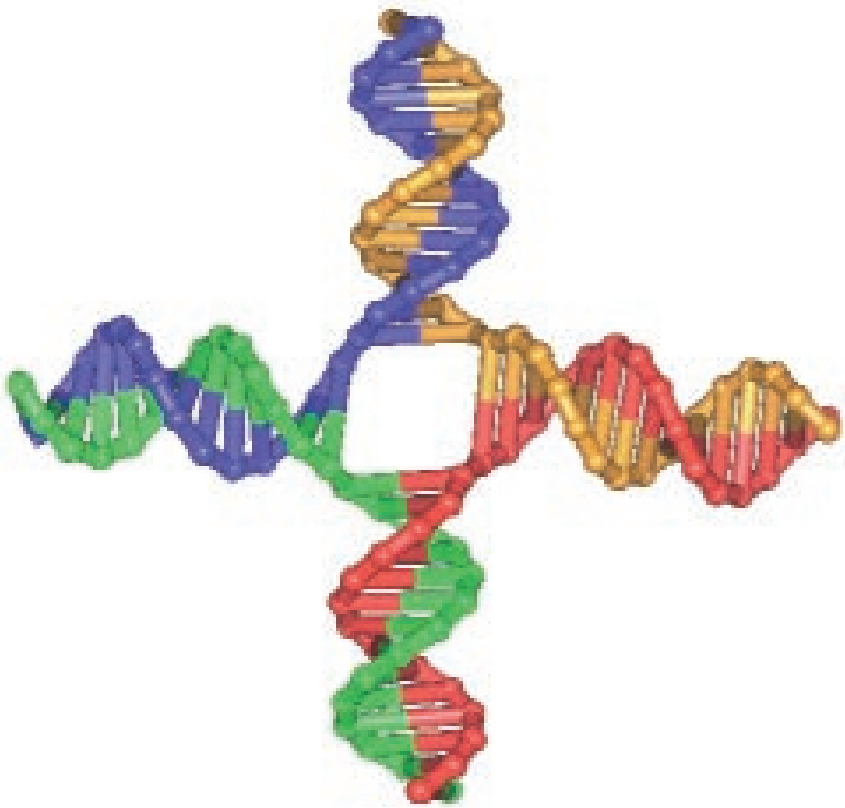
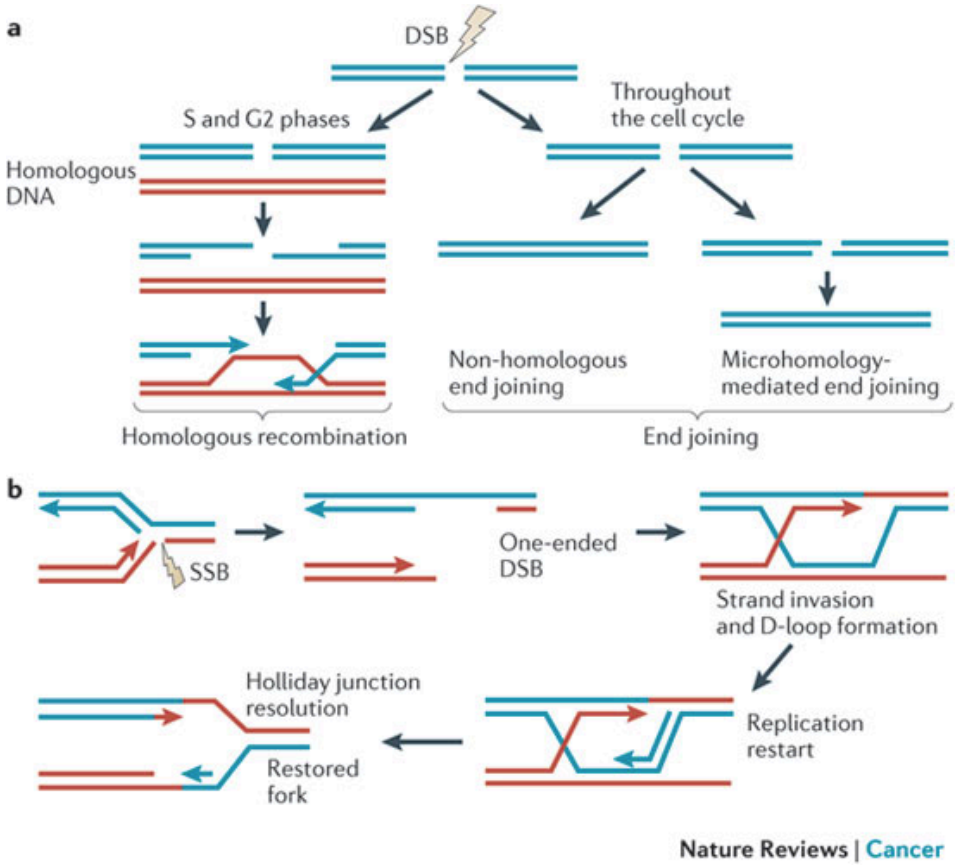
DNA Four-ways junctions
« Holliday junctions »



PNAS | **April 11, 2000** | vol. 97 | no. 8 | **3971–3976**

- *These structures have been described in 1964 by Robin Holliday*
- *Key intermediatestructure in many types of genetic recombination, as well as in double-strand break repair*
- *Natural 4-ways junctions have a symmetrical sequence and are thus mobile, meaning that the four individual arms may slide through the junction*

DNA Four-ways junctions
« Holliday junctions »



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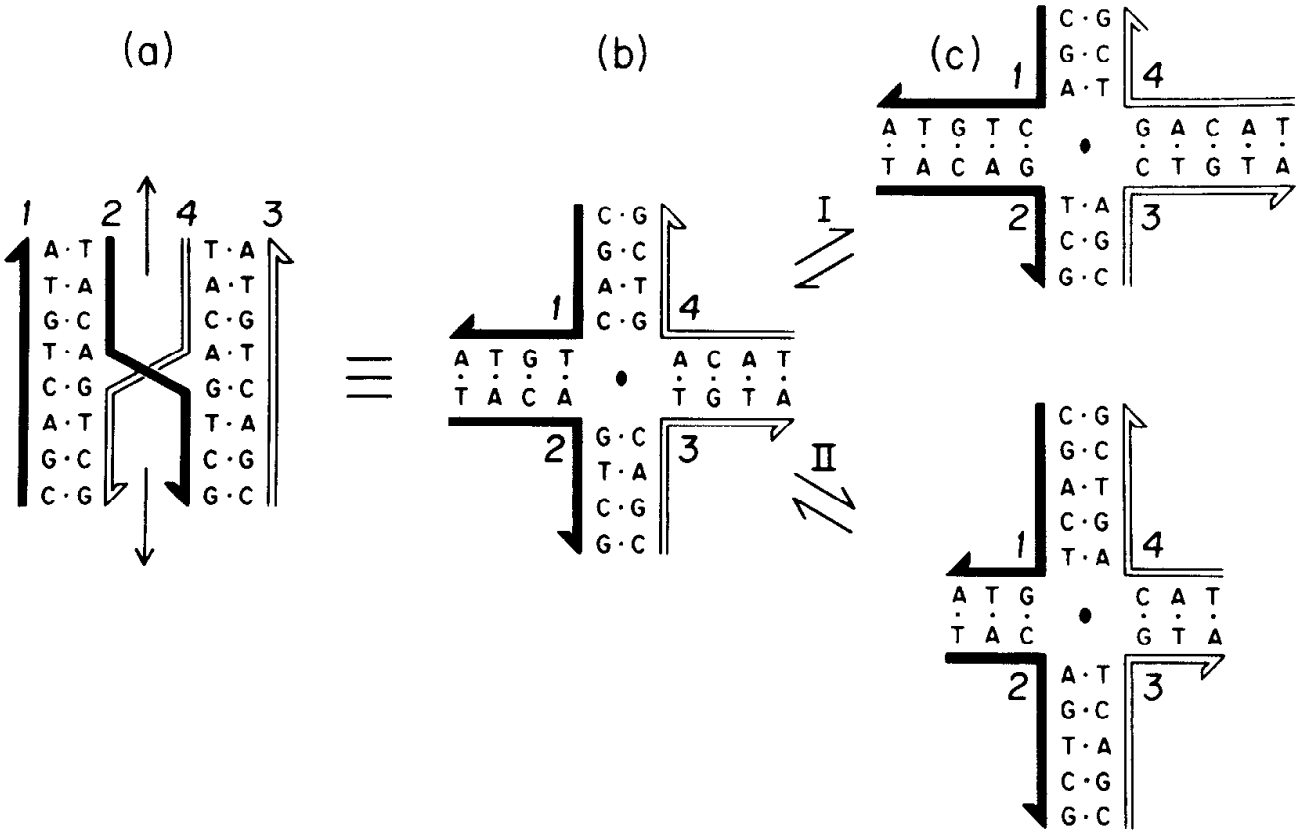
DNA six-ways junctions

Impossible d'afficher l'image. Votre ordinateur manque peut-être de mémoire pour ouvrir l'image ou l'image est endommagée. Redémarrez l'ordinateur, puis ouvrez à nouveau le fichier. Si le x rouge est toujours affiché, vous devrez peut-être supprimer l'image avant de la réinsérer.

- *These structures have been designed and produced in the early 1980s by Nadrian Seeman, State Univ. New York*
- *Inspiration from 4-ways junctions and cristallograph issues*
- *He got the initial idea while he was drinking a beer in a bar and looking at this painting of flying fishes…*

Mobile Holliday junction



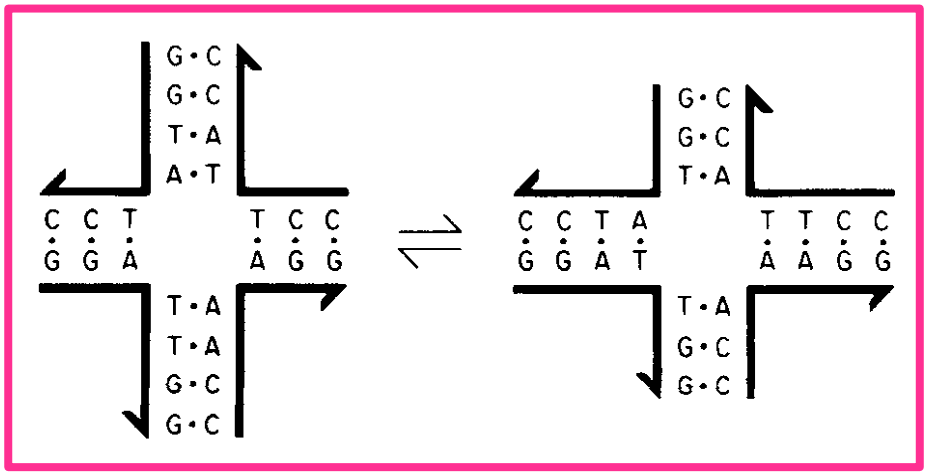
J. theor. Biol. (1982) **99**, 237–247

Nucleic Acid Junctions and Lattices

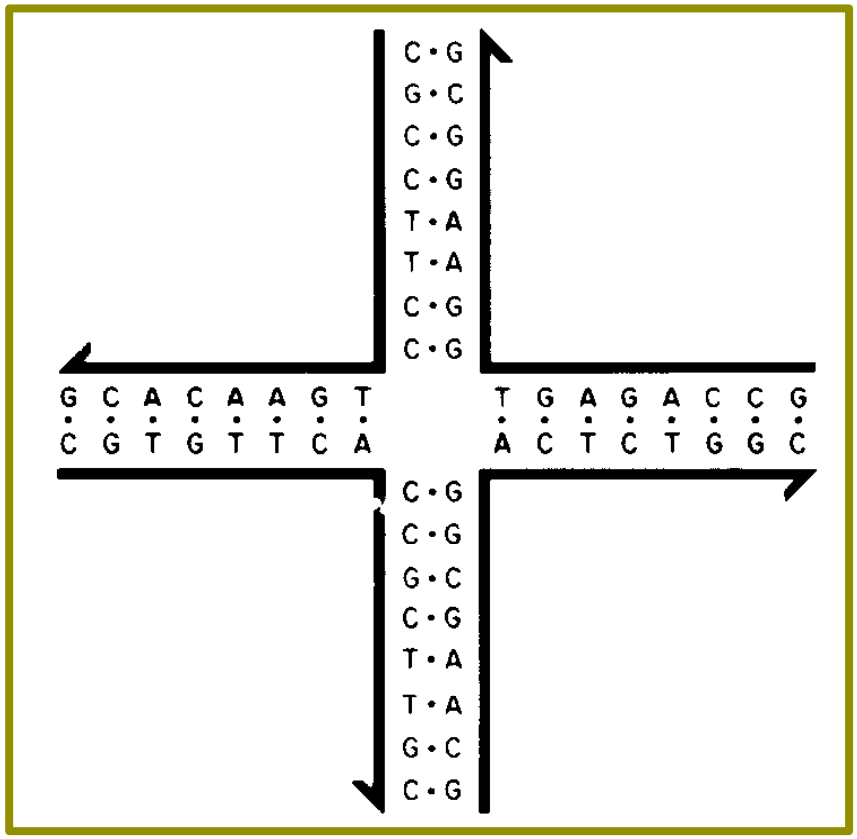
NADRIAN C. SEEMAN

Center for Biological Macromolecules, State University of New York at Albany, Albany, New York 12222, *U.S.A.*

Semi-mobile and immobile Holliday junction

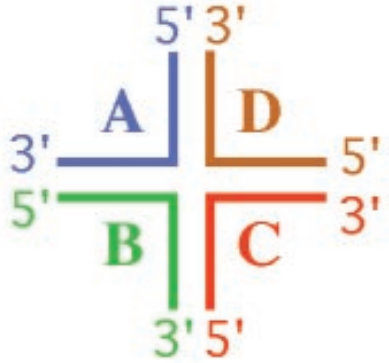


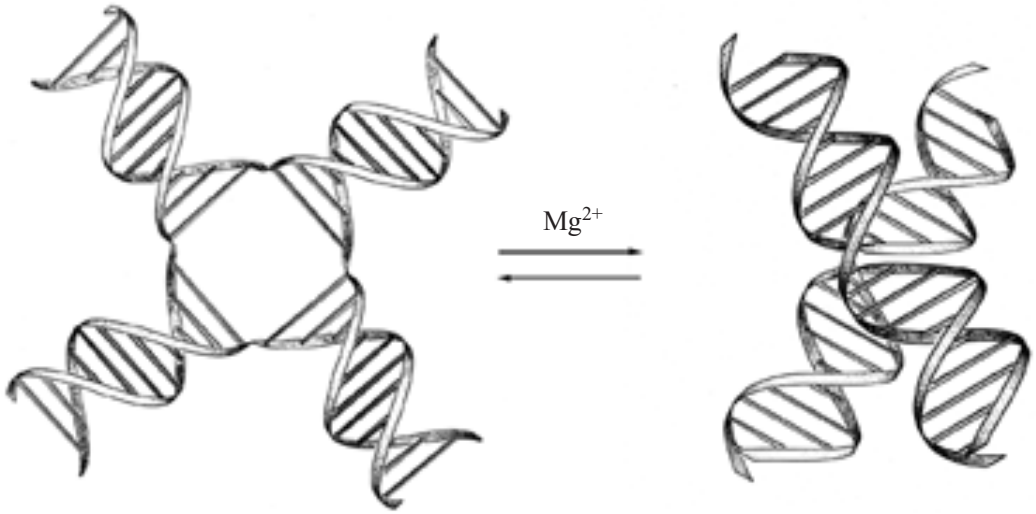
Semi-mobile



Immobile

Holliday junction conformations





Several possible conformations (extended X-form if Mg^{2+}<0.1μM; left or stacked X-form if Mg^{2+}>0.1μM, right)

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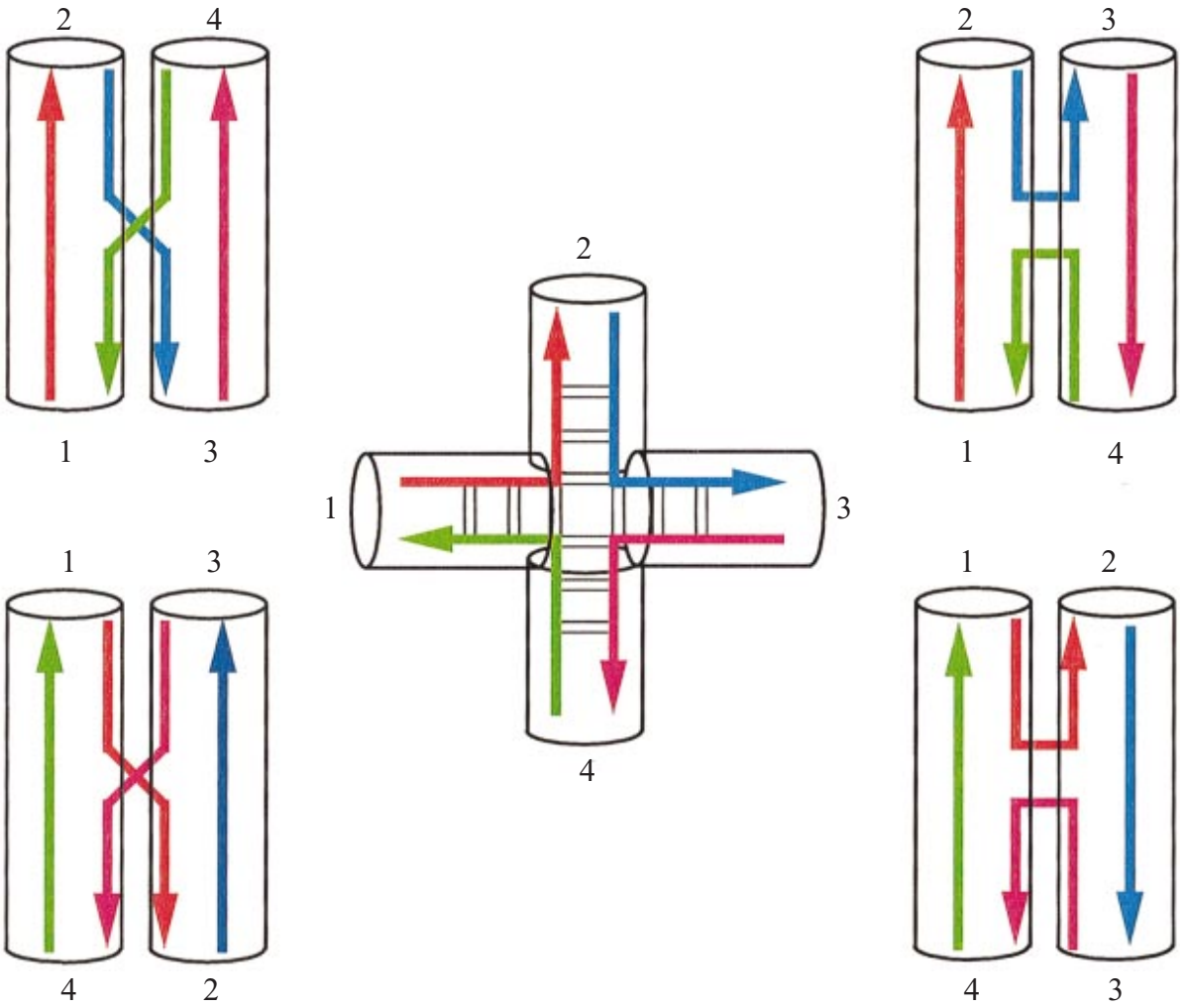
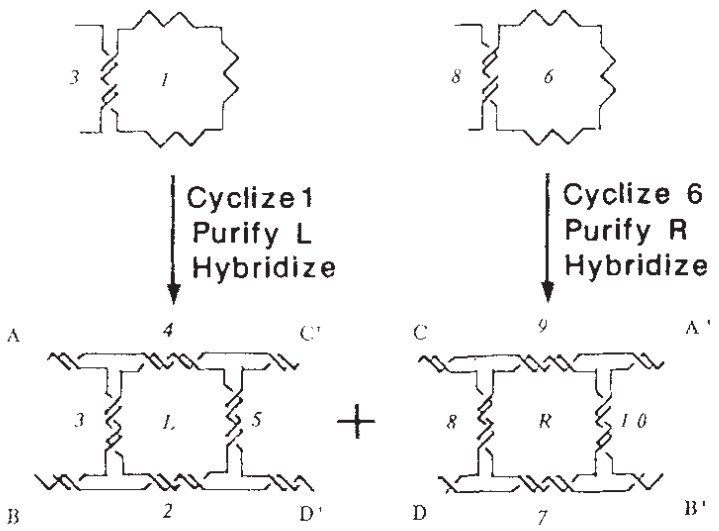
Holliday junction conformations



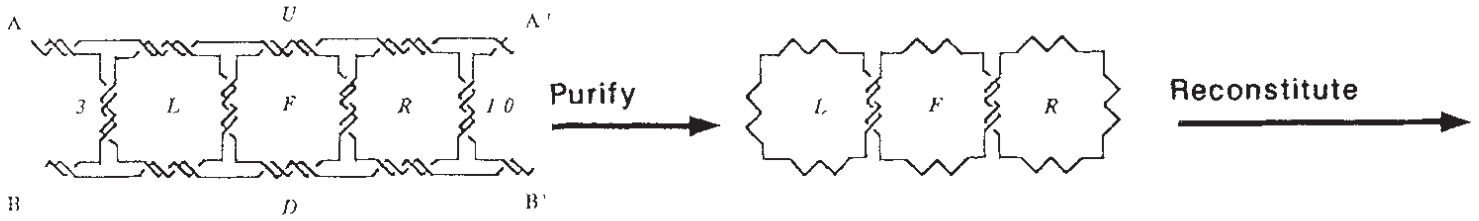
Parallel *Anti-parallel*

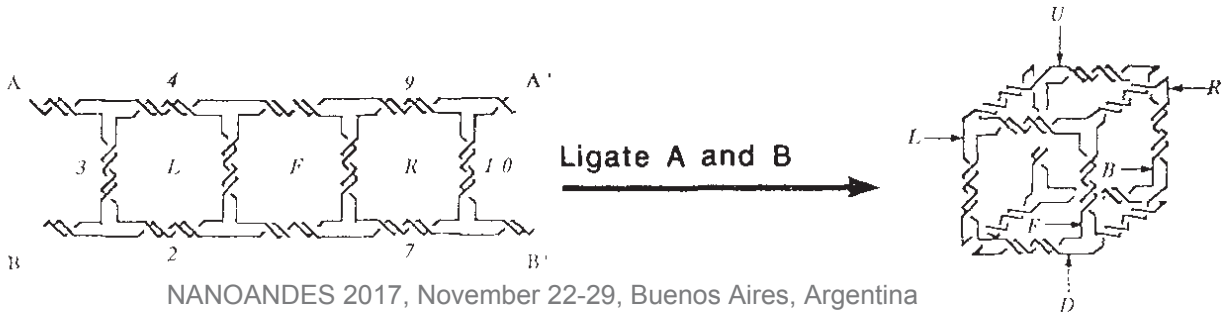
PNAS | **April 11, 2000** | vol. 97 | no. 8 | **3971–3976**

The first 3D objects built from DNA 3-ways junctions



Ligate C and D



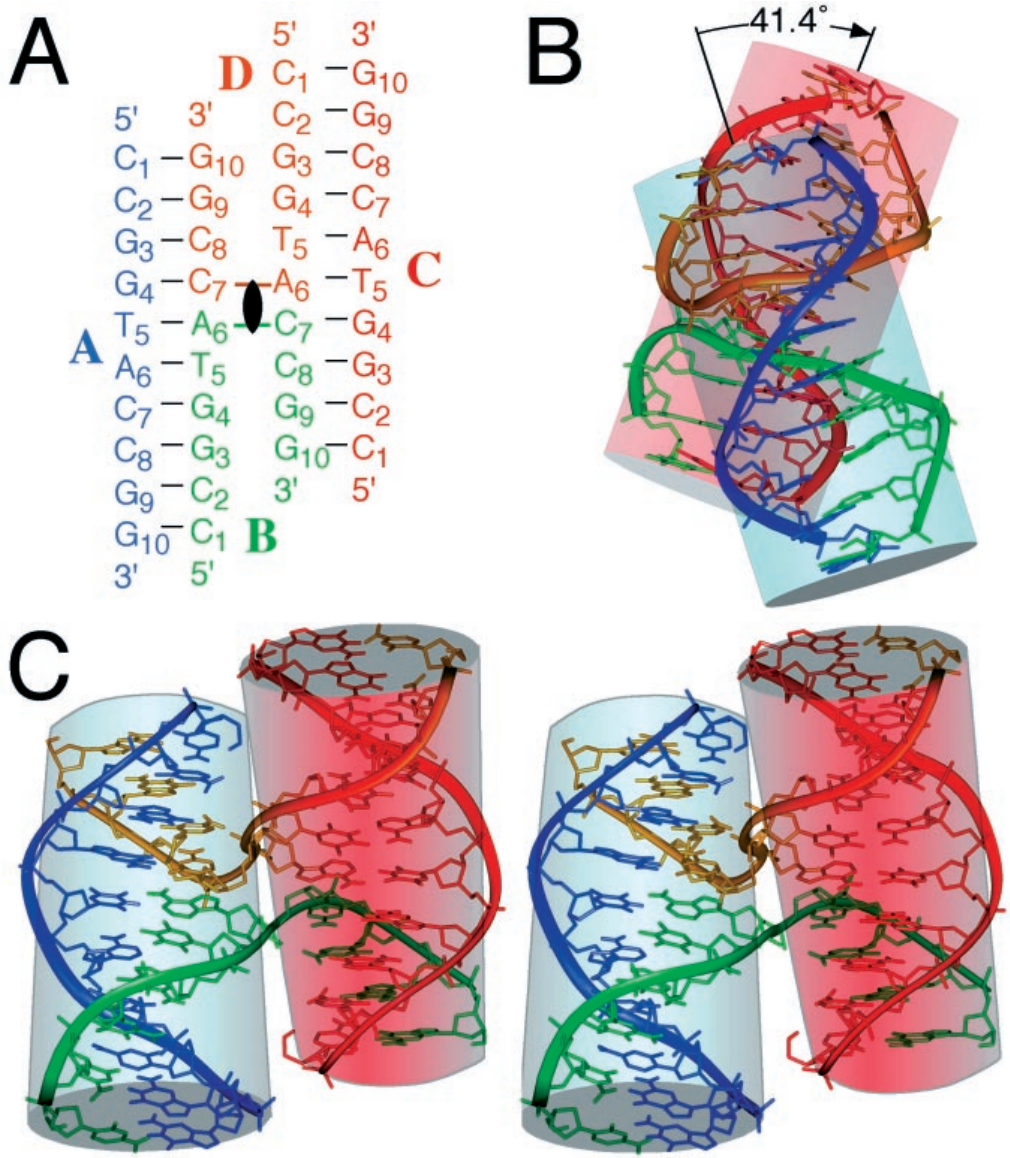


Synthesis from DNA of a molecule with the connectivity of a cube

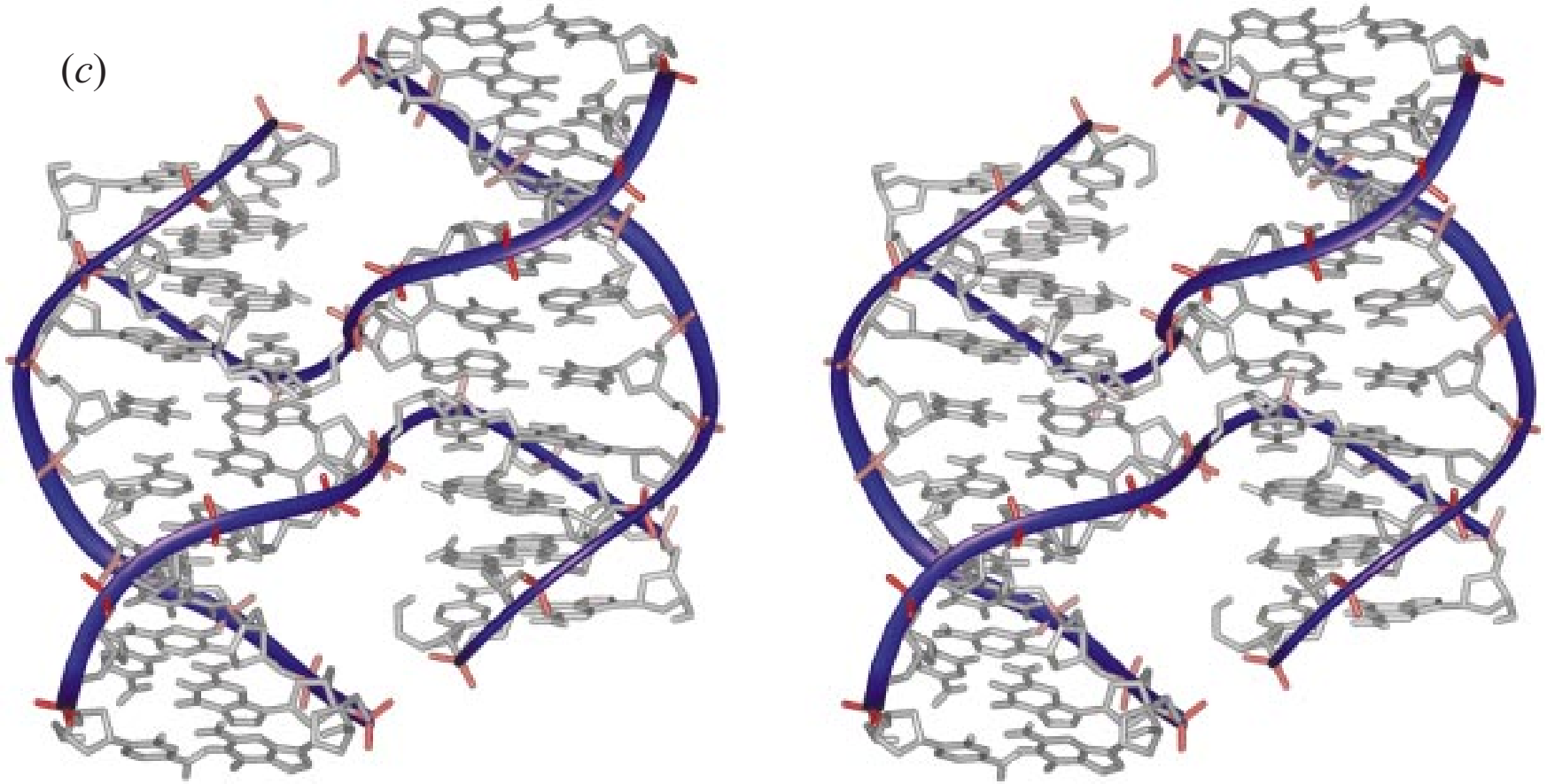
Junghuei Chen & Nadrian C. Seeman

NATURE · VOL 350 · 18 APRIL 1991

Holliday junction conformations



Holliday junction conformations



I. DNA molecular structure and properties

DNA and RNA chemical structures
Biological functions of nucleic acids
DNA (un)stability
DNA synthesis (chemical and PCR-based)

II. Design of new functionalities for DNA

Aptamers
Data storage with DNA

III. DNA as a nanometric tunable object

Seeman's work
DNA origamis, structures & design
DNA based origamis for sensing
DNA bricks
DNA multi-enzyme catalysts

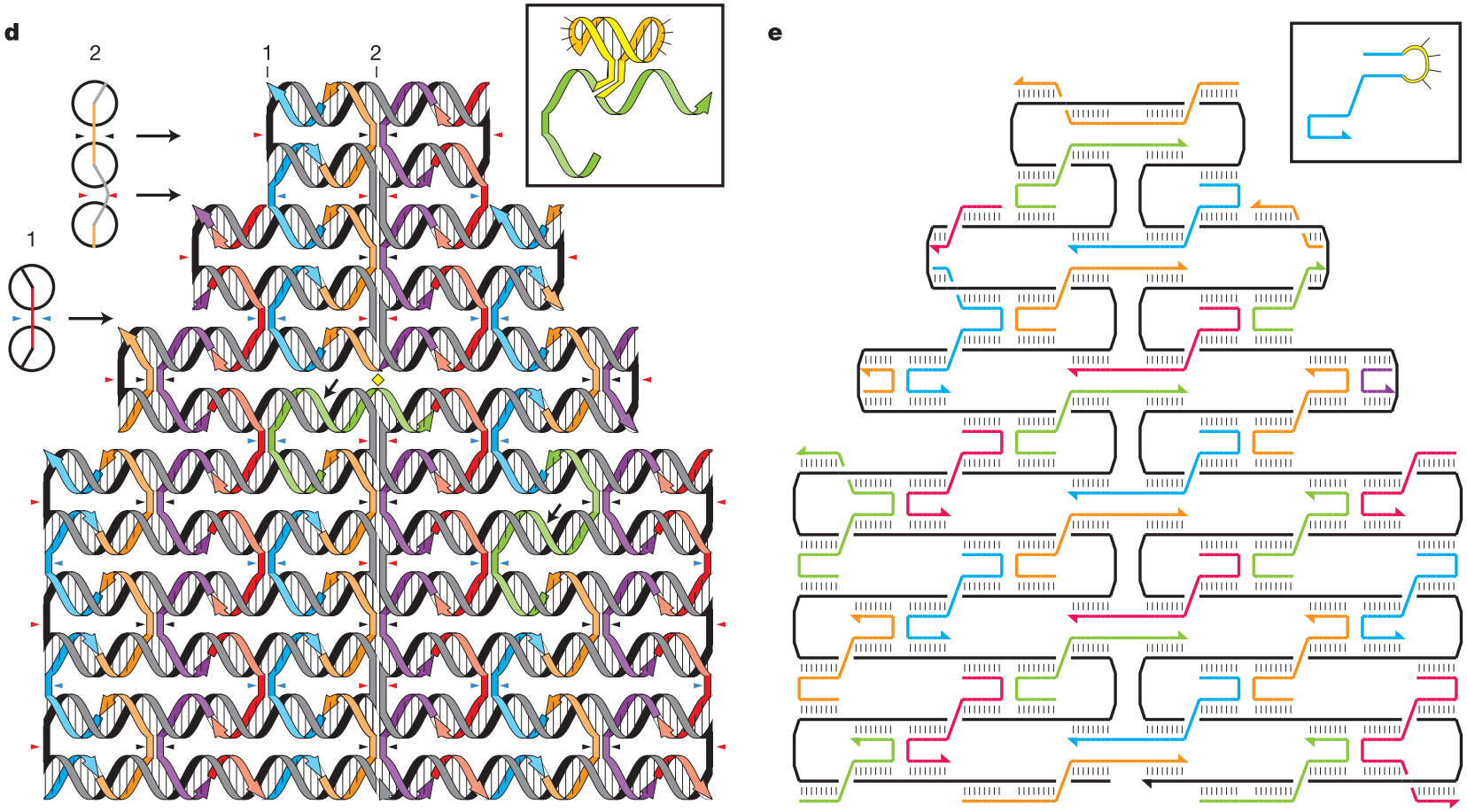
IV. DNA for nano-electronics

DNA based nano-lithography
DNA based nano-wires

Folding DNA to create nanoscale shapes and patterns

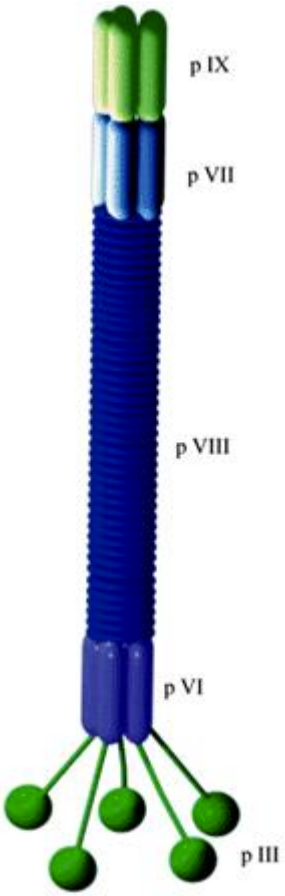
Vol 440|16 March 2006|**doi:10.1038/nature04586**

Paul W. K. Rothemund[1]



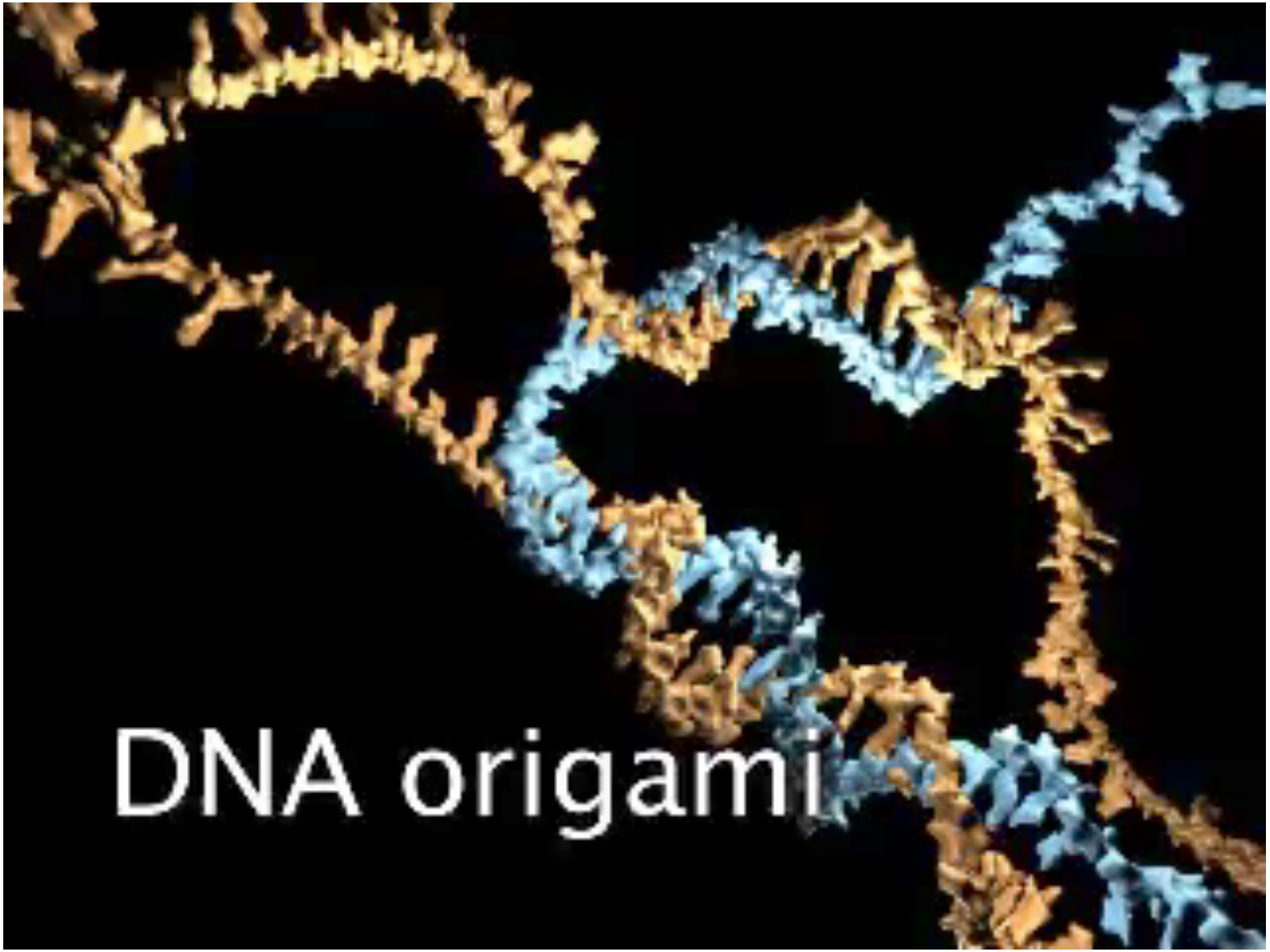
Bacteriophage M13

« M13 is a virus that infects the bacterium *Escherichia coli*. It is composed of **a circular single-stranded DNA molecule** encased in a thin flexible tube made up of about 2700 copies of a single protein called P8, the major coat protein. The ends of the tube are capped with minor coat proteins. »
source: Wikipedia

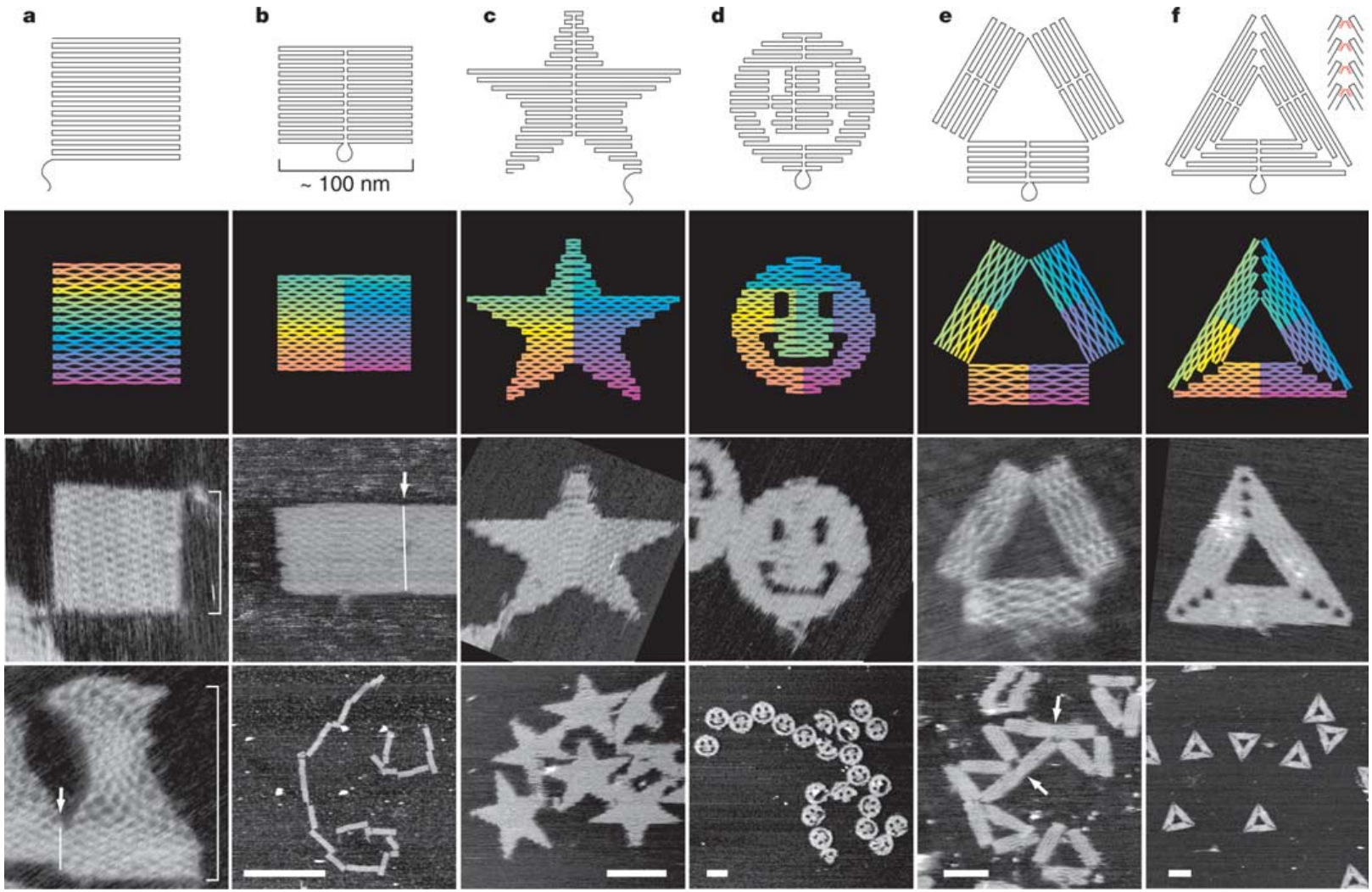


http://2010.igem.org/wiki/images/e/ed/P3_image.jpg

DNA origami

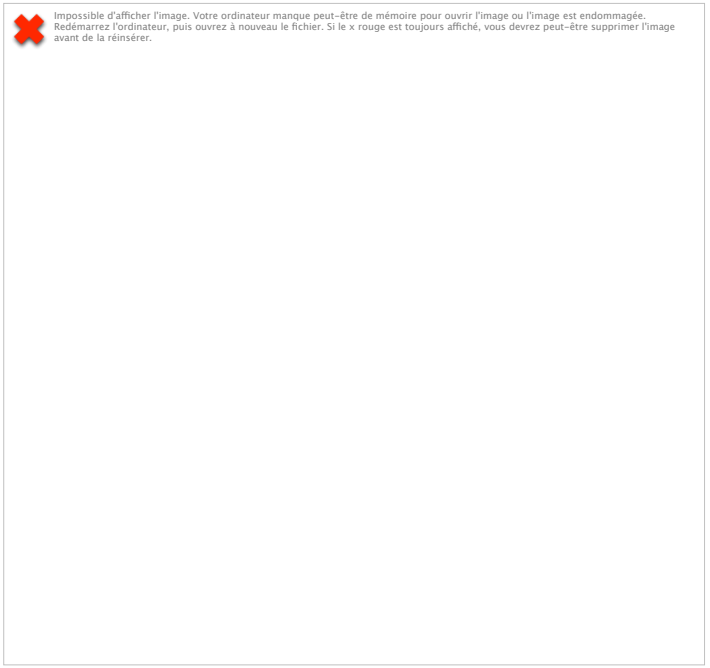


DNA origami



Dedicated softwares for DNA origami designs

caDNAno (Shi's group, MIT)



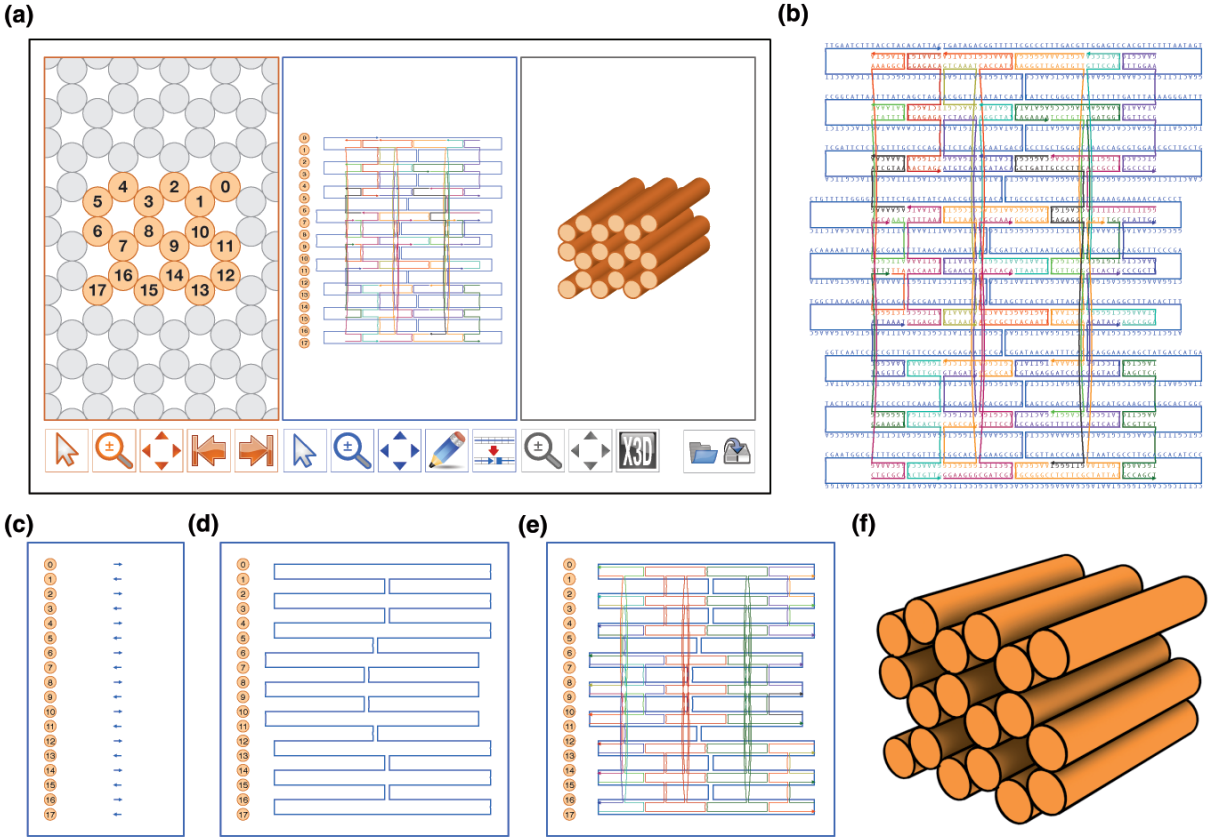
scale bars: 20 nm

Vol 459|21 May 2009|**doi:10.1038/nature08016**

Dedicated softwares for DNA origami designs

caDNAno (Shi's group, MIT)

→ dedicated to M13 ssDNA 7,249 nt) use as scaffold

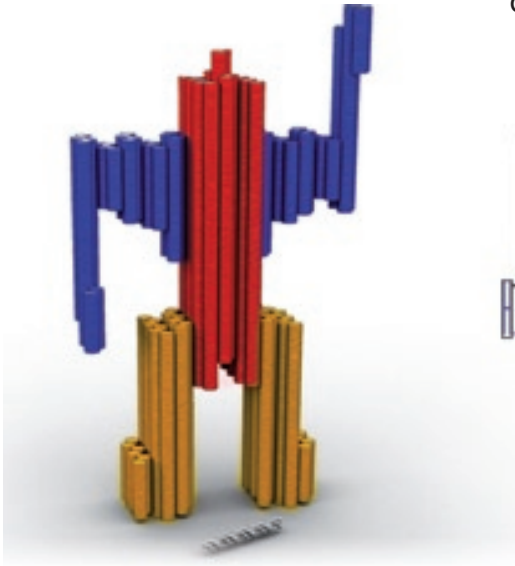


Nucleic Acids Research, 2009, Vol. 37, No. 15 ***5001–5006***
doi:10.1093/nar/gkp436

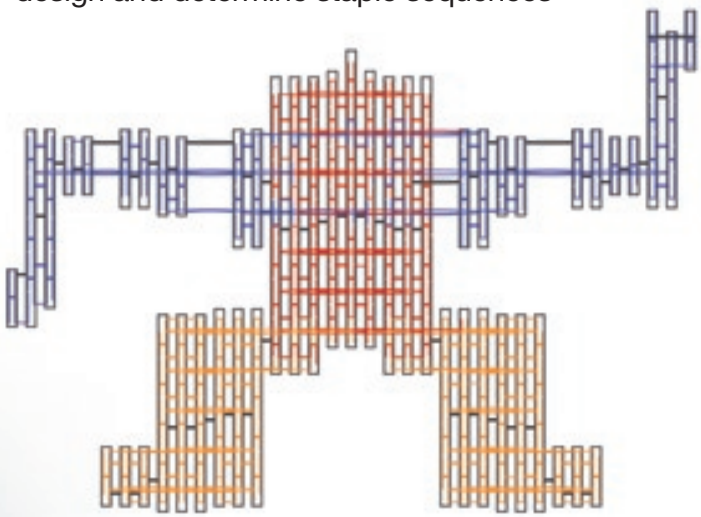
Dedicated softwares for DNA origami designs

Methodology

Step 1: conceive a target shape

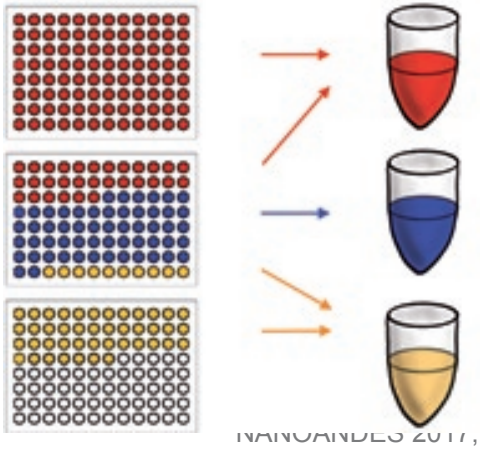


Step 2: design scaffold-staple layout, evaluate design and determine staple sequences

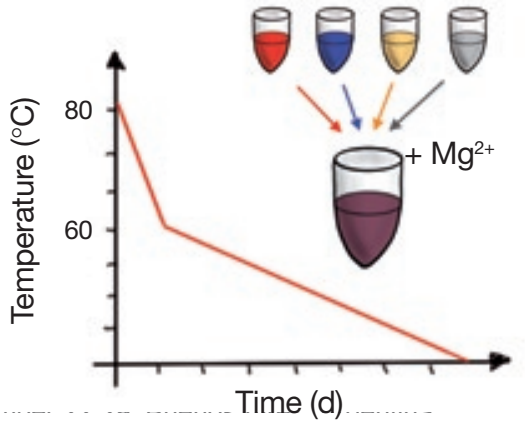


Step 3: prepare scaffold DNA and synthesize staple oligonucleotides

Step 4: pool staple oligonucleotides

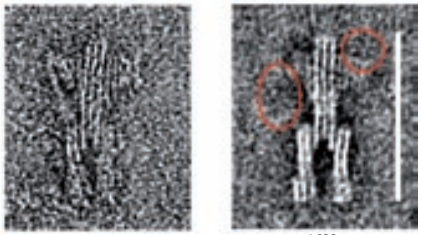


Step 5: run molecular self-assembly reactions



Step 6: analyze folding quality and purify

Step 7: analyze structural details

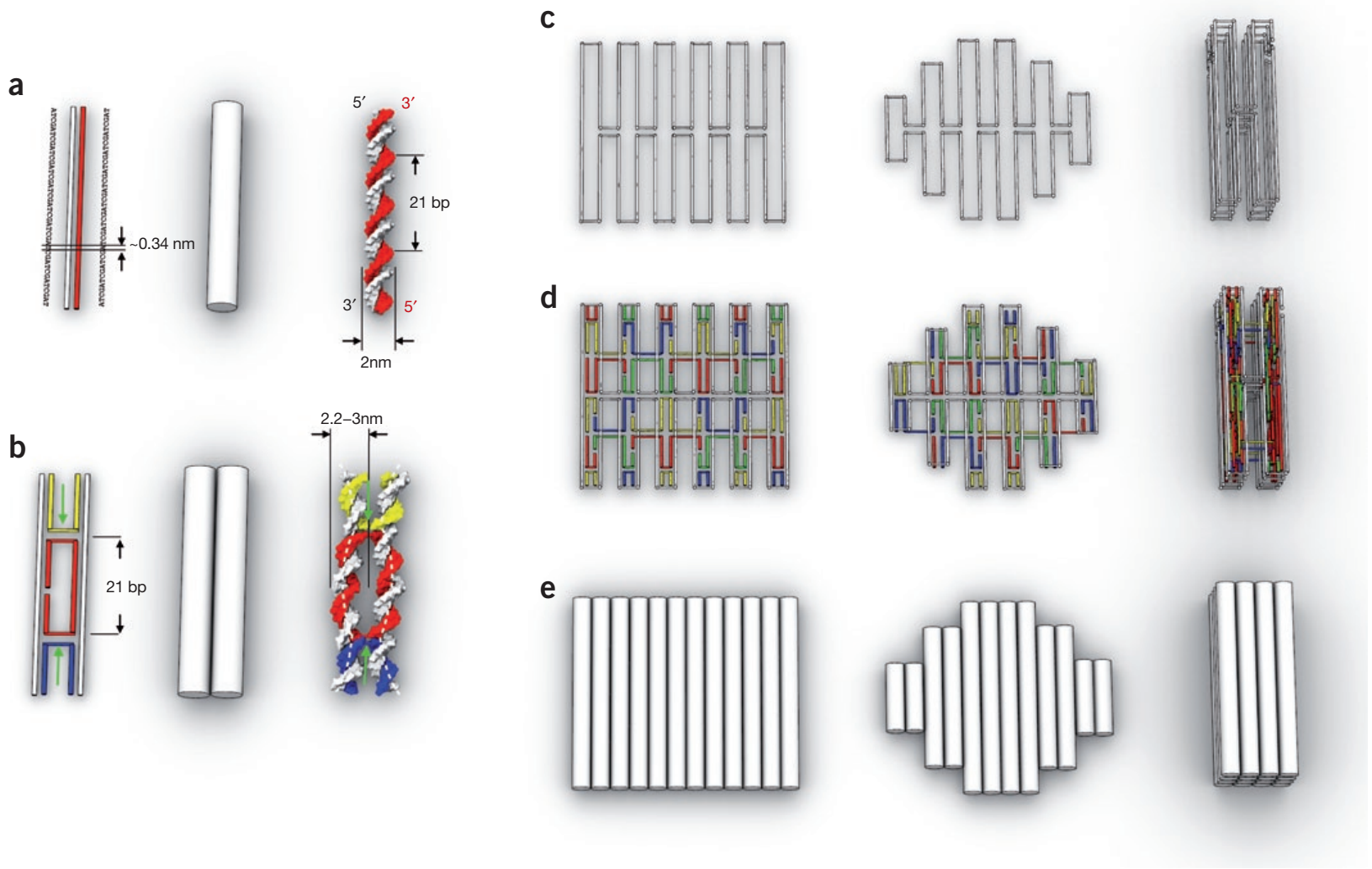


Castro et al., Nature Meth, 2011,DOI:10.1038/NMETH.1570

Dedicated softwares for DNA origami designs

CanDo (https://cando-dna-origami.org/examples/)

works with caDNAno files

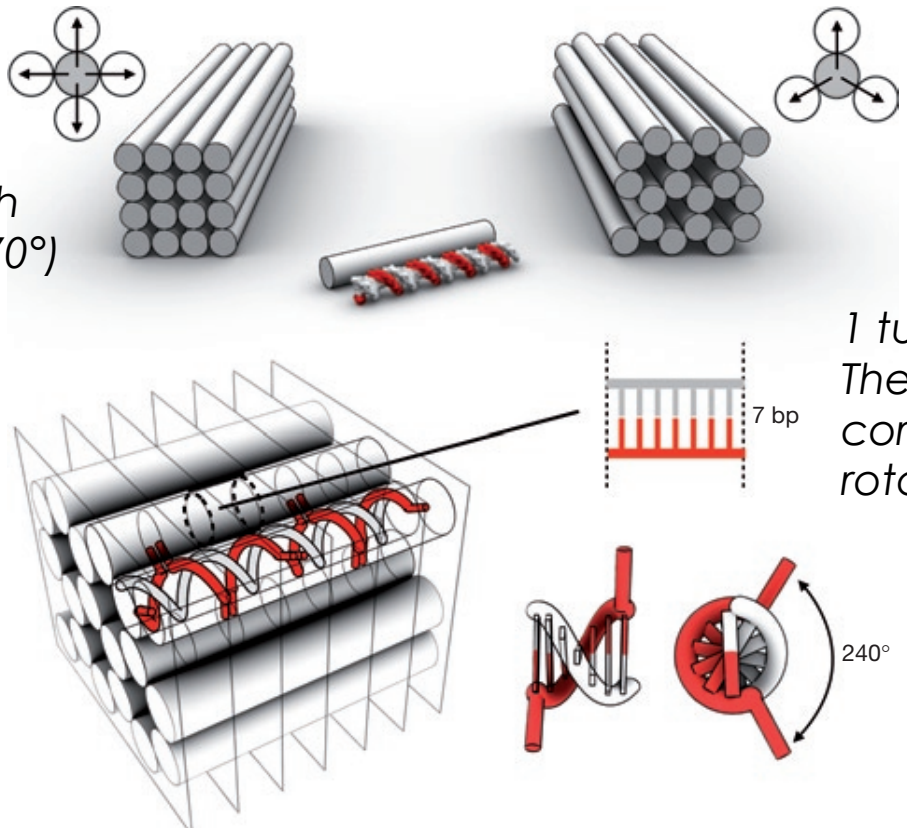


Castro et al., Nature Meth, 2011,DOI:10.1038/NMETH.1570

Dedicated softwares for DNA origami designs

CanDo *(https://cando-dna-origami.org/examples/)*

1 turn = 10.67 bp
Then, fourfold symetry with cross-overs every 8 bp (270°)



1 turn = 10.67 bp
Then, every 7 bp correspond to a 240° rotation

Castro et al., Nature Meth, 2011,DOI:10.1038/NMETH.1570