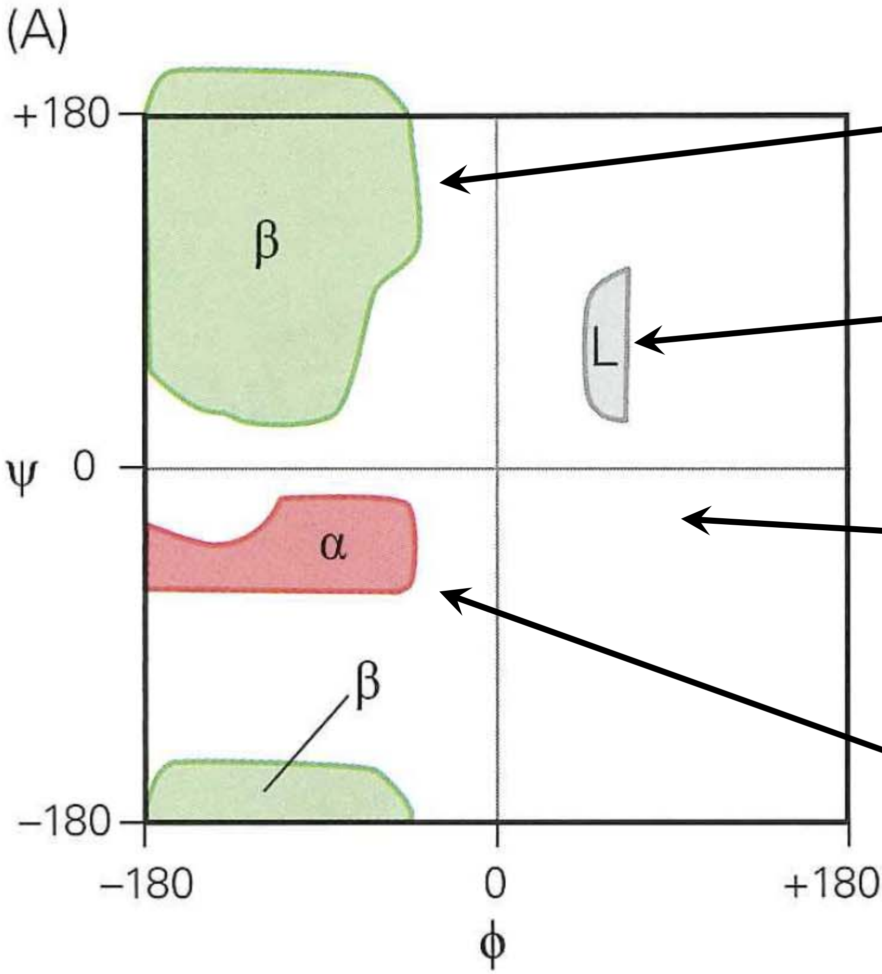
The Ramachandran Plot:

Sterically-allowed ϕ and ψ



Beta strand region

Left-handed alpha helix region
(Rare, but short helices do happen.)

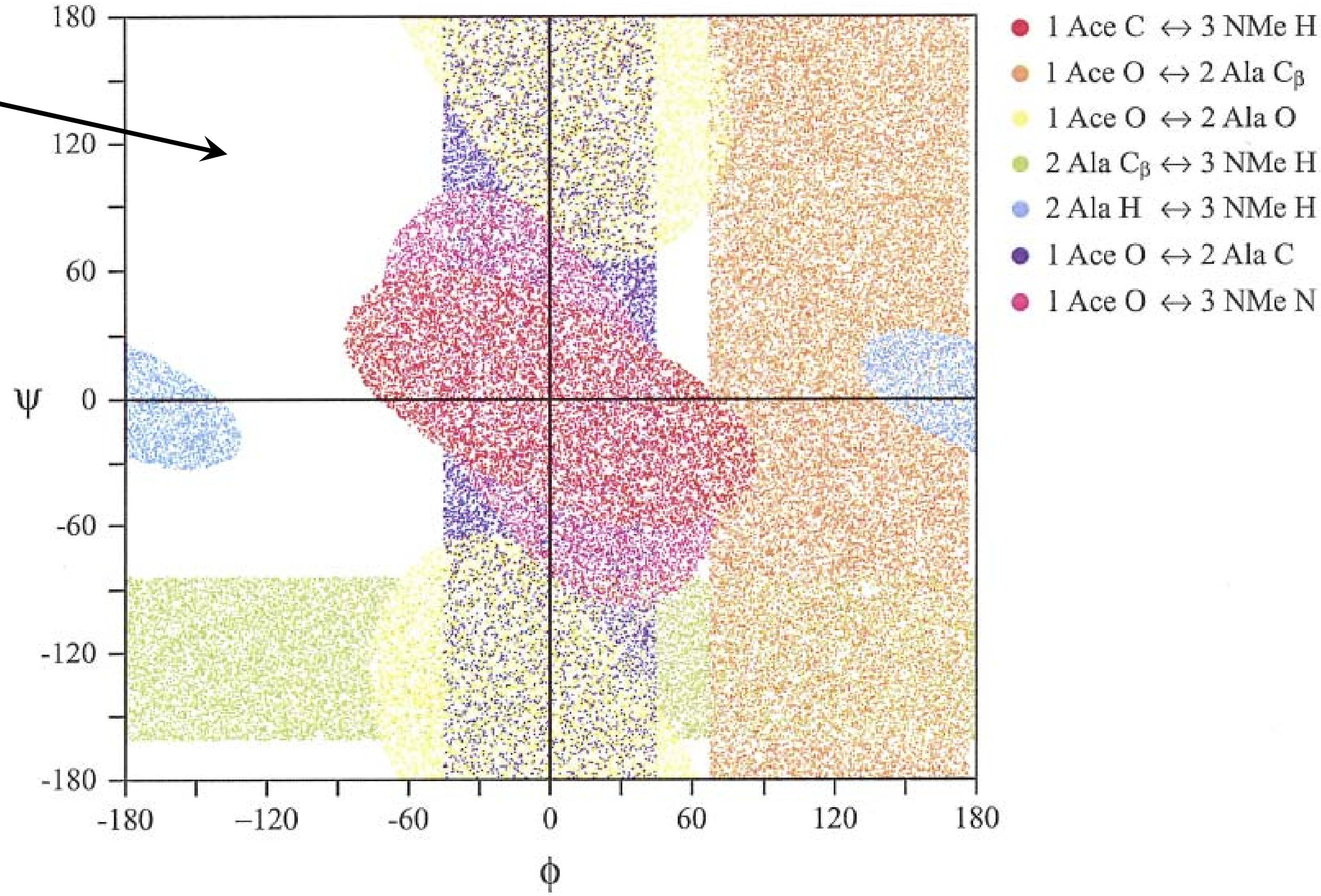
White regions are "disallowed" because of steric clash (atoms bump)

Alpha helix region

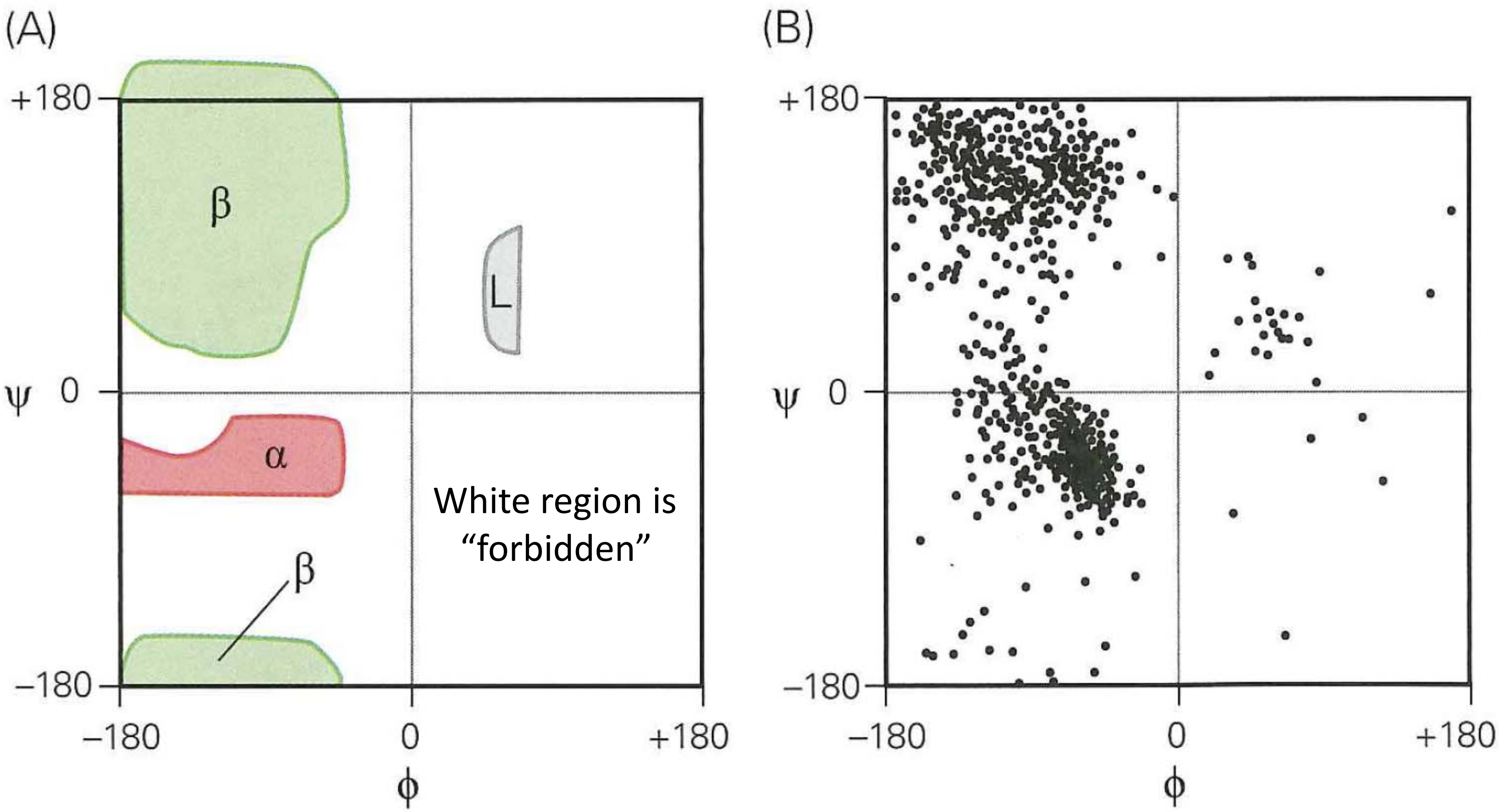
Molecules of Life, pp. 142

Ramachandran Reversed

White regions are allowed, colored dots represent steric clash.

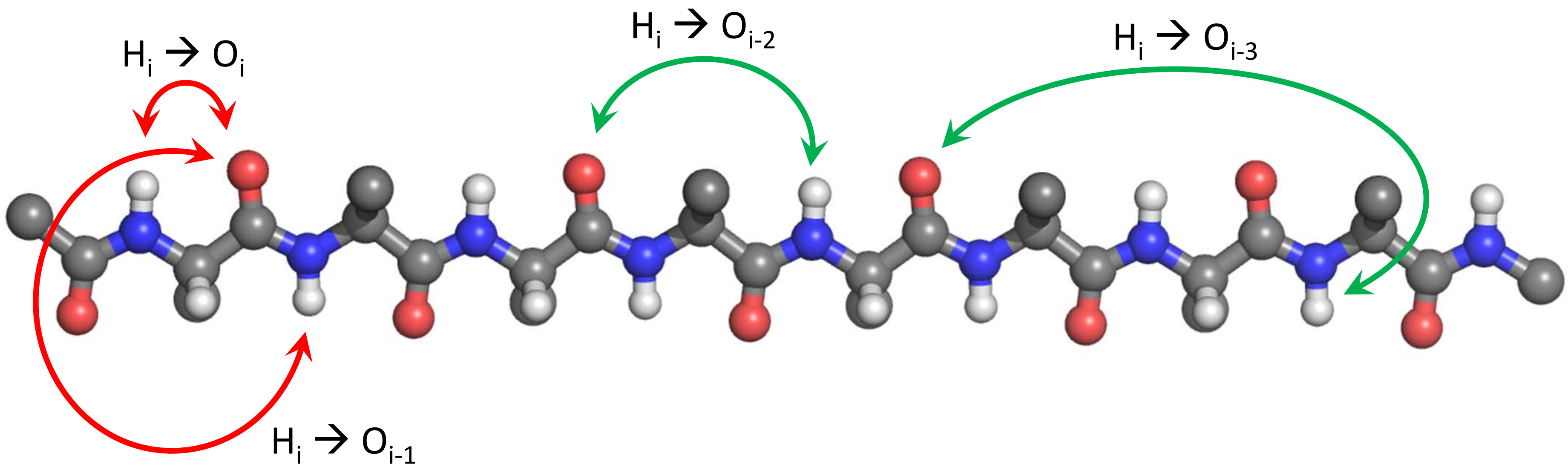


Ramachandran Plot



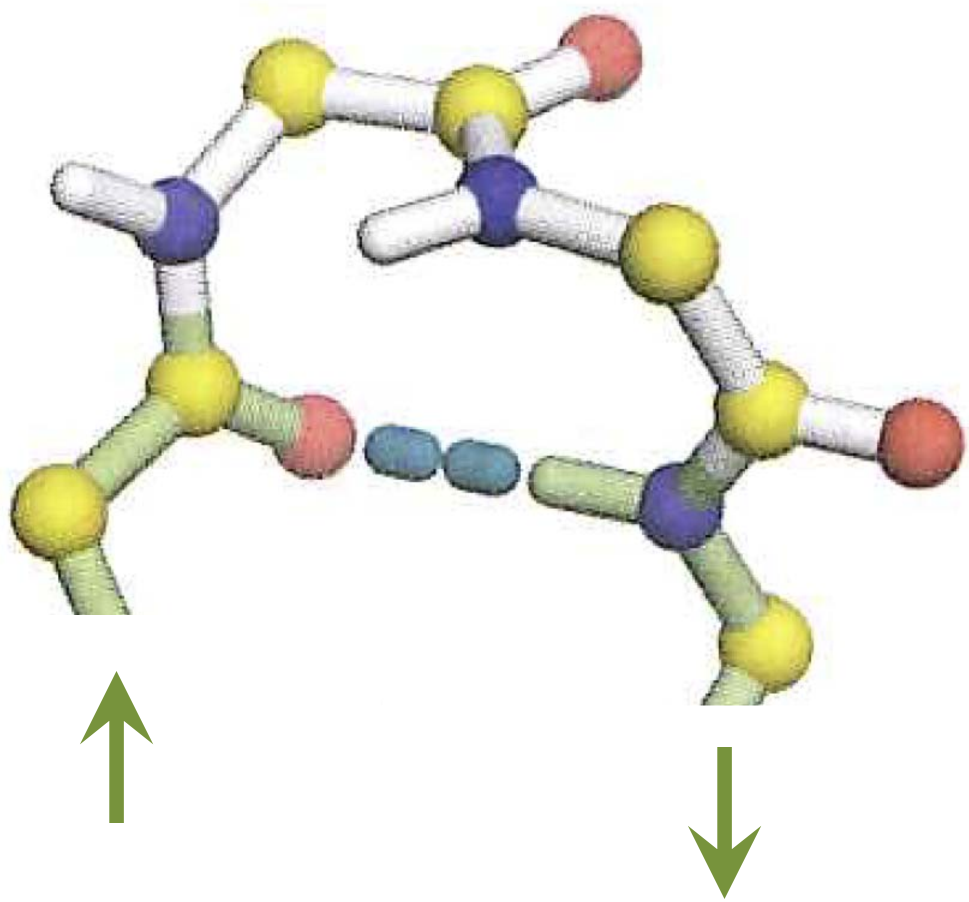
Molecules of Life, pp. 142

Backbone Hydrogen Bonding



- Non-repeating backbone patterns:
  - **Too much strain:** $H_i \rightarrow O_i$ and $H_i \rightarrow O_{i\pm1}$ hydrogen bonds
  - **Rare, but possible:** $H_i \rightarrow O_{i-2}$ (Gamma turns)
  - **Frequently observed:** $H_i \rightarrow O_{i-3}$ (Beta turns)

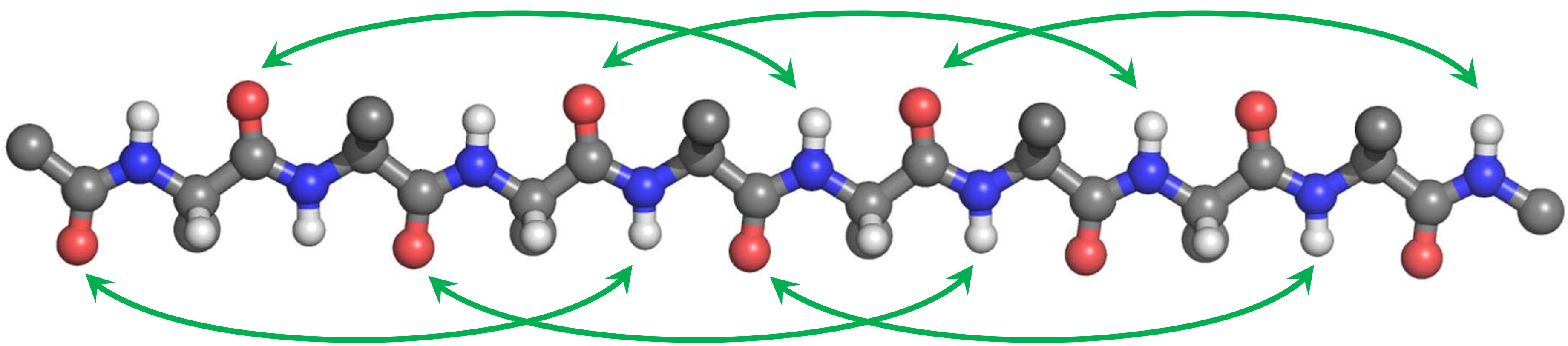
Beta Turns Reverse the Direction of the Backbone



Molecules of Life, pp. 147

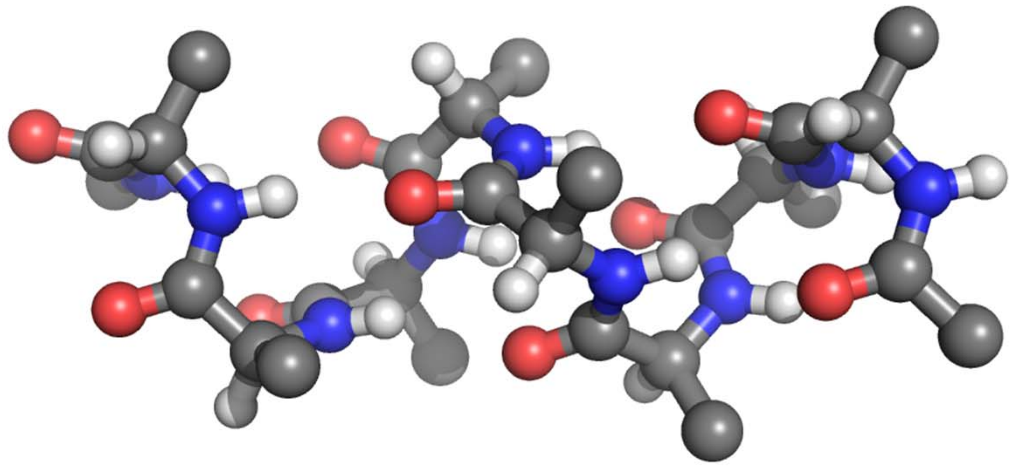
Backbone Hydrogen Bonding

$H_i \rightarrow O_{i-3}$



- The Alpha Helix Can be Repeated
  - $H_i \rightarrow O_{i-4}$ (Gamma turns)
  - Average ϕ is = -60^o, Average ψ is -40^o

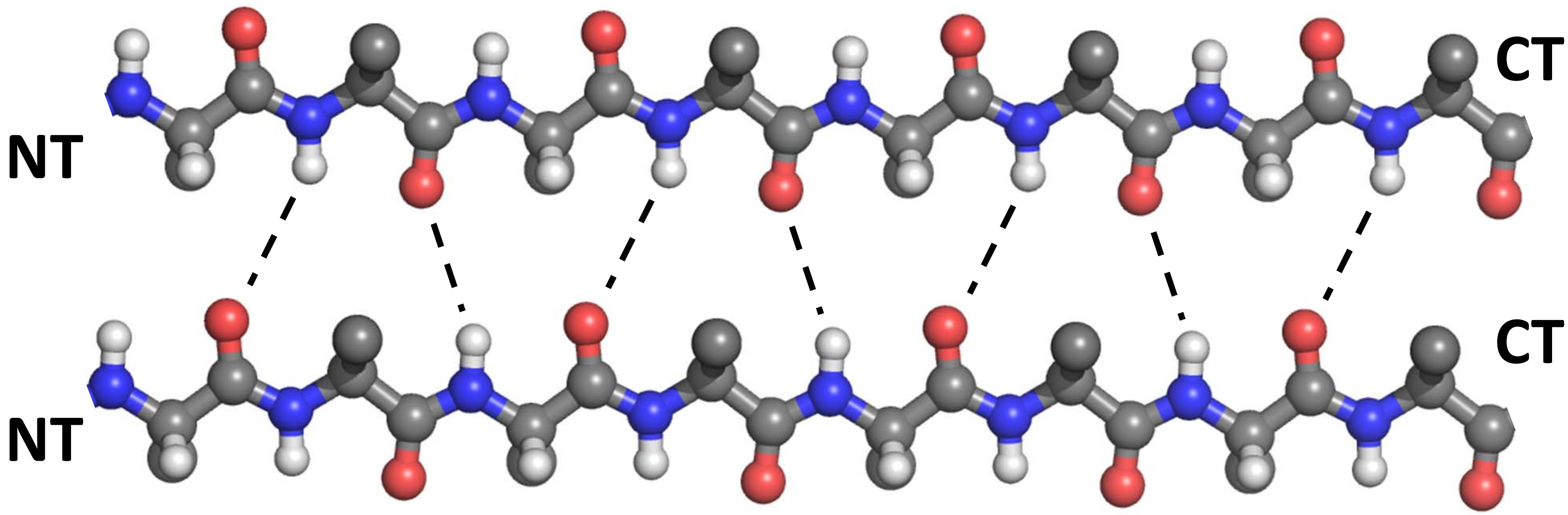
A (Right-Handed) Alpha Helix



- Download helix.pdb from the course website for a model you can examine in PyMOL
- Notice that helix ends have unsatisfied H-bonds

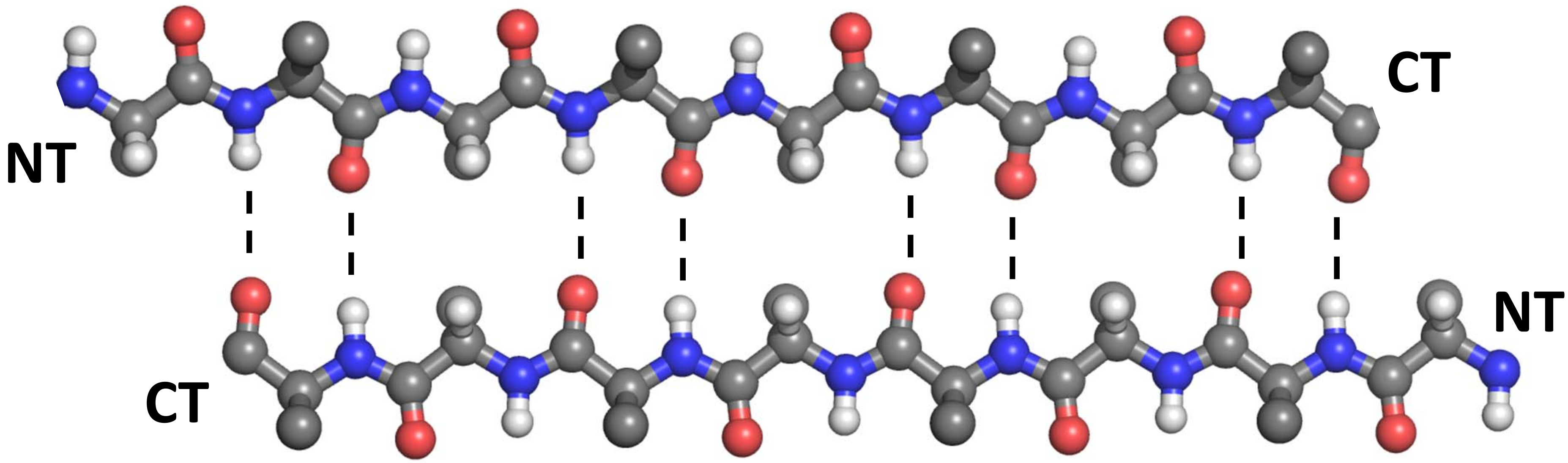
Molecules of Life, pp. 28

Backbone Hydrogen Bonding



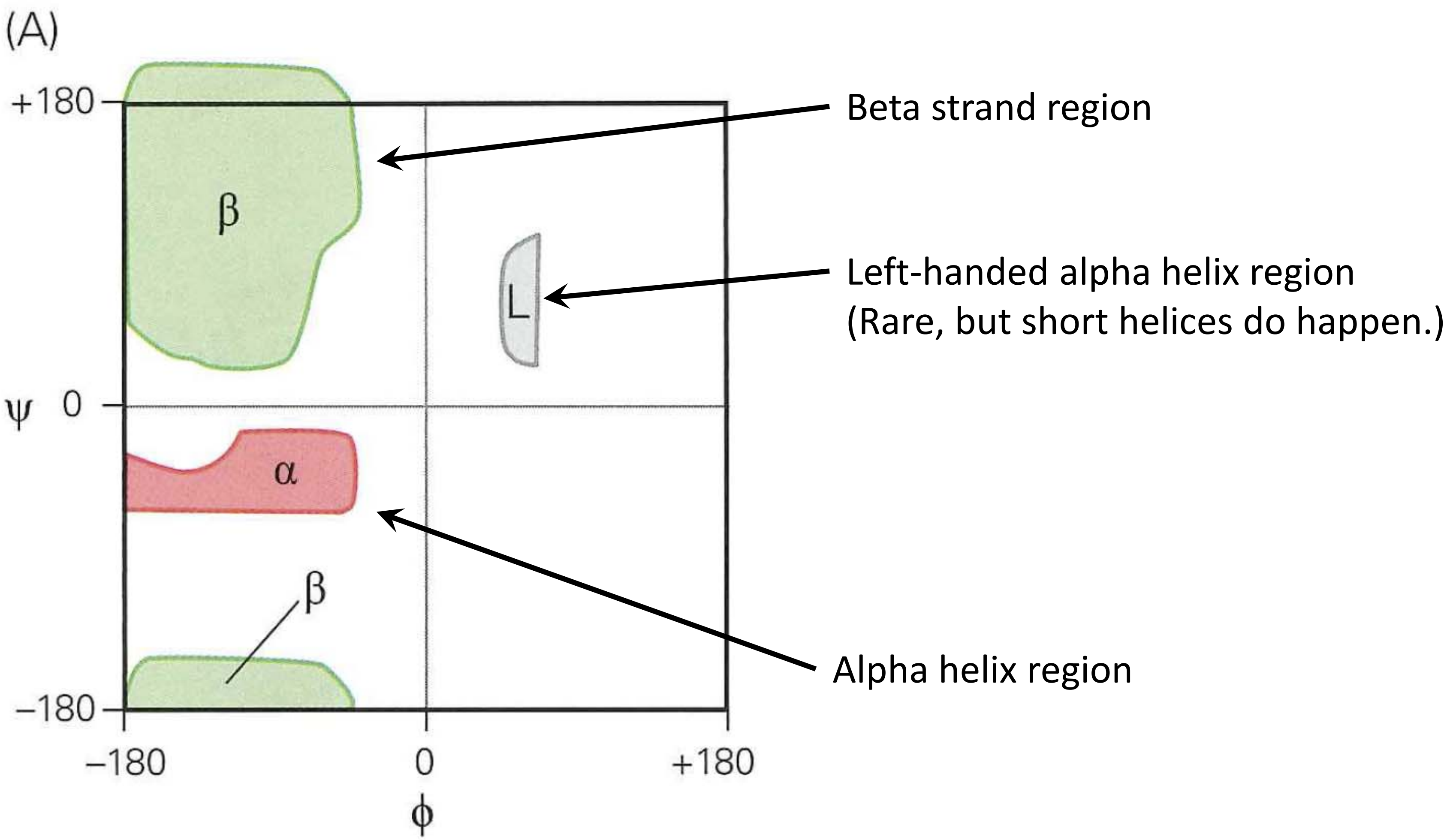
- Beta sheets are made of beta strands
  - No specified hydrogen bonding formula
  - Sheets can form between distant sets of residues
  - **Shown:** Parallel beta sheet

Backbone Hydrogen Bonding



- Beta sheets are made of beta strands
  - No specified hydrogen bonding formula
  - Average ϕ is = -120^{o}, Average ψ is 120^{o} (with large variation)
  - Sheets can form between distant sets of residues
  - **Shown:** Antiparallel beta sheet

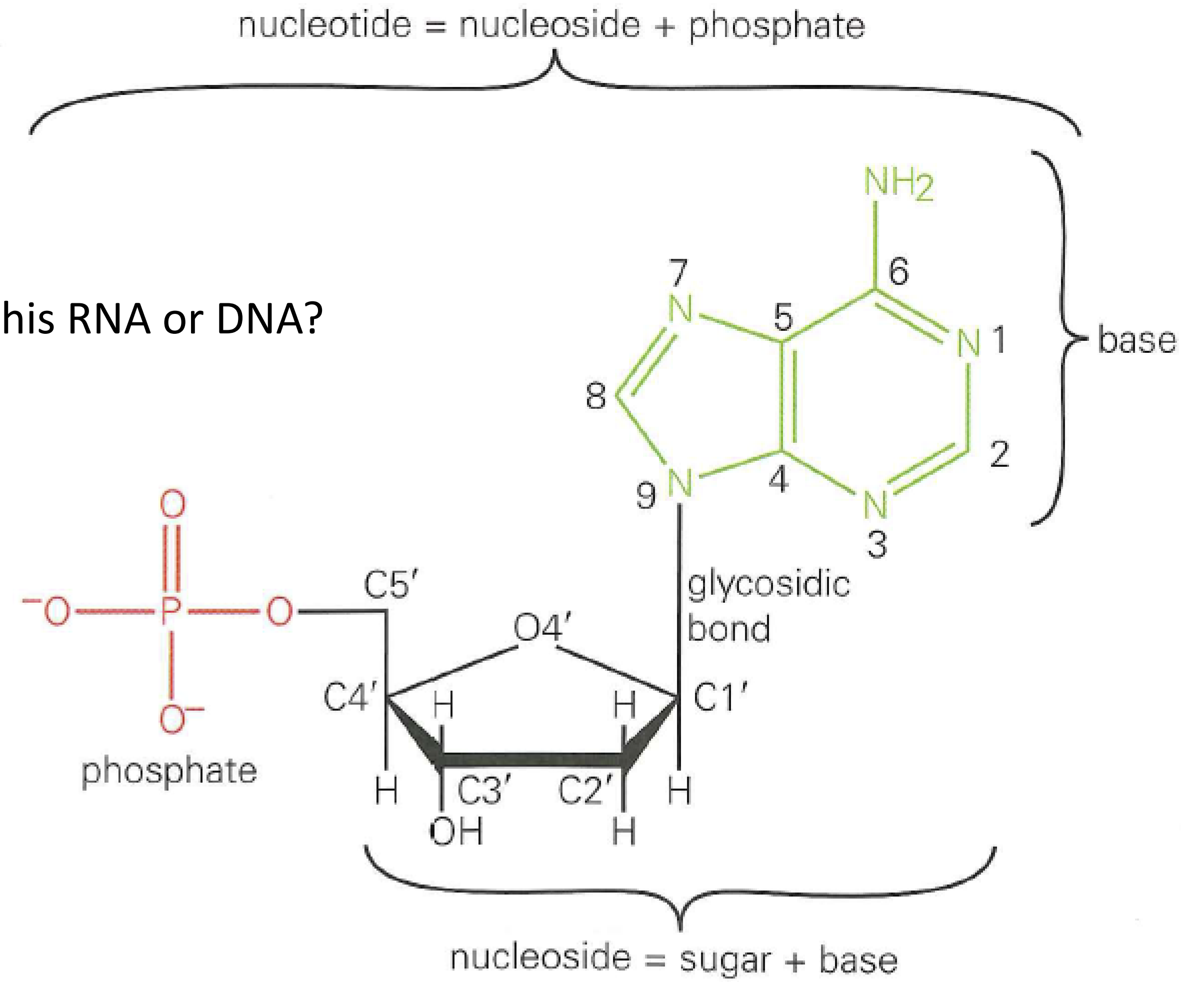
Ramachandran Revisited



Molecules of Life, pp. 142

Nucleic Acid Structure

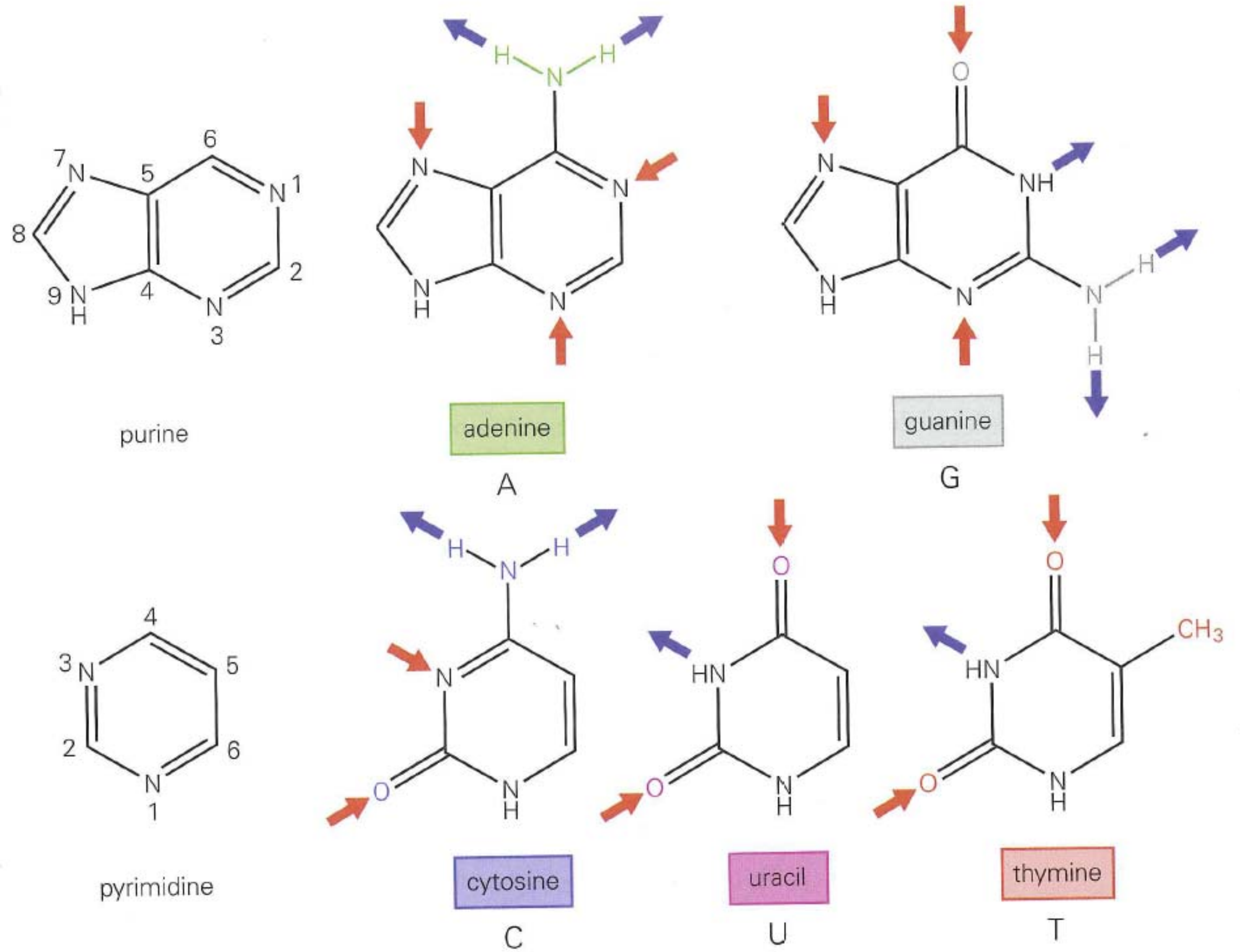
Question: Is this RNA or DNA?



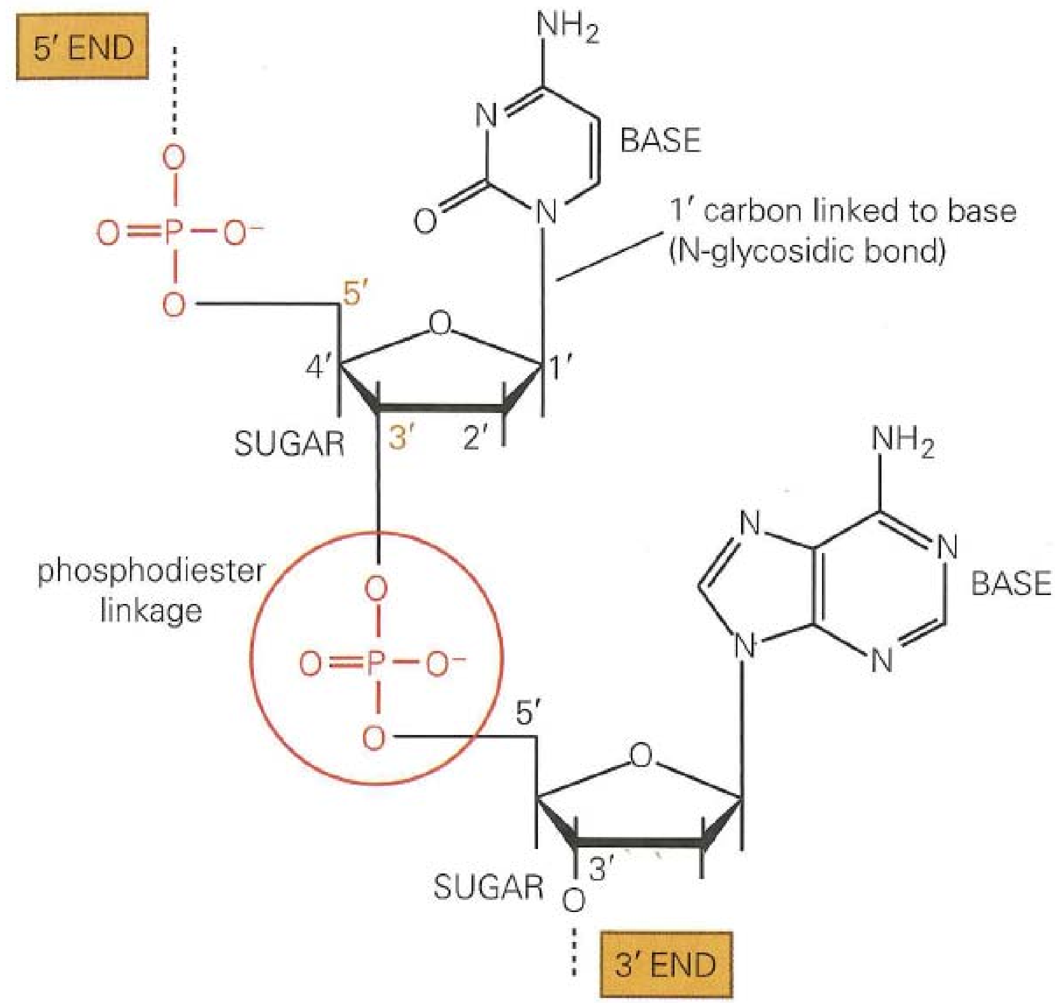
Molecules of Life, pp. 15

Nucleic Acid Bases

(You must memorize these.)



Nucleic Acids Are Also Polymers



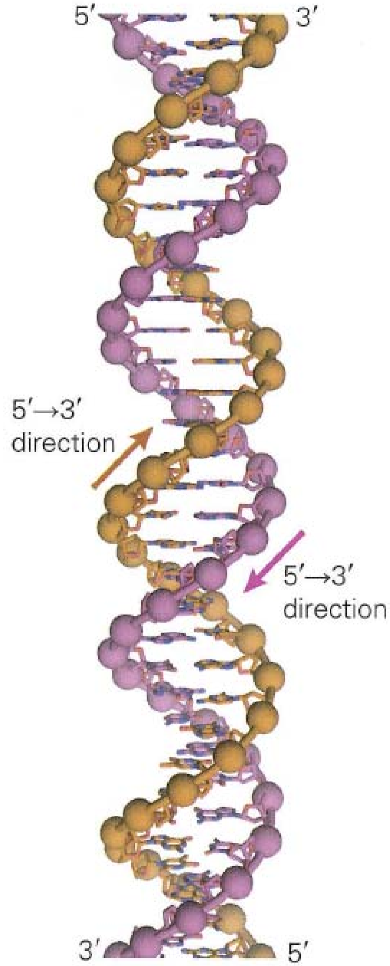
DNA & RNA Polymerase: Build up DNA and RNA from nucleoside triphosphates (5′ → 3′ synthesis)

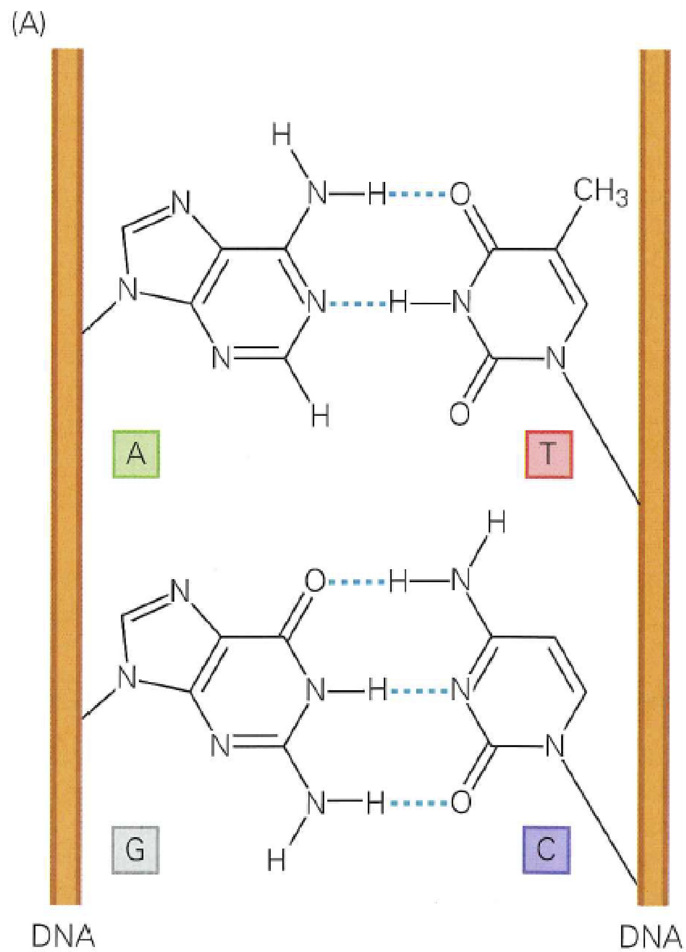
Convention: RNA/DNA typically is read from 5′ to 3′ direction (e.g. 5′-ATTGCAAC-3′)

And yes, you must have the backbone structure of DNA memorized, too. (The level of detail in this slide is fine.)

Molecules of Life, pp. 21

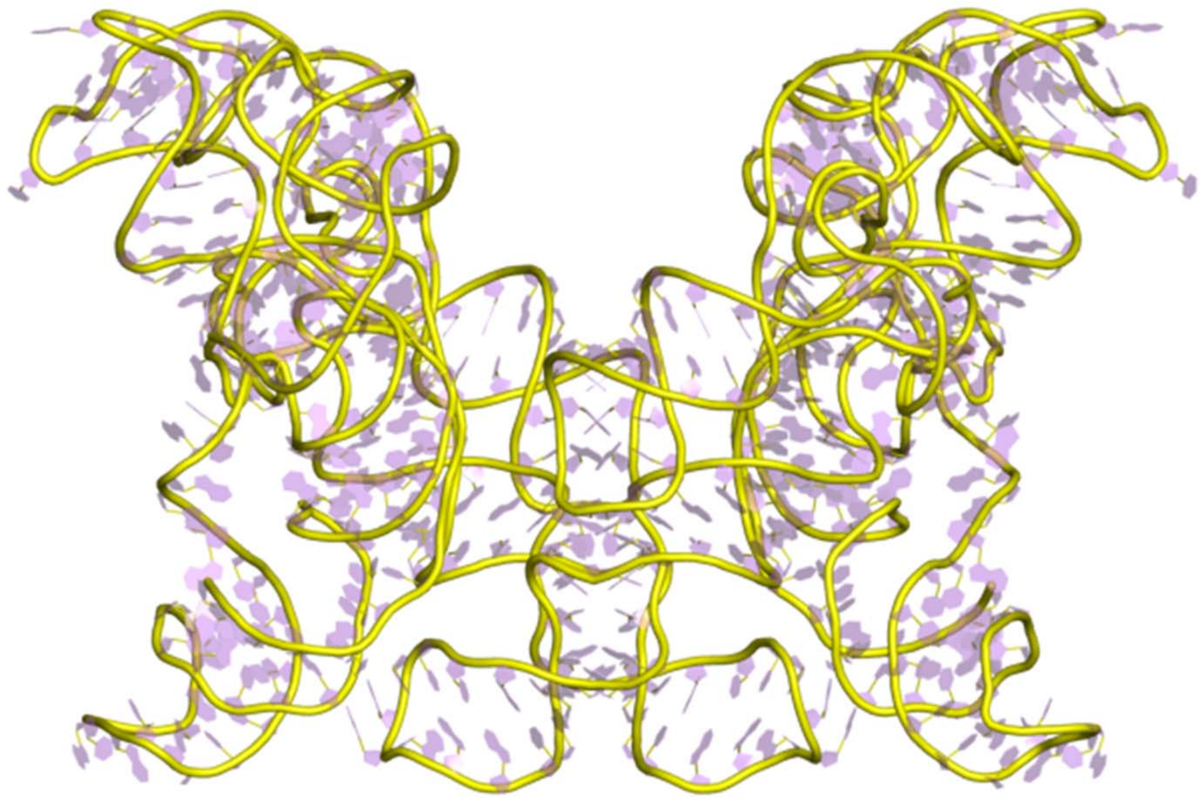
Watson-Crick Base Pairing in an (Antiparallel) Double Helix





Molecules of Life, pp. 23

Diversity of Nucleic Acid Structure



Ribozyme: An RNA capable of catalyzing a chemical reaction

The ribosome contains a significant amount of RNA as well as proteins

Macromolecules can perform incredibly diverse structures!
(And we haven't even mentioned lipids and sugars.)

Wikipedia, "Group I Catalytic Intron." Accessed 8/23/2012.