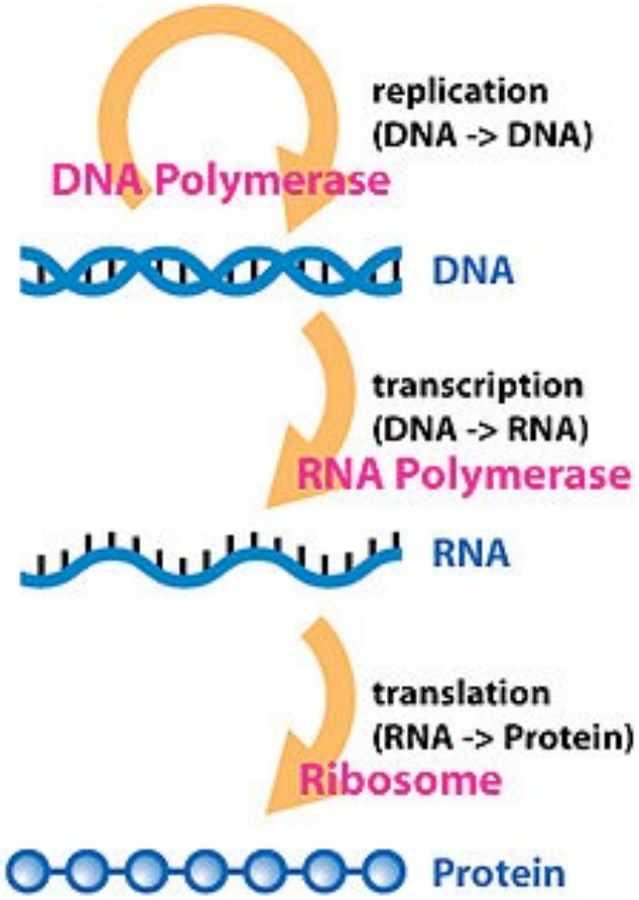
Proteins

Molecular Machinery

Proteins & the Central *Dogma* (of Biology)

- Proteins are a **diverse** and **abundant** class of biomolecules, constituting more than 50% of the dry weight of cells.
- The pattern by which each is tailored resides within the genetic information of cells, encoded in a specific sequence of nucleotide bases in DNA.

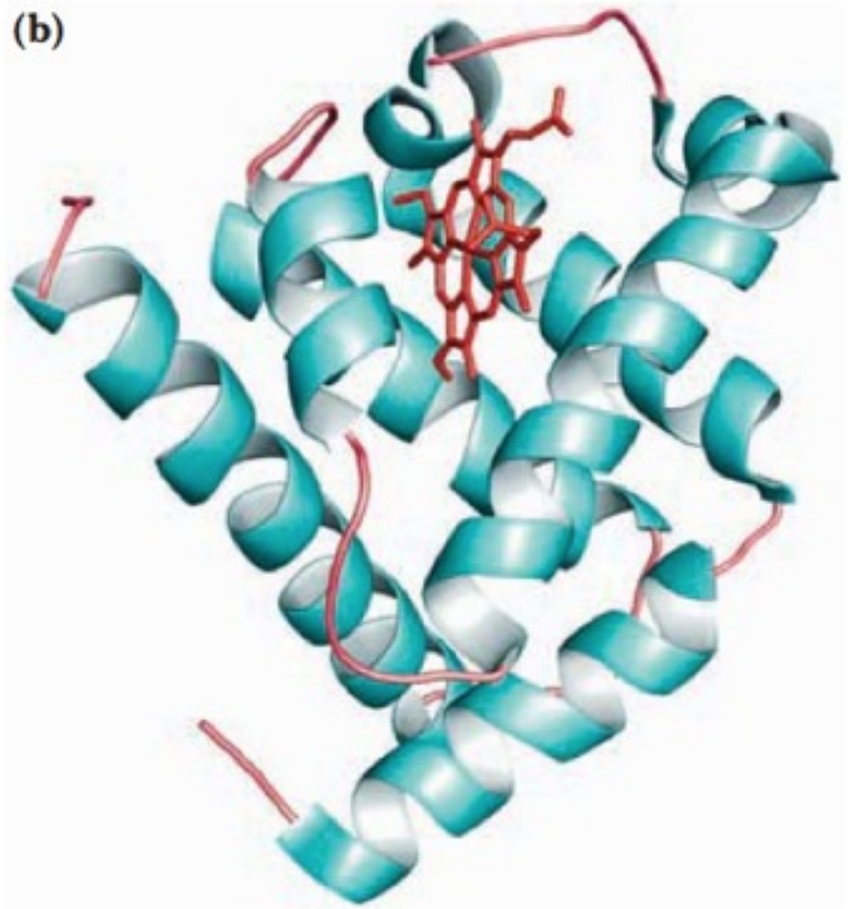


Garrett, R. H., and C. M. Grisham. "Biochemistry. 4th Eds." *Brooks Cole Cengage Learning, Boston USA* (2010).

Protein Classes

- Classification based on shape & solubility

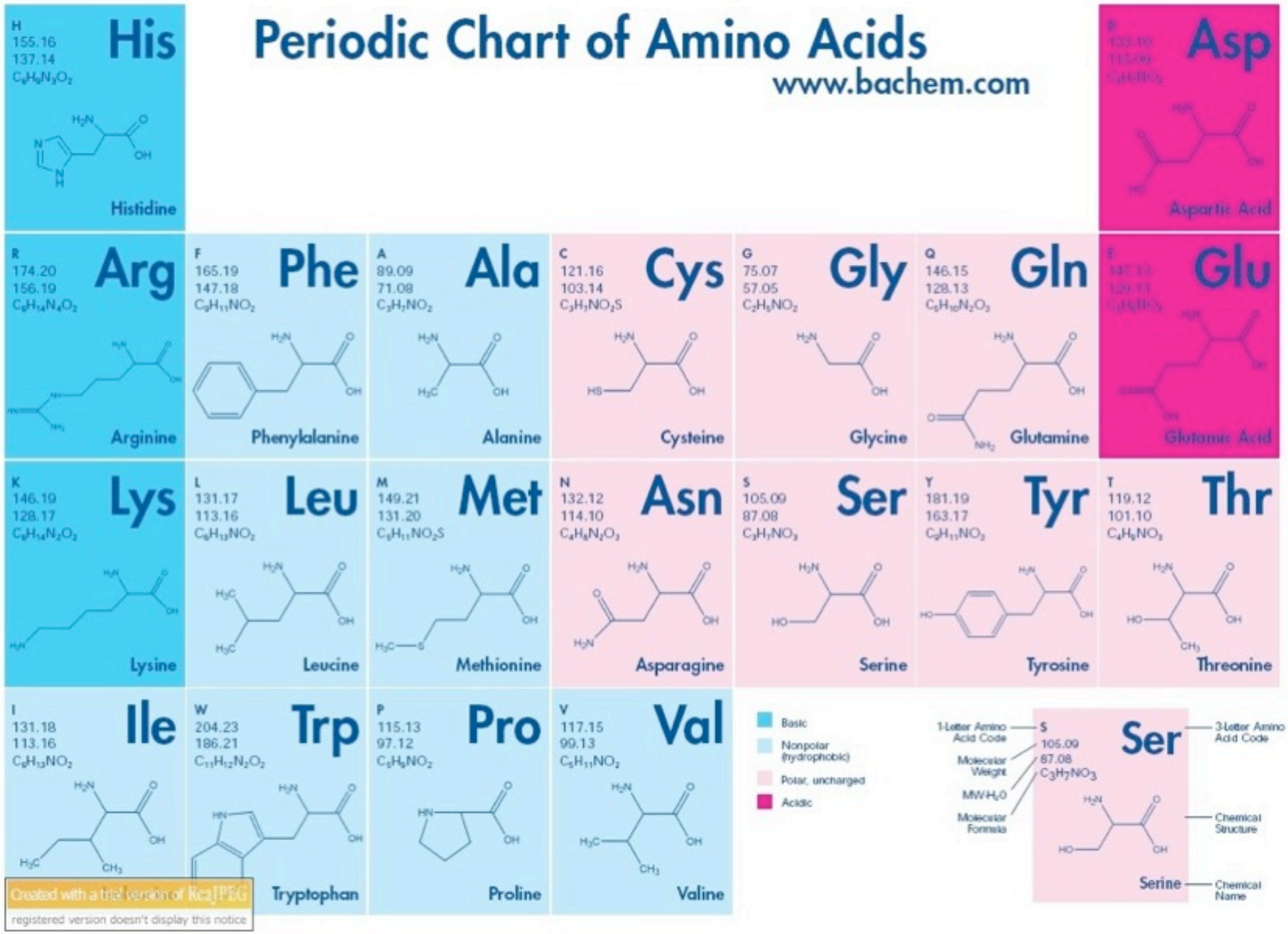
Bacteriorhodopsin, a membrane protein



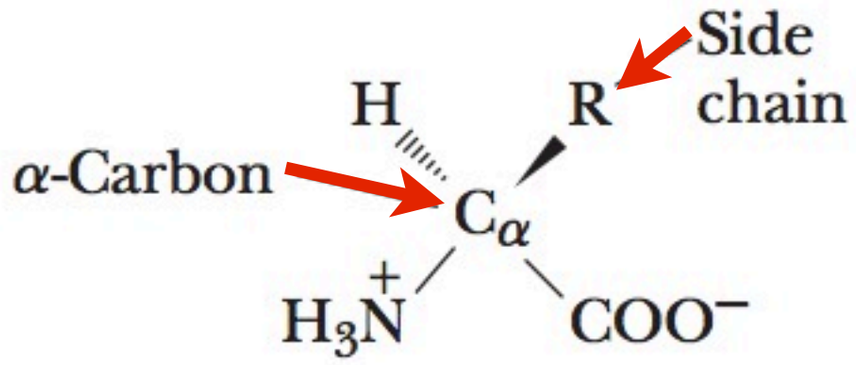
Myoglobin, a globular protein

Collagen,
a fibrous protein

Amino Acids

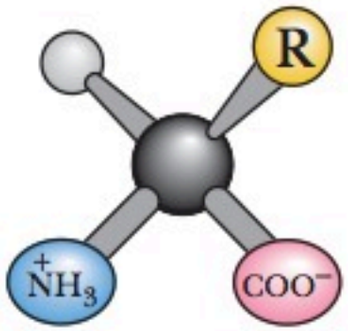


Anatomy of Amino Acids

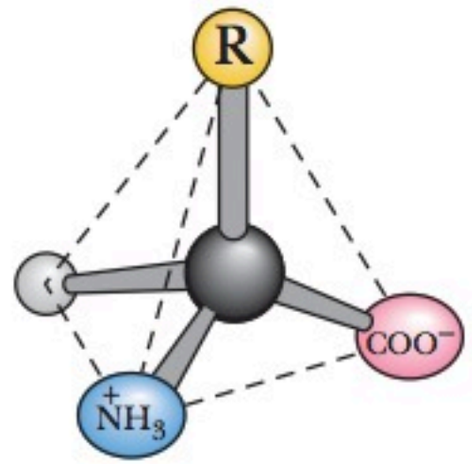


Amino group

Carboxyl group

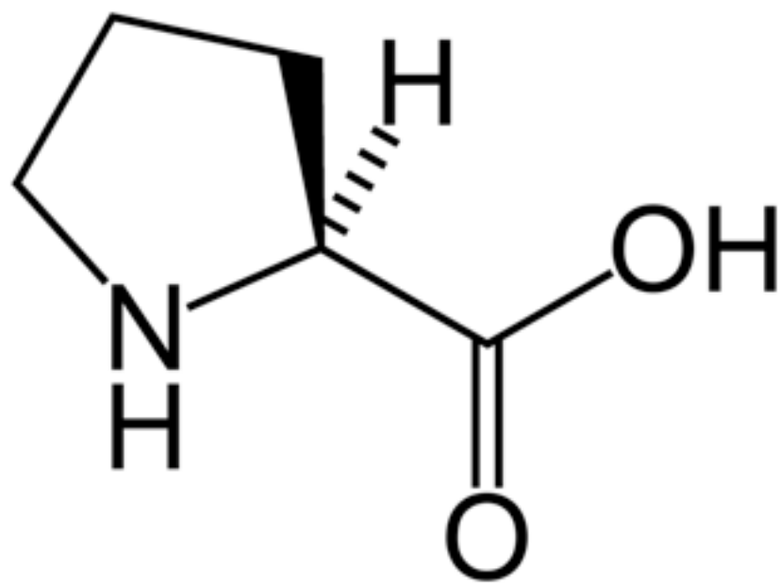


Ball-and-stick model

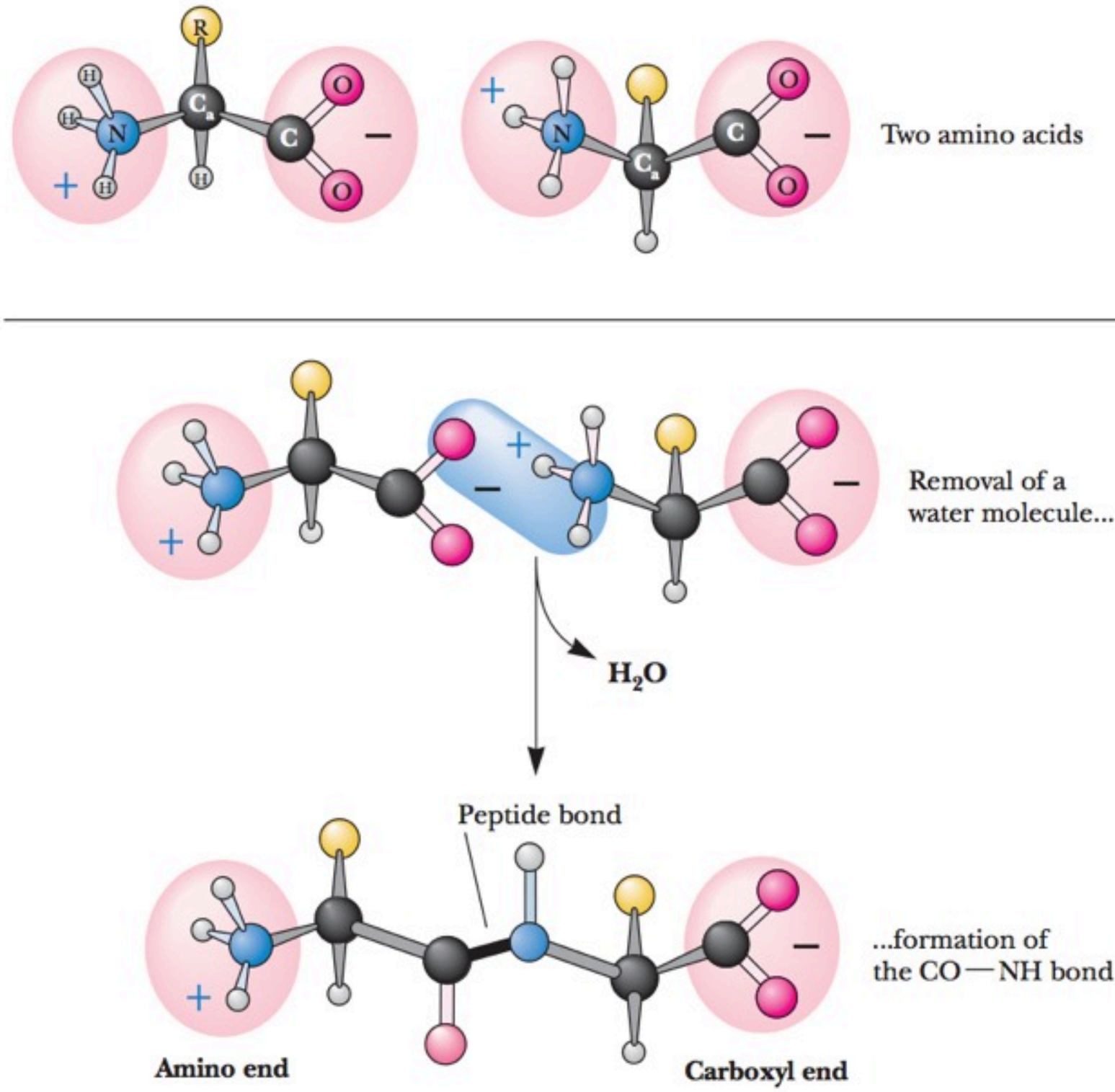


Amino acids are tetrahedral structures

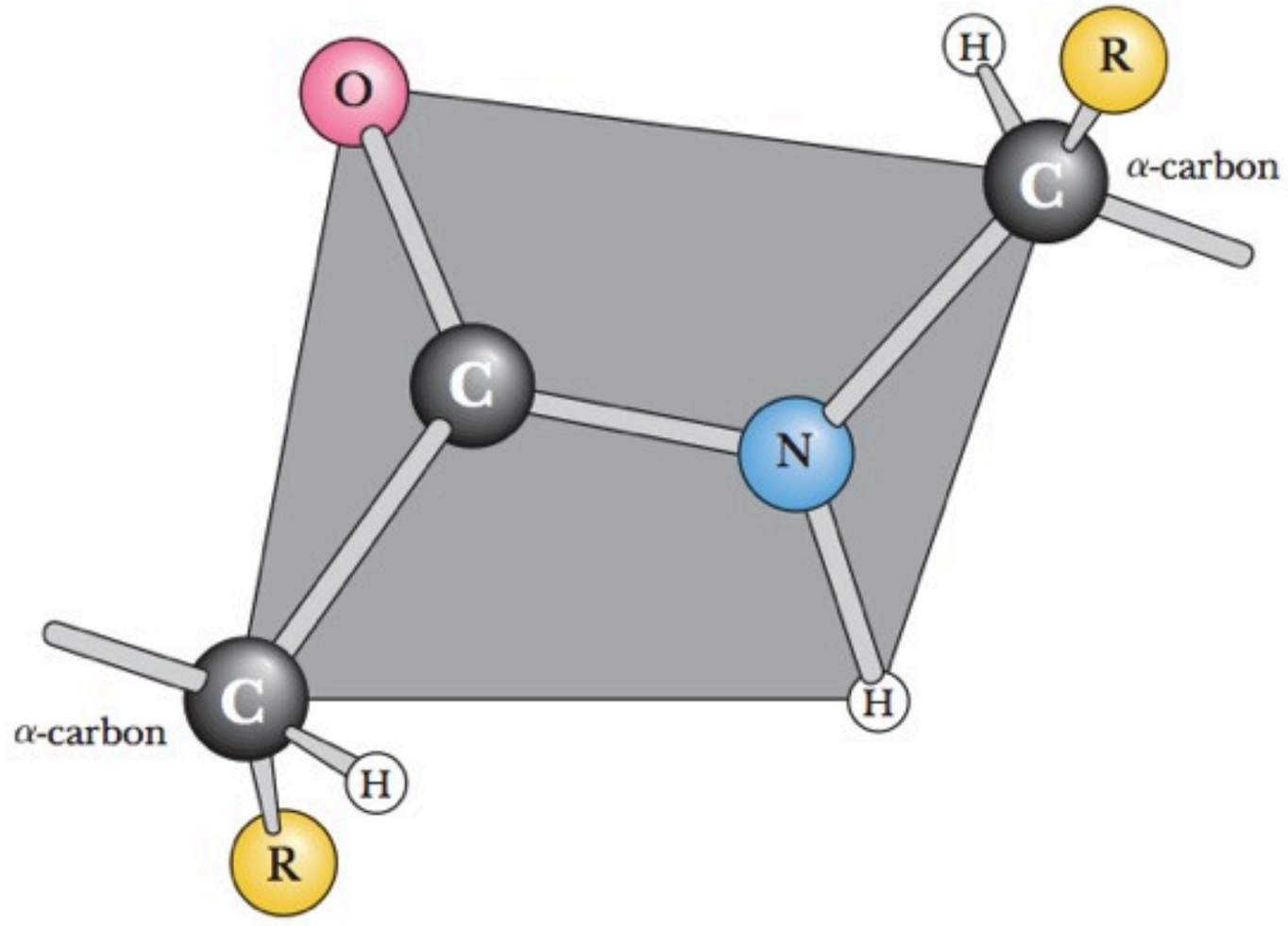
- The only exception is proline (PRO)

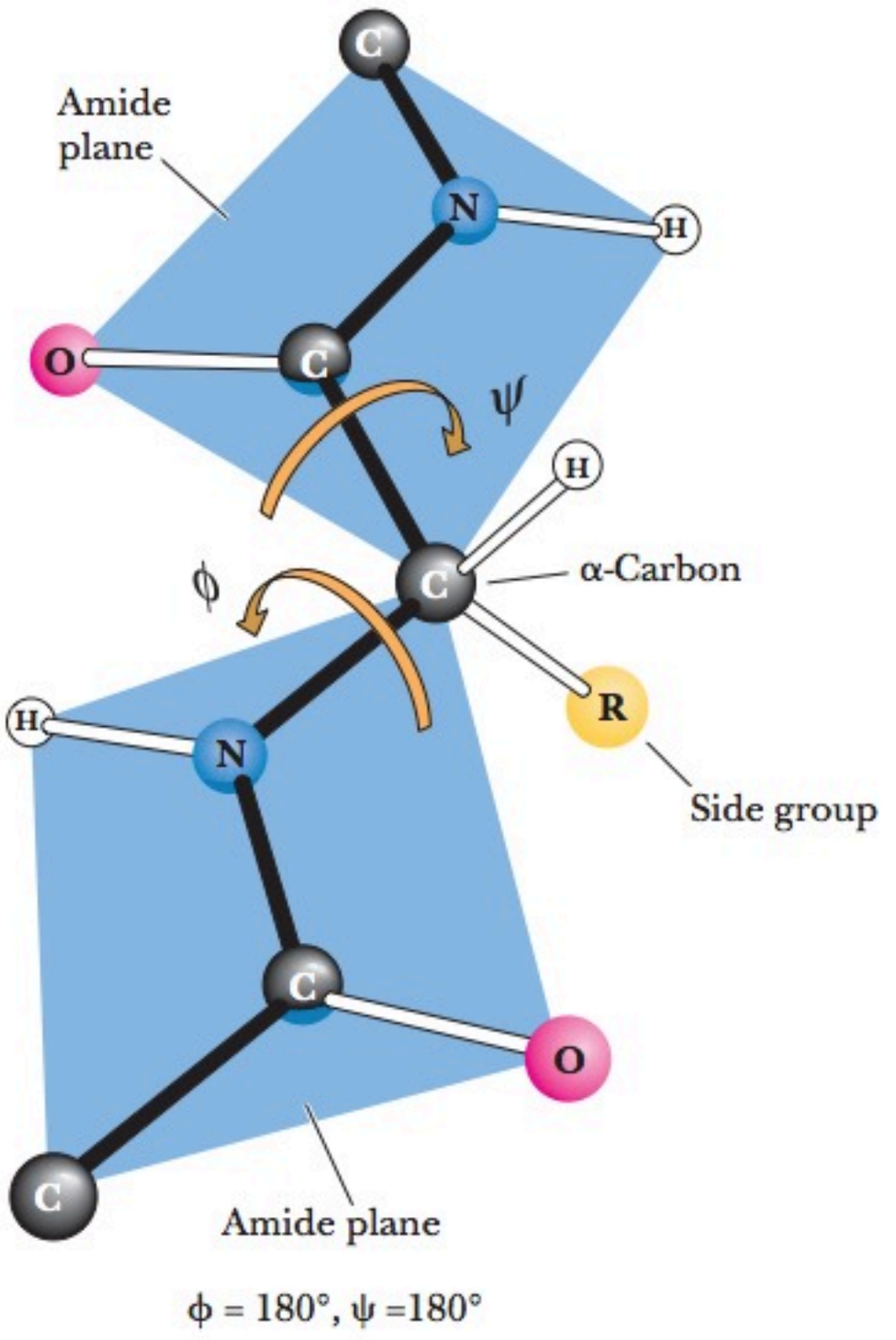


Peptide Bonds



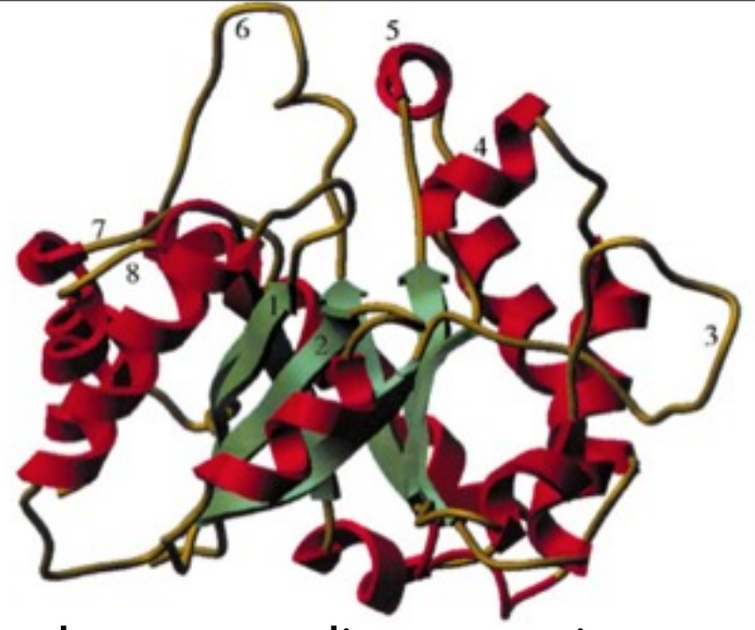
Dihedral Angles



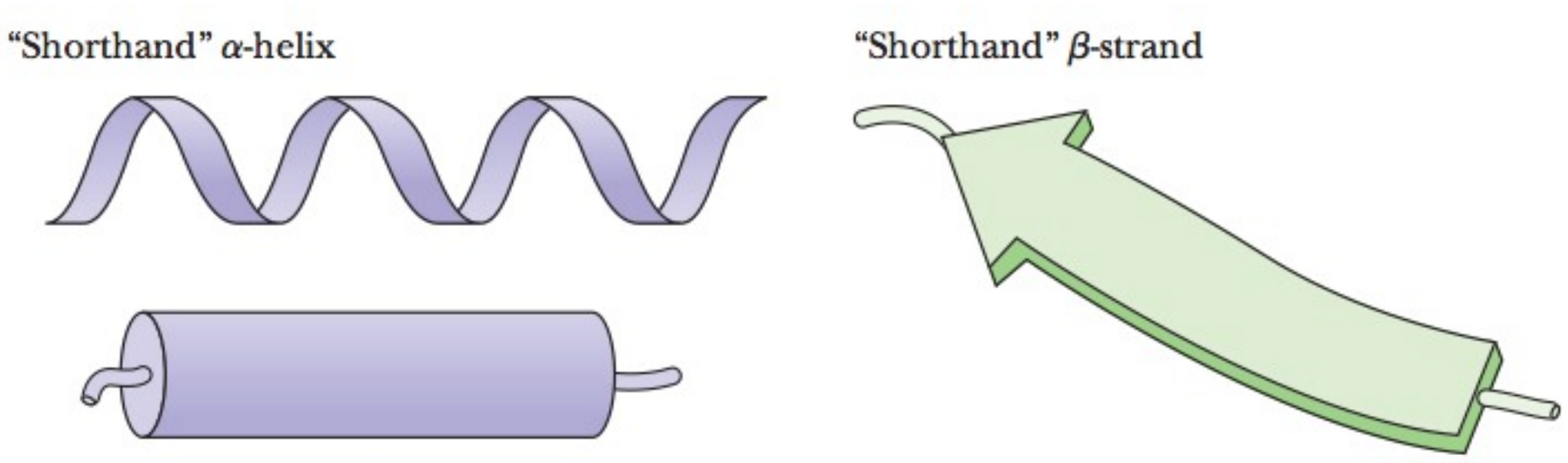


$\phi = 180°, \psi = 180°$

Structure Levels



- **Modeling**: coarse-grained VS all-atom
- Primary structure: the amino acid sequence (covalent bonds)
- Secondary structure: through **hydrogen-bonding** interactions between adjacent amino acid residues ("short-range" hydrogen-bond interactions) [alpha-helix; **beta-sheet**]
- Tertiary structure: when the polypeptide chains of protein molecules bend and fold in order to assume ("long-range" non-covalent interactions)
- Quaternary structure: two or more interacting poly-peptide chains of characteristic tertiary structure



It is important to emphasize that "***all***" the information necessary for a protein molecule to achieve its intricate architecture is contained within its primary structure!

Homology: Sequence VS Structure

- In the context of proteomics, homology is the existence of shared ancestry between a pair of molecules
- Homologous proteins from different organisms have homologous amino acid sequences
- Computer programs can align sequences and discover homology between proteins
- **Structural similarity**: structure is more evolutionarily conserved than sequence!
- Experimental methods for structure determination: X-ray diffraction (solid state) & NMR (solution)
- Protein Data Bank