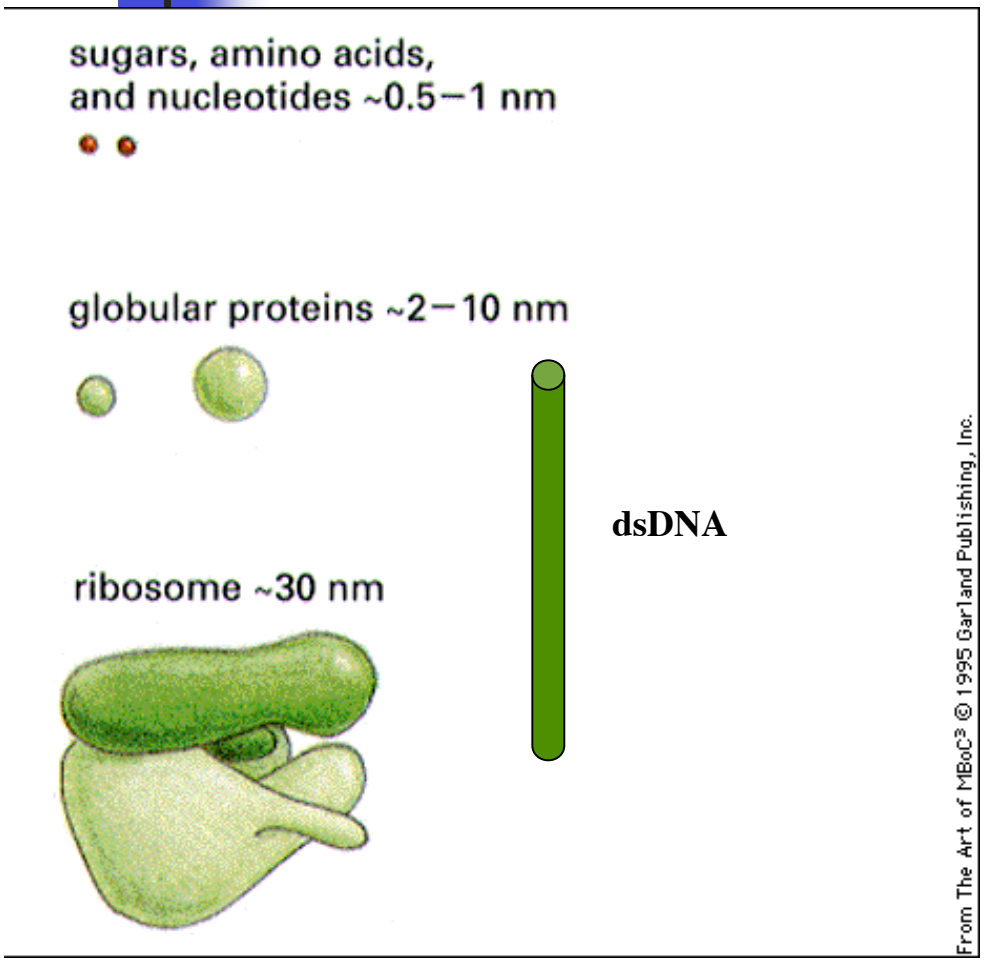
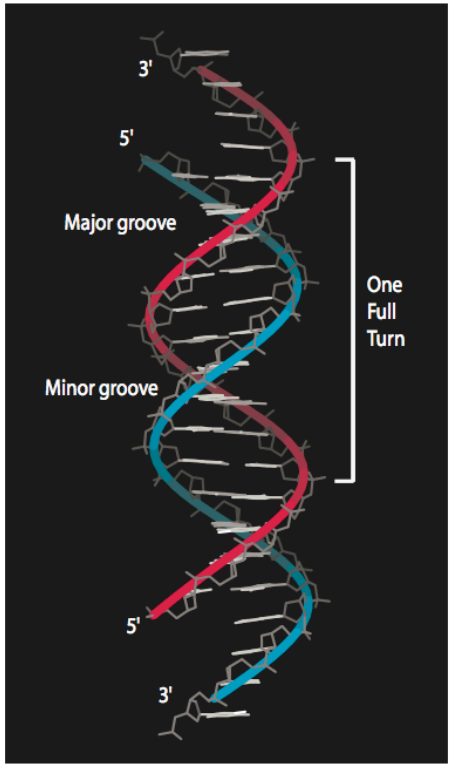
Biomolecule sizes

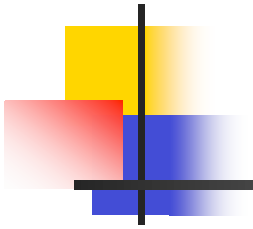




~3.4 nm

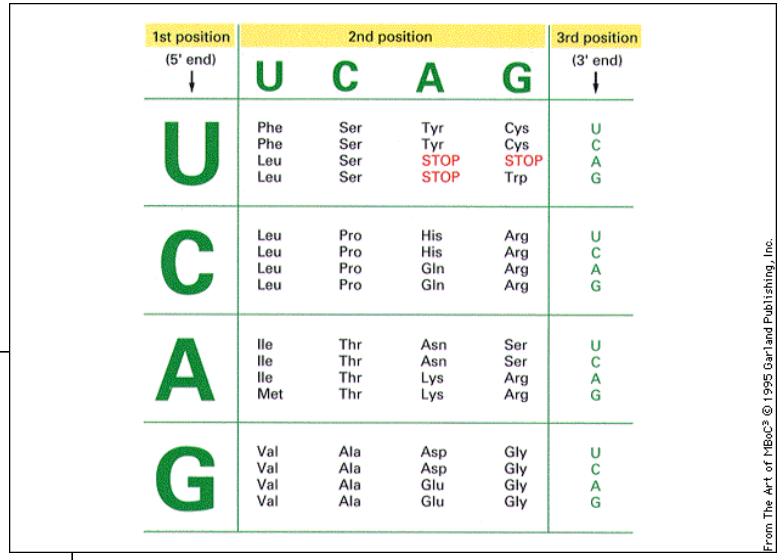
~1.8 nm

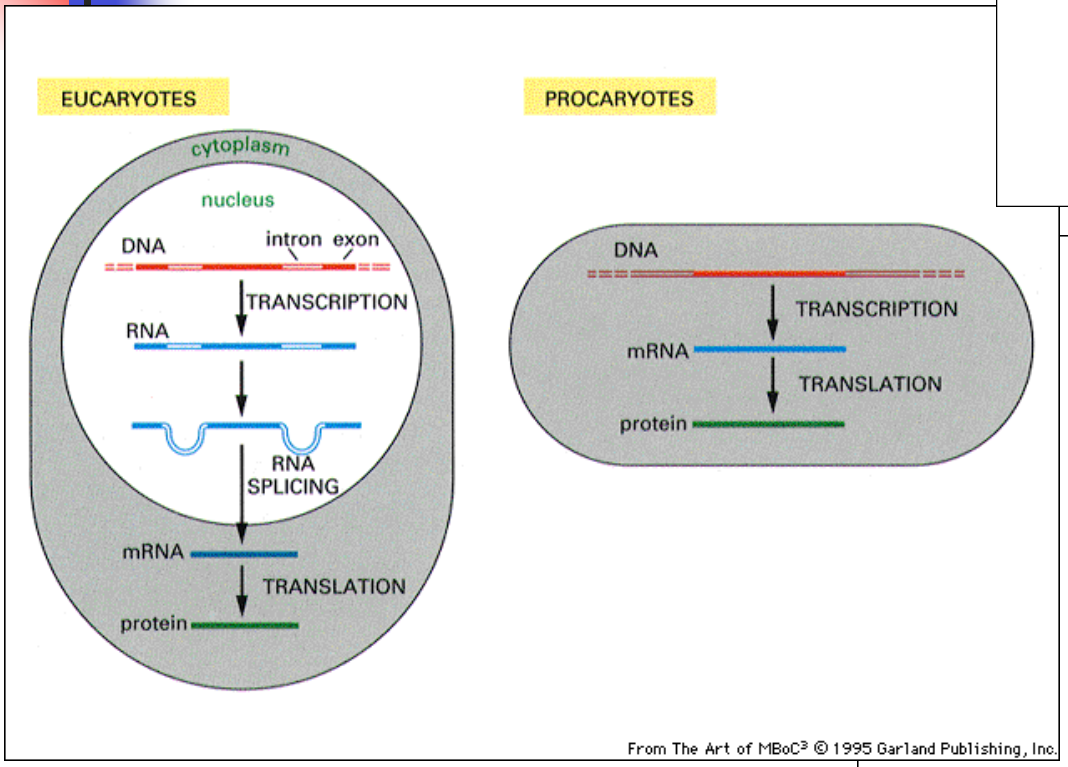
Canons and Definitions

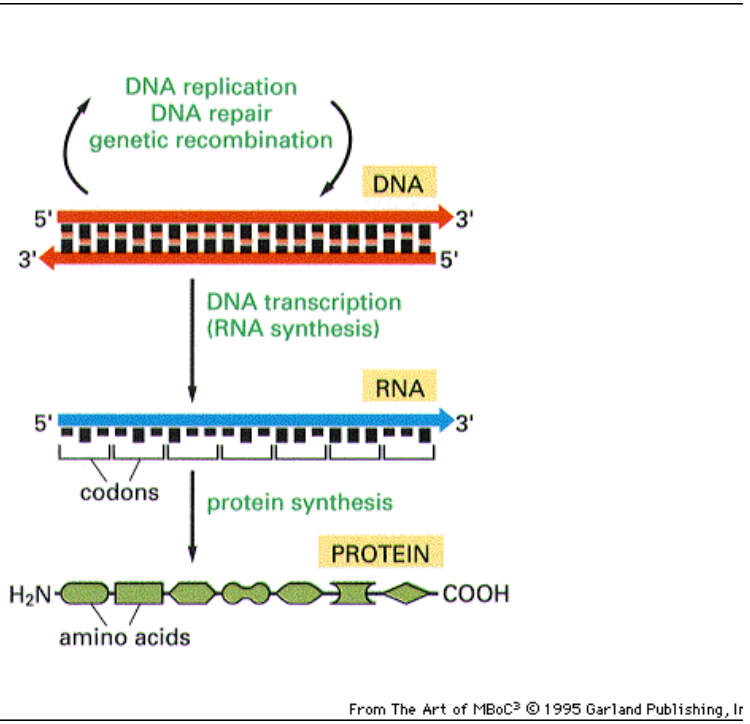


- Biomolecules, biomacromolecules.
- Structure determines Function.
- Monomer, oligomer, polymer.
  - Deoxyribonucleotide, ribonucleotide, amino acid.
- Configuration (covalent structure) vs Conformation (3D structure).

Central Dogma

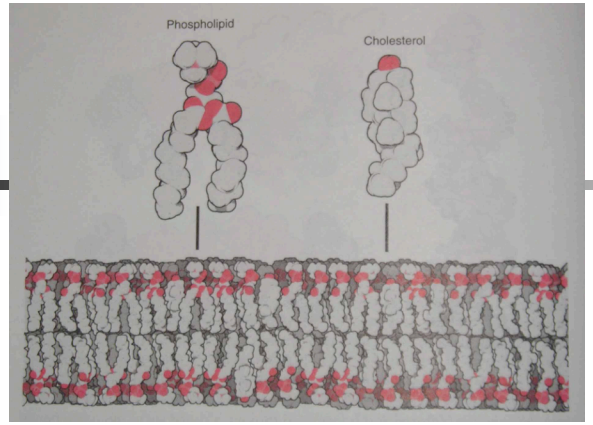


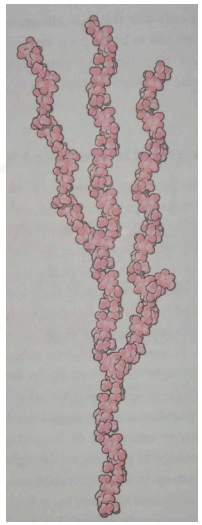




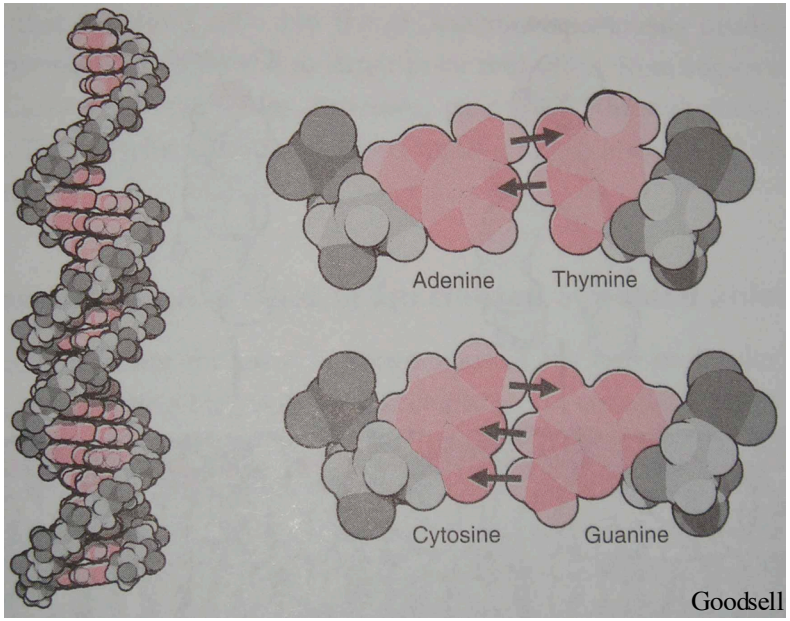
DNA--> RNA--> Protein

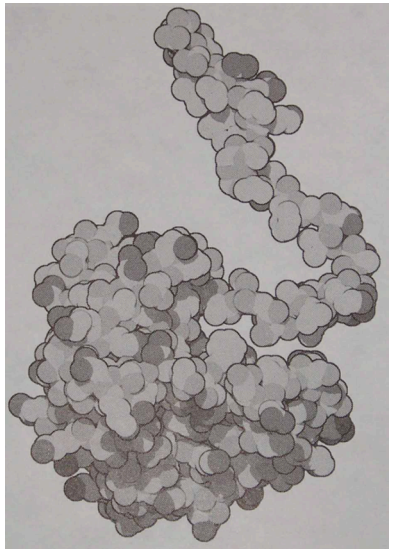
Biomolecules





- Lipids
- Carbohydrates
- Proteins
- Nucleic acids



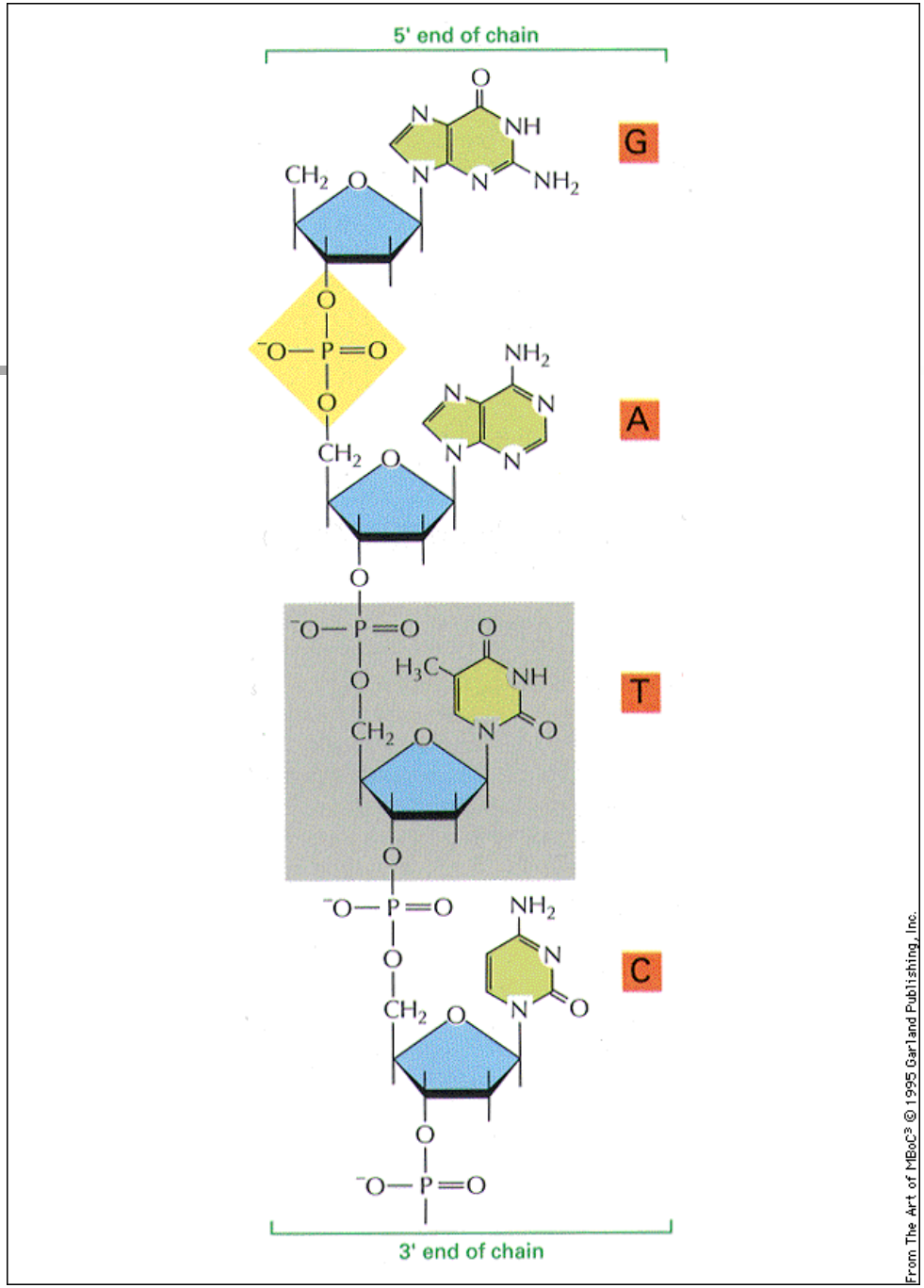


ssDNA, chemical structure

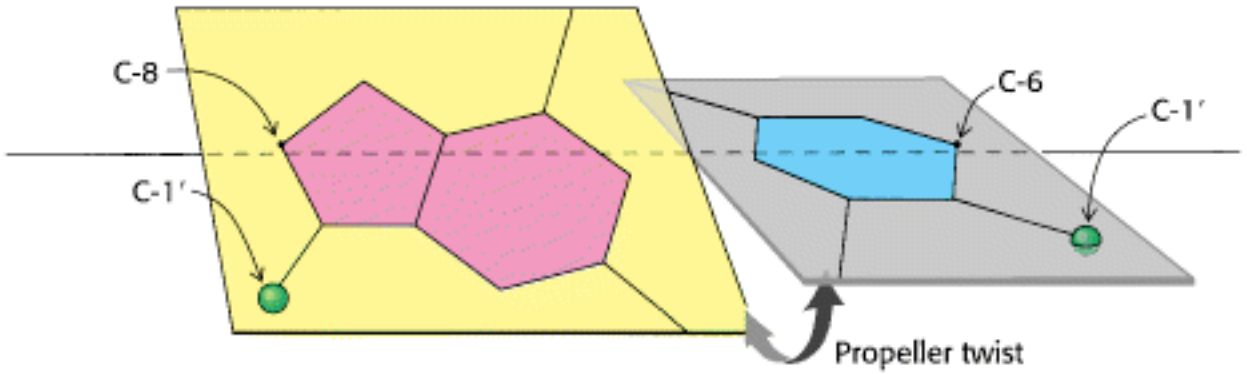
Nucleoside (sugar + base)
Nucleotide (sugar + base + phosphate)

RAG & TYC

Purine (R): adenine (A), guanine (G)
Pyrimidine (Y): thymine (T), cytosine (C)

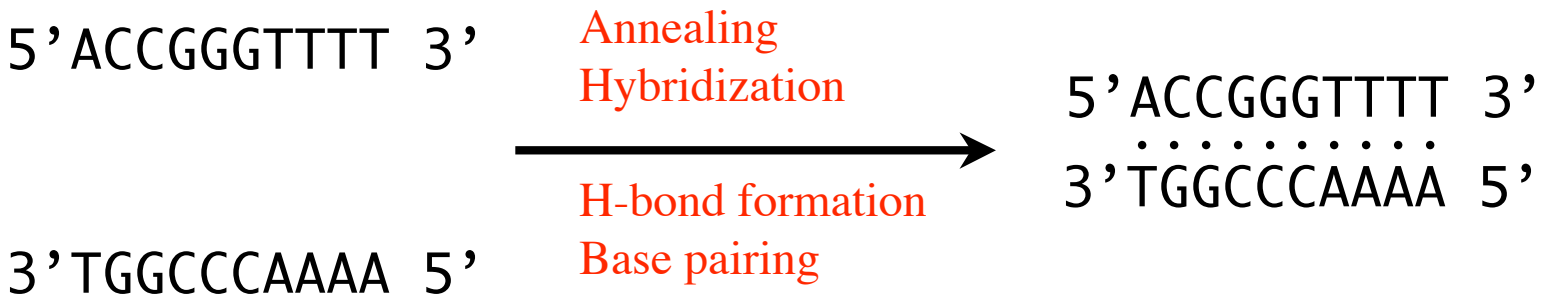


DNA structural details…



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



$a^L = N$

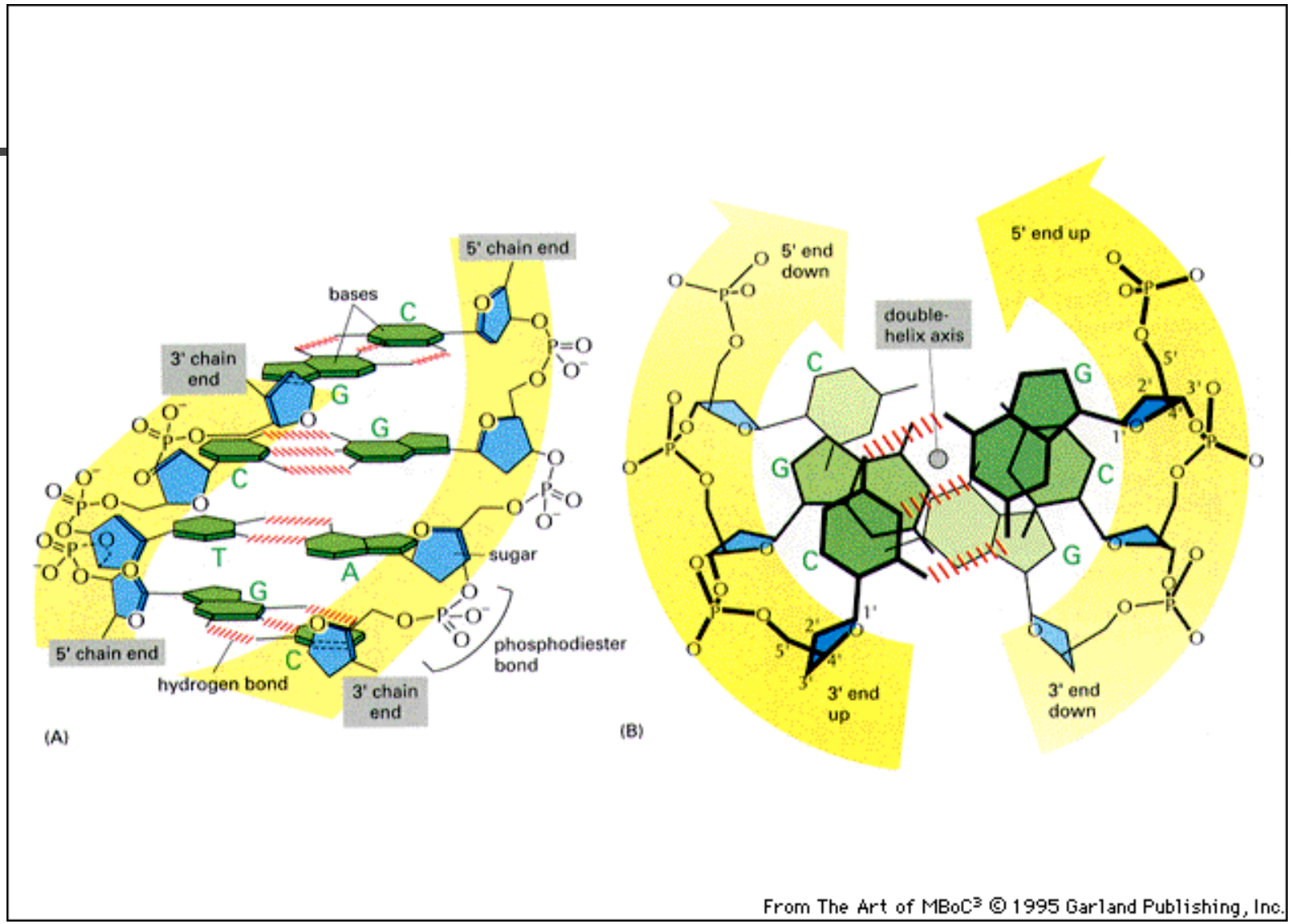
$4^5 = 1{,}024$

$4^{10} = 1{,}048{,}576$

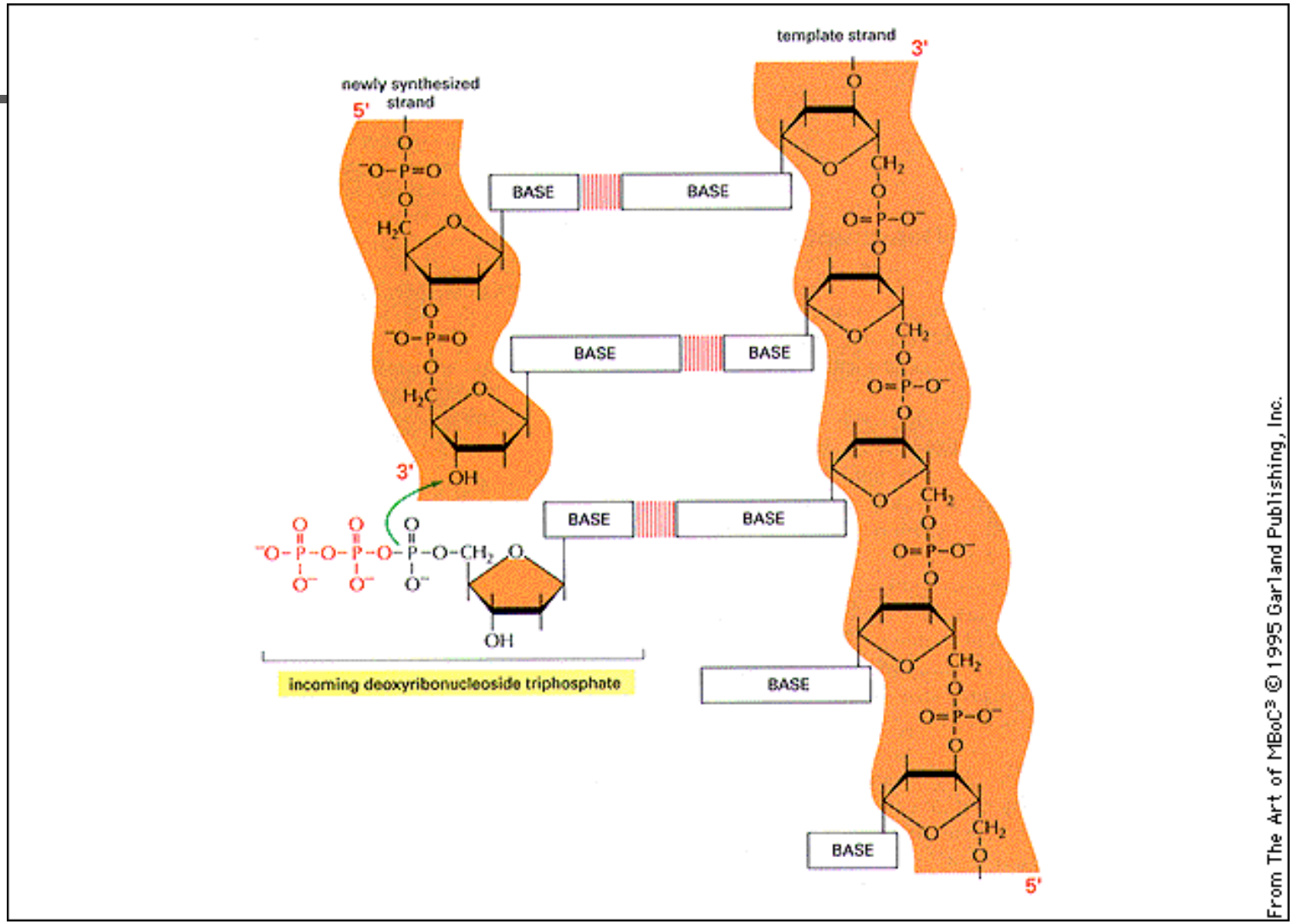
$4^{100} = 2 \times 10^{60}$

Number of sequences of a given length available.

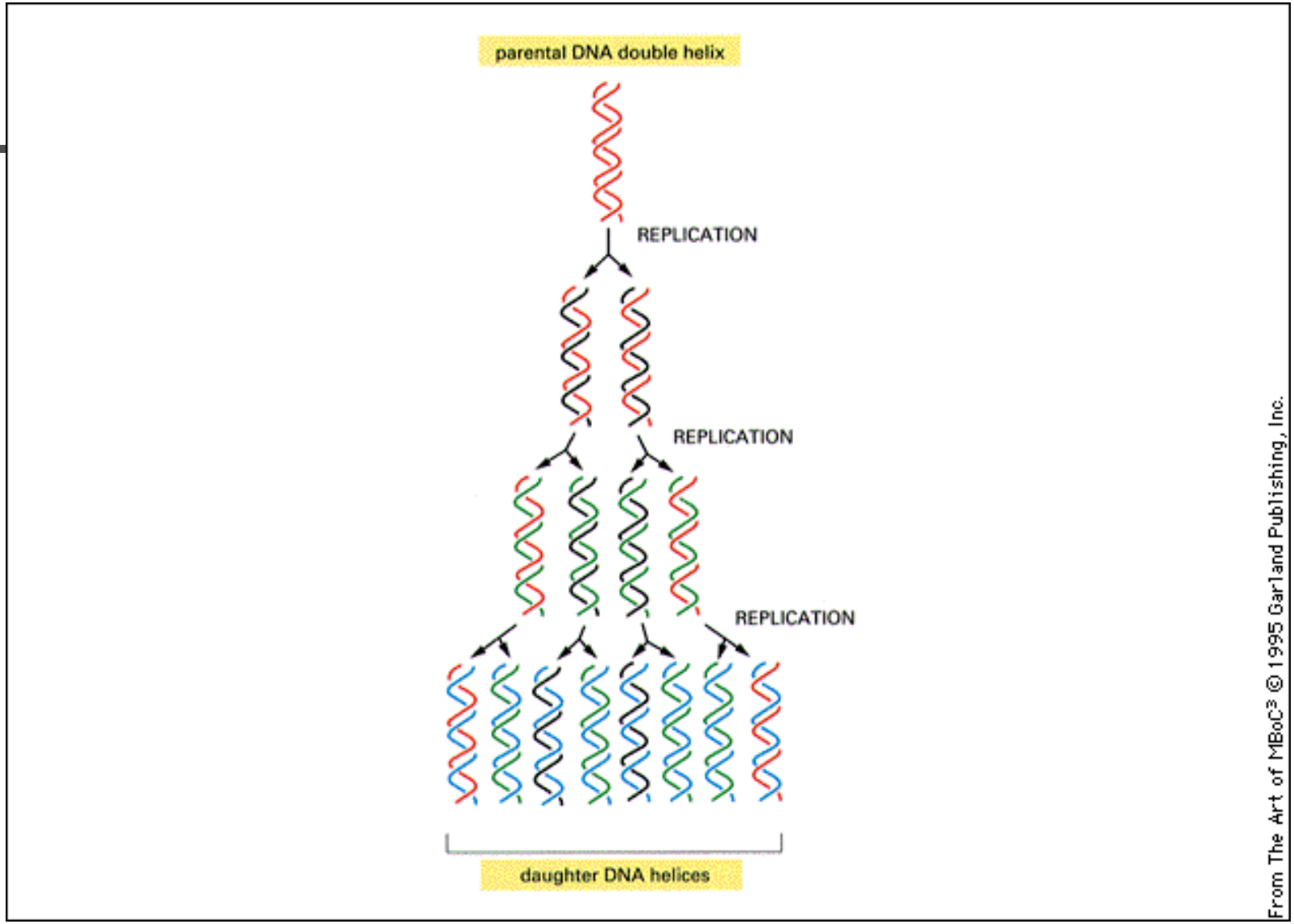
dsDNA, antiparallel helix



DNA polymerization

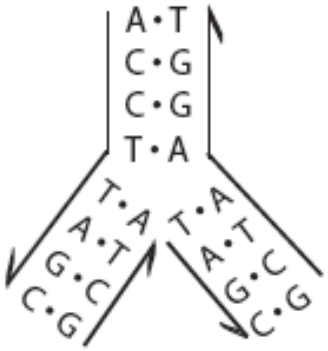


DNA replication

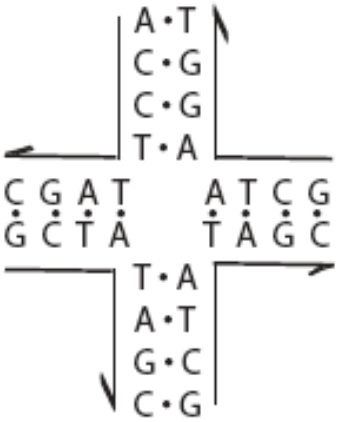


Linear vs branched junctions

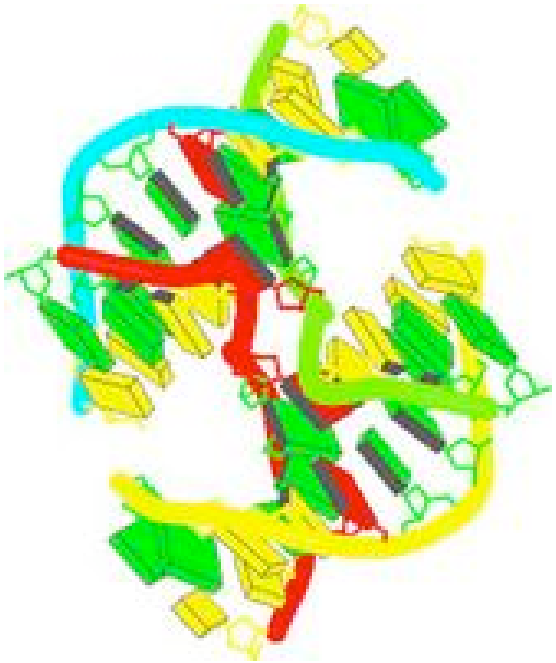
dsDNS



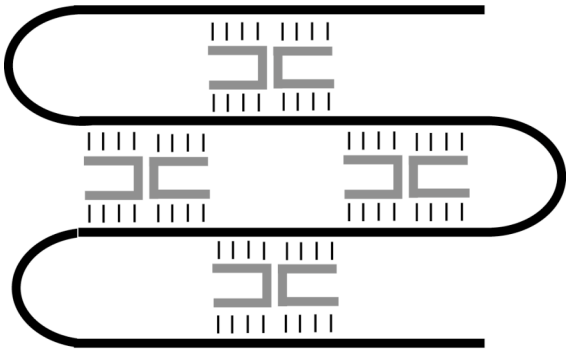
3-arm Junction

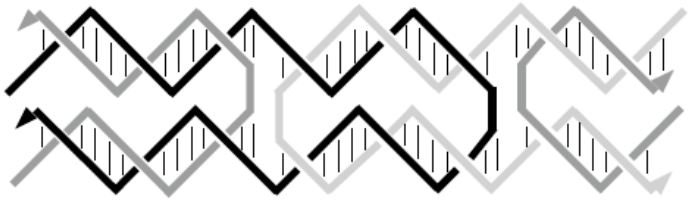


4-arm Junction

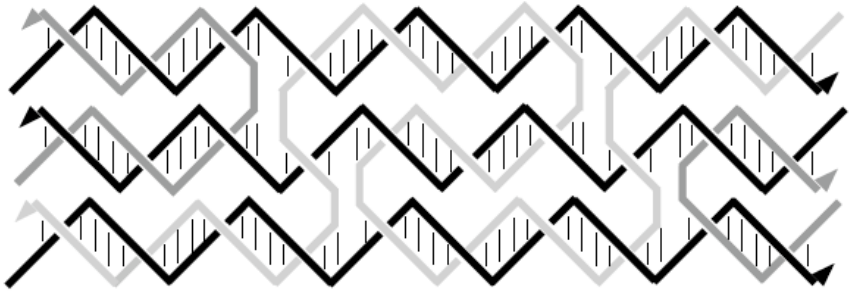


DNA tiles

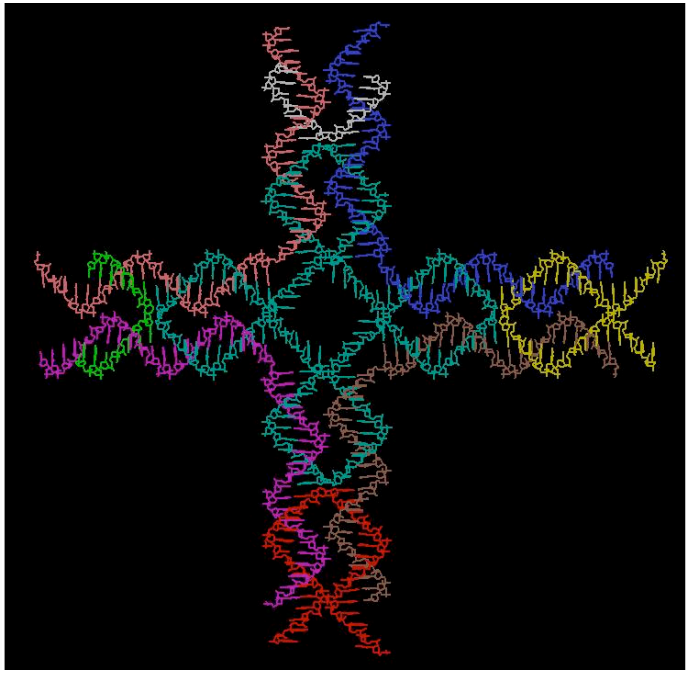




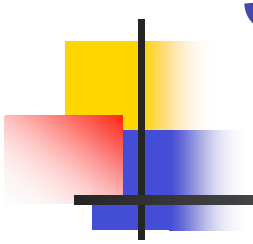
DAO



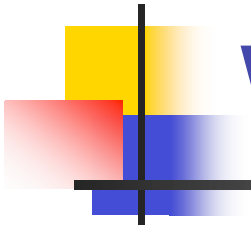
TAE



Software and databases



- 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?

- 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 stabile chemistry