The Art of Molecular Programming Problem-Set Examples

Key Concept: **Helicity & Crossovers**

Comprehension Ex.

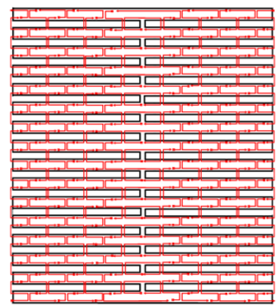
Multiple Choice: You can place a staple extension on ANY base along the helix of a 2D or 3D structure

A. Yes, DNA structures are fully addressable and extensions/sticky ends can be positioned anywhere with subnanometer accuracy
B. Yes, but it might point INSIDE the structure, in the wrong direction, or be thermodynamically unstable
C. No, sticky ends can only be positioned every 10.5 bases from one another
D. No, sticky ends must have motifs that bind multiple scaffold sections

True/False: you can use the left hand rule to determine where a sticky end will point

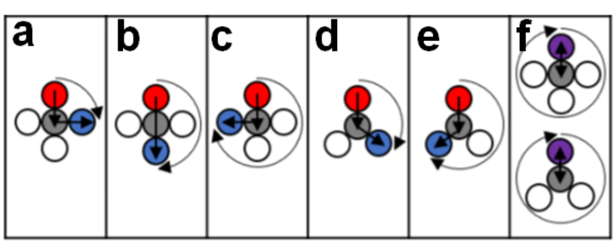
Skill Demonstration Ex.

Short Answer: For the Rothemund Tall Rectangle (full image to the right) explain why all of the staple 5' & 3' ends point out towards the same side of the origami - these staples almost exclusively have an 8 base-crossover-16base-crossover-8base motif structure.



Short Answer: For a standard 2D origami on a square lattice (below), there is a single position labeled with a sticky end. Find the two closest positions where you could add a sticky end (including by adding a staple break)

Quantitative Question: The rectangular lattice and hexagonal lattice represent different angles at which helices connect when looking down the helix direction. A single helix can have 4 neighboring helices at 90° in rectangular, but in the hexagonal lattice it will have 3 neighboring helices at 120°. The 'relaxed' number of bases between turns is 10.5 bases.
For the below, what is the minimum number of bases between enforcing crossovers?



Decision Making and Derivation Ex.

Short Answer/Design: For the Rothemund Tall Rectangle, all 5' and 3' staple positions point out the same direction (out bottom) of the origami. Modify the staples below to create a staple with a 5' or 3' end which will point in the opposite direction (through the top)