

# Biomolecule sizes

sugars, amino acids,  
and nucleotides ~0.5–1 nm



globular proteins ~2–10 nm

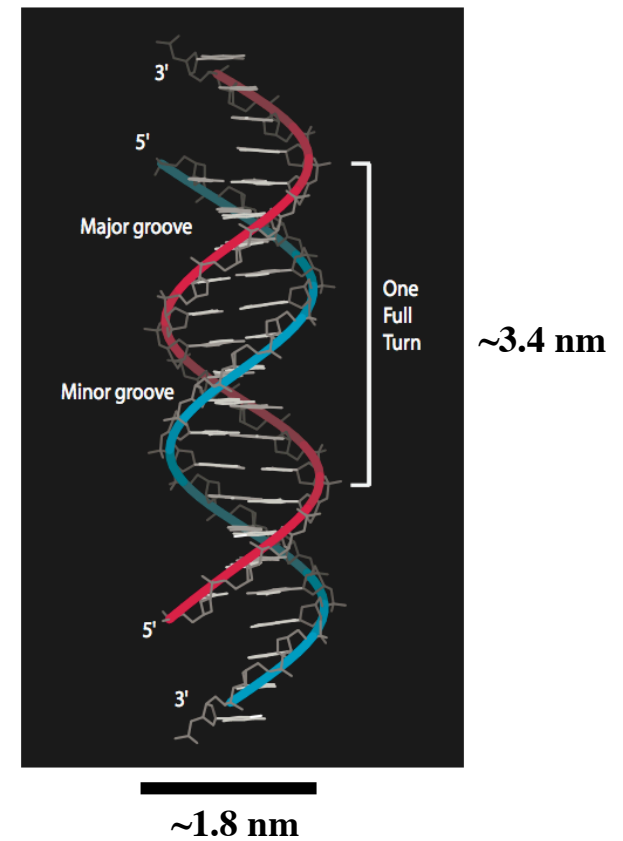


ribosome ~30 nm



dsDNA

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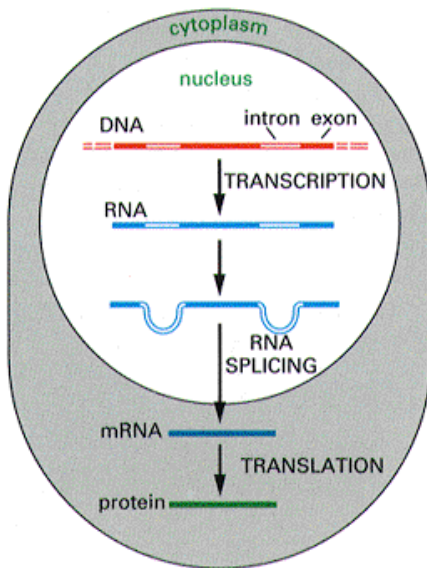
# Canons and Definitions

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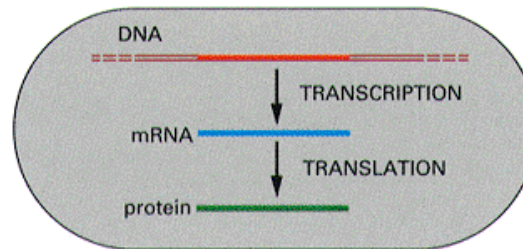
- Biomolecules, biomacromolecules.
- Structure determines Function.
- Monomer, oligomer, polymer.
  - Deoxyribonucleotide, ribonucleotide, amino acid.
- Configuration (covalent structure) vs Conformation (3D structure).

# Central Dogma

## EUCARYOTES



## PROCARYOTES

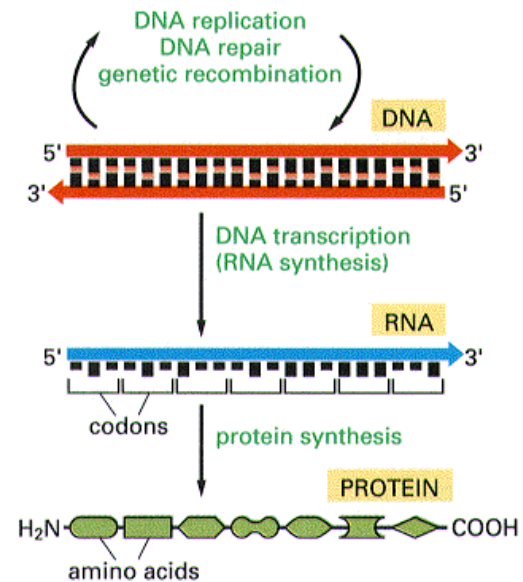


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DNA--> RNA--> Protein

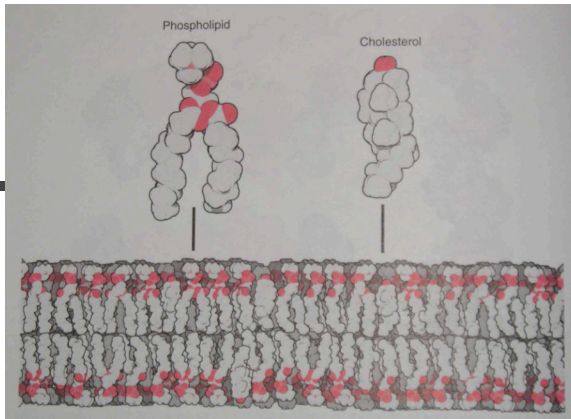
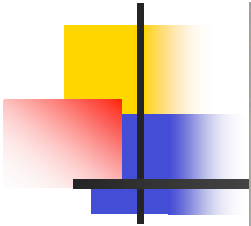
1st position (5' end) ↓	2nd position				3rd position (3' end) ↓
U	Phe Phe Leu Leu	Ser Ser Ser Ser	Tyr Tyr STOP STOP	Cys Cys STOP Trp	U C A G
C	Leu Leu Leu Leu	Pro Pro Pro Pro	His His Gln Gln	Arg Arg Arg Arg	U C A G
A	Ile Ile Ile Met	Thr Thr Thr Thr	Asn Asn Lys Lys	Ser Ser Arg Arg	U C A G
G	Val Val Val Val	Ala Ala Ala Ala	Asp Asp Glu Glu	Gly Gly Gly Gly	U C A G

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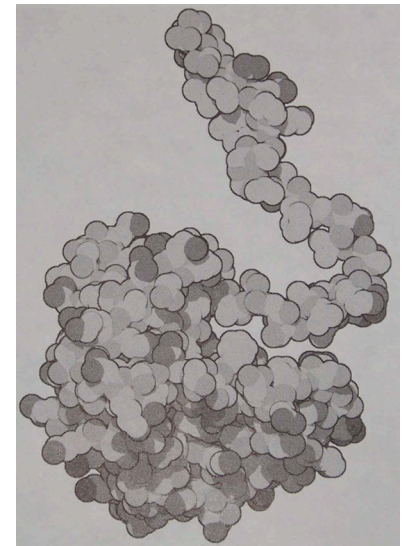
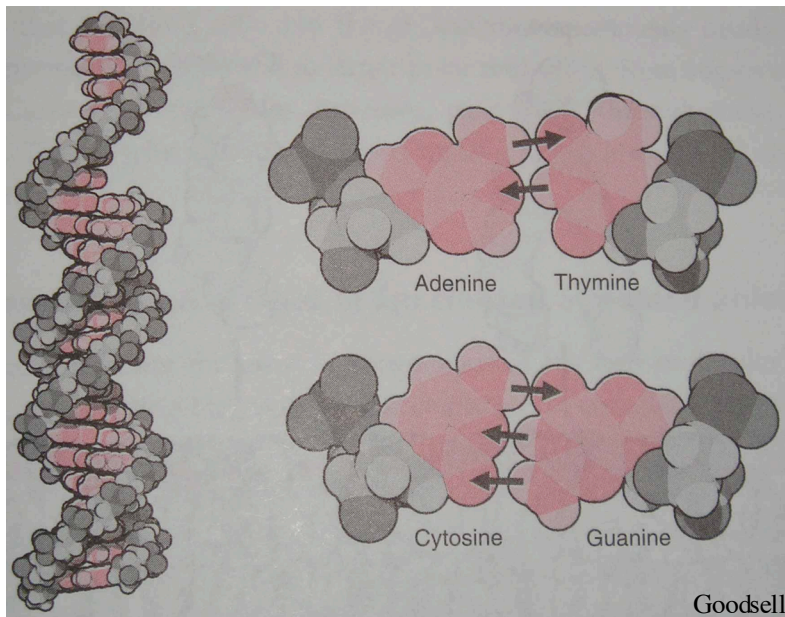
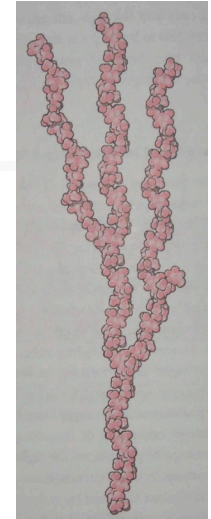


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# Biomolecules



- Lipids
- Carbohydrates
- Proteins
- Nucleic acids



# ssDNA, chemical structure

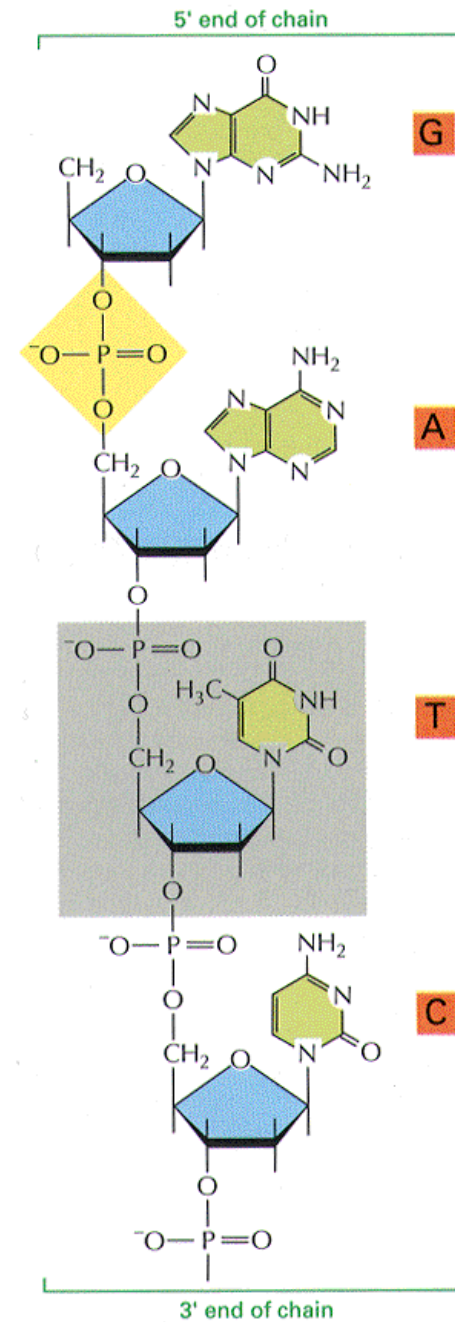
Nucleoside (sugar + base)

Nucleotide (sugar + base + phosphate)

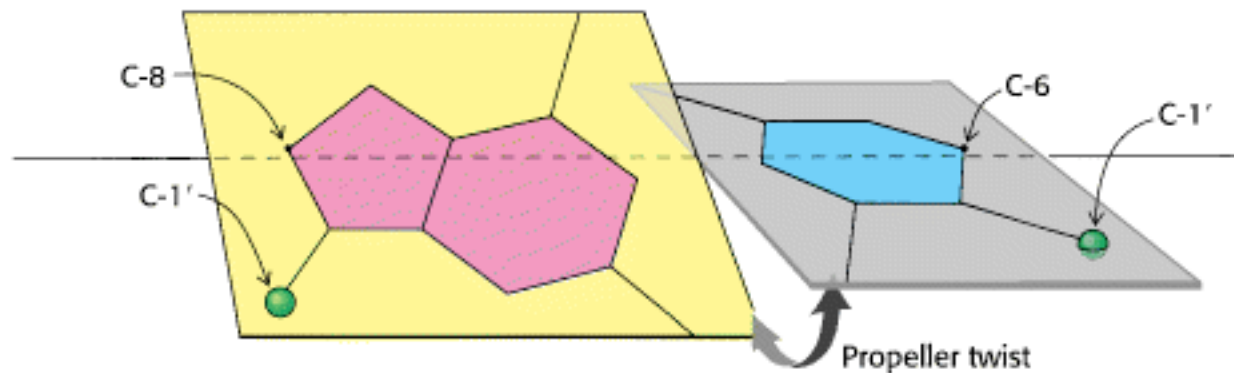
## RAG & TYC

Purine (R ): adenine (A), guanine (G)

Pyrimidine (Y): thymine (T), cytosine (C )



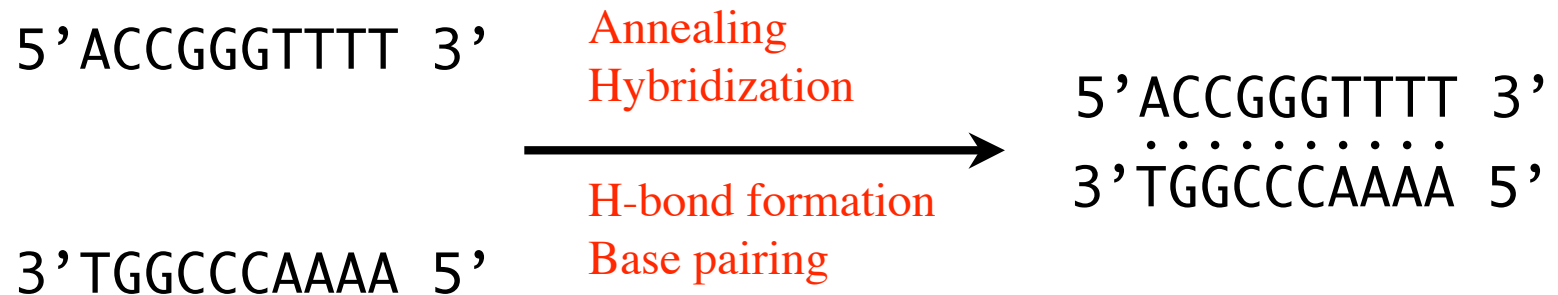
# DNA structural details...



**Propeller Twist.** The bases of a DNA base pair are often not precisely coplanar. They are twisted with respect to each other, like the blades of a propeller.



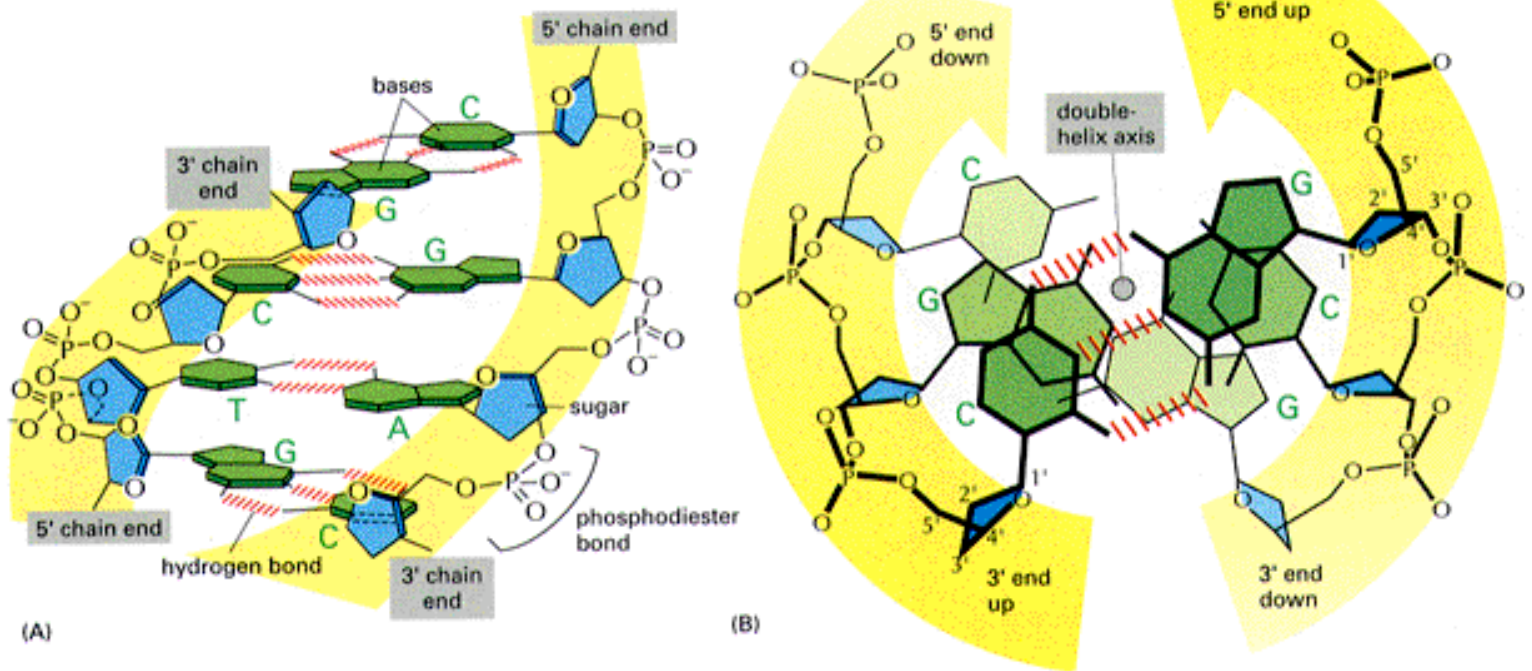
# Complementary Base Pairing



	$4^5 = 1,024$	Number of sequences of a given length available.
$a^L = N$	$4^{10} = 1,048,576$	
	$4^{100} = 2 \times 10^{60}$	



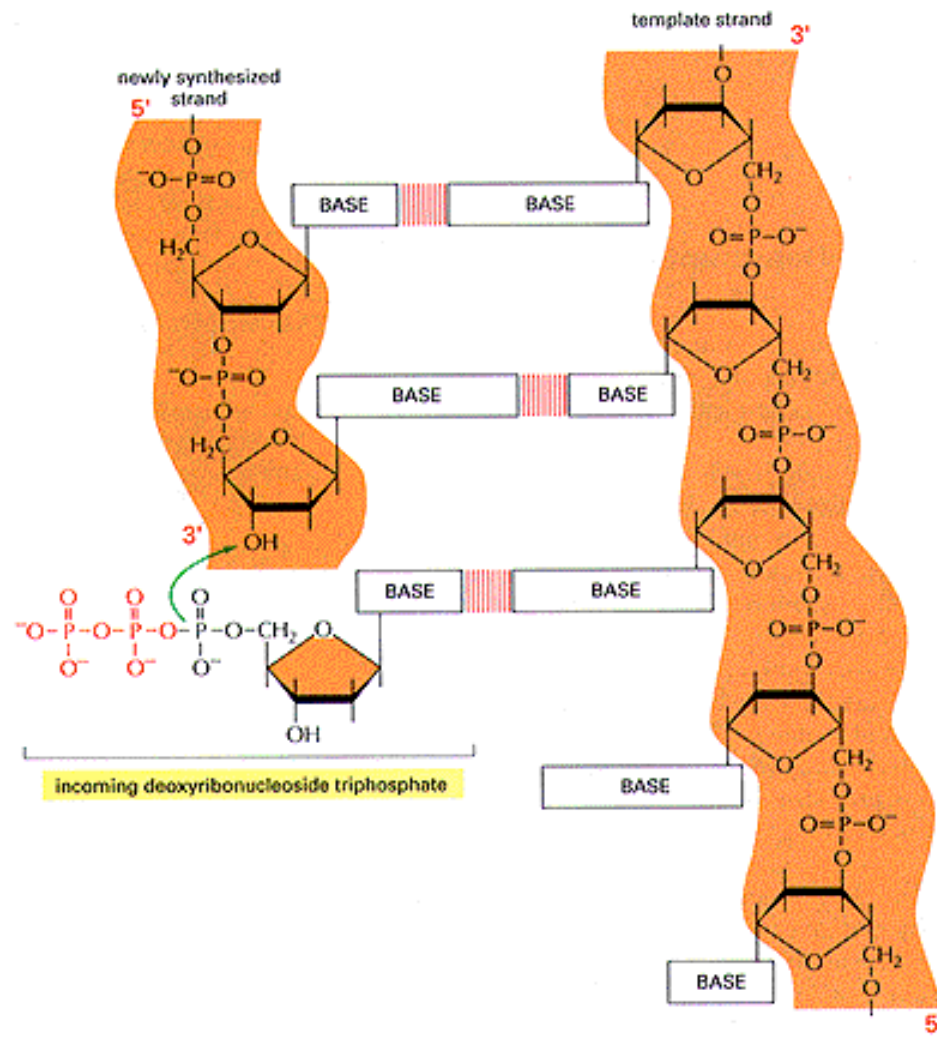
# dsDNA, antiparallel helix



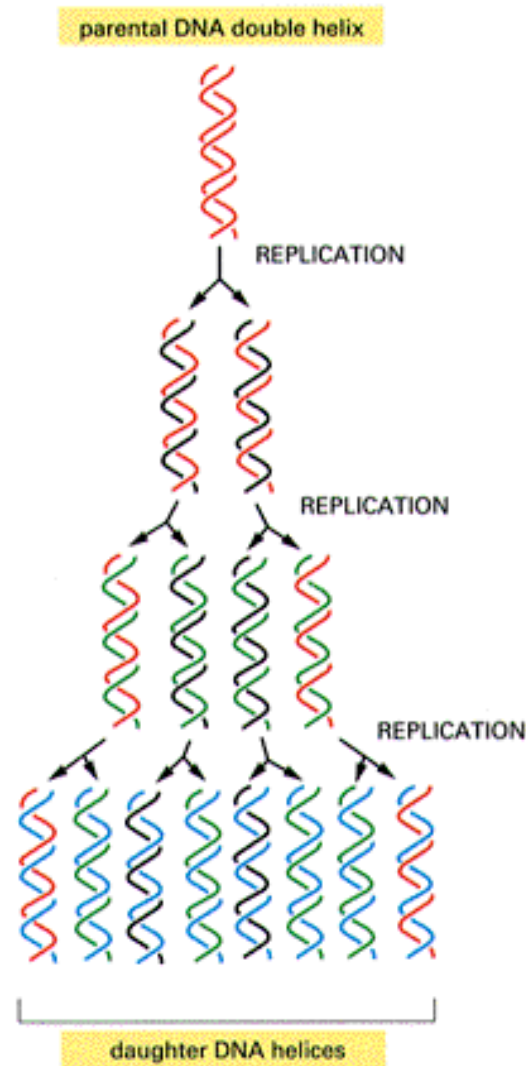
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# DNA polymerization



# DNA replication

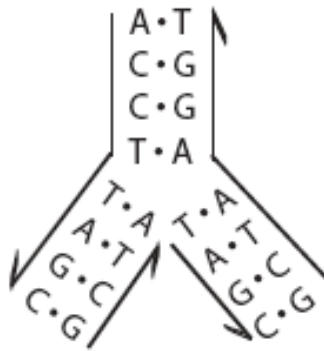


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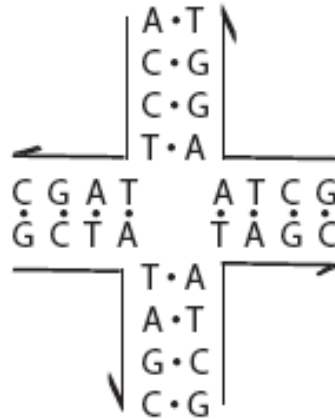
# Linear vs branched junctions



dsDNS



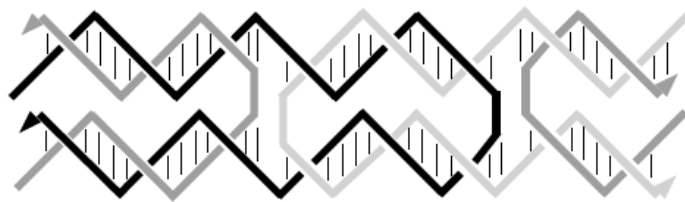
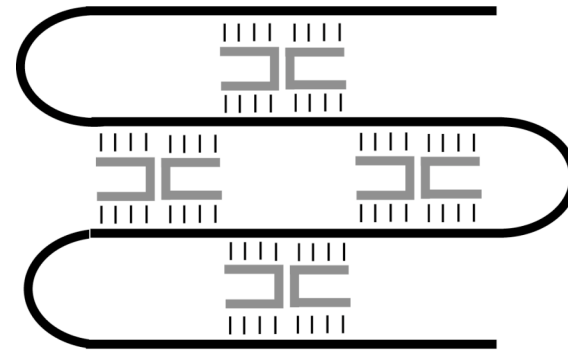
3-arm Junction



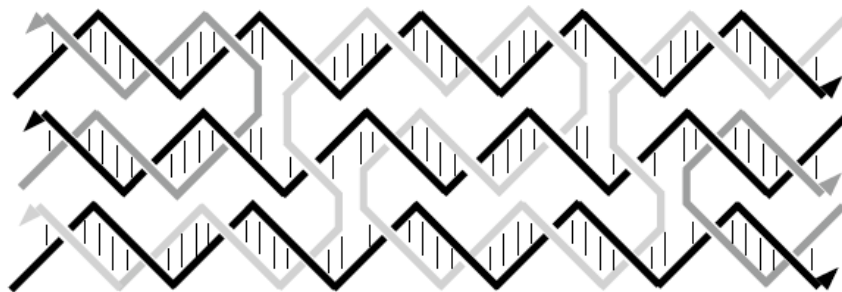
4-arm Junction



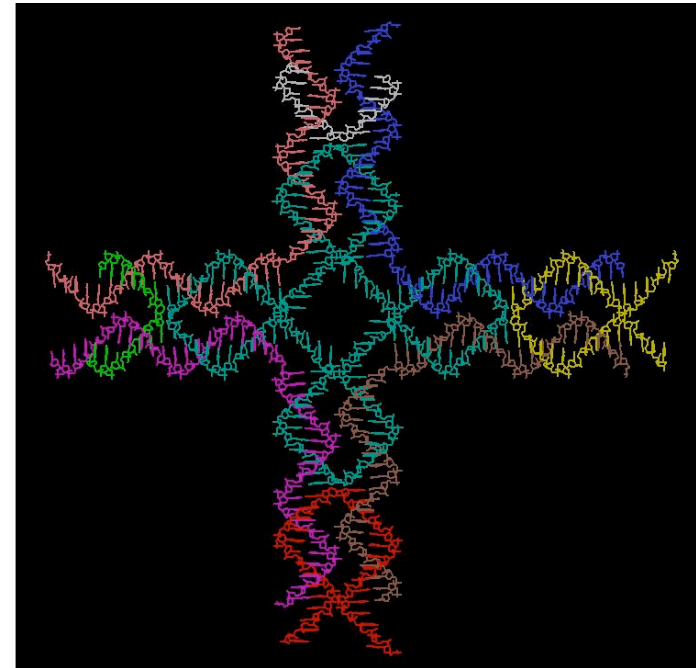
# DNA tiles



DAO



TAE





# Software and databases

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- Richardson Lab
  - <http://kinemage.biochem.duke.edu/>
    - Molecular display and analysis software for all platforms (free!)
- Nucleic acid database
  - <http://ndbserver.rutgers.edu/>
    - 3D structure data for DNA and RNA
- Protein Data Bank
  - <http://www.rcsb.org/pdb/>
    - 3D structure data for proteins



# Why DNA in BioNano?

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- Programmable molecular recognition.
  - “smart velcro”
  - Understandable rules (WC base-pairing)
  - Large sequence space -- big library of addresses
- Biotechnology infrastructure
  - Chemical synthesis of oligonucleotides
  - Enzymes for DNA manipulation and modification
  - Diverse attachment chemistry
- Fairly stable chemistry