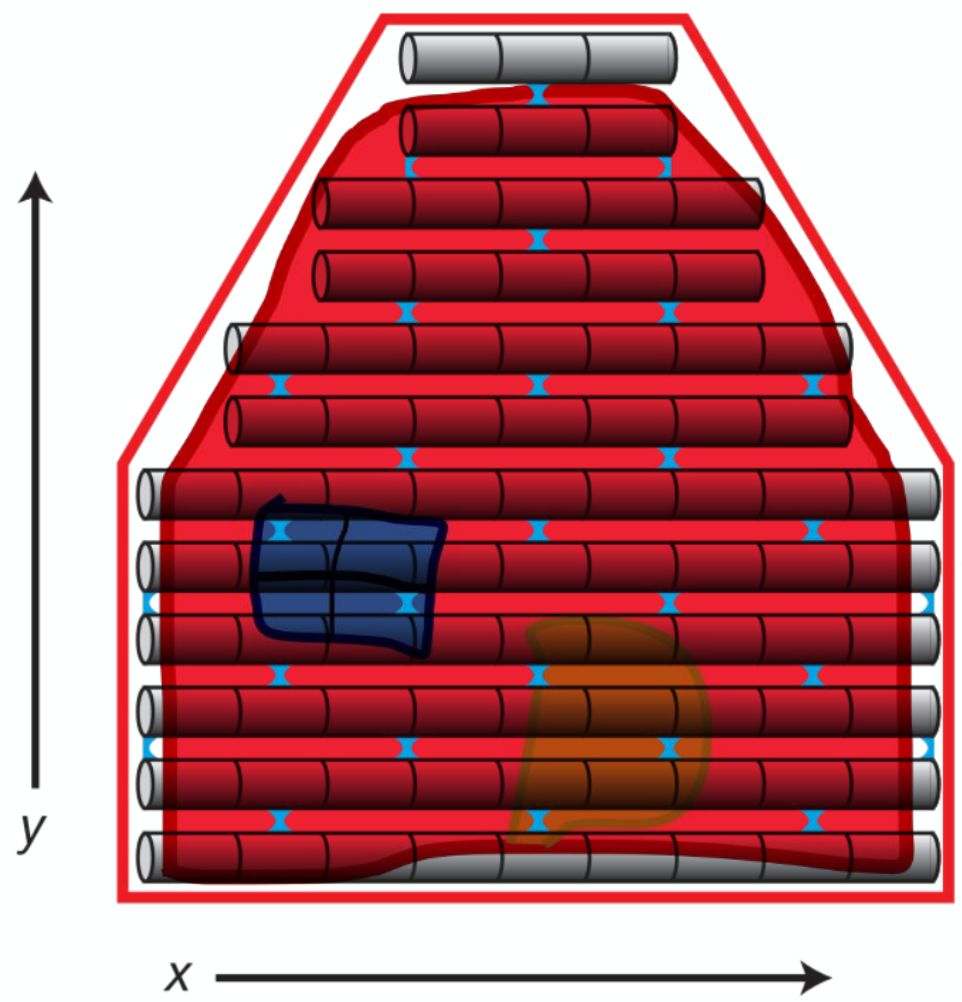


Folding





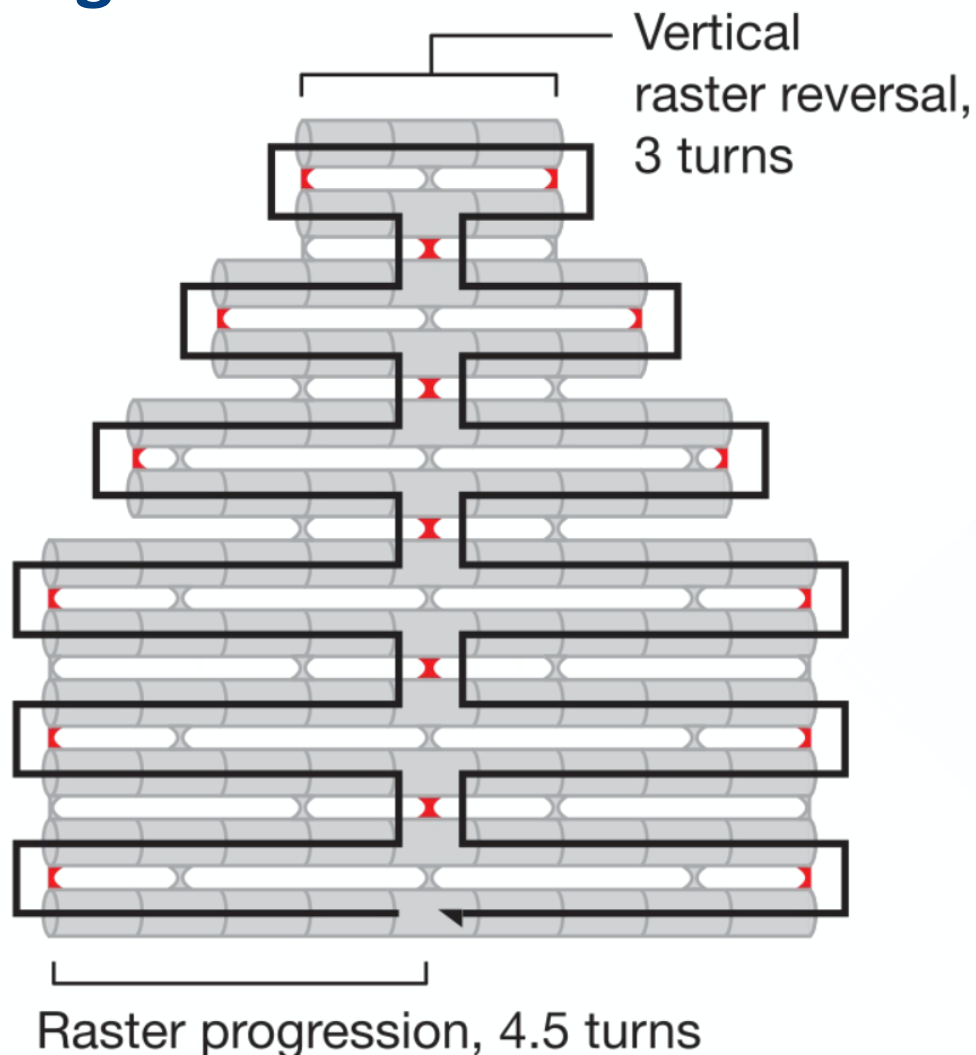
# Folding - Cheating ?????!?! mmm...





# Folding - Cheating ?????!?! not so far...

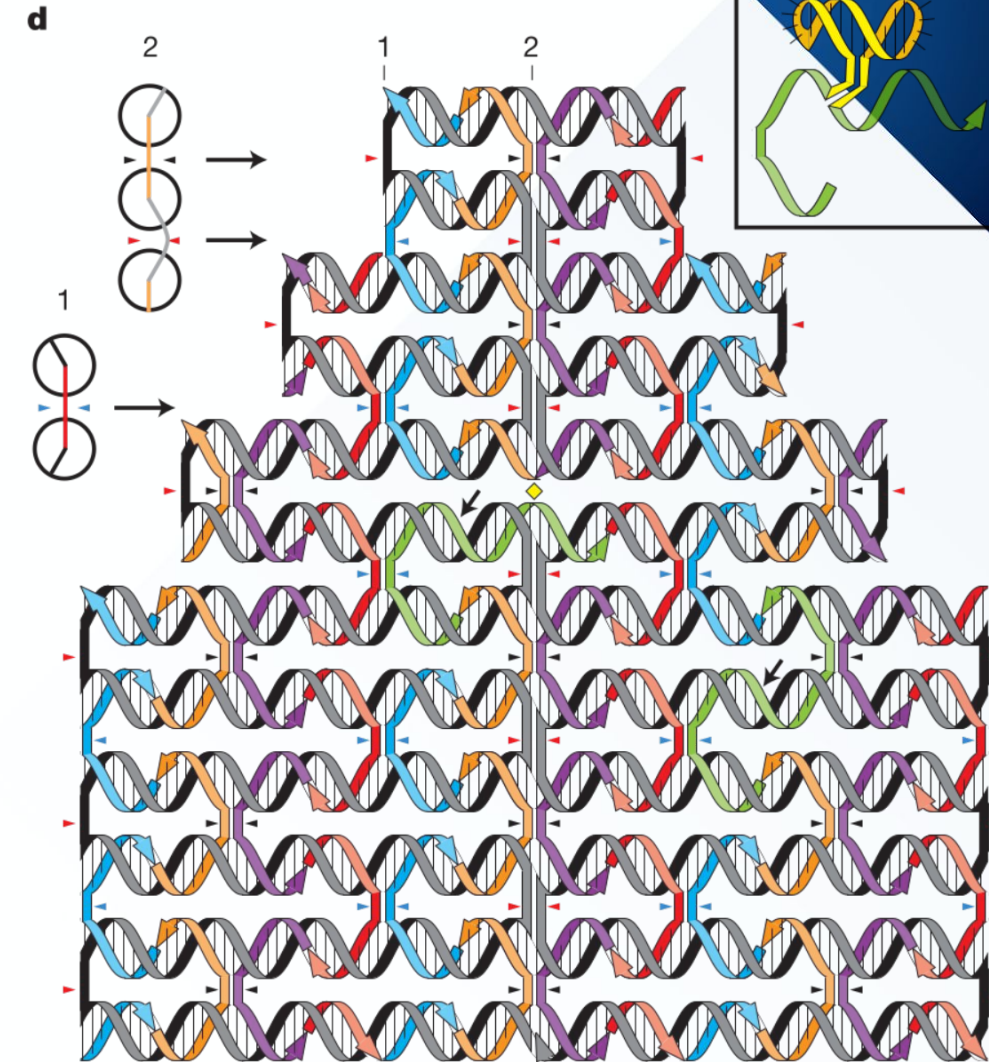
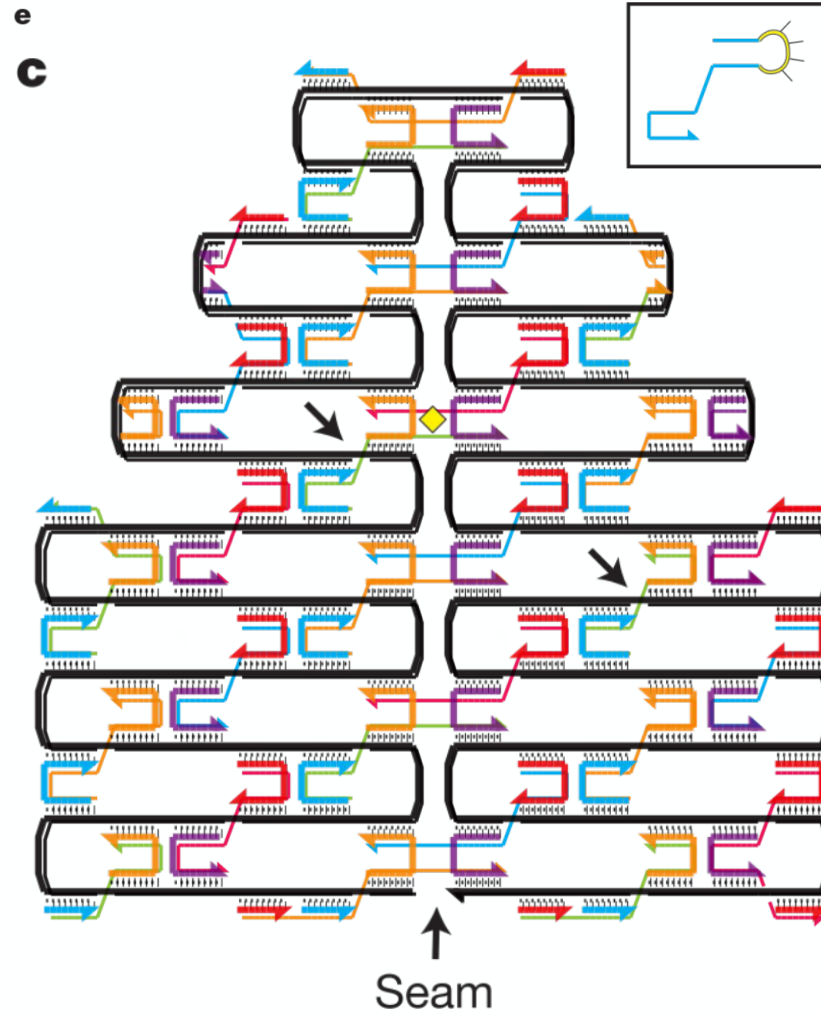
**b**



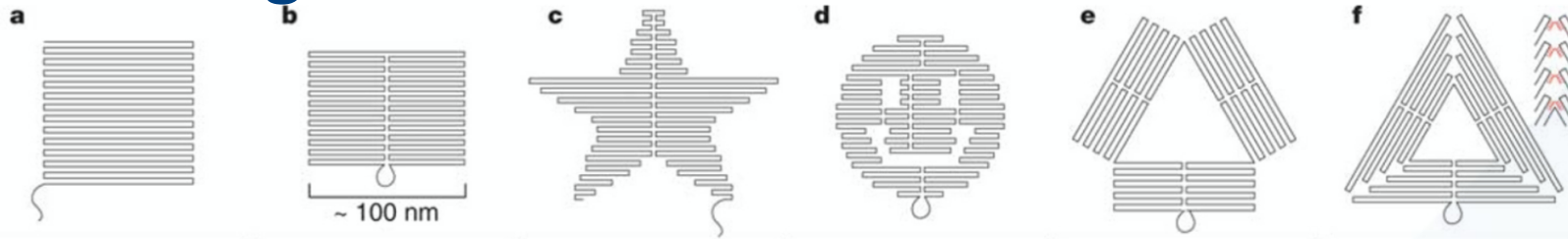




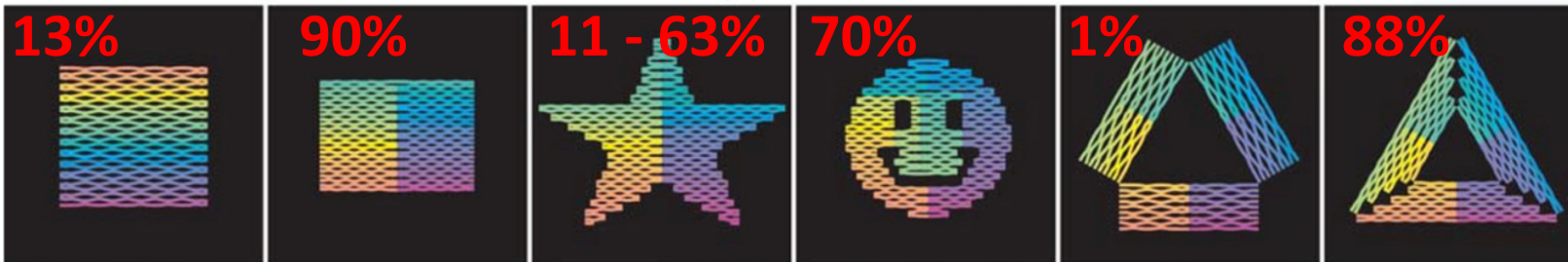
# Folding - Cheating ?????!?! ok...



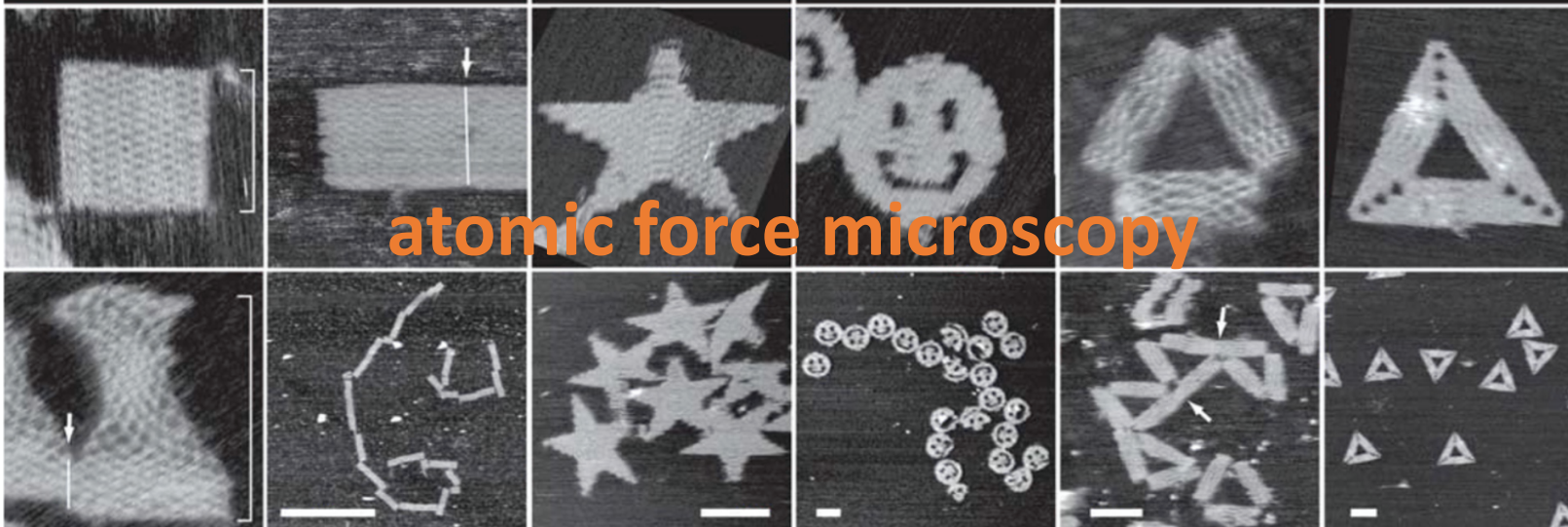
# Folding - Cheating ?????!?! worth it



yield



1 to 100  
scaffold-to-staples  
growth > nucleation



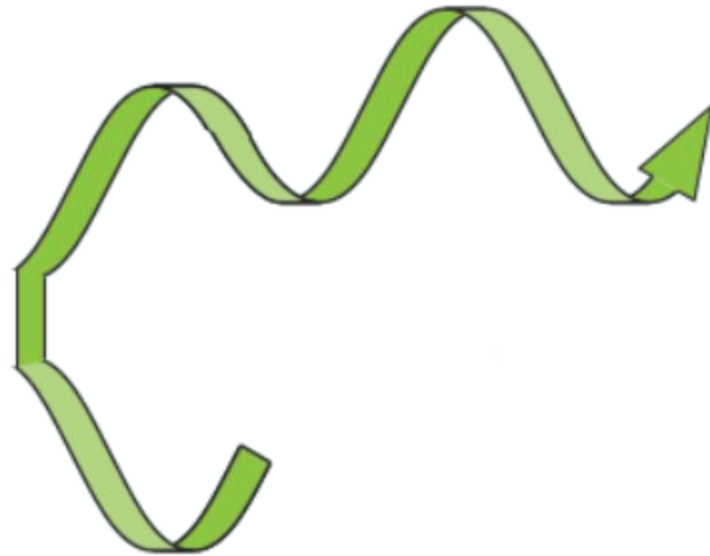
95 °C to 20 °C  
in 2h

scale bar  
100 nm



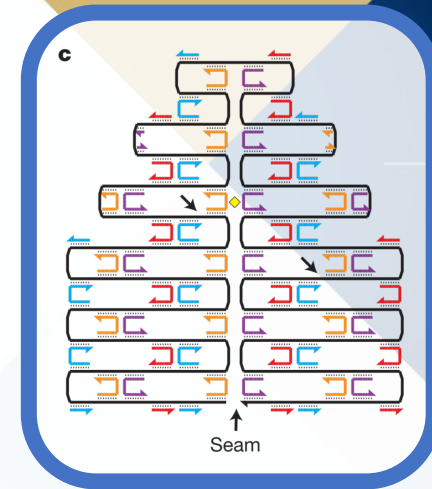
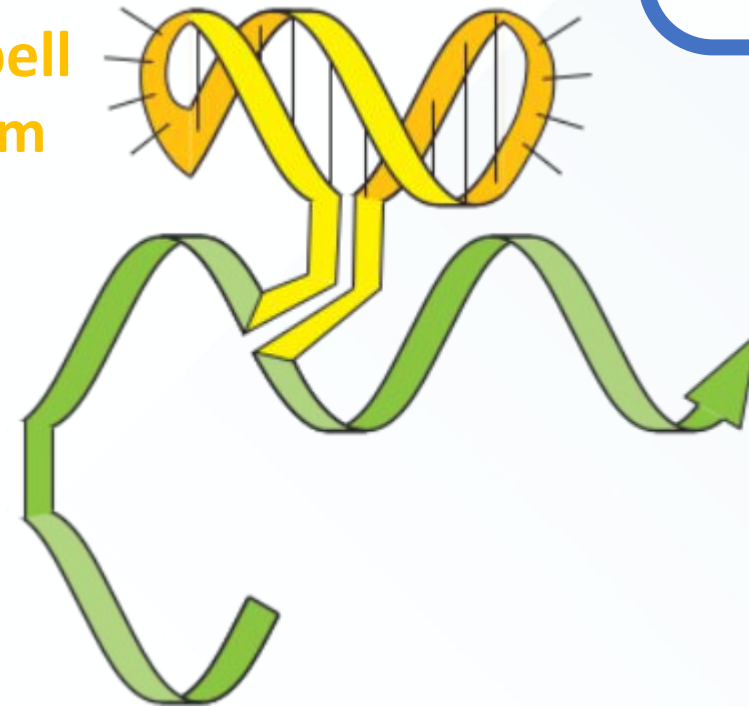
# Patterning

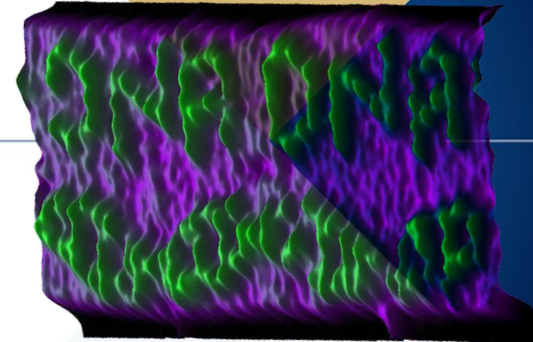
0



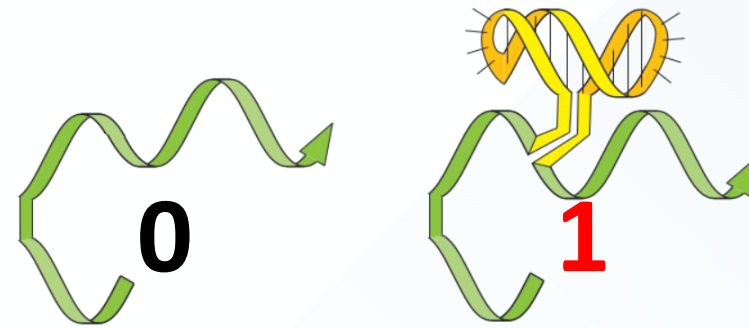
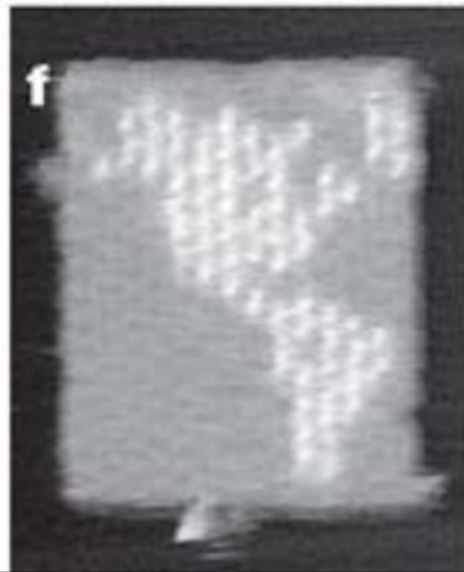
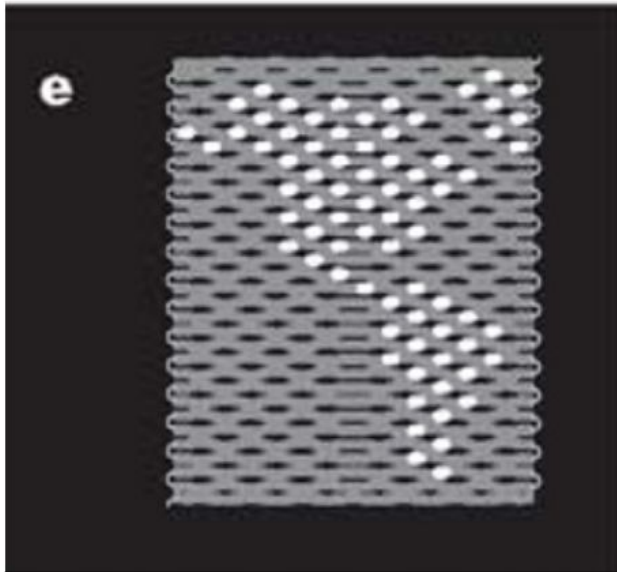
1

Dumbbell  
1.5 nm

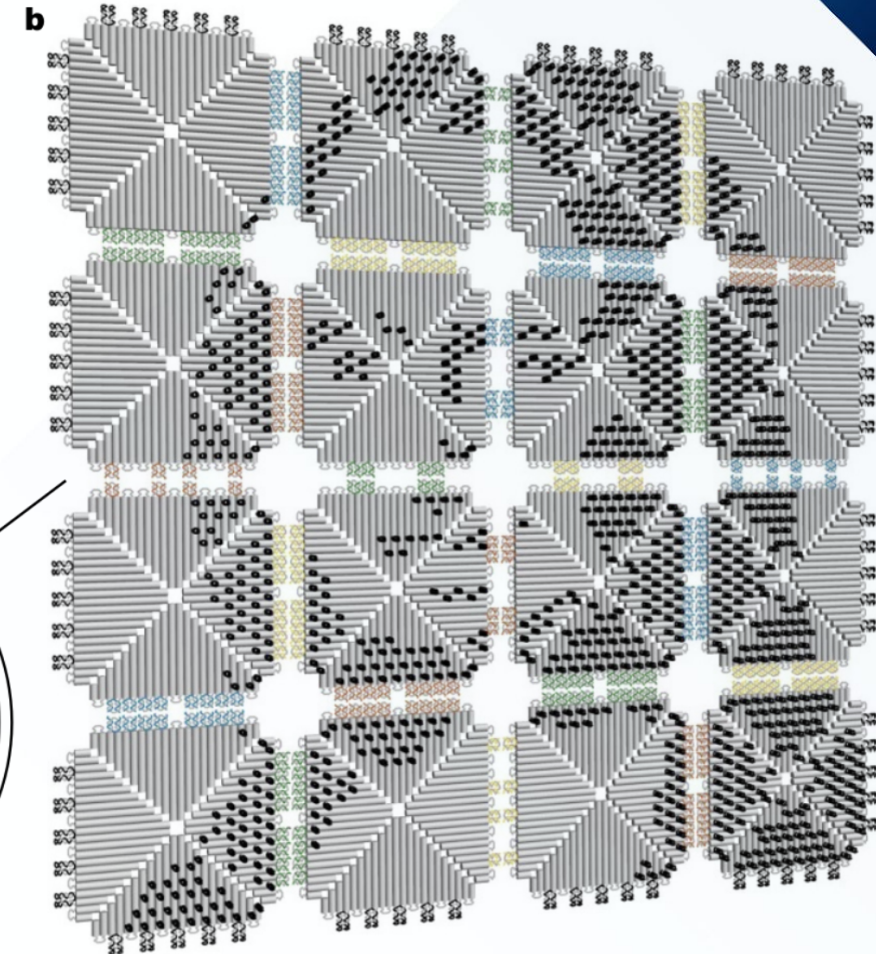
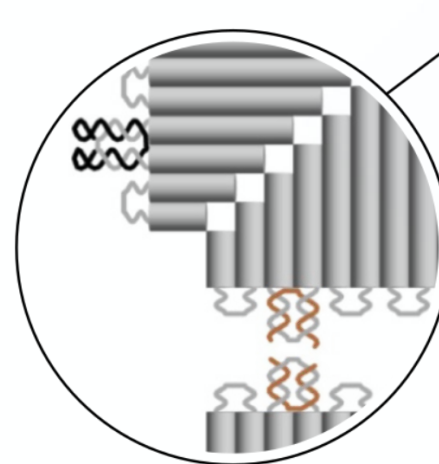
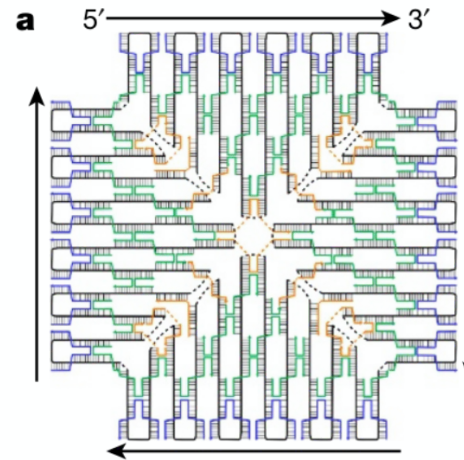
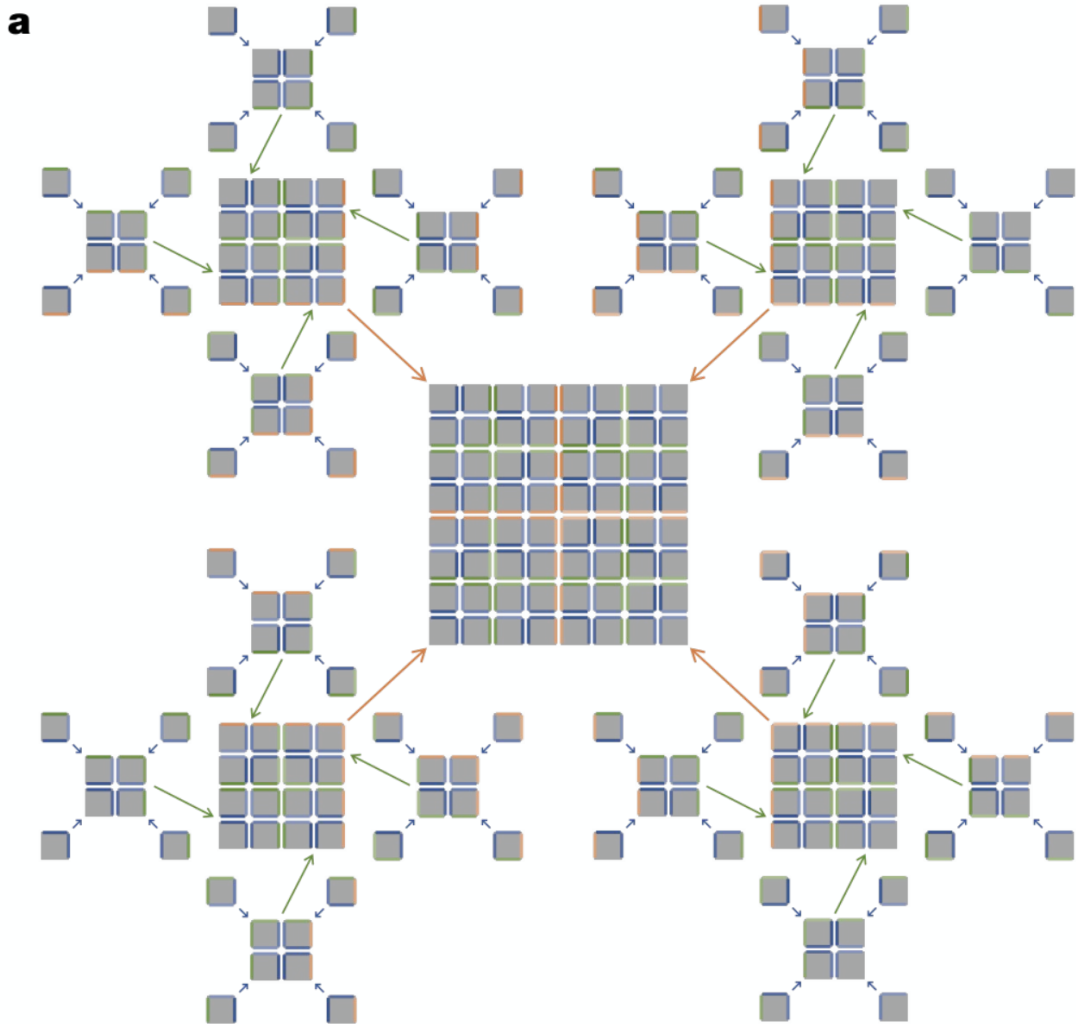




# Patterning

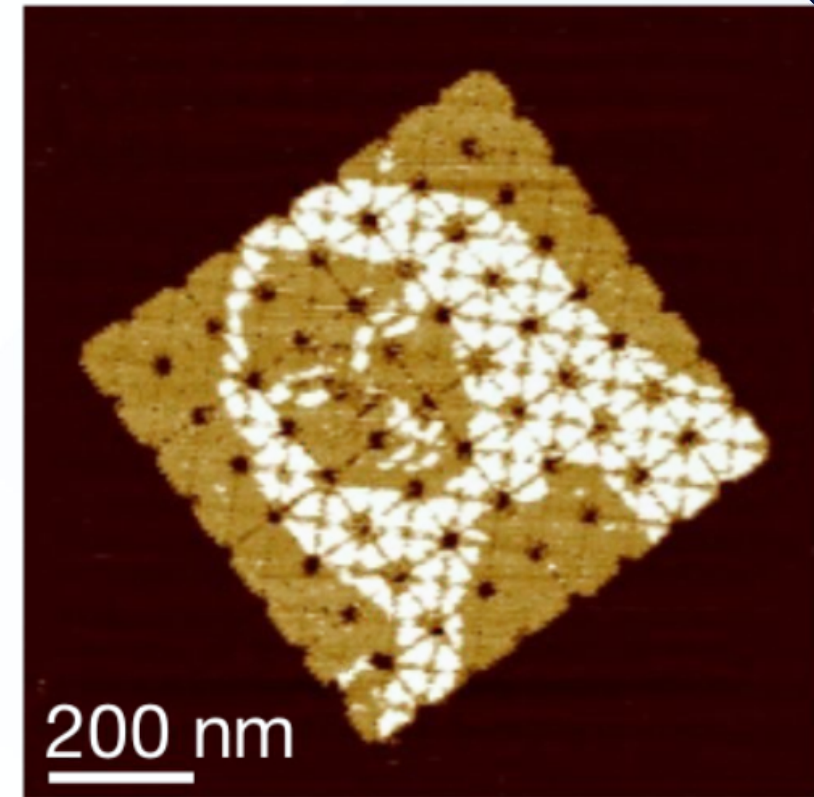
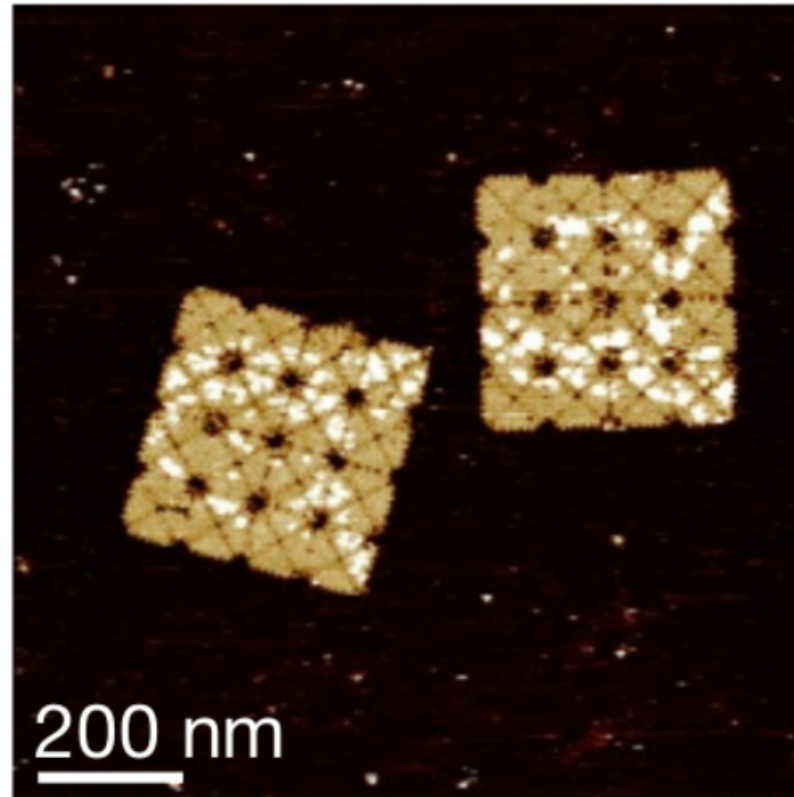
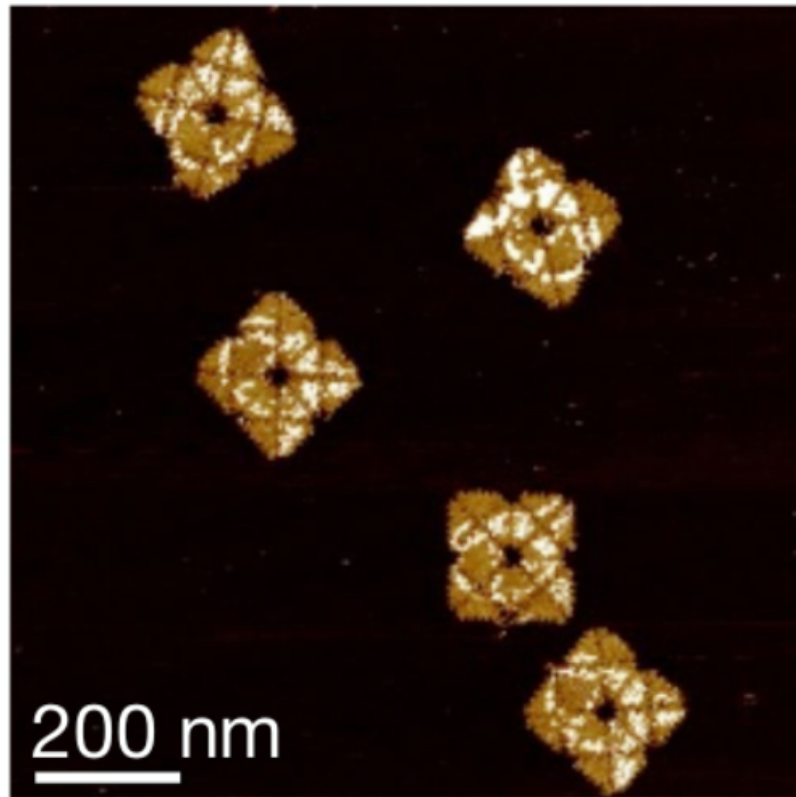


# Assembly of Assemblies - Tiles

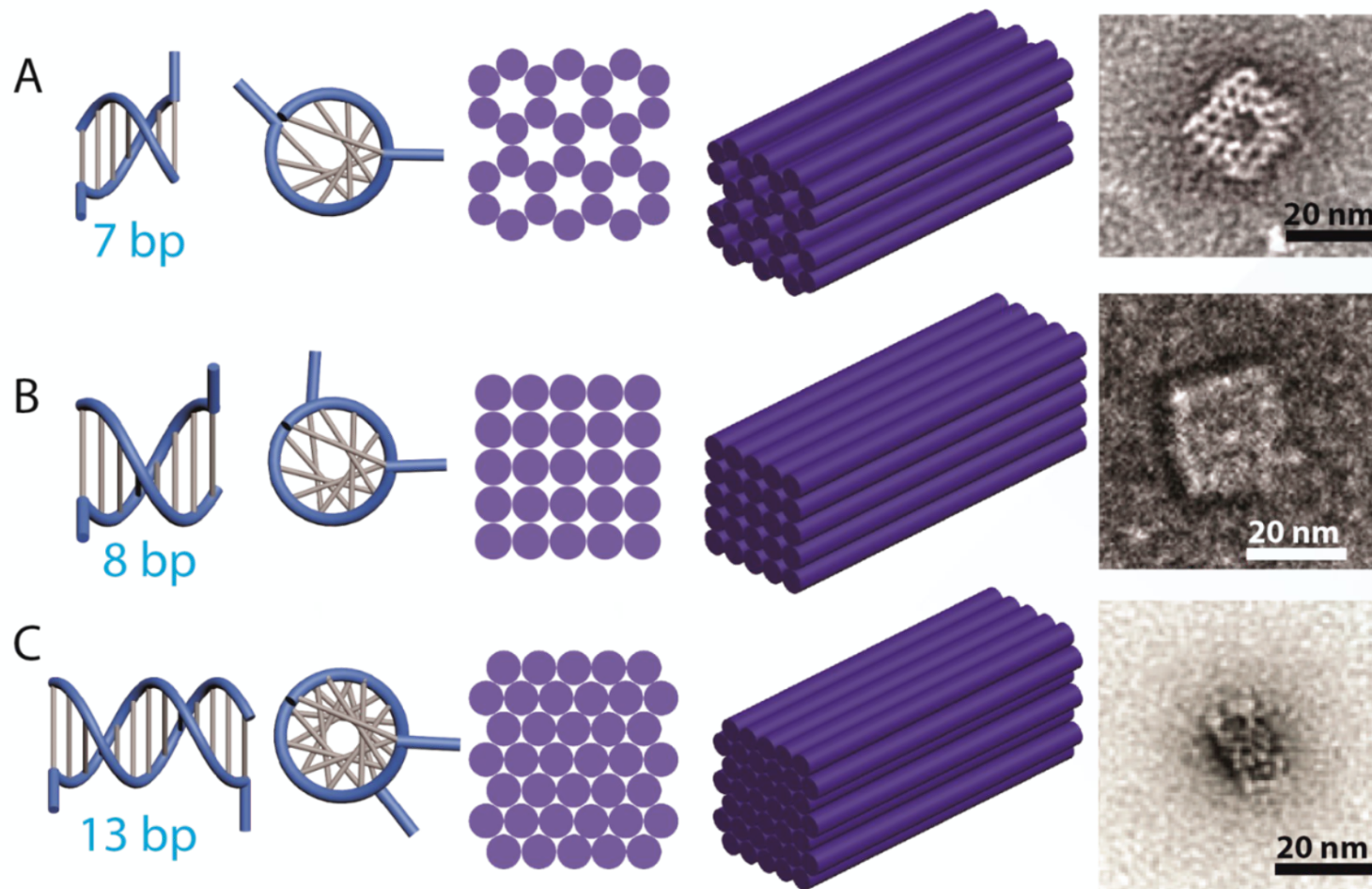




## Assembly of Assemblies - Tiles



# 3D Origami



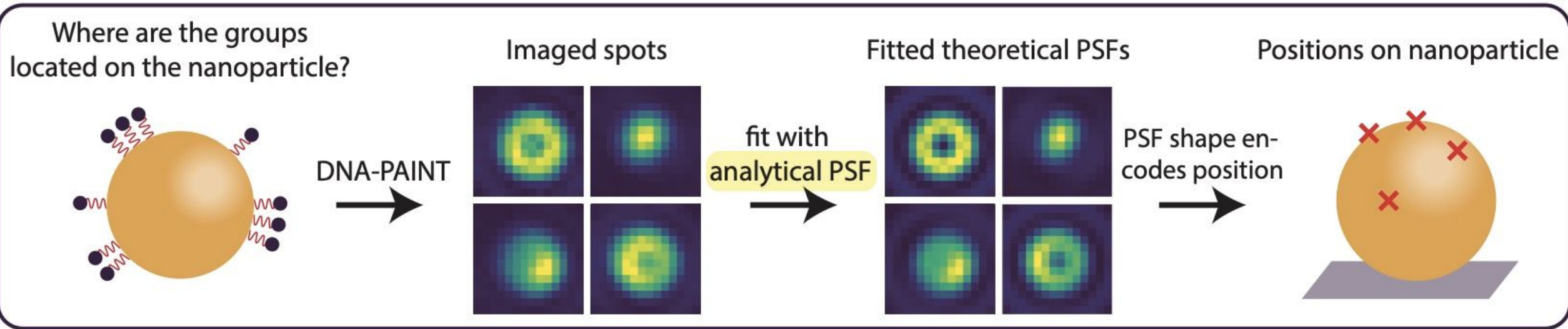
# Fluorophore Orientation

a

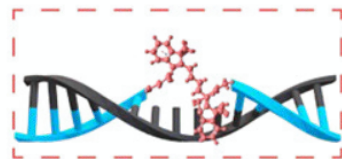
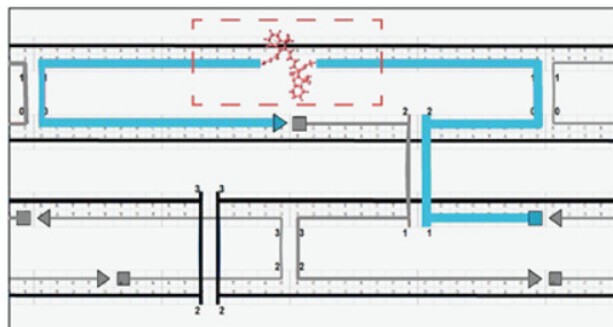
ssDNA for DNA-PAINT

DNA origami

$90^\circ$



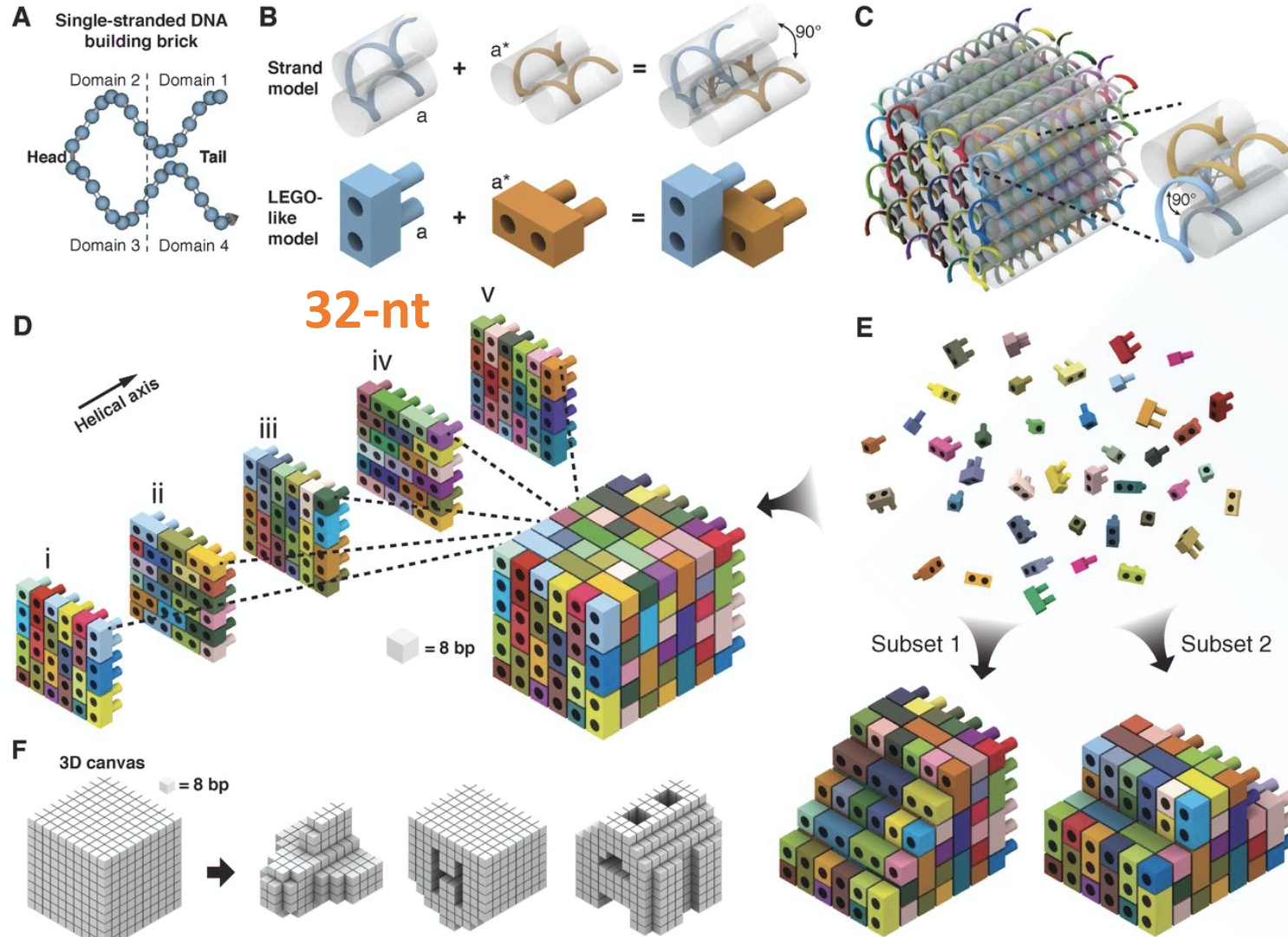
b







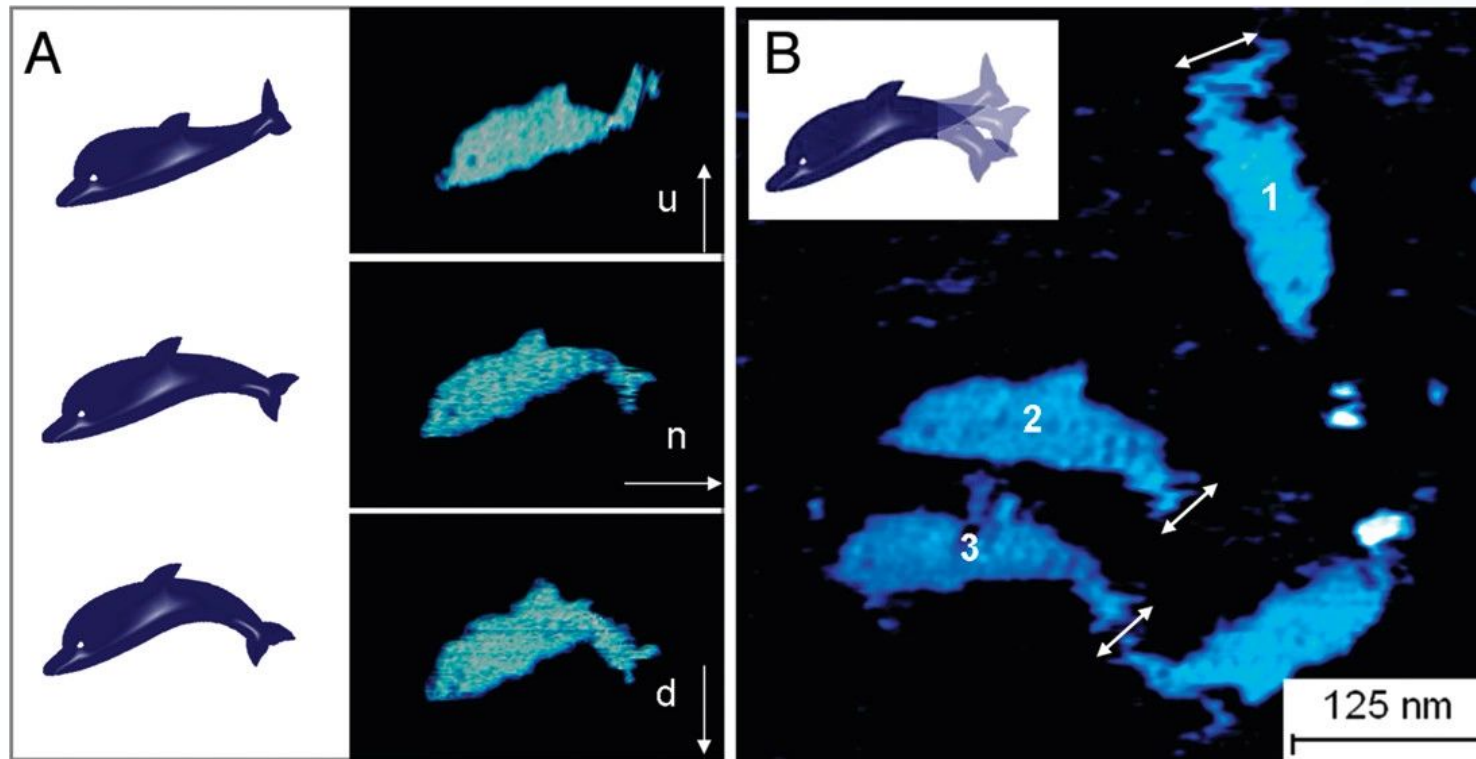
# Origami Alternatives





# Summary

- Selective base pairing hybridizes ssDNA into a double stranded helix (A-T, C-G)
- Exciting nanometer building material





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# Thank you

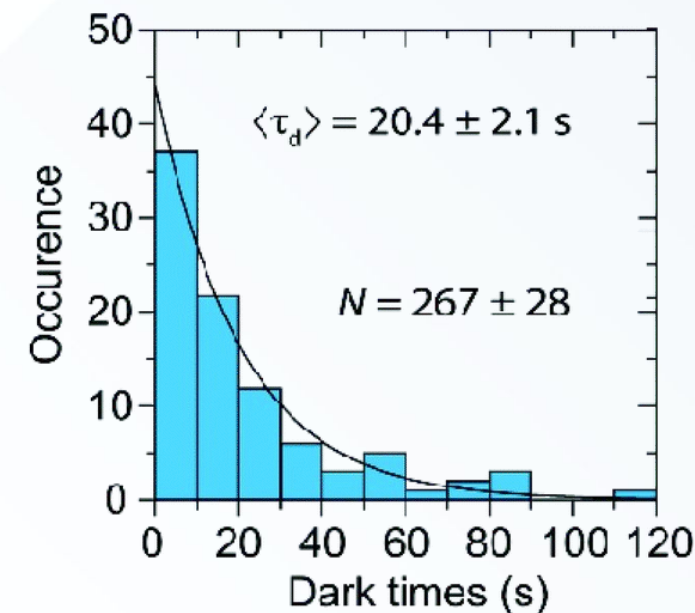
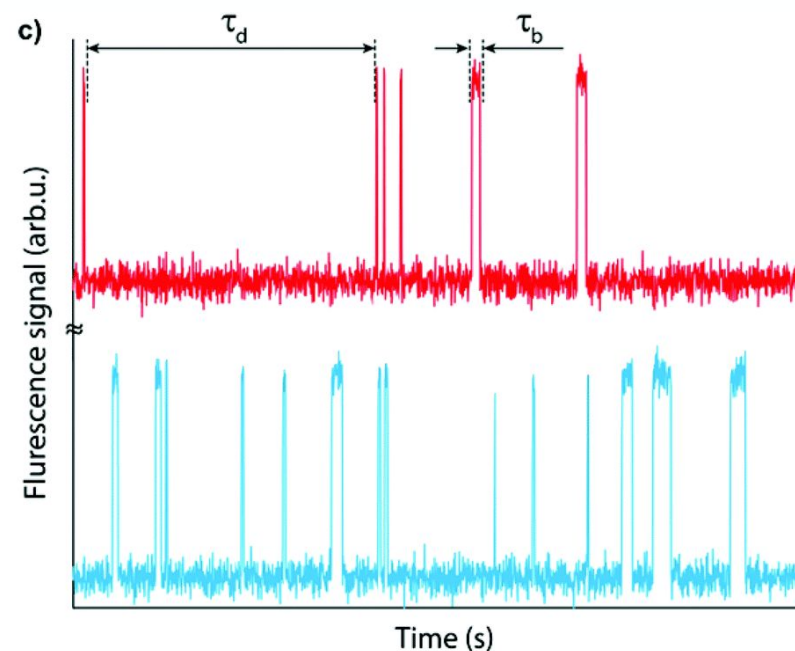
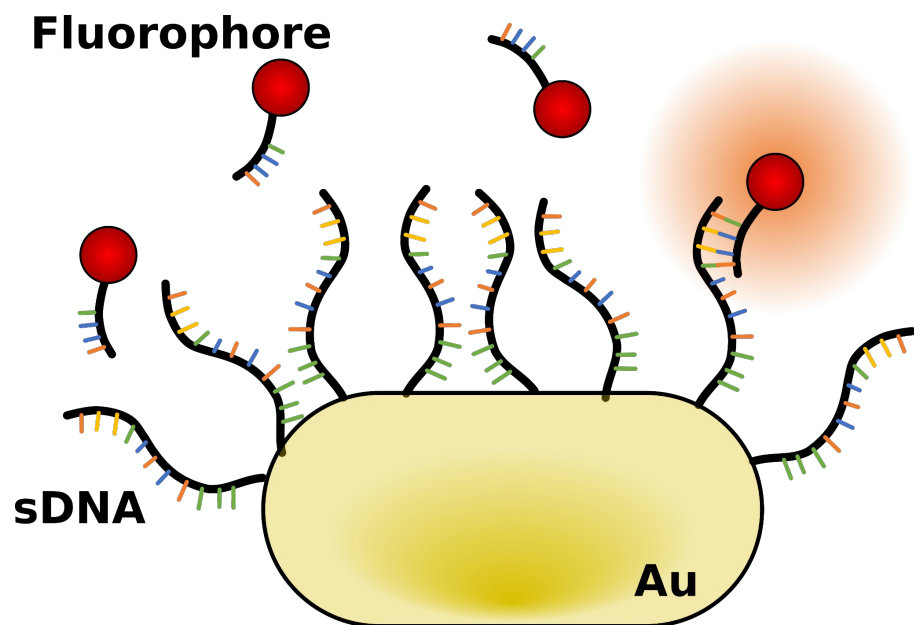
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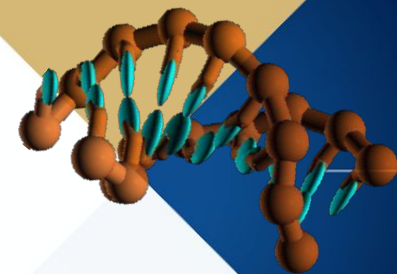
The SuperCol project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 860914



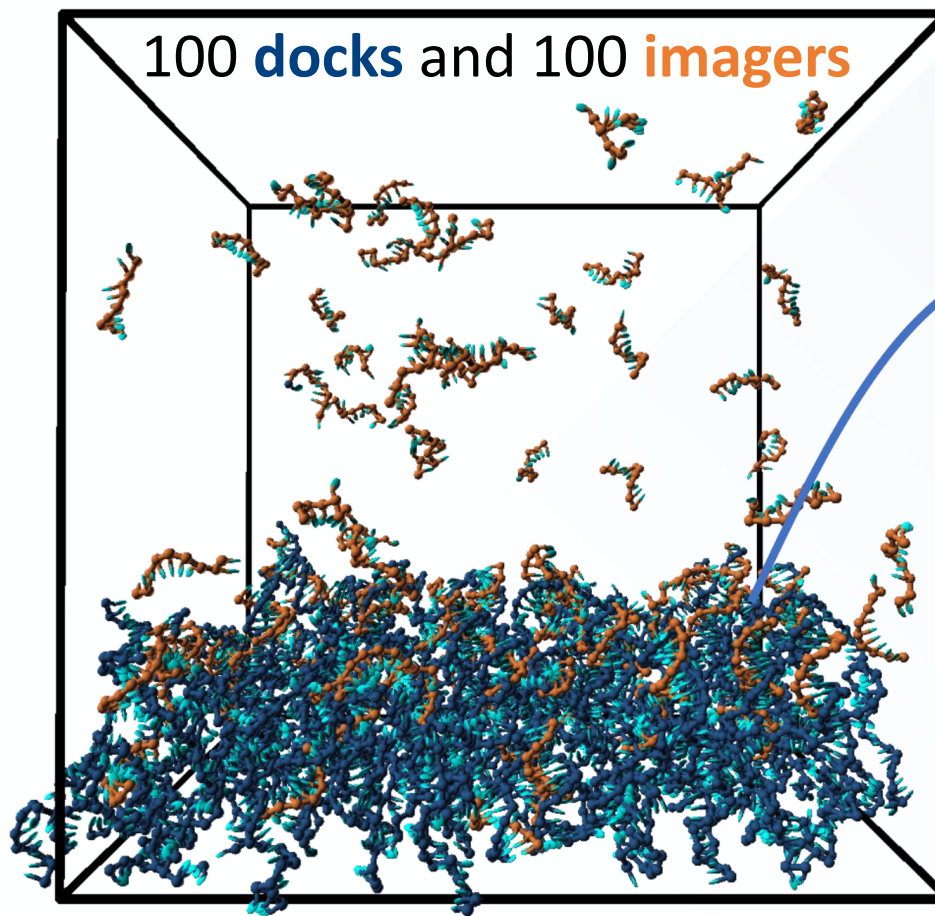
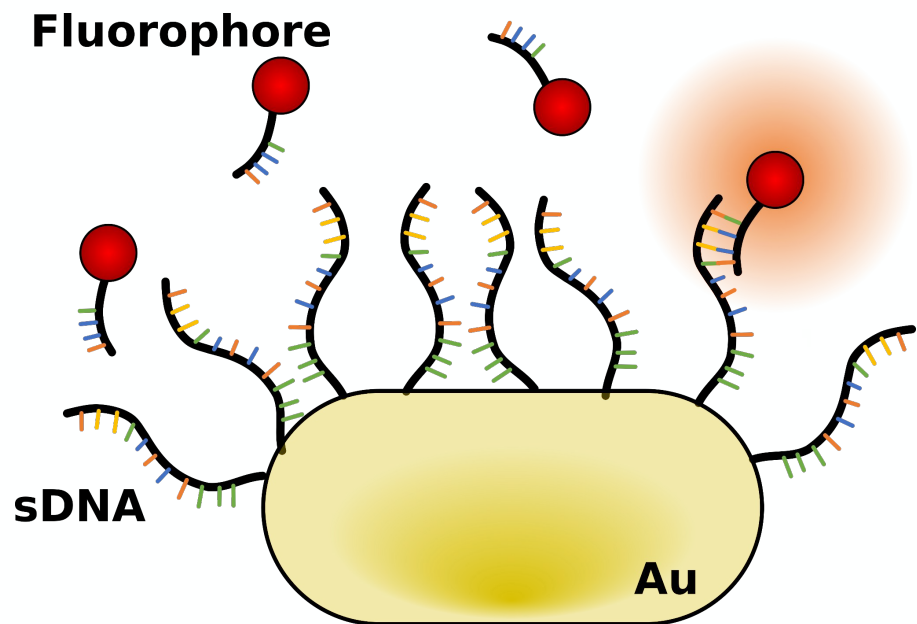
# Quantitative Single-Molecule Counting

$$\frac{\tau_d}{\tau_b} = \frac{k_{\text{off}}}{Nc_{\text{img}}k_{\text{on}}}$$



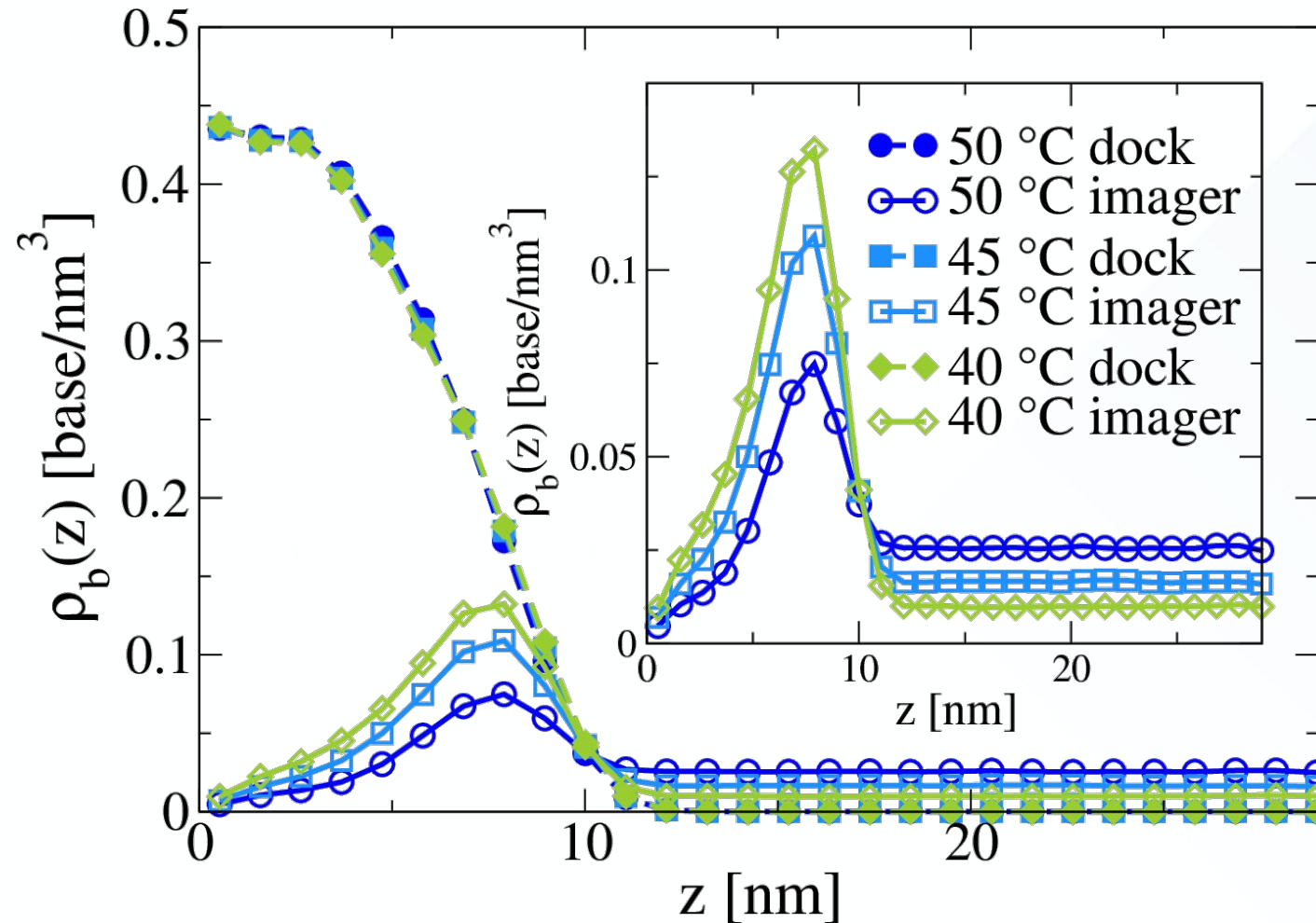


# Quantitative Single-Molecule Counting



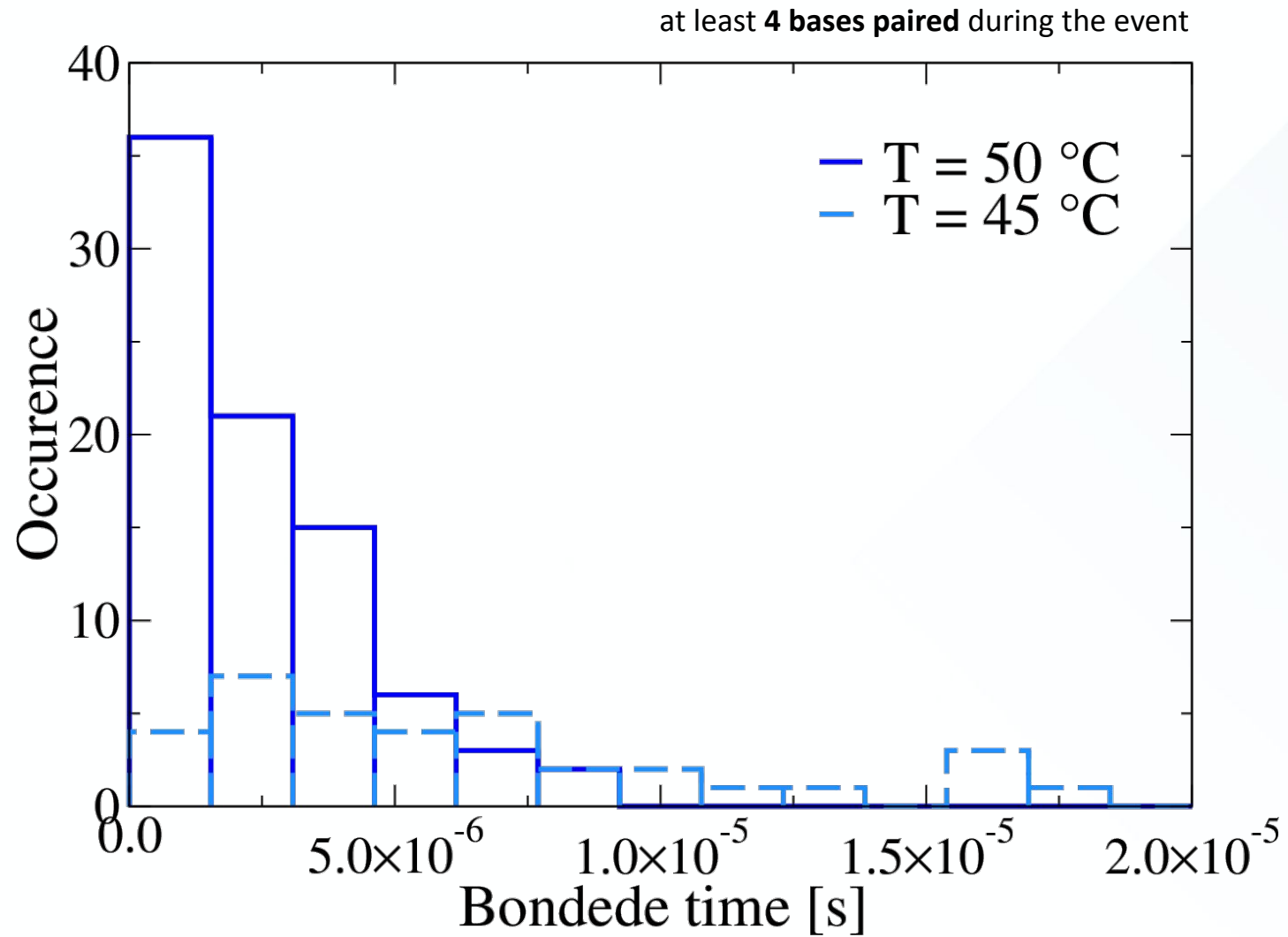


# Height Density Profile - Bases





# Bond Lifetime

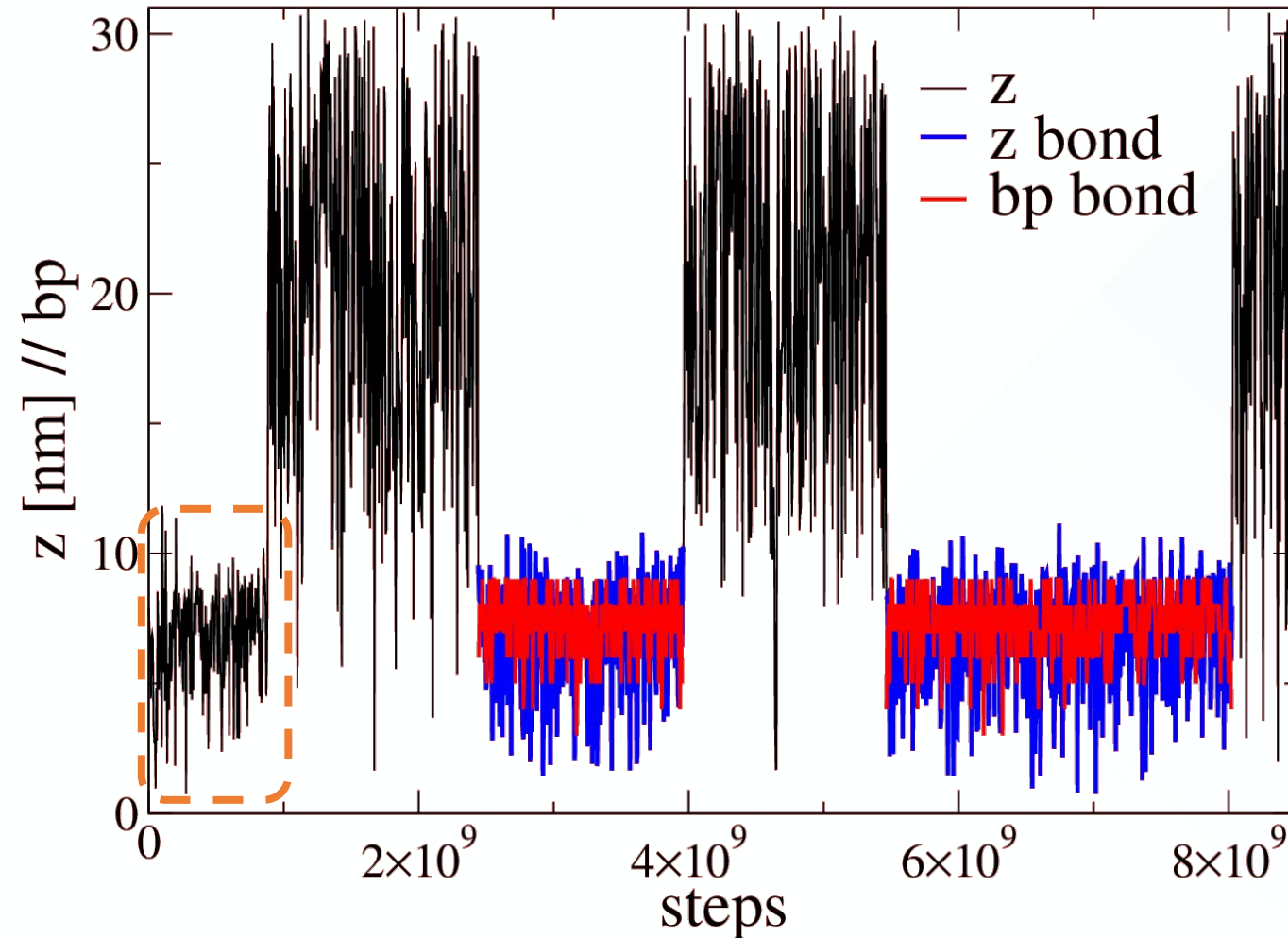




# Bond Definition Comparison - Time Evolution

T = 50 °C - single imager

step size =  $1.515 \cdot 10^{-15}$  s







## Overview

- staples long
- staples excess
- self assembly
- annealing temperature time
- \$1000 per nmol 2006
- dna software
- moma
- 3d box opens to queue
- Three-Dimensional Structures Self-Assembled from DNA Bricks alternative
- 3d as single layers and multilayers