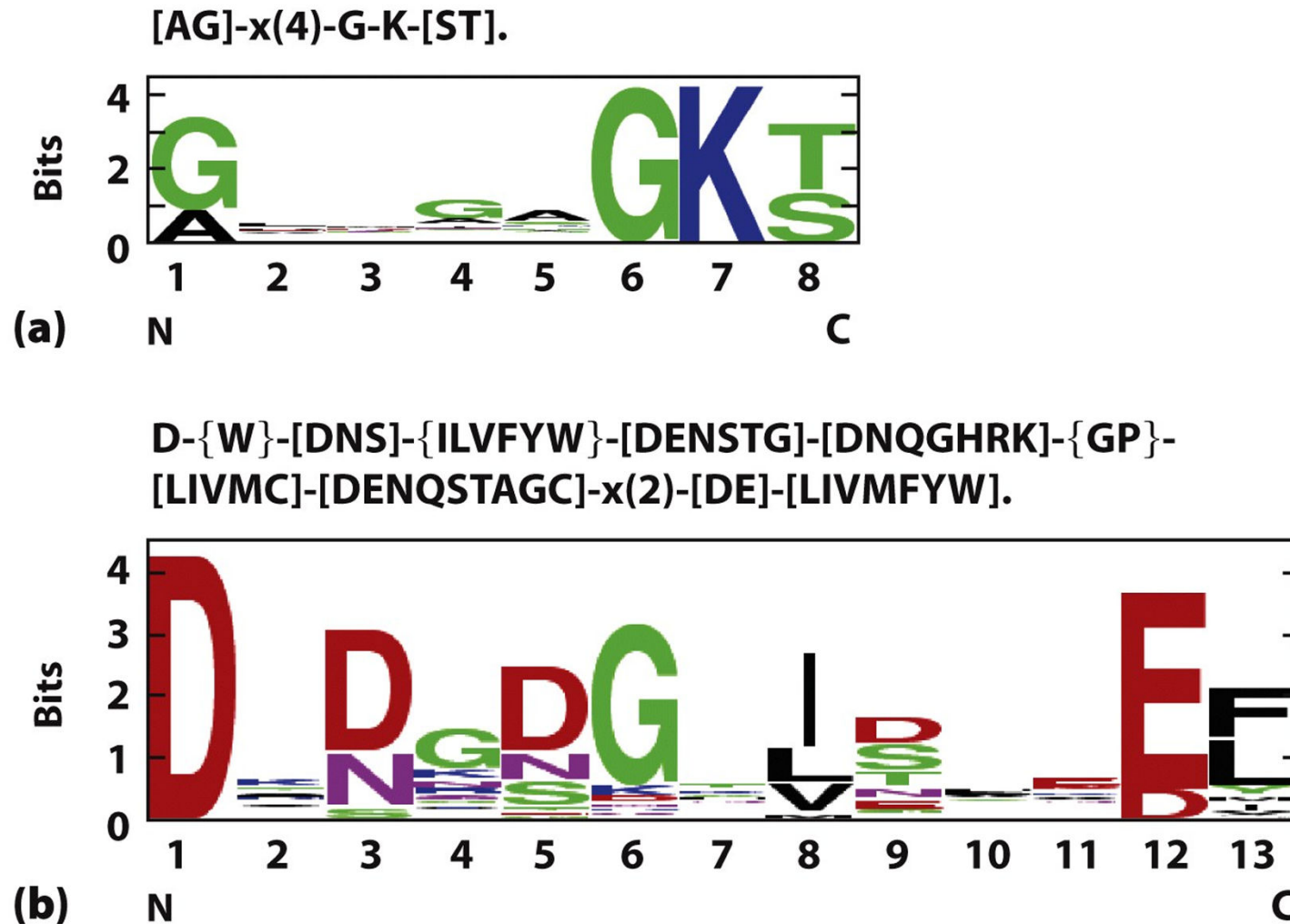
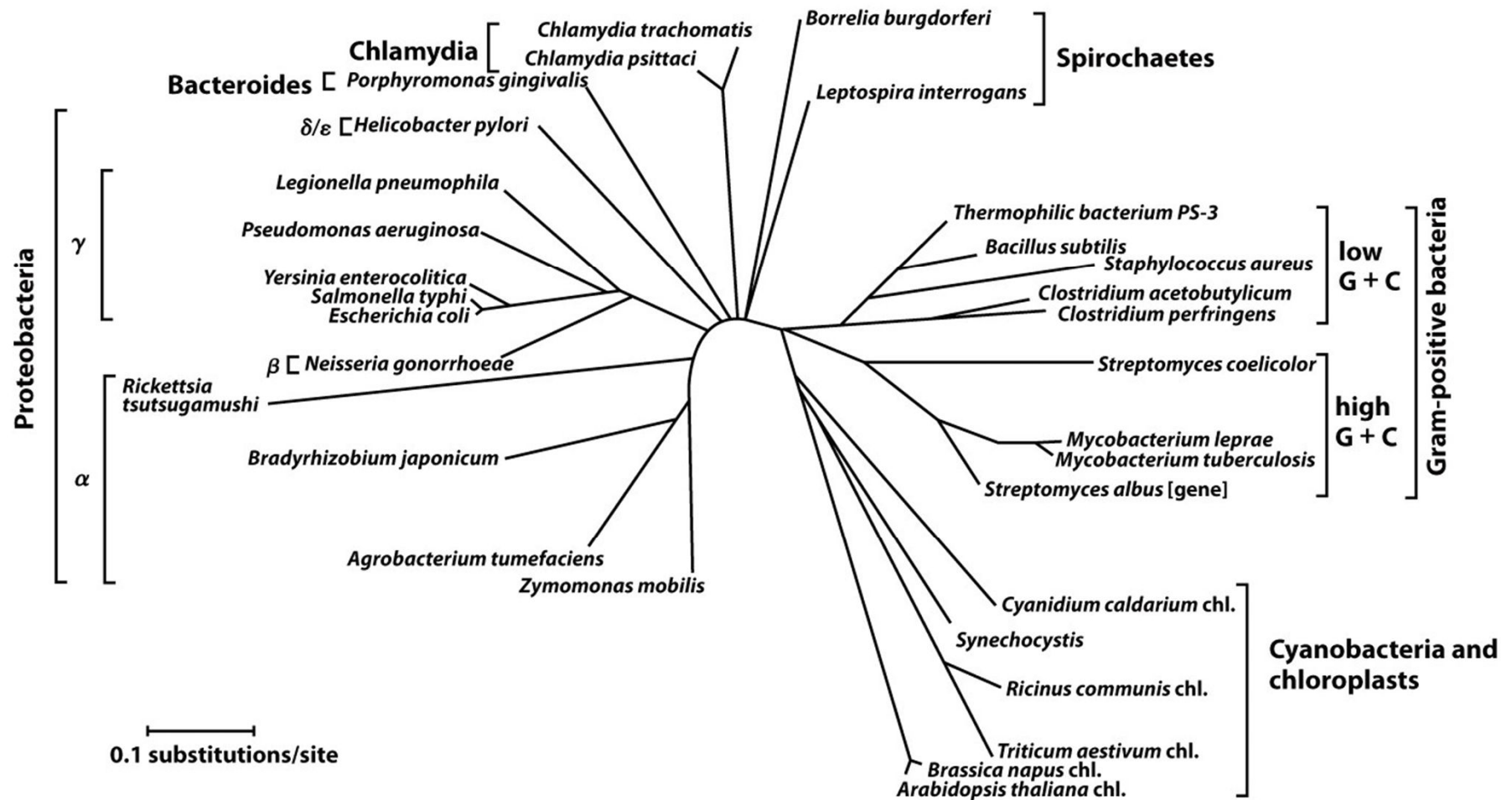


Consensus sequences, showing conserved sites, may be represented in different ways

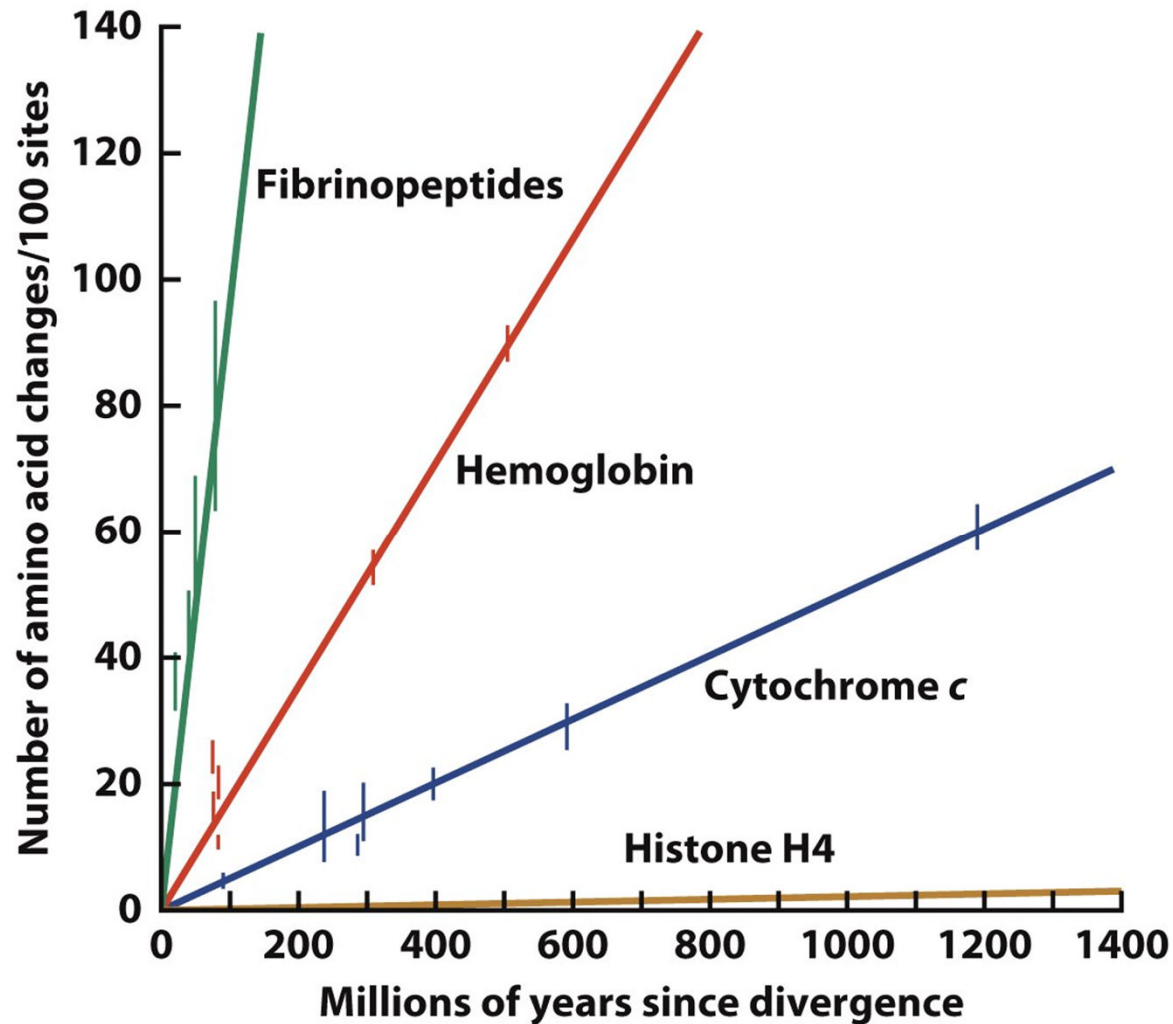


# Differences between orthologous sequences suggest phylogenetic relationships



Tree calculated by comparing bacterial GroEL sequences

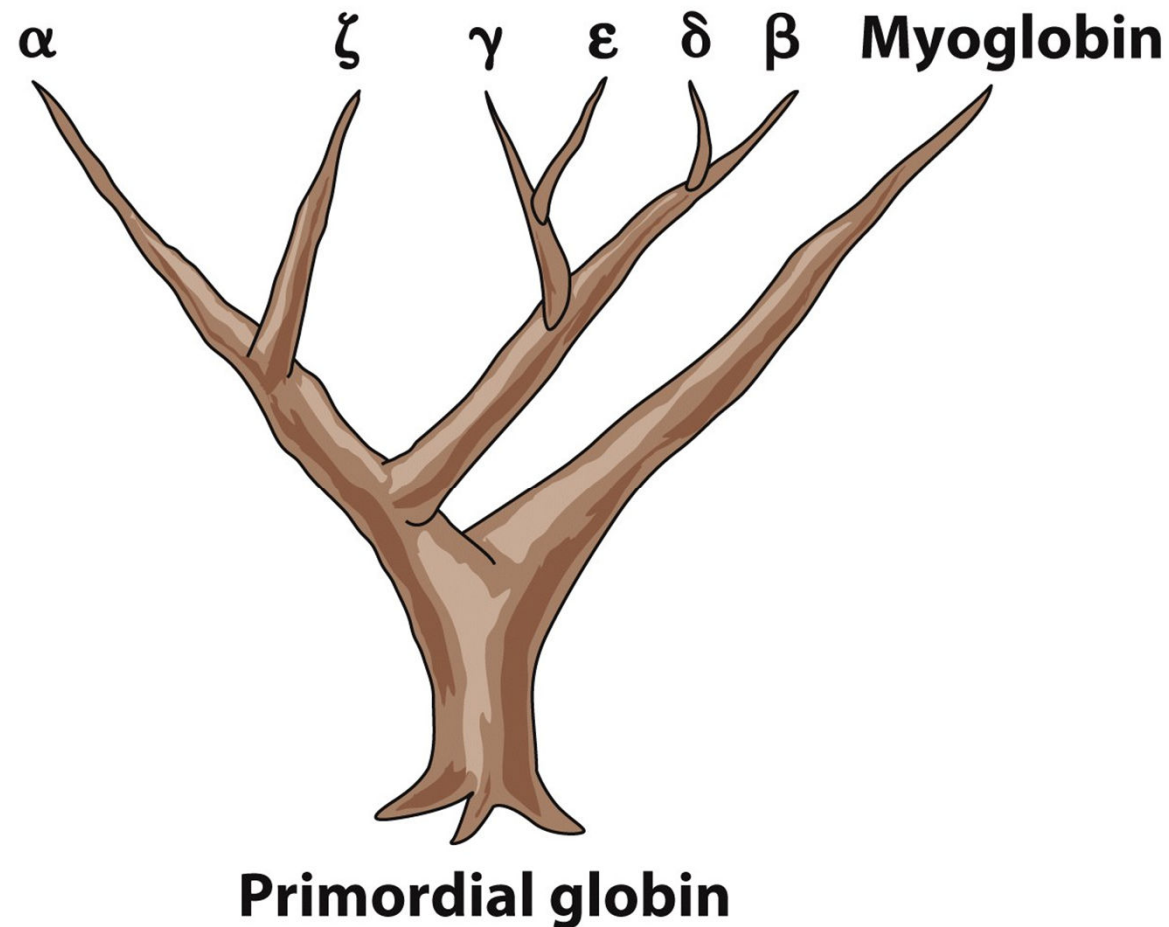
Different proteins have different sequence requirements and evolve at different rates



Illustration, Irving Geis/Geis Archives Trust. Copyright Howard Hughes Medical Institute. Reproduced with permission.

Figure 5-23

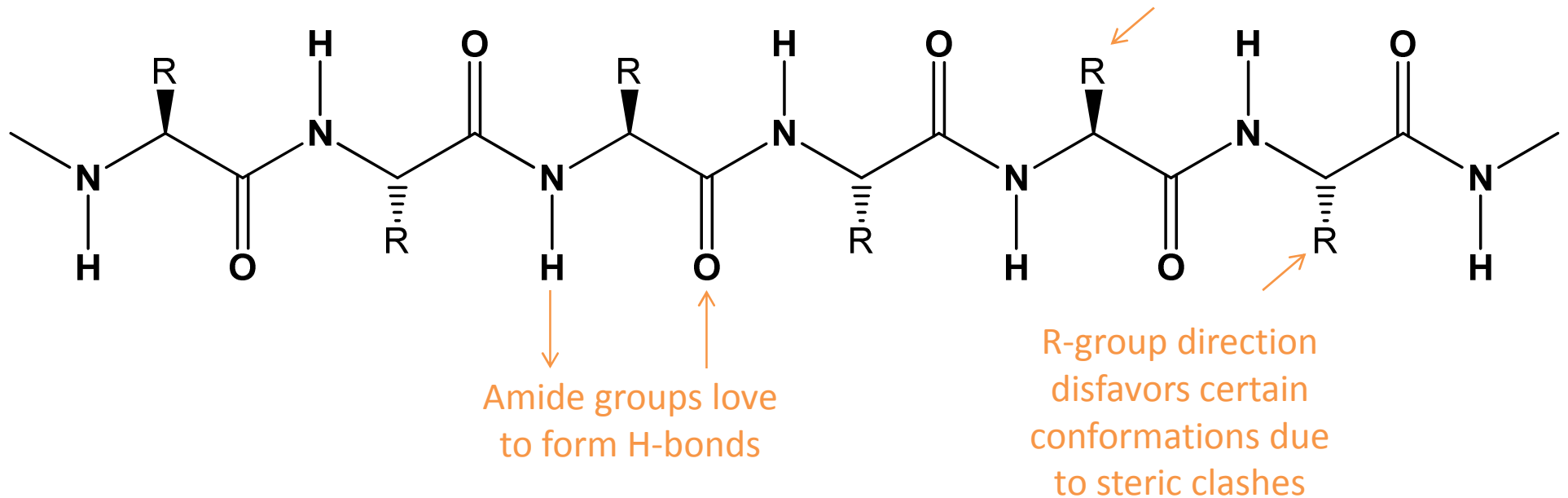
Differences between paralogous sequences  
predict gene duplication events



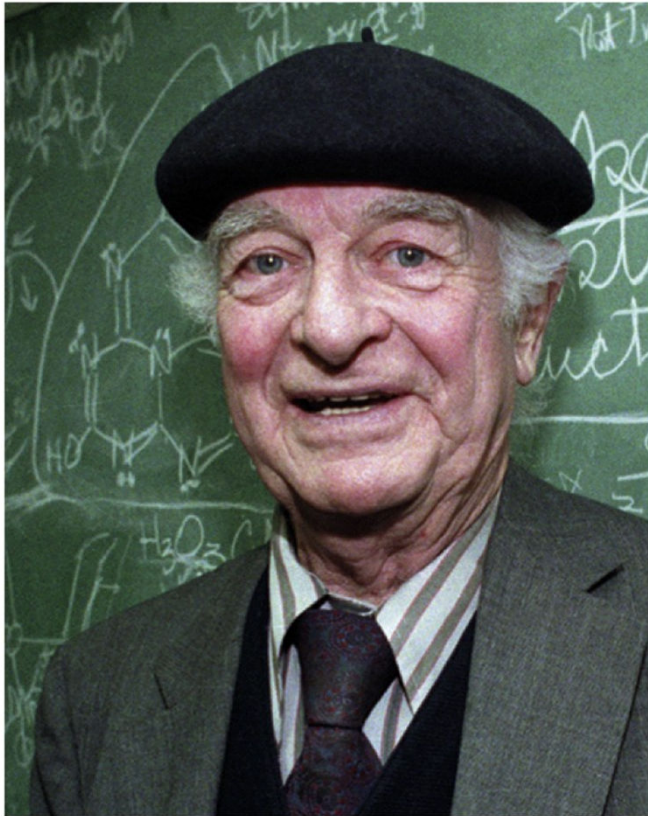
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Figure 5-22

# The connectivity of functional groups in the protein backbone directs its conformations

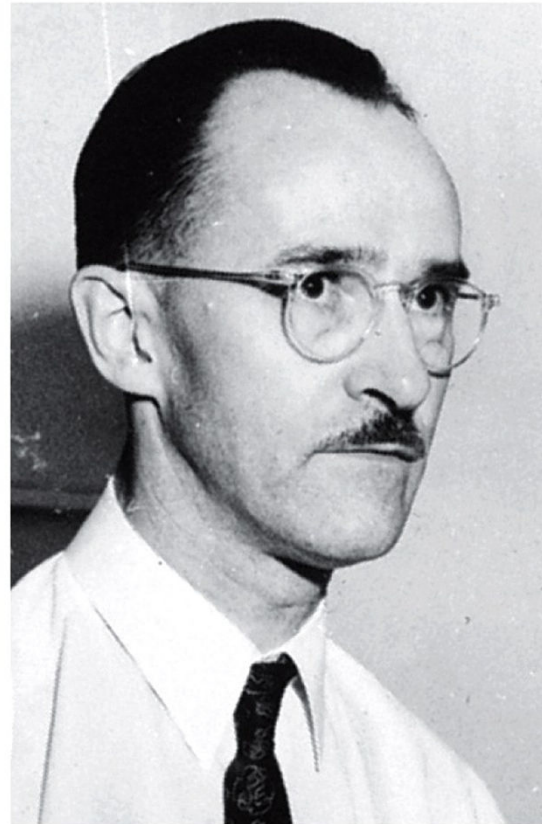


# Pauling & Corey's studies of oligopeptides revealed structural requirements of proteins



**Linus Pauling, 1901–1994**

Unnumbered 4 p115a  
*Lehninger Principles of Biochemistry, Fifth Edition*  
© 2008 W. H. Freeman and Company

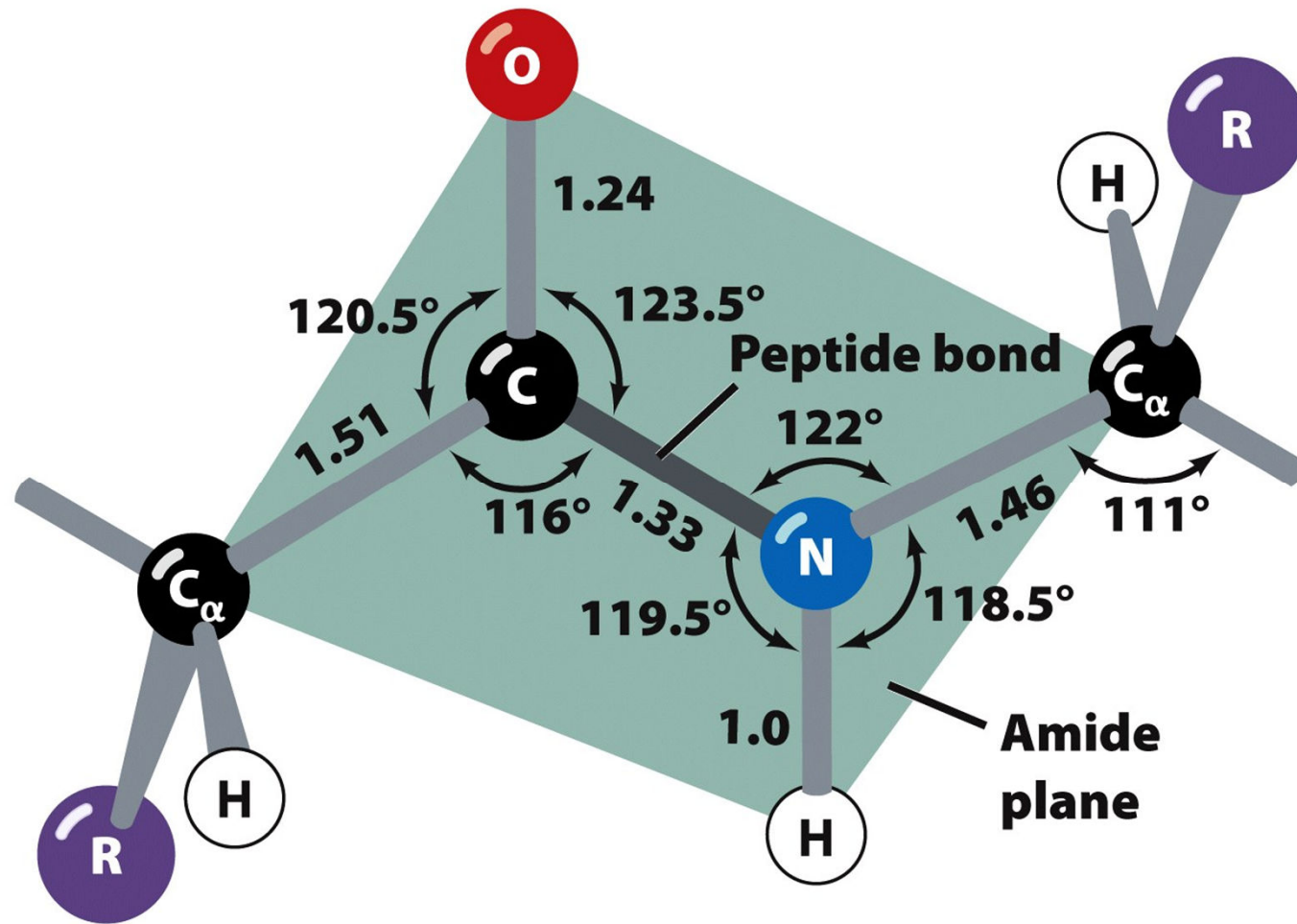


**Robert Corey, 1897–1971**

Unnumbered 4 p115b  
*Lehninger Principles of Biochemistry, Fifth Edition*  
© 2008 W. H. Freeman and Company



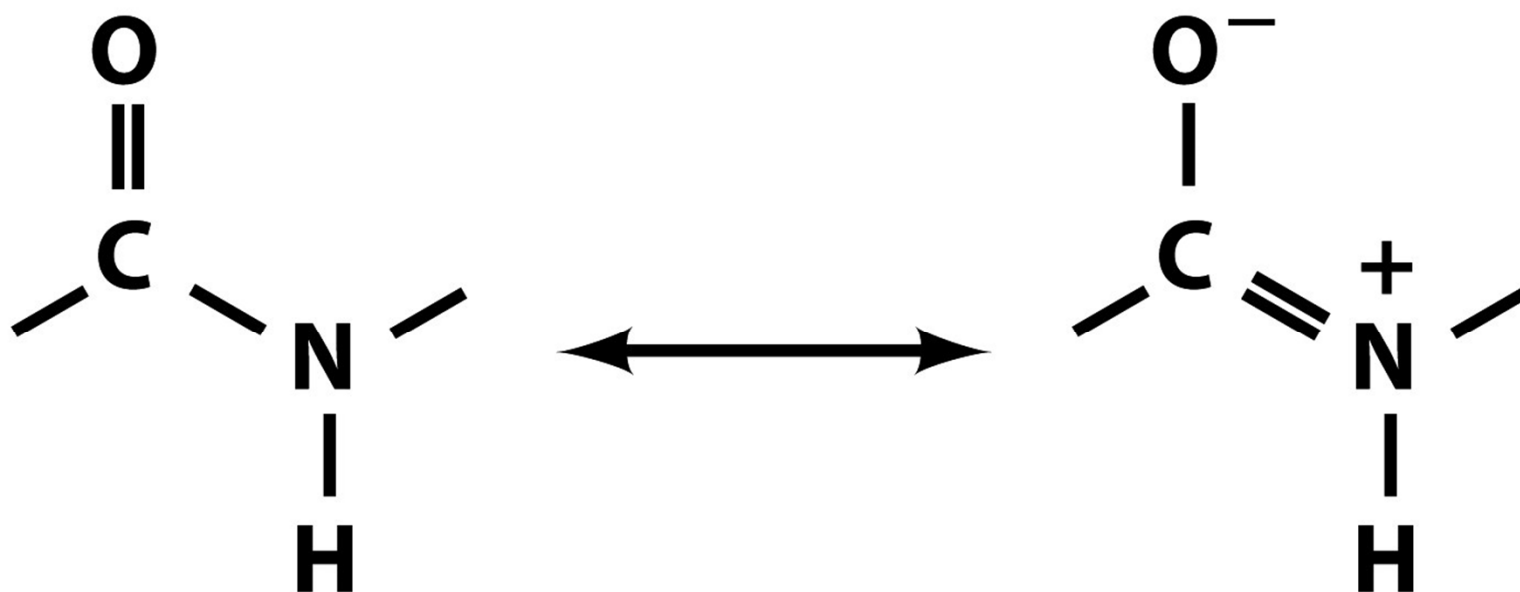
Structural studies of peptides revealed a planar amide group with a short C-N bond



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Figure 6-2

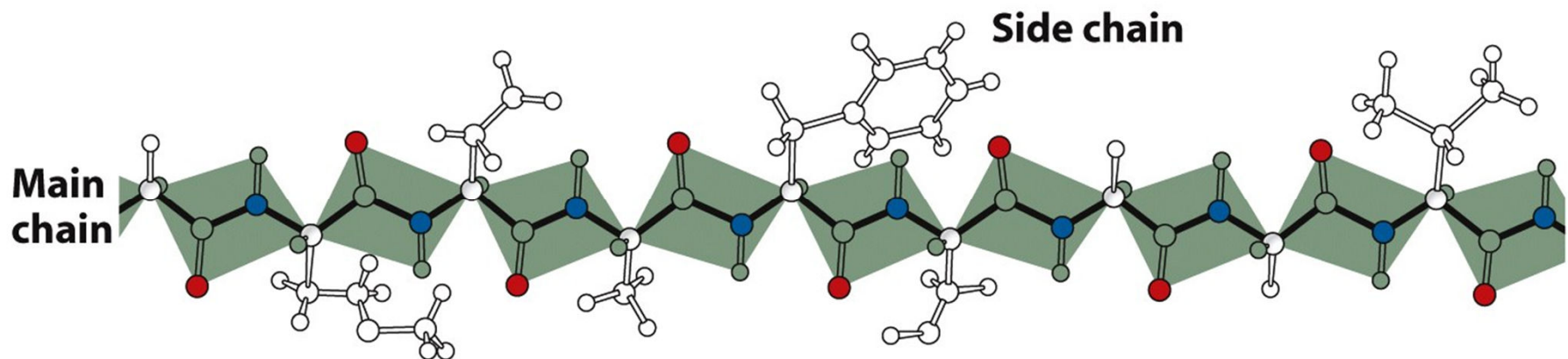
Resonance explains the double-bond character of the C-N amide bond



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The protein backbone (main chain) is a connected series of peptide planes



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Figure 6-3

Although fixed along the amide bond, the backbone may rotate about the other bonds

Dihedral angle: the angle between two planes

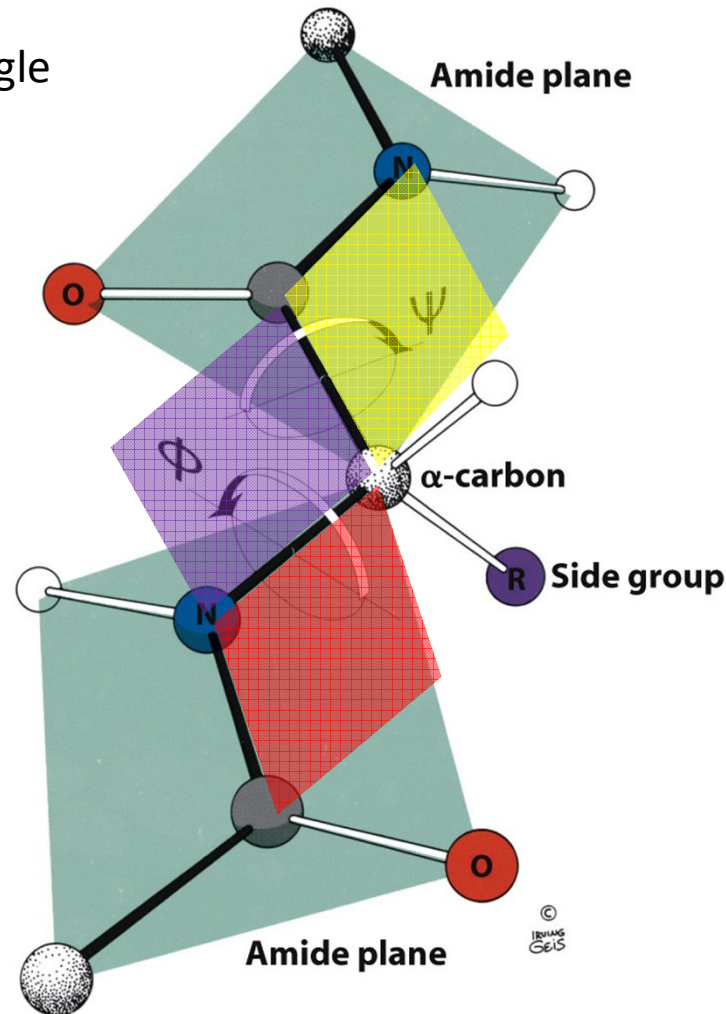
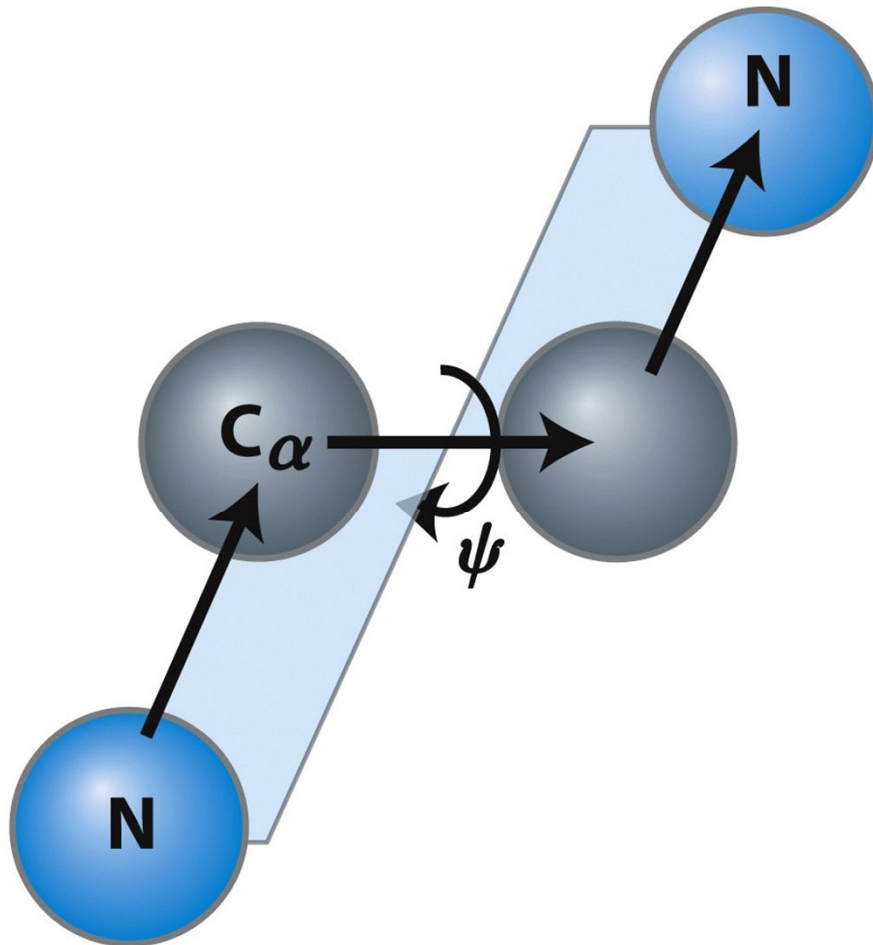


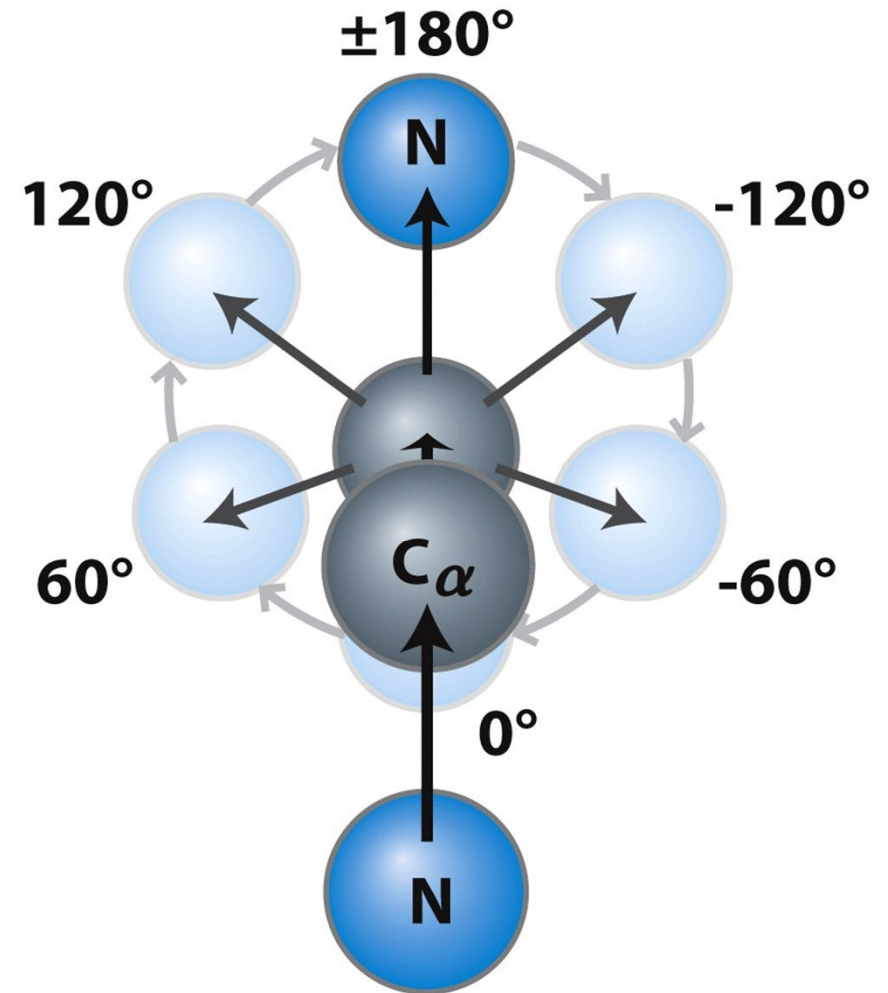
Figure 6-4

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Looking down the  $C_{\alpha}$ -X bond, the value of  $\phi$  or  $\psi$  increases as the rear group rotates CW



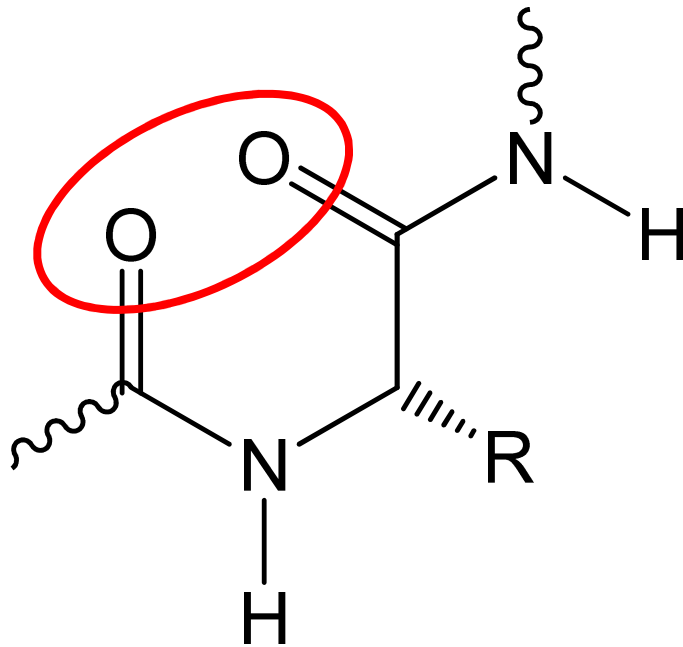
**Figure 4-2c**  
*Lehninger Principles of Biochemistry, Fifth Edition*  
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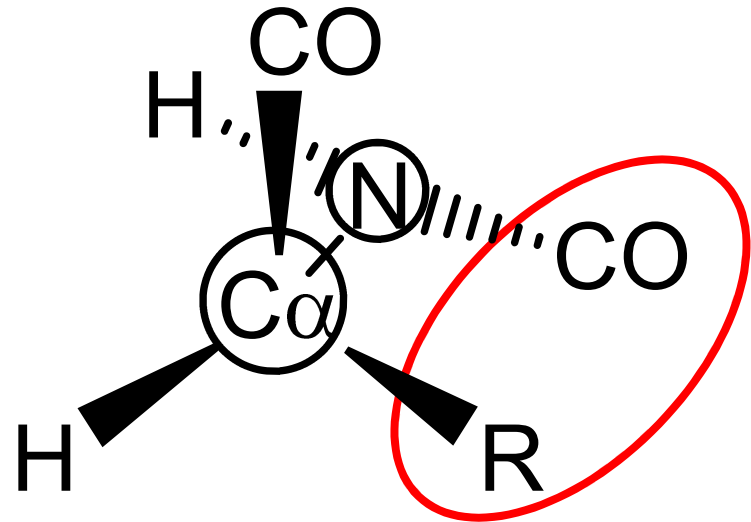
**Figure 4-2d**  
*Lehninger Principles of Biochemistry, Fifth Edition*  
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Some values of  $\phi$  and  $\psi$  correspond to overlap of atoms (steric clashes)

Ex: Backbone-backbone clash  
 $0^\circ, 180^\circ$



Ex: Backbone-side chain clash  
 $120^\circ, 180^\circ$



The Ramachandran plot depicts favorable, allowed, and disallowed backbone angles

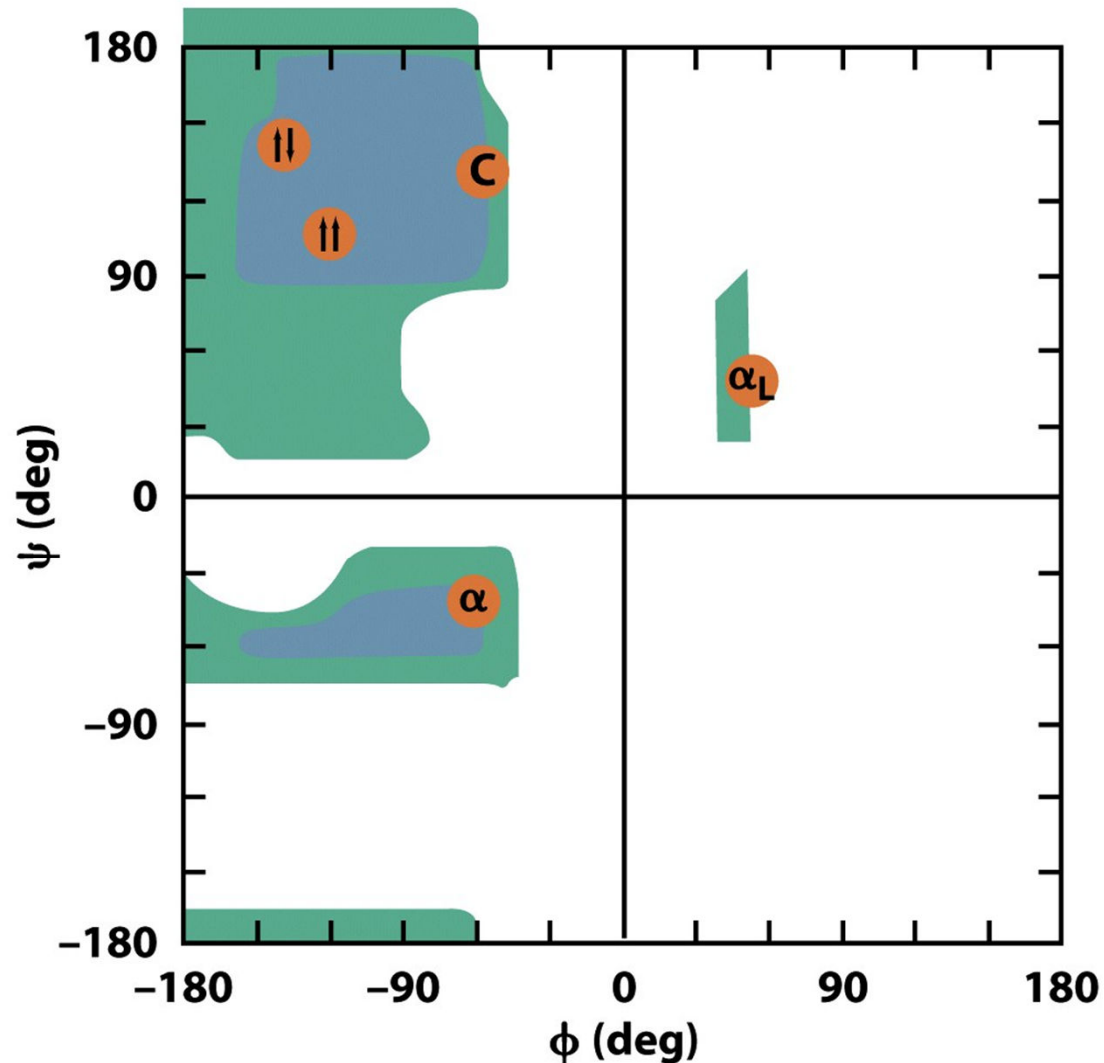


Figure 6-6

# Pauling, Corey, and Herman Branson predicted the major secondary structures

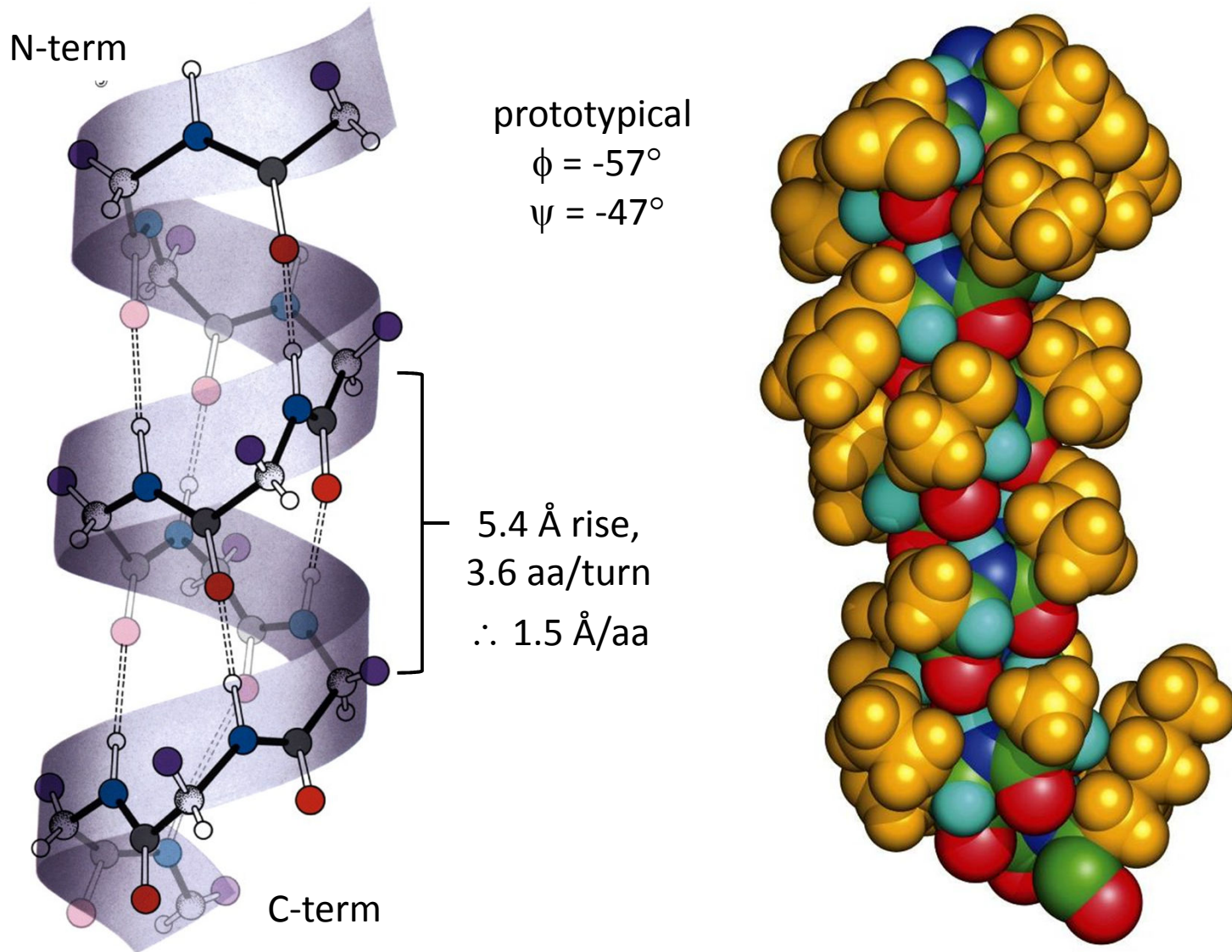
They considered:

- Planarity of peptide bond
- Measured bond lengths and angles within the peptide plane
- Allowed  $\phi$  and  $\psi$  dihedral angles
- Favorable hydrogen-bonding arrangements of backbone groups





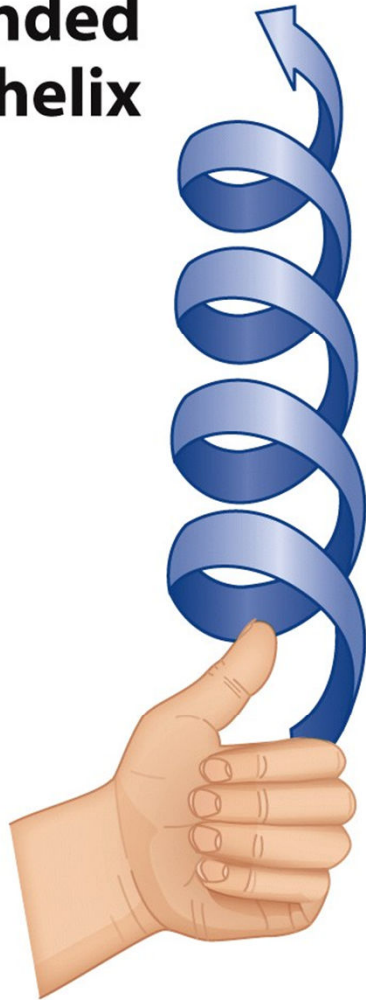
The  $\alpha$ -helix forms within a continuous stretch of the polypeptide chain



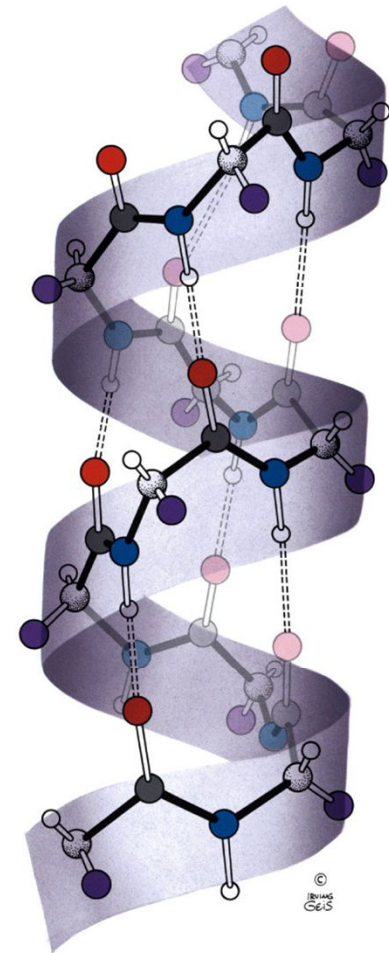
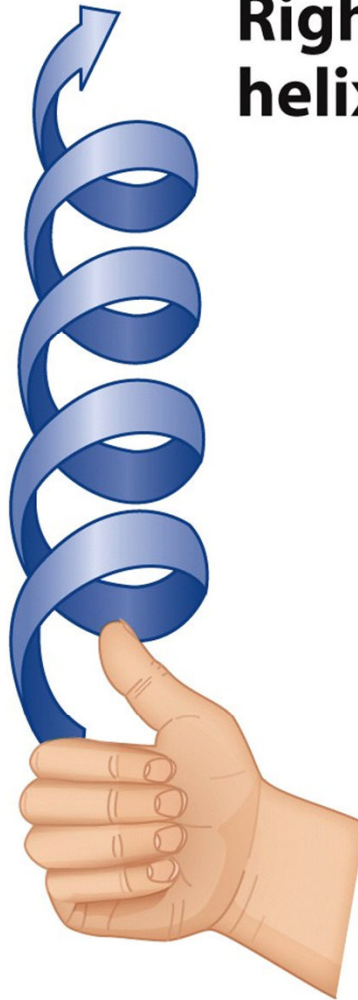


# The $\alpha$ -helix is a right-handed helix

**Left-handed  
helix**



**Right-handed  
helix**



$\alpha$ -Helices have a dipole moment, due to unbonded and aligned N-H and C=O groups

