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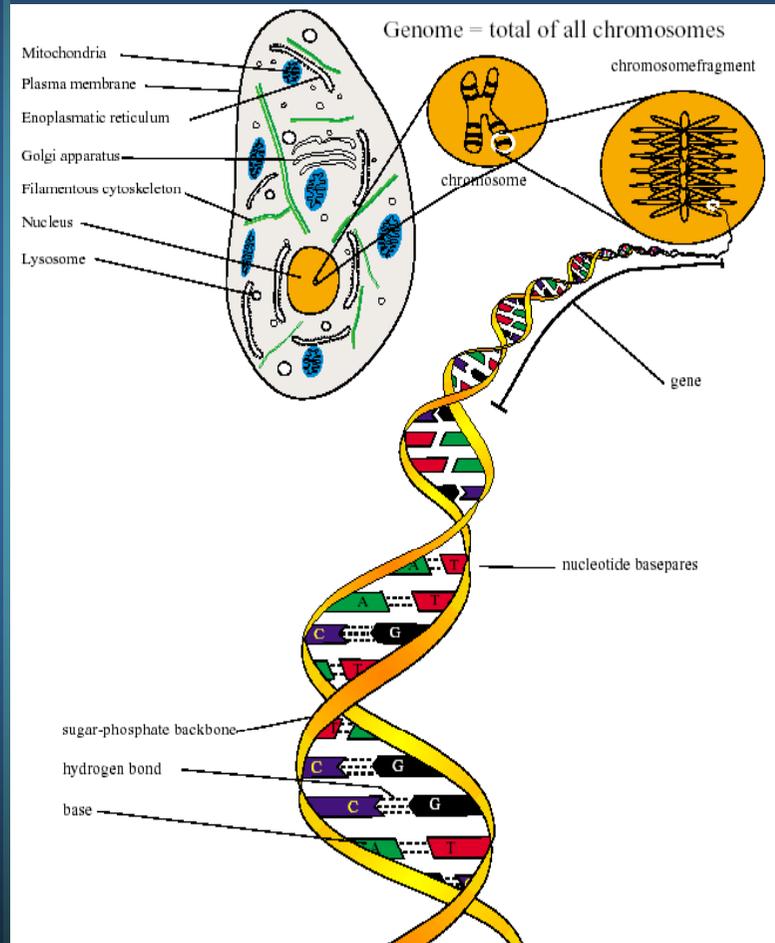
DNA: The Secret of Life

James D. Watson

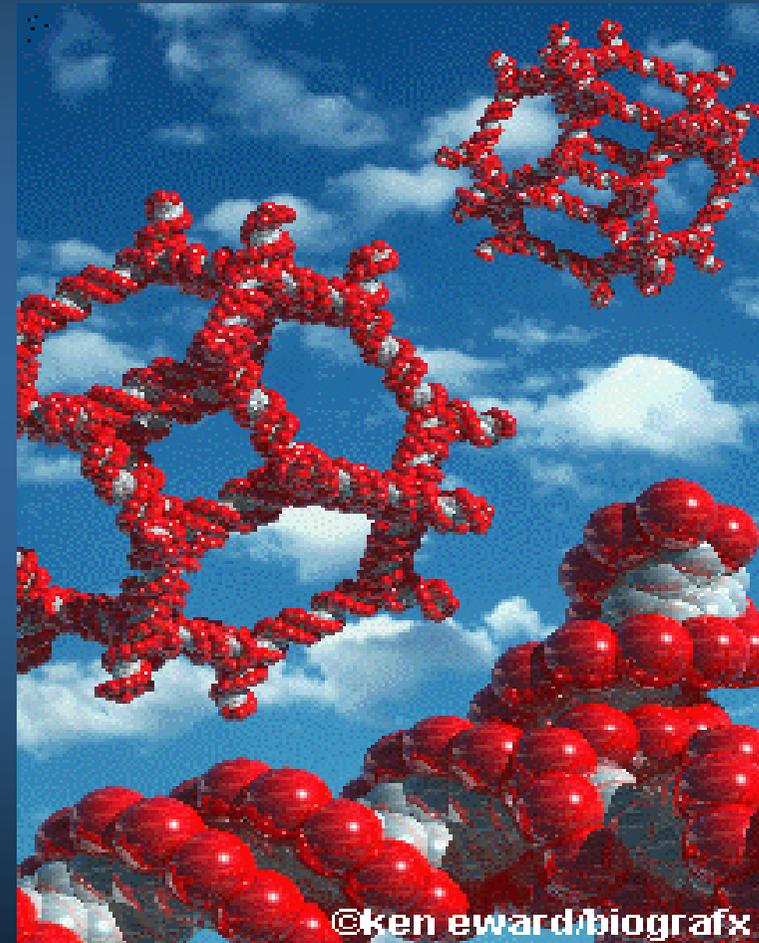
DNA: **Not Merely** the Secret of Life

Nadrian Seeman

DNA: The Secret of Life



DNA: Not Merely The Secret of Life



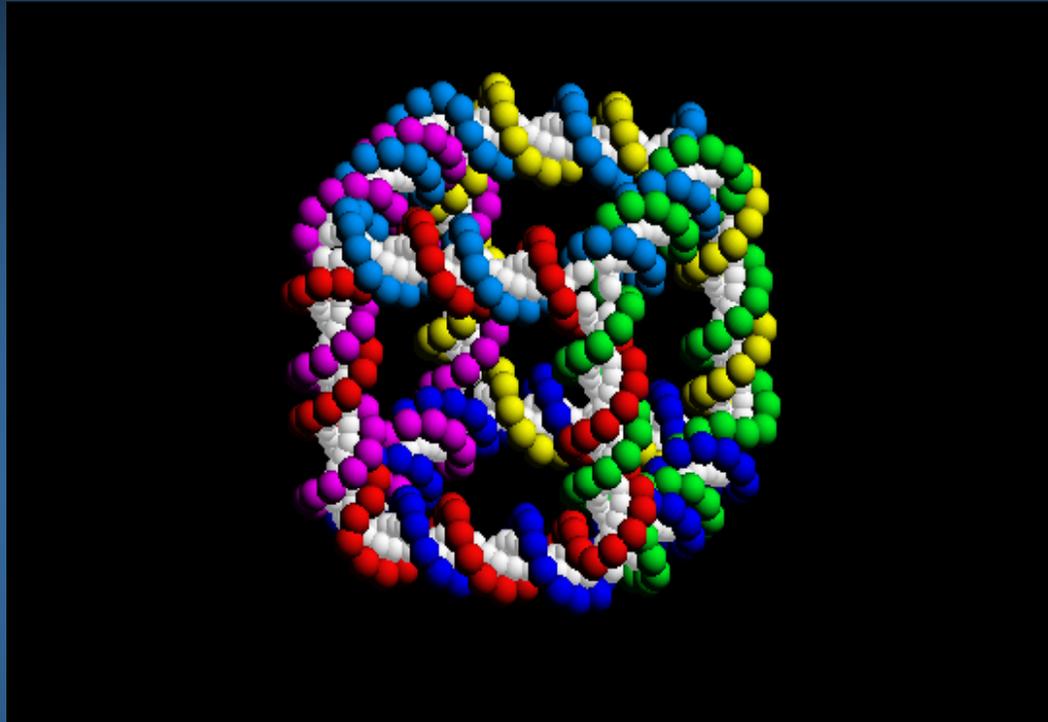
..... DNA Nanotechnology

- **Nadrian Seeman at New York University**

<http://seemanlab4.chem.nyu.edu/nanotech.html>

- **Ref: Nanobiotechnology, Chapter 20**
- **Ultimate goals for this approach**
 - **the rational synthesis of periodic matter**
 - **the assembly of a biochip computer**

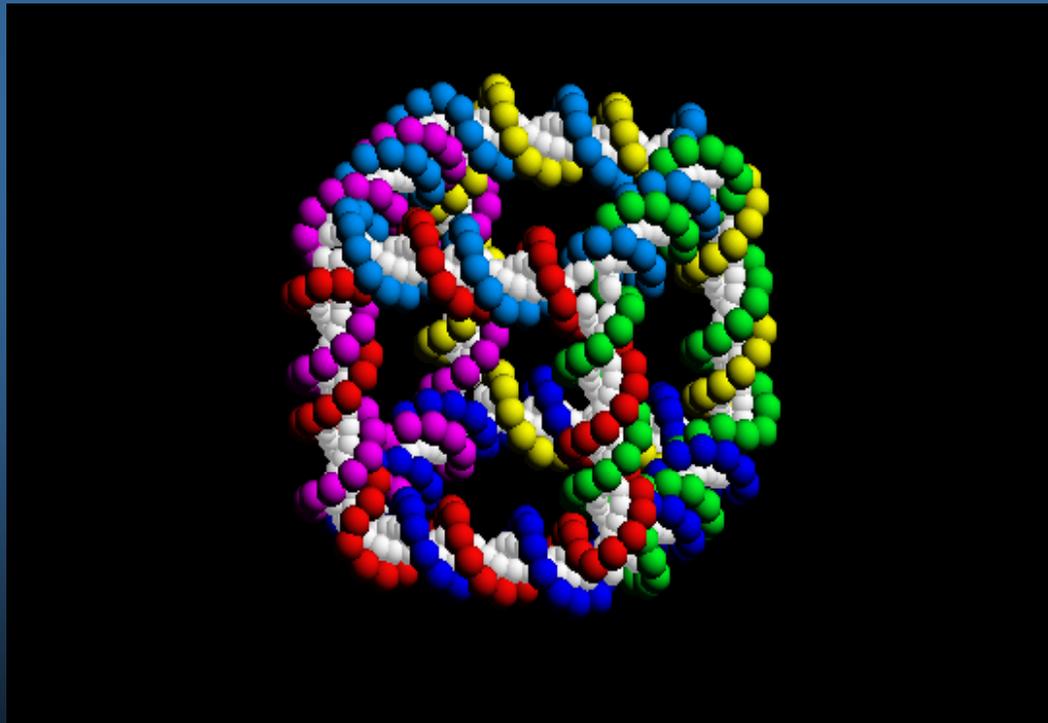
DNA Cube



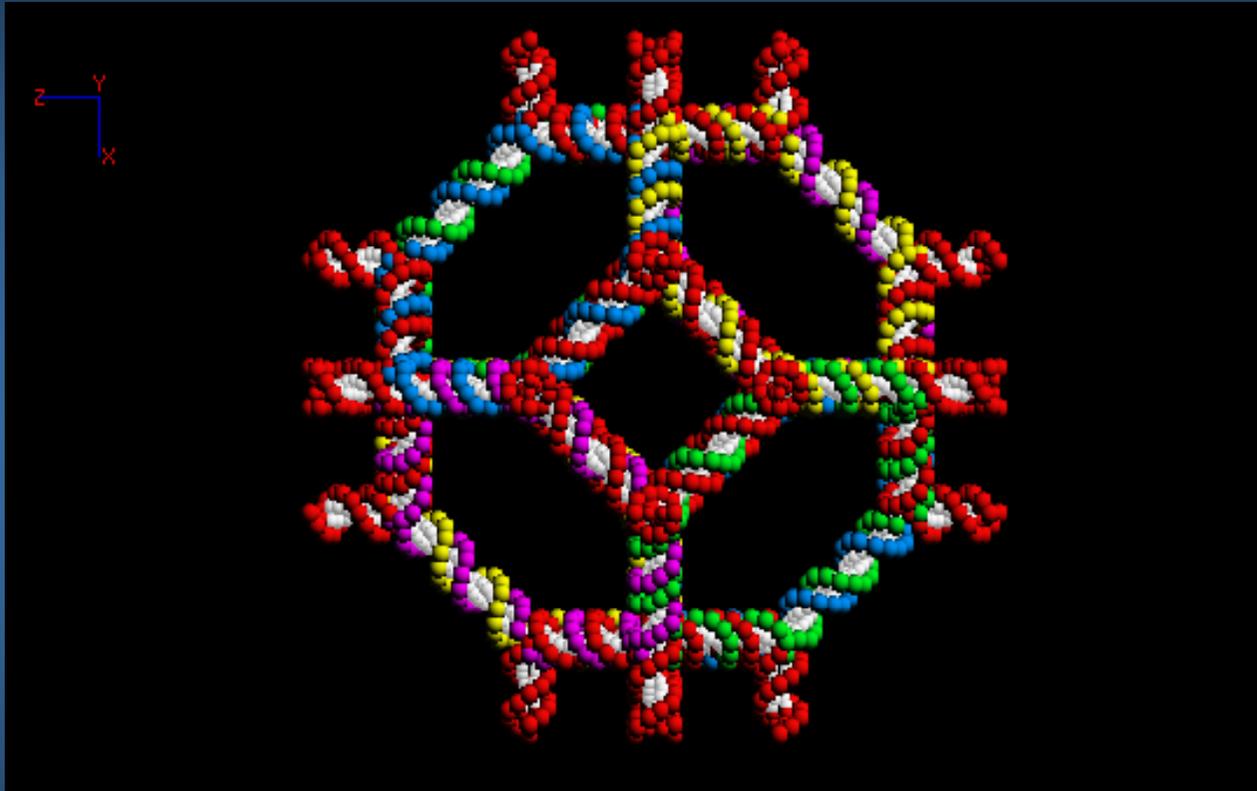
- Cube contains six different cyclic strands
- Backbones : red (front), green (right), yellow (back), magenta (left), cyan (top), and dark blue (bottom)
- Base : a single white dot

DNA Cube

- **Each edge of the cube**
 - a piece of double helical DNA, containing two turns of the double helix.



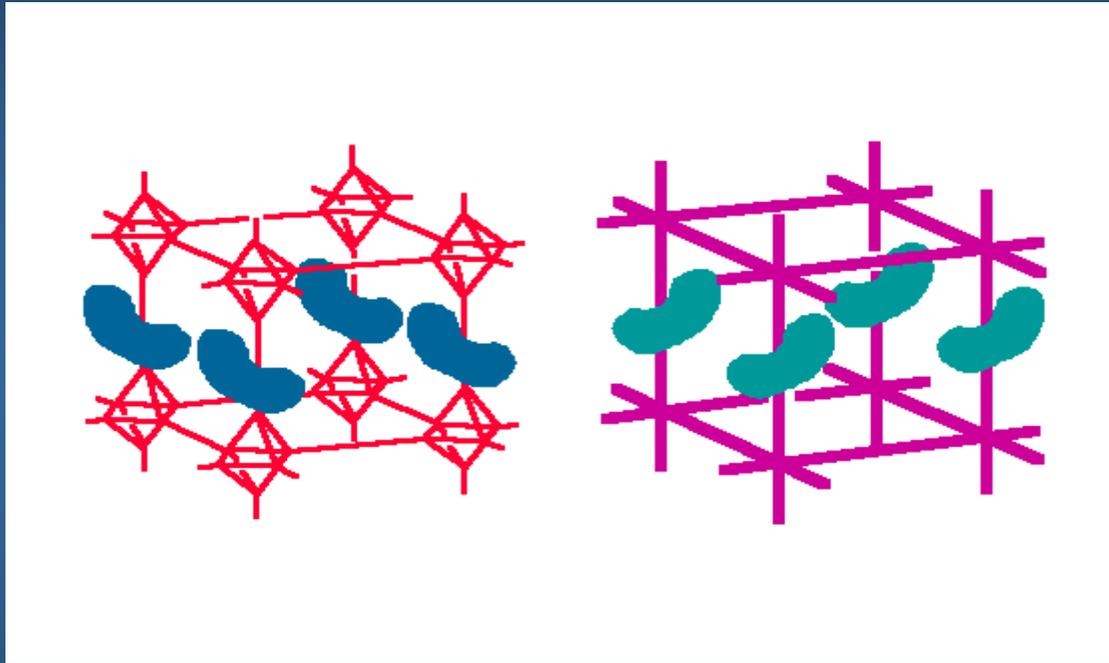
Truncated Octahedron



- contains six squares and eight hexagons.
- molecular weight: about 790,000 Daltons.

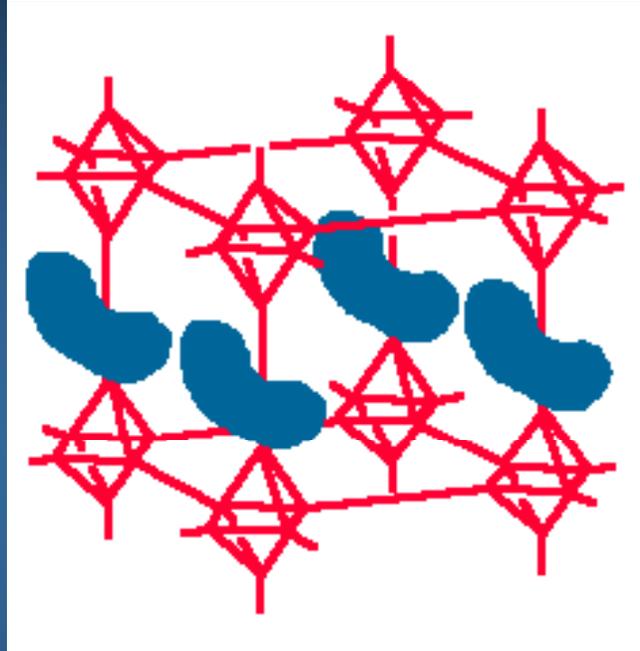
DNA Cages

Containing Oriented Guests



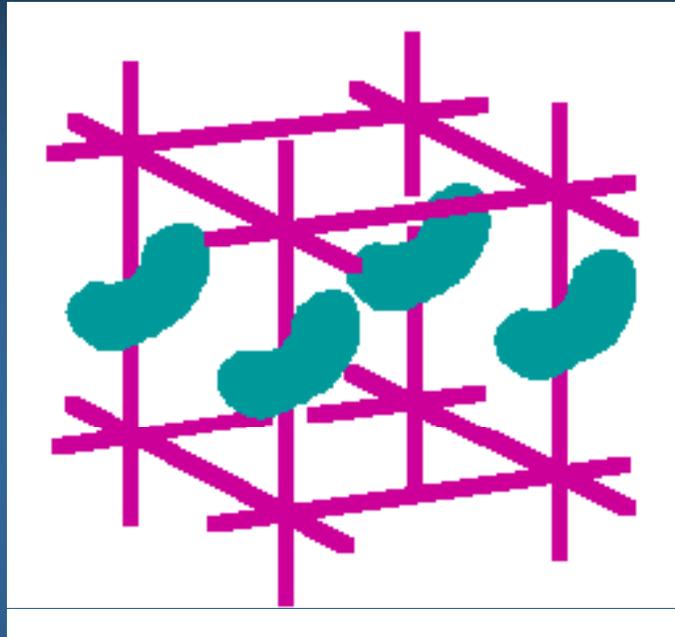
- Both networks contain kidney-shaped objects that are oriented in a parallel fashion within each network.

5-connected network



- Each vertex is connected to five other vertices.
- It contains octahedra and a truncated cube.

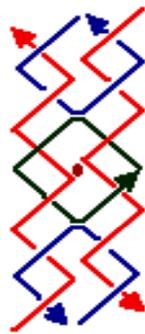
6-connected network



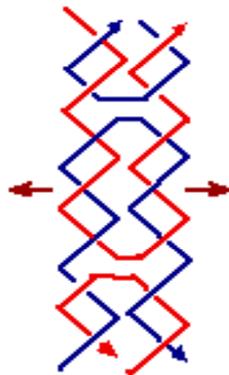
- Each vertex is connected to six different networks.
- It contains only cubes

Double Crossover Molecules

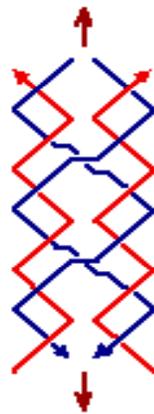
DAE



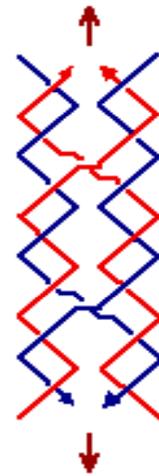
DAO



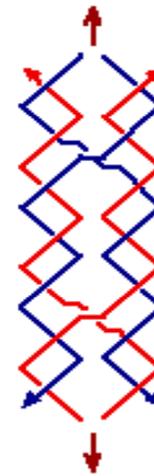
DPE



DPON



DPOW



..... Double Crossover Molecules

- All names begin with '**D**' for **double crossover**.
- '**A**' for **antiparallel** and '**P**' for **parallel**.
- The third character refers to the number of helical half-turns between crossovers, '**E**' for an **even number** and '**O**' for an **odd number**.
- The extra half-turn can correspond to a major (**wide**) groove separation, designated by '**W**', or an extra minor (**narrow**) groove separation, designated by '**N**'.

.....Ultimate goals for this approach.....

- the rational synthesis of periodic matter
- the assembly of a biochip computer

..... DNA Nanomechanical Devices (DNA Motor)

The goals of nanotechnology include nanorobotics.

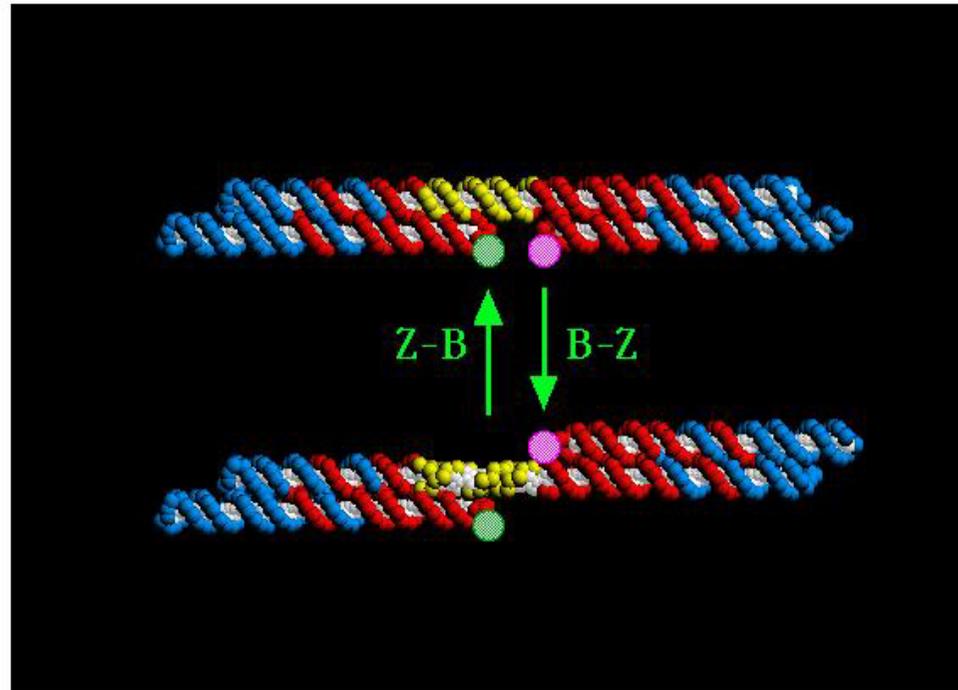
(1) Based on the B-Z transition of DNA

(2) Based on hybridization topology

(3) Bipedal walking device

--- The rise and fall of each foot of the biped is controlled by introducing DNA strands with specific sequences into the solution.

(1) Based on the B-Z Transition of DNA



B-DNA (right-handed DNA) Z-DNA (left-handed DNA)

.....(1) Based on the B-Z Transition of DNA.....

- Two double crossover molecules (red and blue regions) were connected by a bridge segment (yellow region).
- The rigidity of the antiparallel **double crossover molecule** has allowed us to use it as a component of a DNA nanomechanical device.

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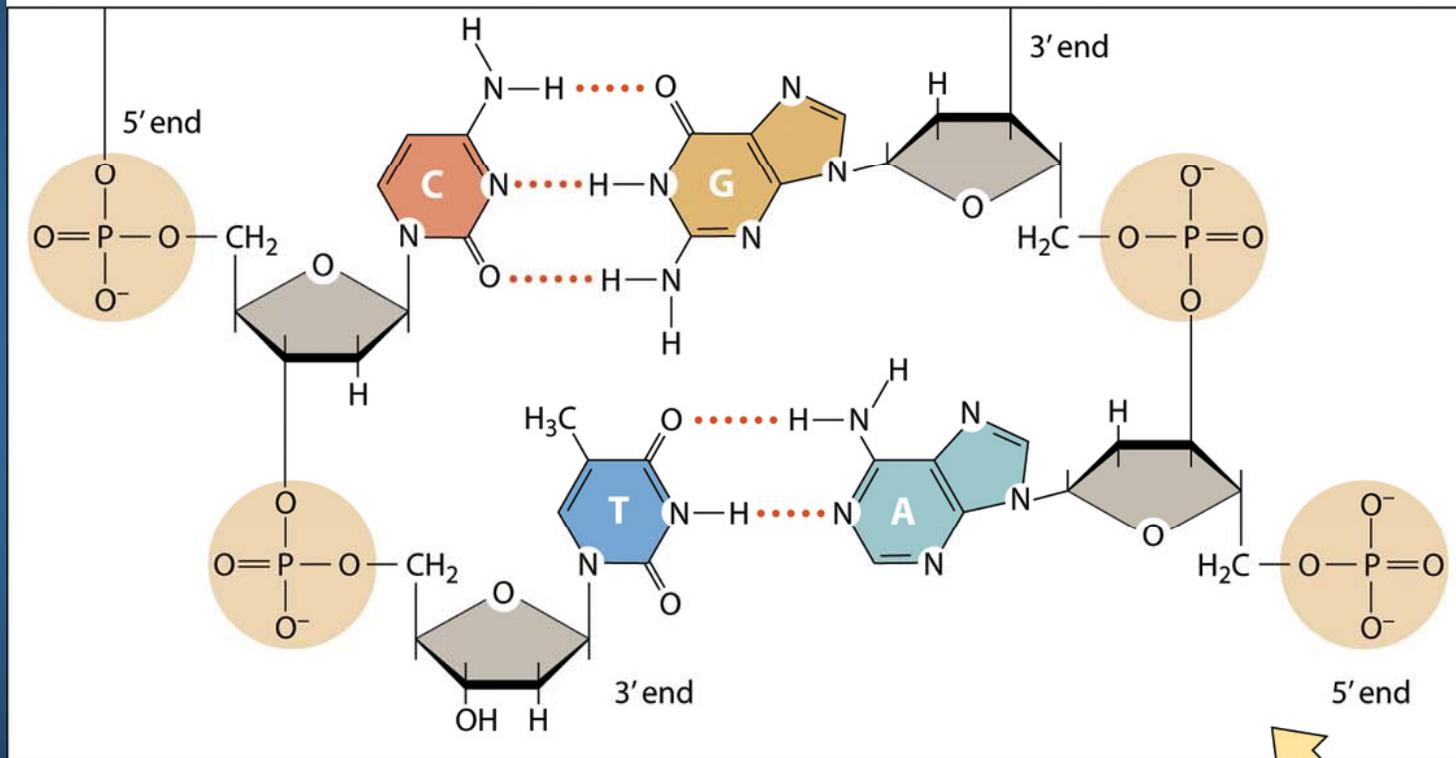
*** Right-handed helix**

- When an observer looks down the axis of the helix in either direction, each strand follows a clockwise path as it moves away from the observer.**
- Naturally occurring DNA molecules are generally right-handed helices.**

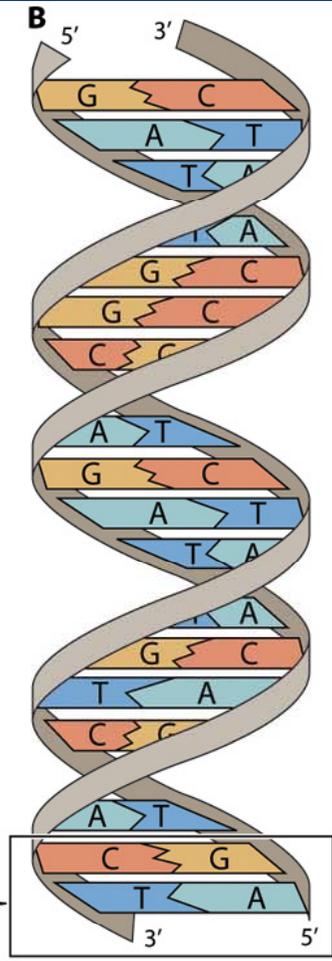
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A



B



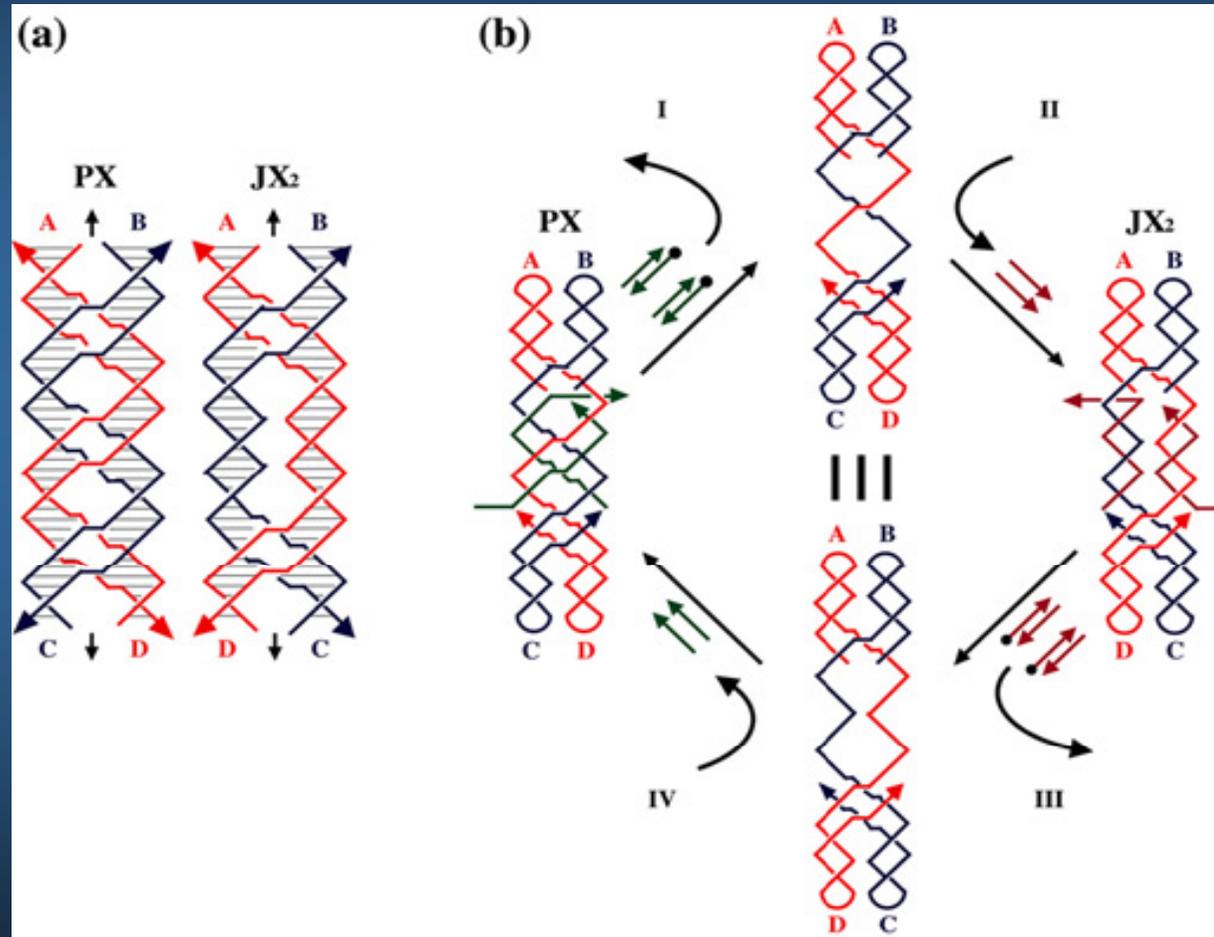
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*** The change from B-DNA to Z-DNA :**
---- by the addition of Hexaamminecobalt(III) chloride to the solution.

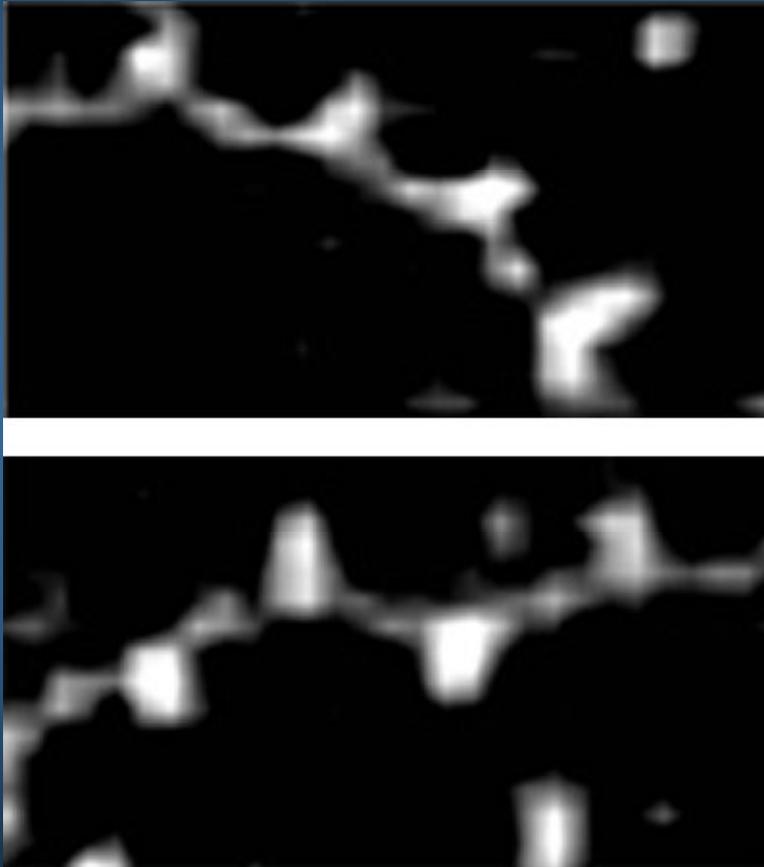
*** The change back:**
---- by removal of this reagent.

The change of conformation from B-DNA to Z-DNA is monitored by fluorescence resonance energy transfer (FRET) spectroscopy involving these two dyes.

..... (2) Based on Hybridization Topology



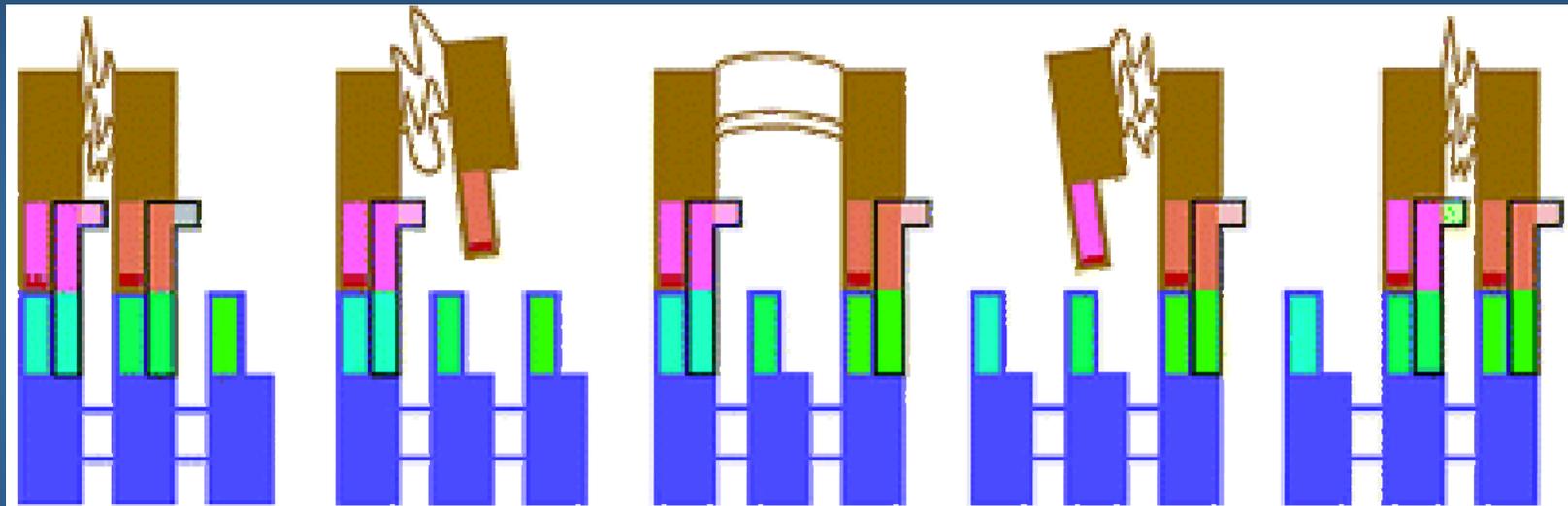
**"A Robust DNA Mechanical Device Controlled by
Hybridization Topology," Nature, January 3, 2002.**



- **The bumps on this DNA motor each consist of three joined DNA tiles.**
 - **Top: bumps aligned with each other**
 - **Bottom: bumps alternating directions**

(3) Bipedal Walking Device **(Walking DNA)**

W. B. Sherman and N. C. Seeman Nano Lett.; 2004; 4(7) pp 1203 - 1207



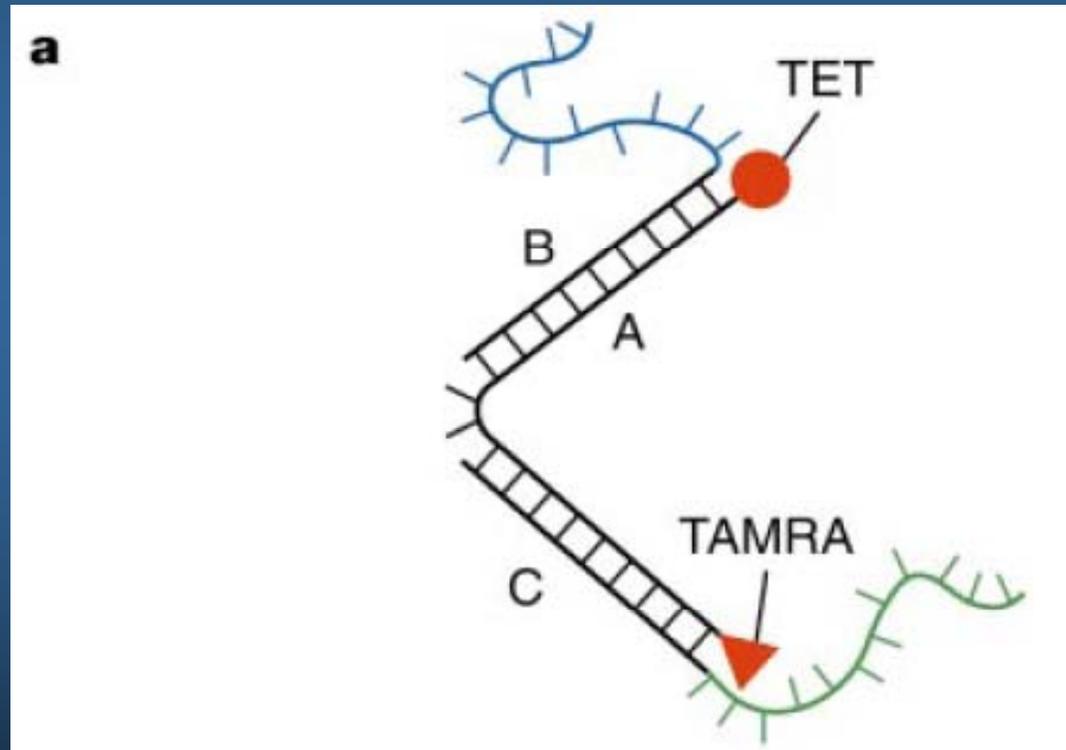
The rise and fall of each foot of the biped is controlled by introducing DNA strands with specific sequences into the solution.

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DNA Tweezers

(Nature, 406, p605, 2000)

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DNA Tweezers

(Nature, 406, p605, 2000)

