PONDICHERRY UNIVERSITY

पाण्डिच्चेरी विश्वविद्यालय புதுவைப் பல்கலைக்கழகம்

Self Assembly of DNA

Nature's Ultimate Building Block

Centre for Nano science and Technology
Course: Biology for Nanotechnology.
Code: NST 625
Course instructor: Asso. Prof. Dr. A. Vadivel Murugan.

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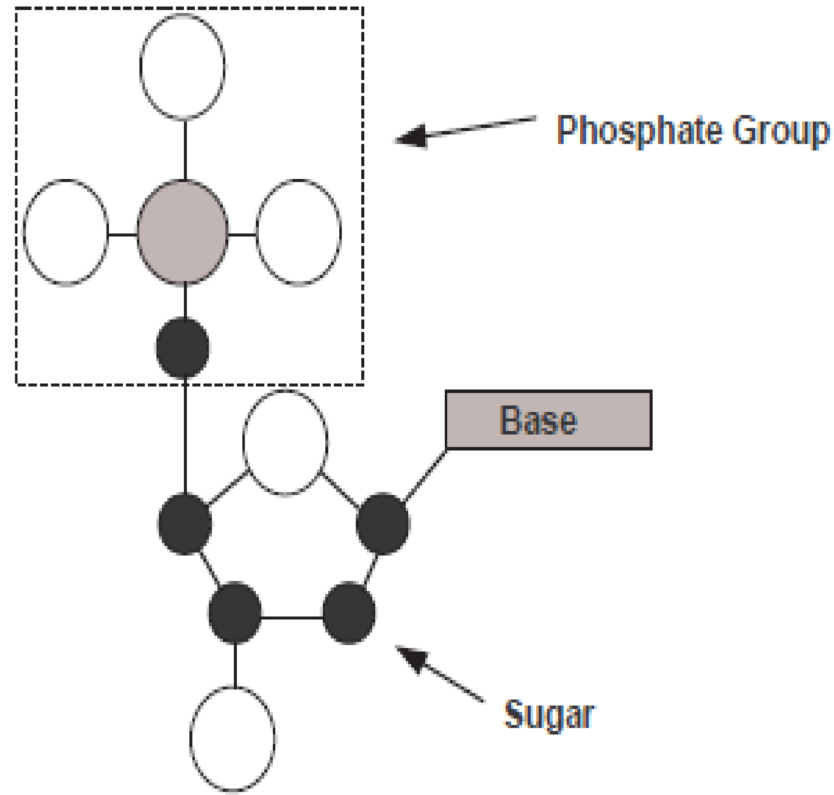
Outline of the Presentation

- Introduction
- Sticky Ends and Branches
- DNA Double Crossover structure (DX)
- DNA Tiles
- DNA ORIGAMI
- Conclusion

Introduction

DNA is an acronym for **deoxyribonucleic acid**.

- Double helix
- Complementary base pairing
- Ability to self replicate
- Ability to carry genetic information

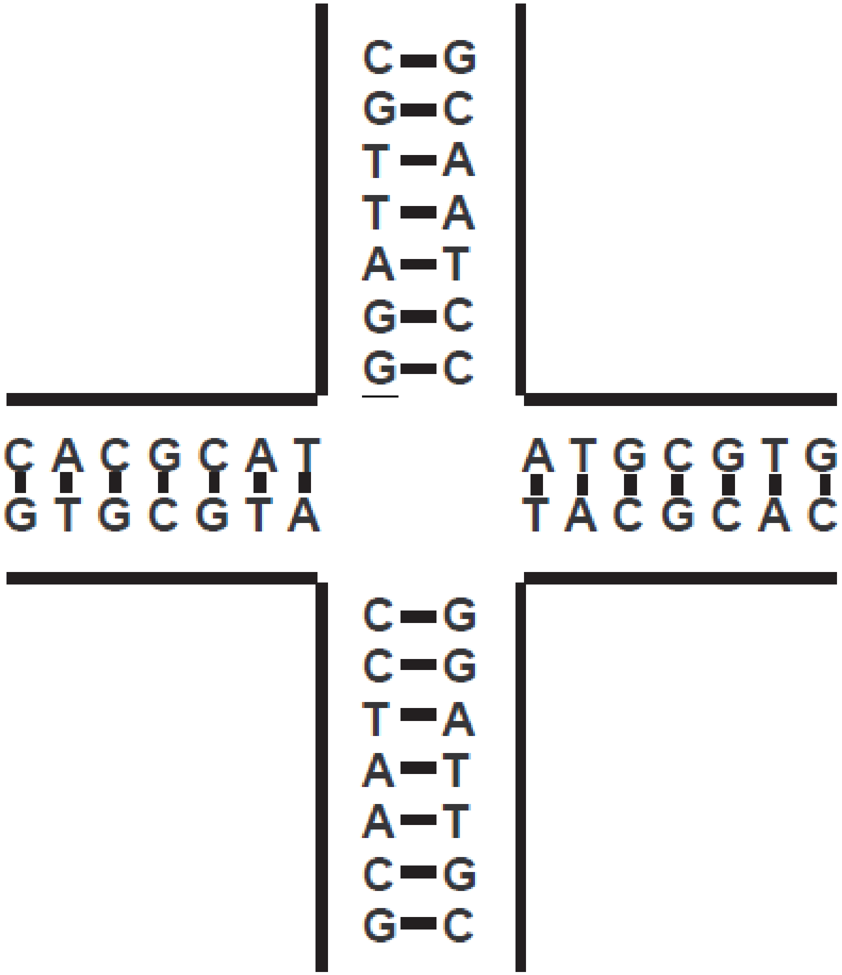


- **By using sticky ends and branched junctions, DNA can be turned into a useful nanoscale building material.**

Sticky Ends and Branches

Short protruding Strand in a double stranded DNA forms a sticky end.

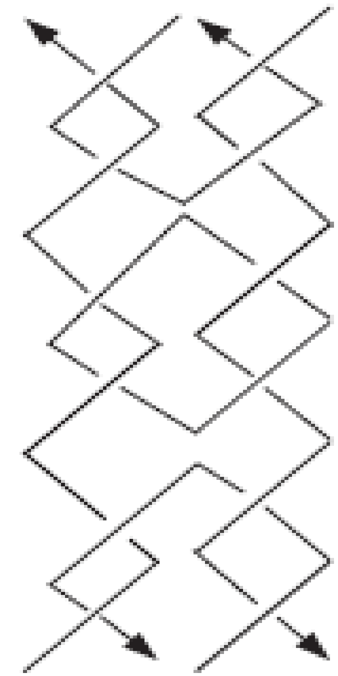
This sticky end is available to **selectively bind** to a variety of molecular structures.



DNA Double crossover over (DX)

Two complete DNA helices lay side by side and are joined as strands from one helix cross over to the other helix.

To this pair one can add a junction and obtain the so-called DX+J structure.

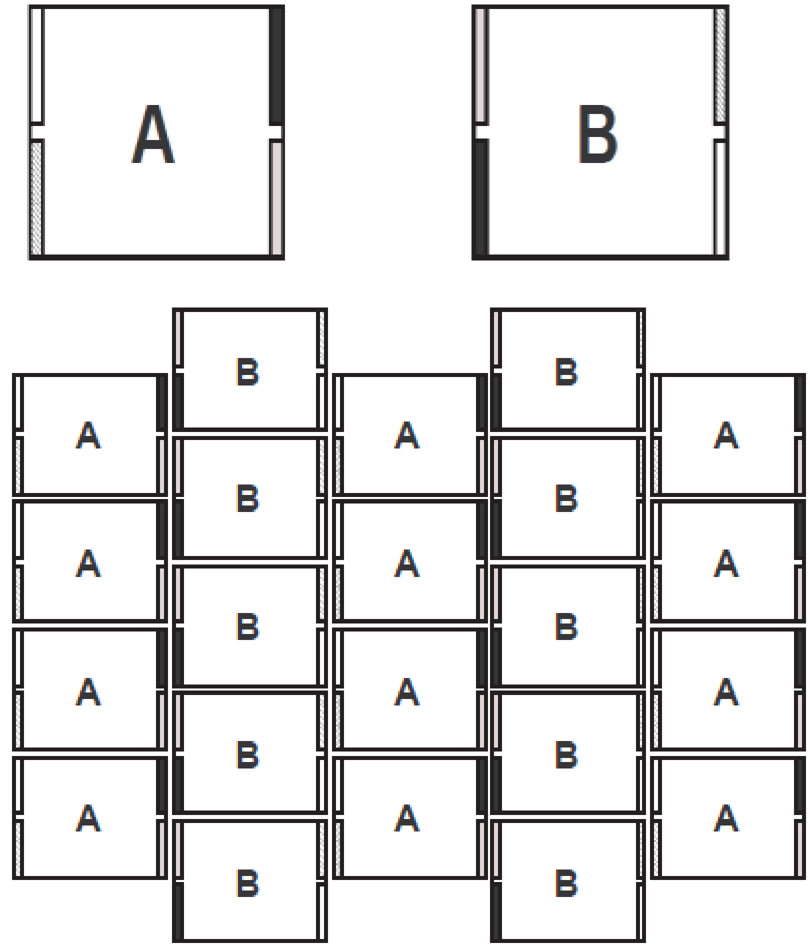


The basic structure of a DNA double-crossover molecule.

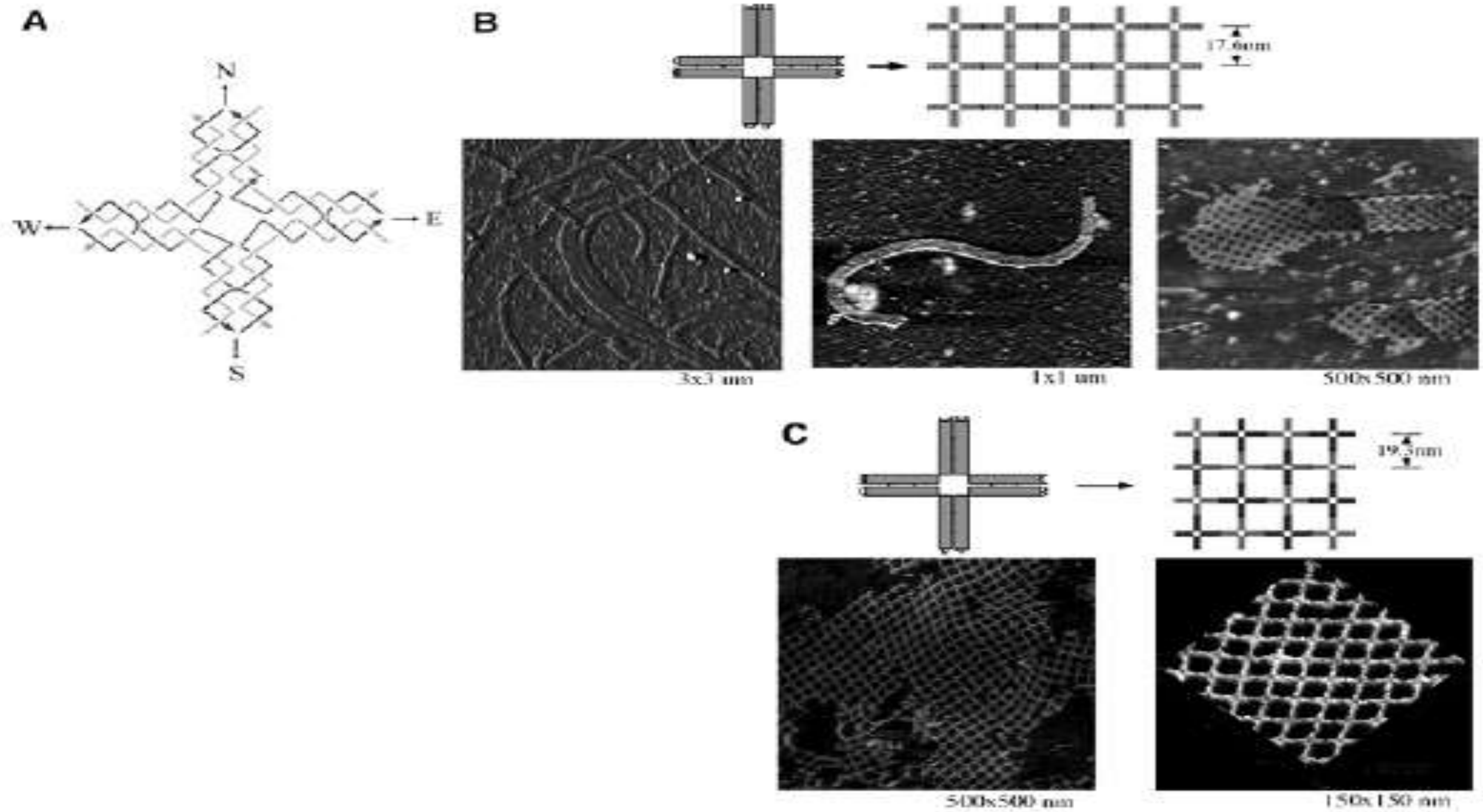
DNA Tiles

DX molecules could be used to design and **fabricate DNA tiles**

It can be speculated that **by "decorating"** tiles in the tile set with other nanoscale objects such as **chemical groups, catalysts, polymer strands, or metallic nanoclusters**, a wide range of nanostructured materials was within reach.



A two dimensional crystalline assembly of DNA tiles.

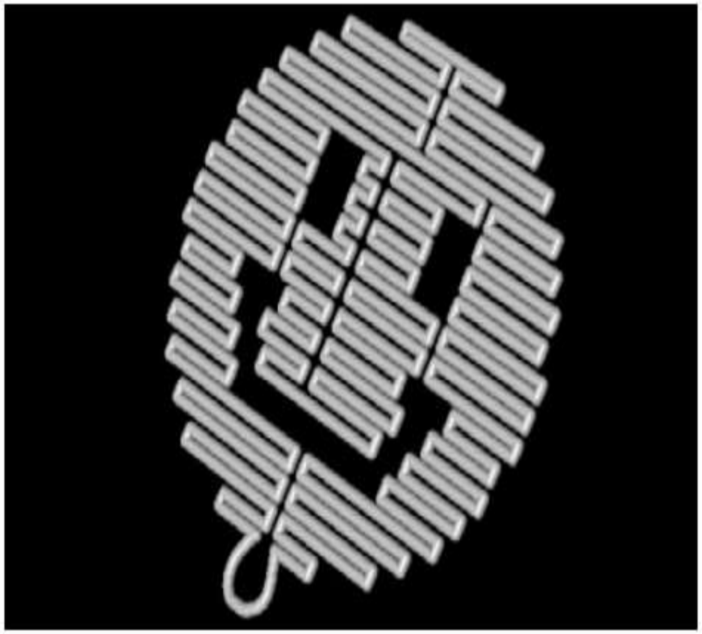


(A) shows the basic tile type. (B) shows the ribbon structure formed from tile subunits, and (C) shows the grid structure formed from tile subunits.

The photographs are AFM pictures of assembled structures. From Yan, et al. , Science, v. 301, pp. 1882-1884, (2003)

DNA ORIGAMI

In 2006, **Paul W.K. Rothemund** introduced an another way to self-assemble two dimensional nanoscale patterns, He called this approach **“DNA Origami**”.

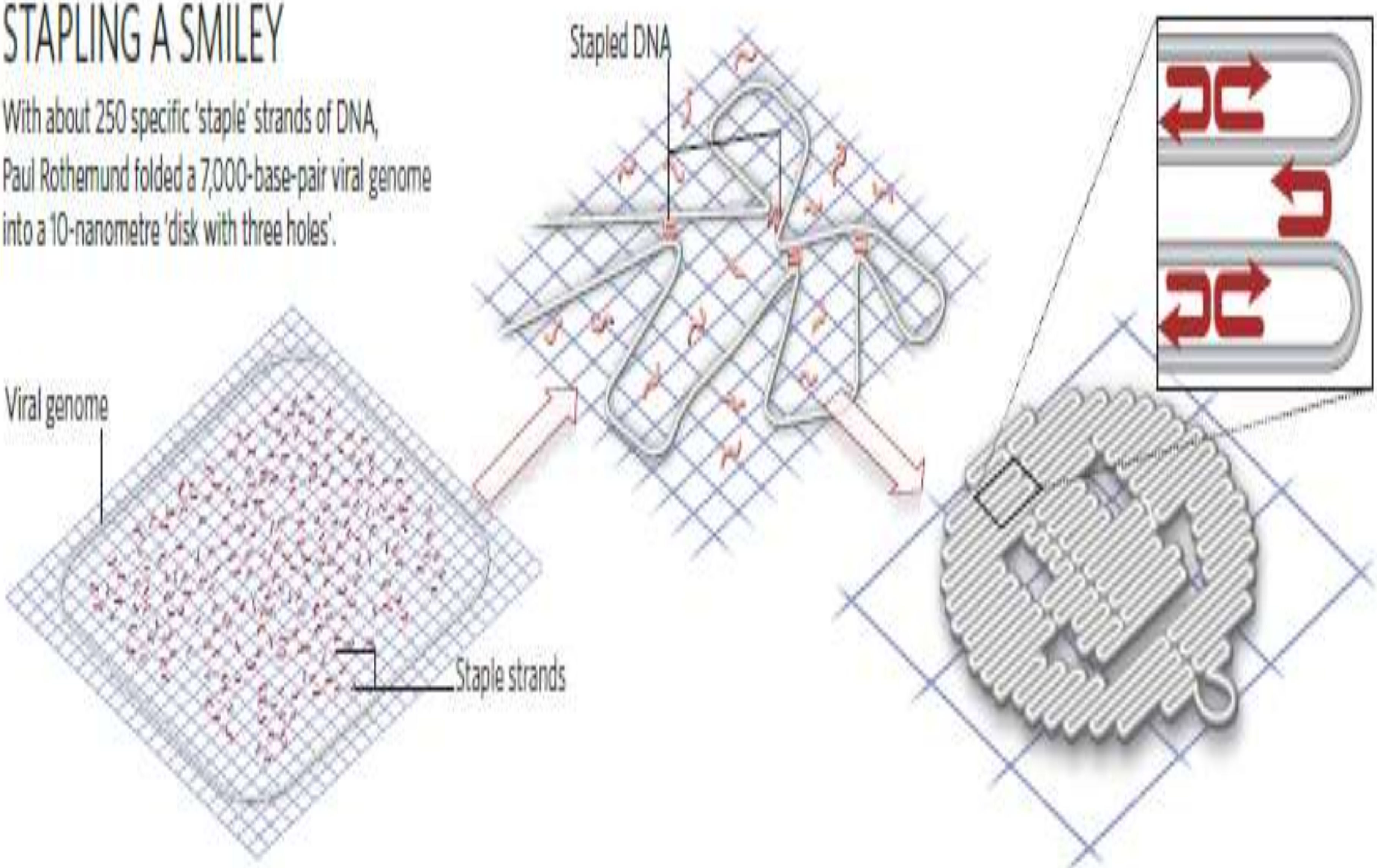


Helper strands, or DNA “staples,”

- short helper strands of DNA
- attach strands of the rasterized structure together.

STAPLING A SMILEY

With about 250 specific 'staple' strands of DNA, Paul Rothemund folded a 7,000-base-pair viral genome into a 10-nanometre 'disk with three holes'.



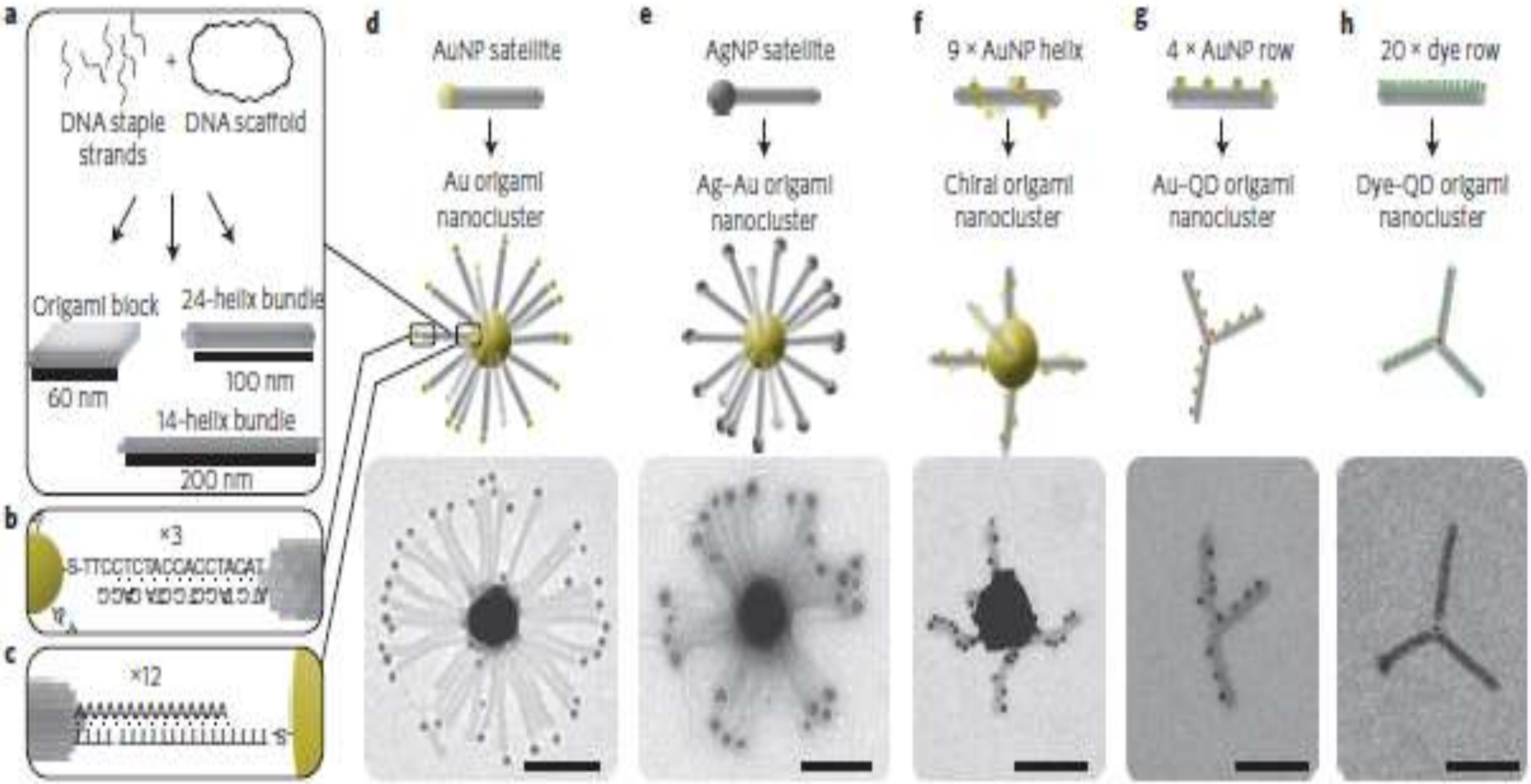


Figure 1 | Planet–satellite nanoclusters. a, A single-stranded DNA scaffold (~8 kb) is annealed with ~200 synthetic oligonucleotides (staples, each ~40 nucleotides long) to create various DNA origami structures of defined shape and size. **b**, Satellite nanoparticles functionalized with multiple thiolated DNA strands are hybridized via handle sequences to the DNA origami structures. **c**, The nanoparticle bearing DNA origami structures are hybridized to nanoparticle planets functionalized with a different DNA sequence. **d–h**, Top: schematic drawings of DNA origami structures carrying various satellites. Middle: schematic drawing of the fully assembled planet–satellite clusters. Bottom: electron micrographs of uranyl-acetate-stained structures. Note that the flattened appearance is a result of the drying process. **d**, Au nanocluster (planet, 60-nm gold nanoparticle (AuNP); satellites, 10-nm AuNPs). **e**, Ag–Au nanocluster (planet, 80-nm AuNP; satellites, 20-nm silver nanoparticles (AgNPs)). **f**, Chiral nanocluster (planet, 80-nm AuNP; satellites, nine × 10-nm AuNPs in a right-handed helix). **g**, Au–quantum dot (QD) nanocluster (planet, QD CdSeTe, 800-nm emission; satellites, four × 10-nm AuNPs). **h**, Dye–QD nanocluster (planet, QD CdSeTe, 800-nm emission; satellites, 20 × Cy3). Scale bars, 100 nm.

References

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- Chad A. Mirkin, Christof M. Niemeyer-Nanobiotechnology II - More Concepts and Applications-Wiley-VCH (2007).
- Nature Vol 464|11 March 2010 NEWS FEATURE

It is a strange model and embodies several unusual features. However, since DNA is an unusual substance, we are not hesitant in being bold.
James D. Watson

Thank you for your kind attention..!