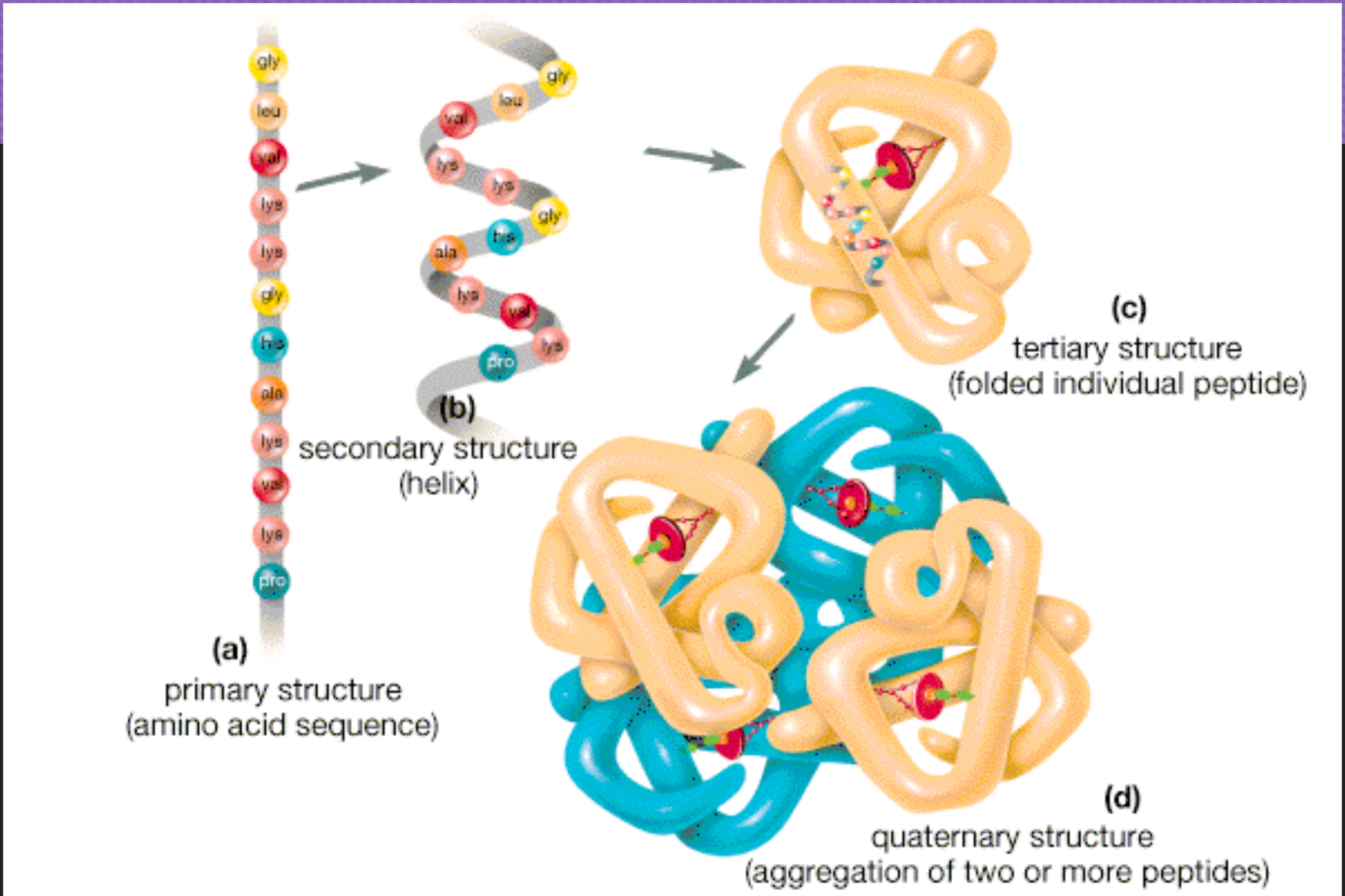
Four Levels of Protein Structure

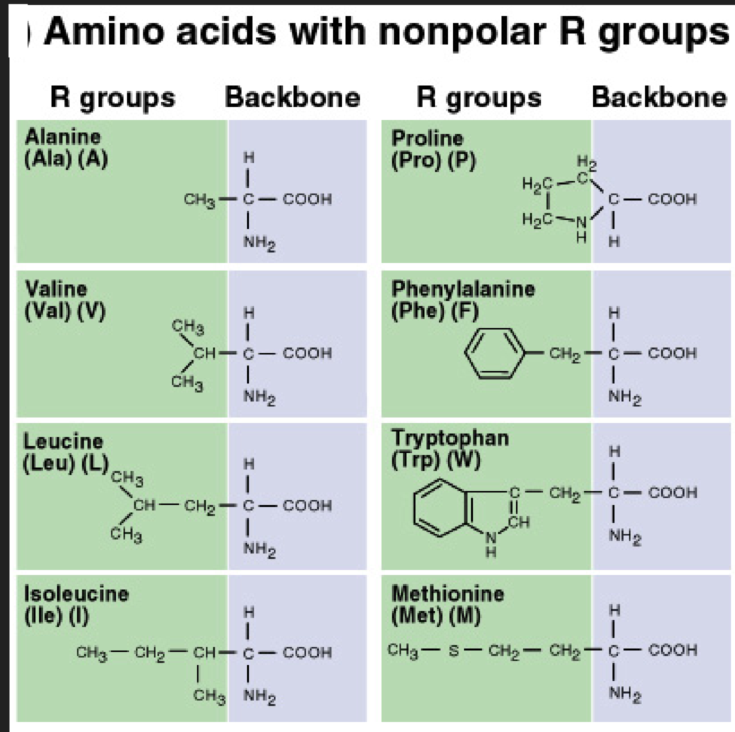


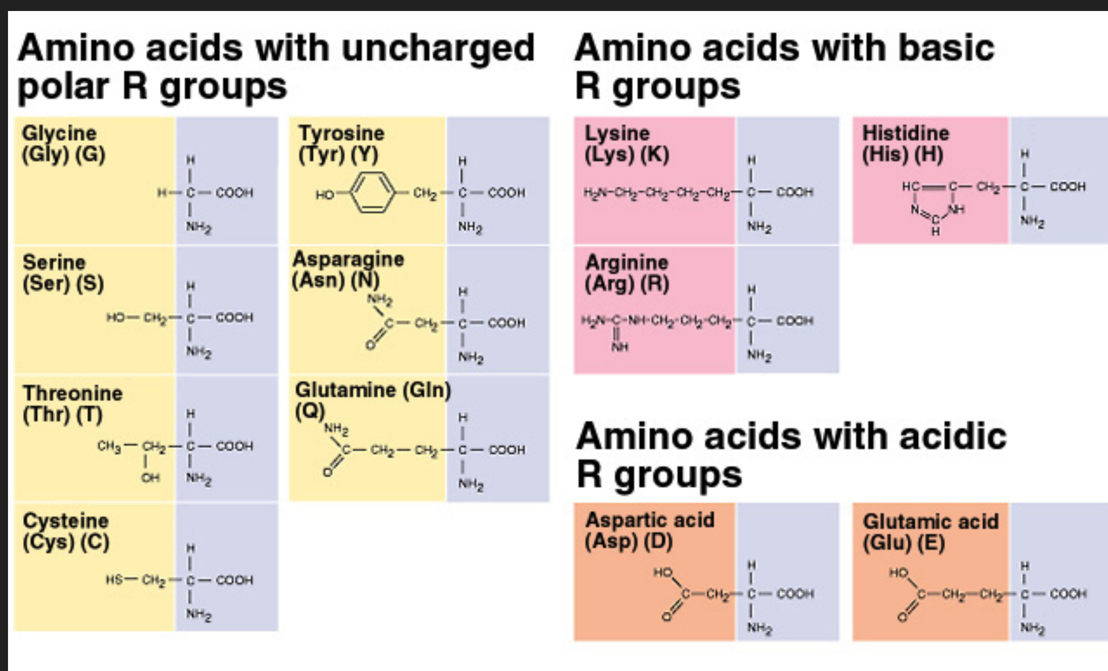
Four Levels of Protein Structure

- Primary Structure:

Linear Sequence of Amino Acids

Each amino acid has
central carbon linked to
---hydrogen (H)
---amino group (NH_2)
---acid group (COOH)
---unique group (R)


Amino acids with nonpolar R groups
R groups
Backbone
R groups
Backbone
Alanine (Ala) (A)
Valine (Val) (V)
Leucine (Leu) (L)
Isoleucine (Ile) (I)
Proline (Pro) (P)
Phenylalanine (Phe) (F)
Tryptophan (Trp) (W)
Methionine (Met) (M)


Amino acids with uncharged polar R groups
Glycine (Gly) (G)
Serine (Ser) (S)
Threonine (Thr) (T)
Cysteine (Cys) (C)
Tyrosine (Tyr) (Y)
Asparagine (Asn) (N)
Glutamine (Gln) (Q)
Amino acids with basic R groups
Lysine (Lys) (K)
Arginine (Arg) (R)
Histidine (His) (H)
Amino acids with acidic R groups
Aspartic acid (Asp) (D)
Glutamic acid (Glu) (E)

Peptide bond formation. Once again it is a condensation reaction

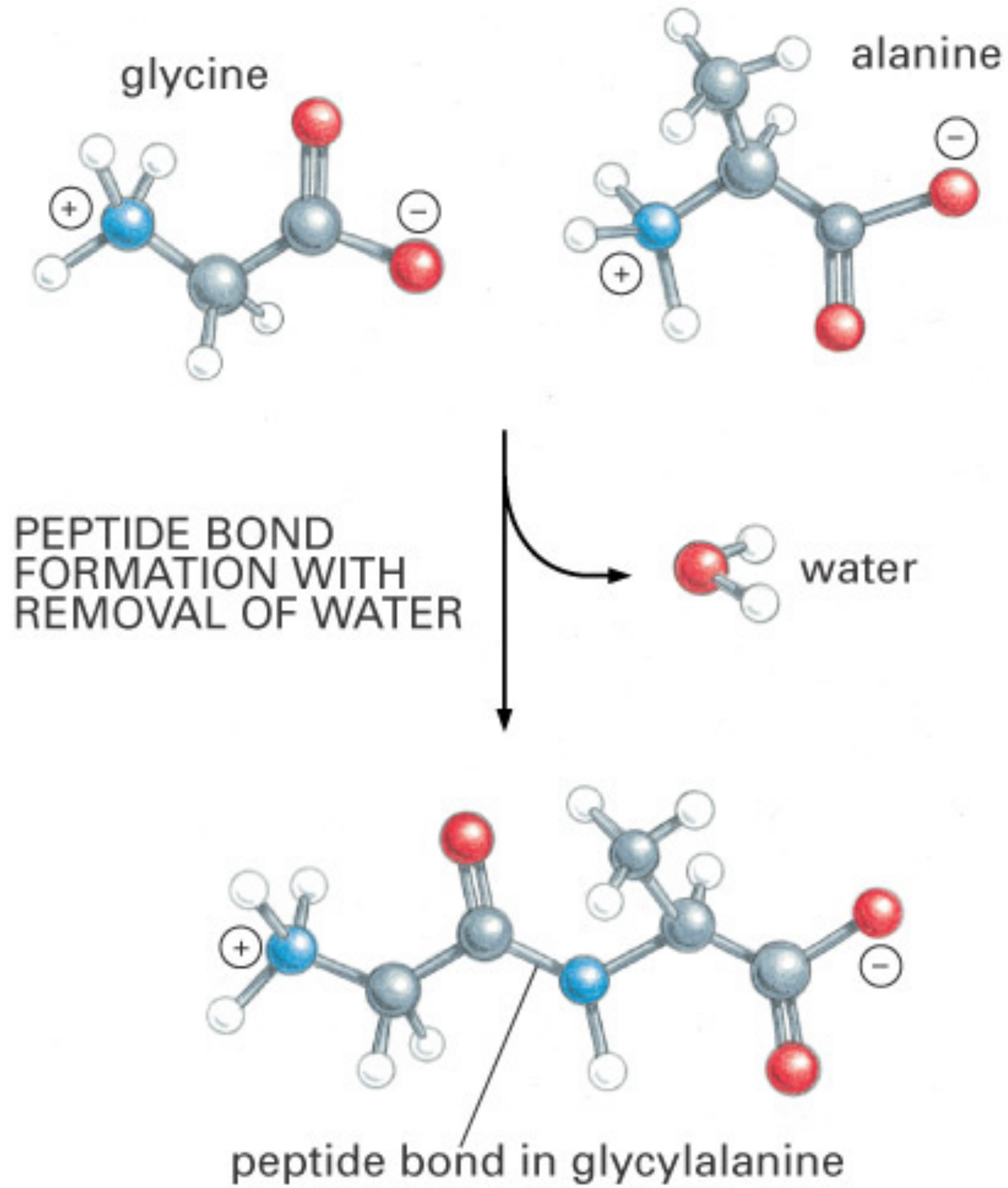


Figure 4-1 **Essential Cell Biology, 2/e. (© 2004 Garland Science)**

Each AA' contributes three atoms to the polypeptide backbone. The side groups of adjacent AA's protrude in an alternating manner

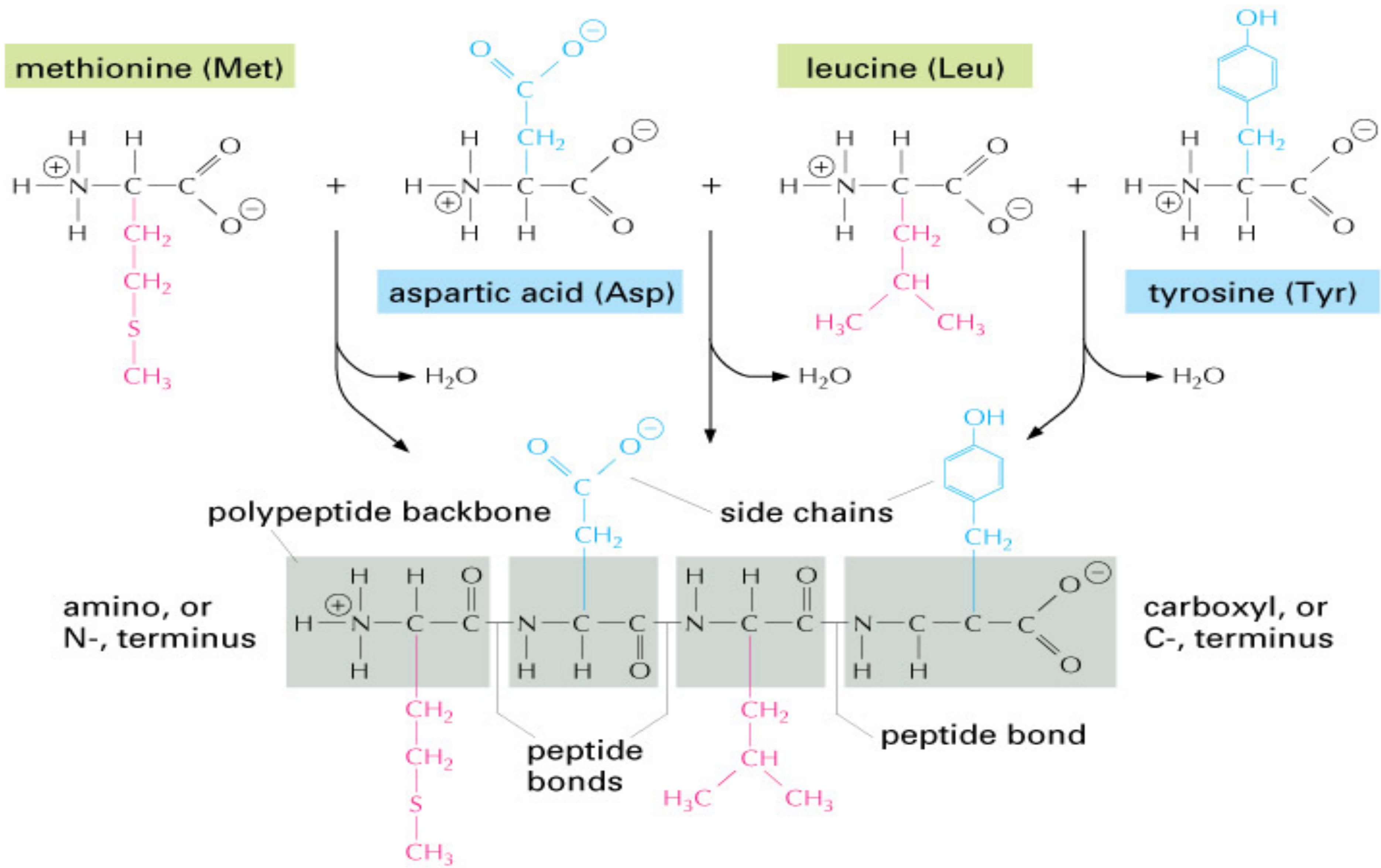
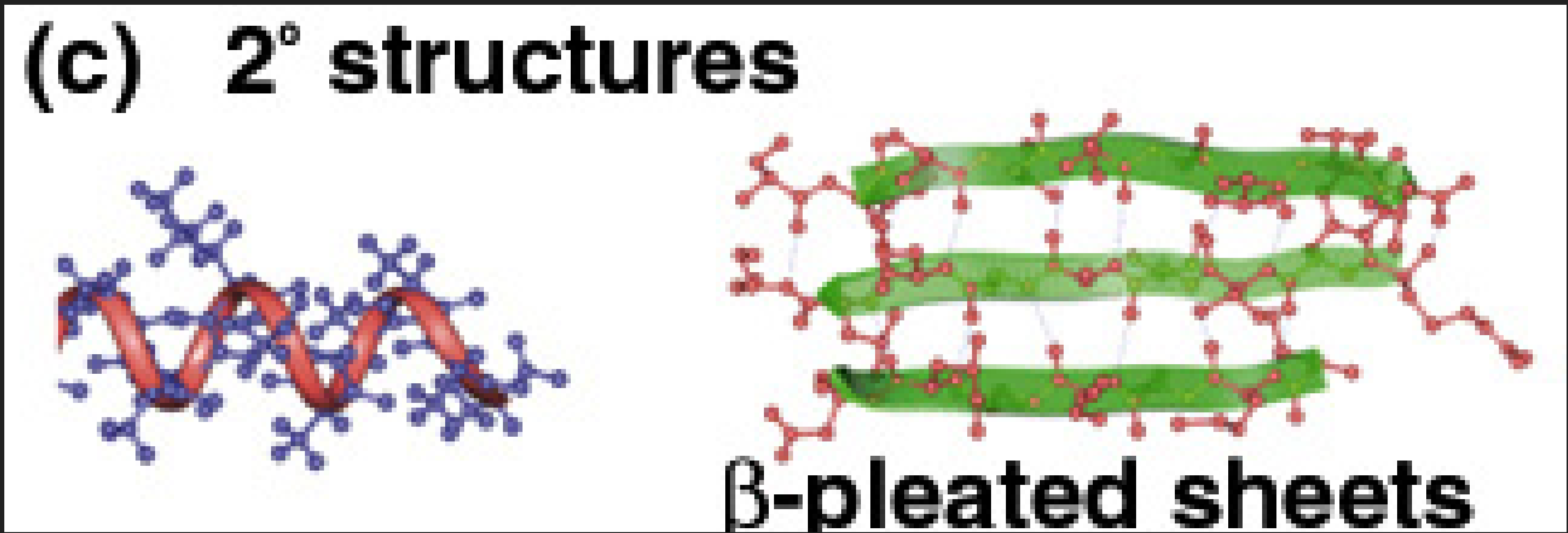


Figure 4-2 Essential Cell Biology, 2/e. (© 2004 Garland Science)

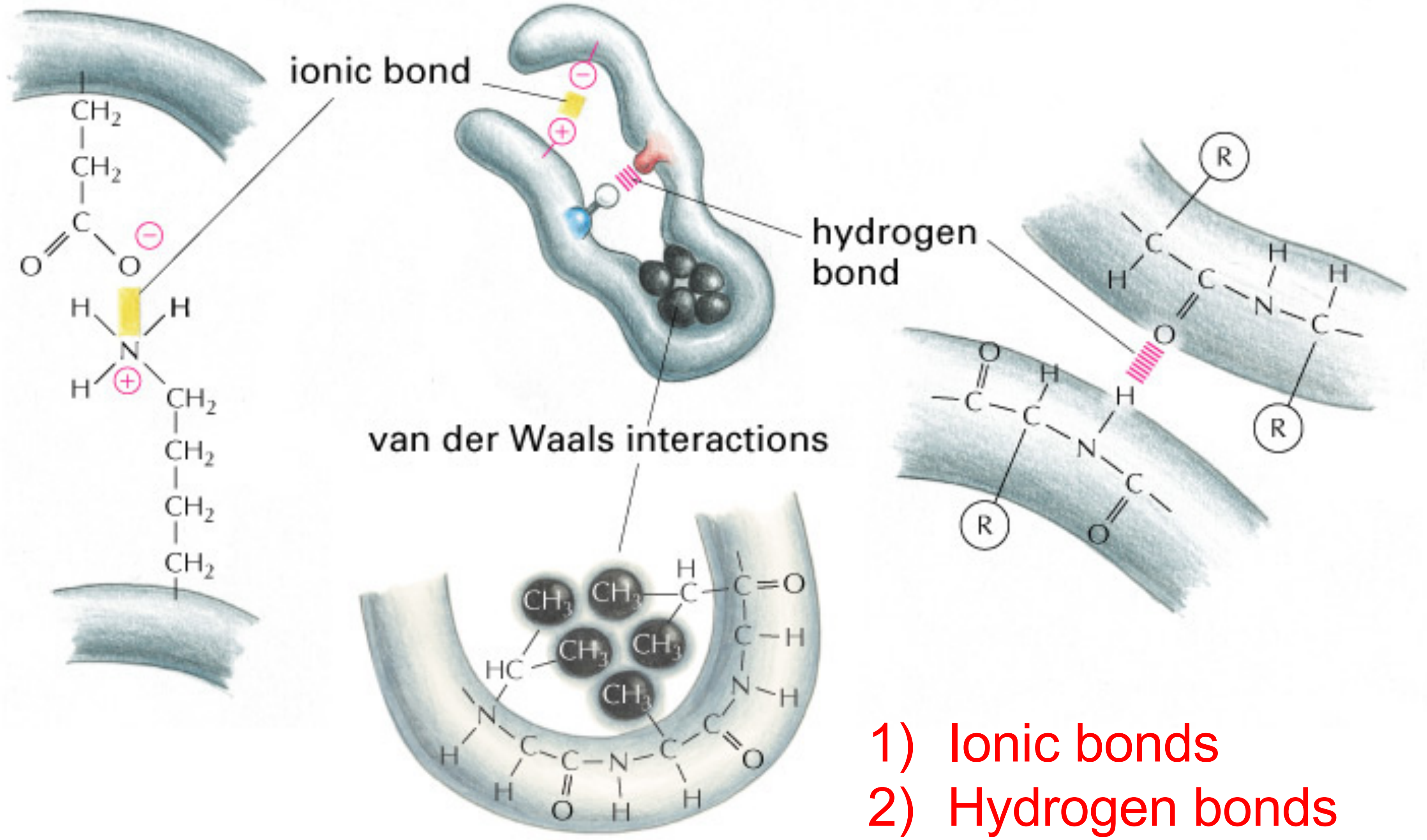
Four Levels of Protein Structure

- Secondary Structure:

Folded structure due to hydrogen bonds between the amino and acid groups of amino acids



Non-covalent bonds within and between Protein chains are as important in their overall conformation and function



1) Ionic bonds
2) Hydrogen bonds
3) Van der Waals forces

Figure 4-4 Essential Cell Biology, 2/e. (© 2004 Garland Science)

The side groups of the linear unfolded polypeptide are intermingled. Only when correctly folded do we see the wonder of Nature!

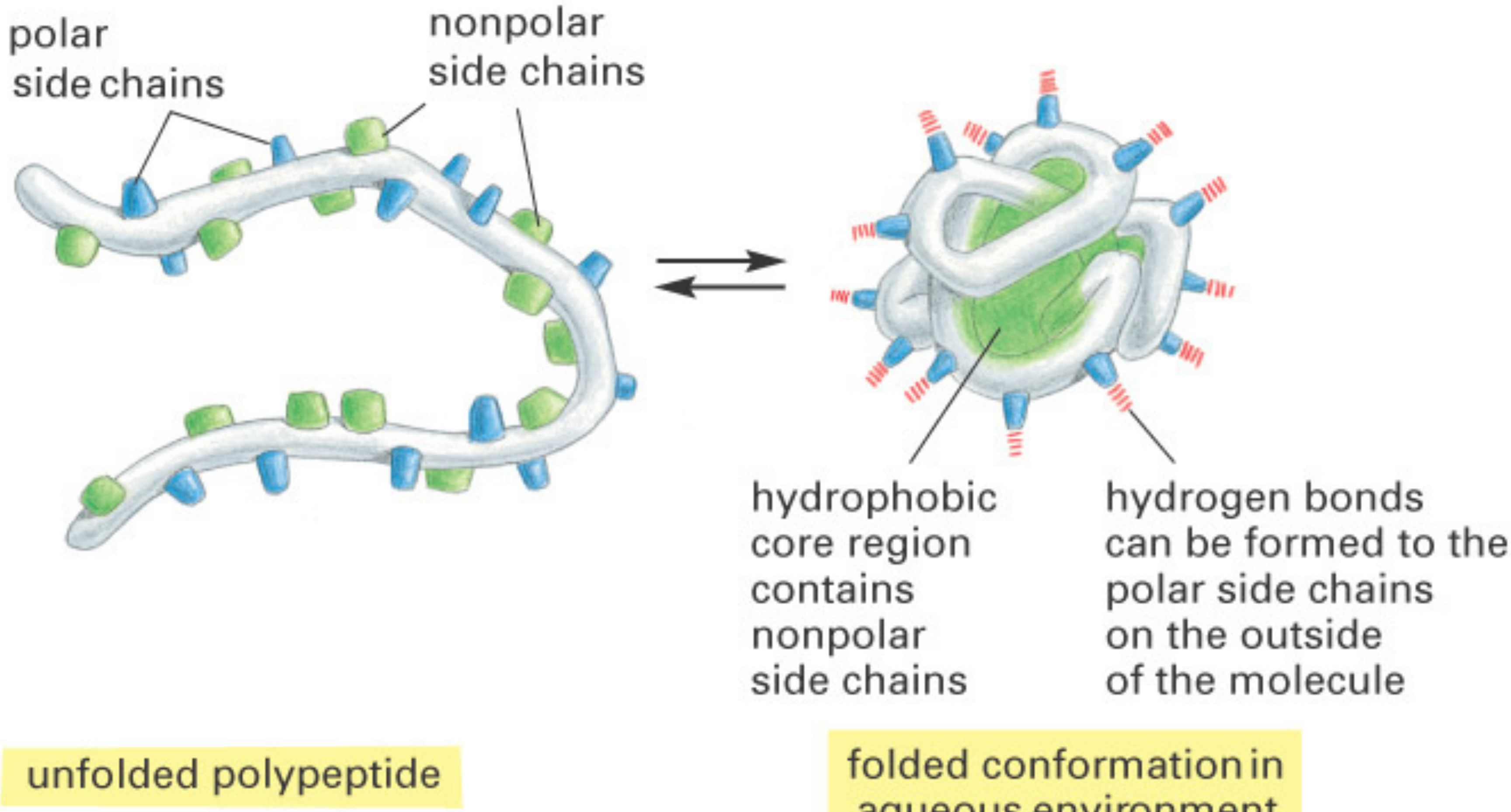


Figure 4-5 **Essential Cell Biology, 2/e. (© 2004 Garland Science)**

The locations of the hydrogen bonds are not restricted to those between the side groups.

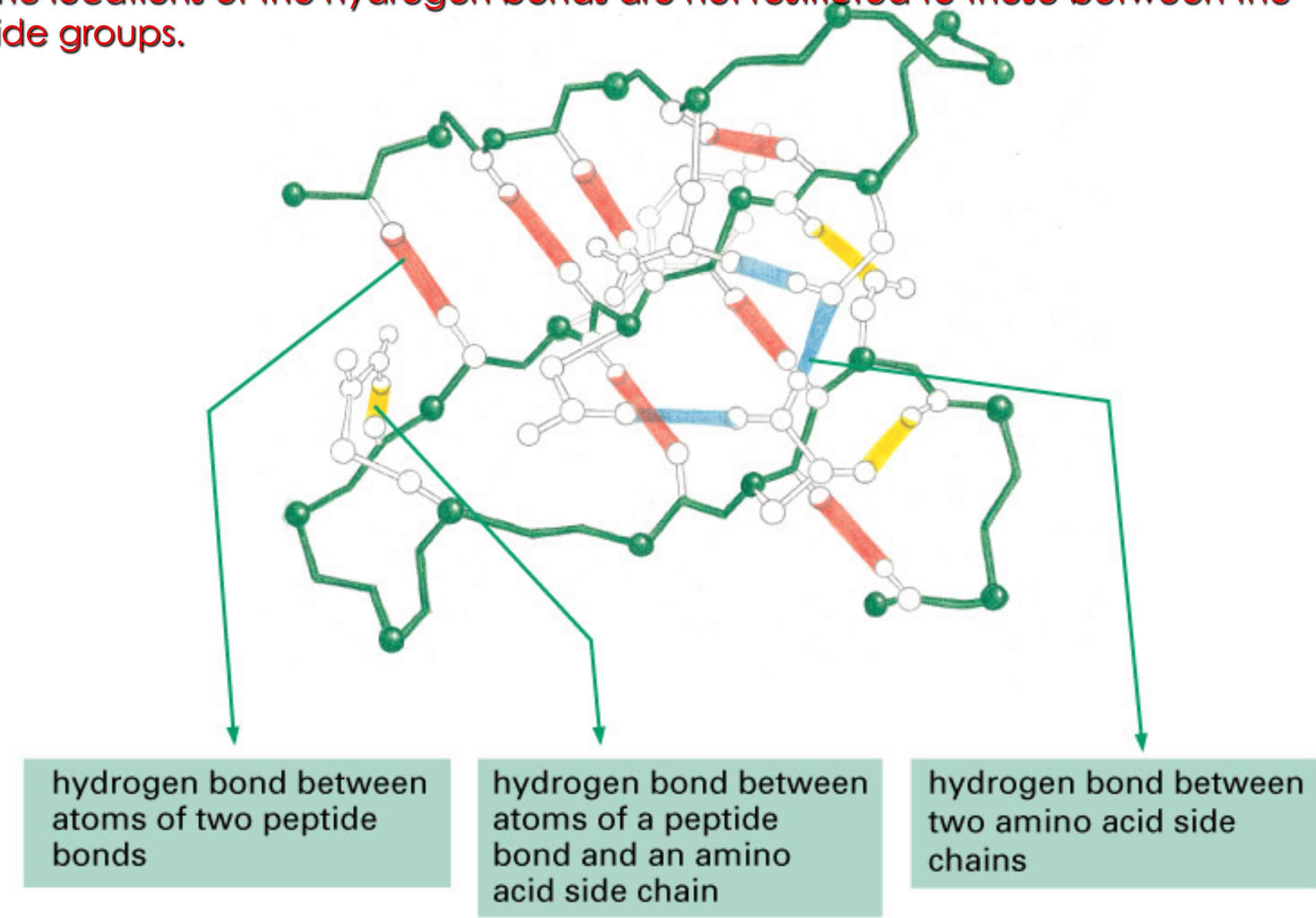


Figure 4-6 Essential Cell Biology, 2/e. (© 2004 Garland Science)

The 3D folding of a Proteins is governed solely by the sequence of the AA's. Under some physiological conditions & in vitro many Proteins can reversibly unfold and refold

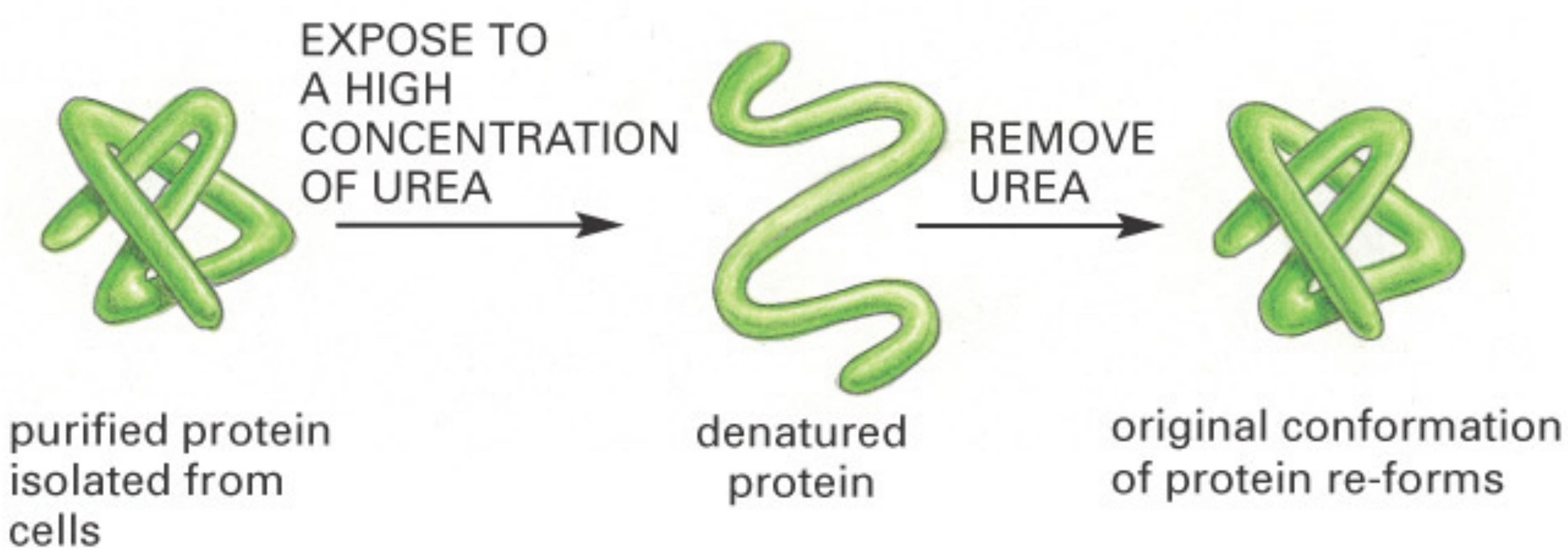
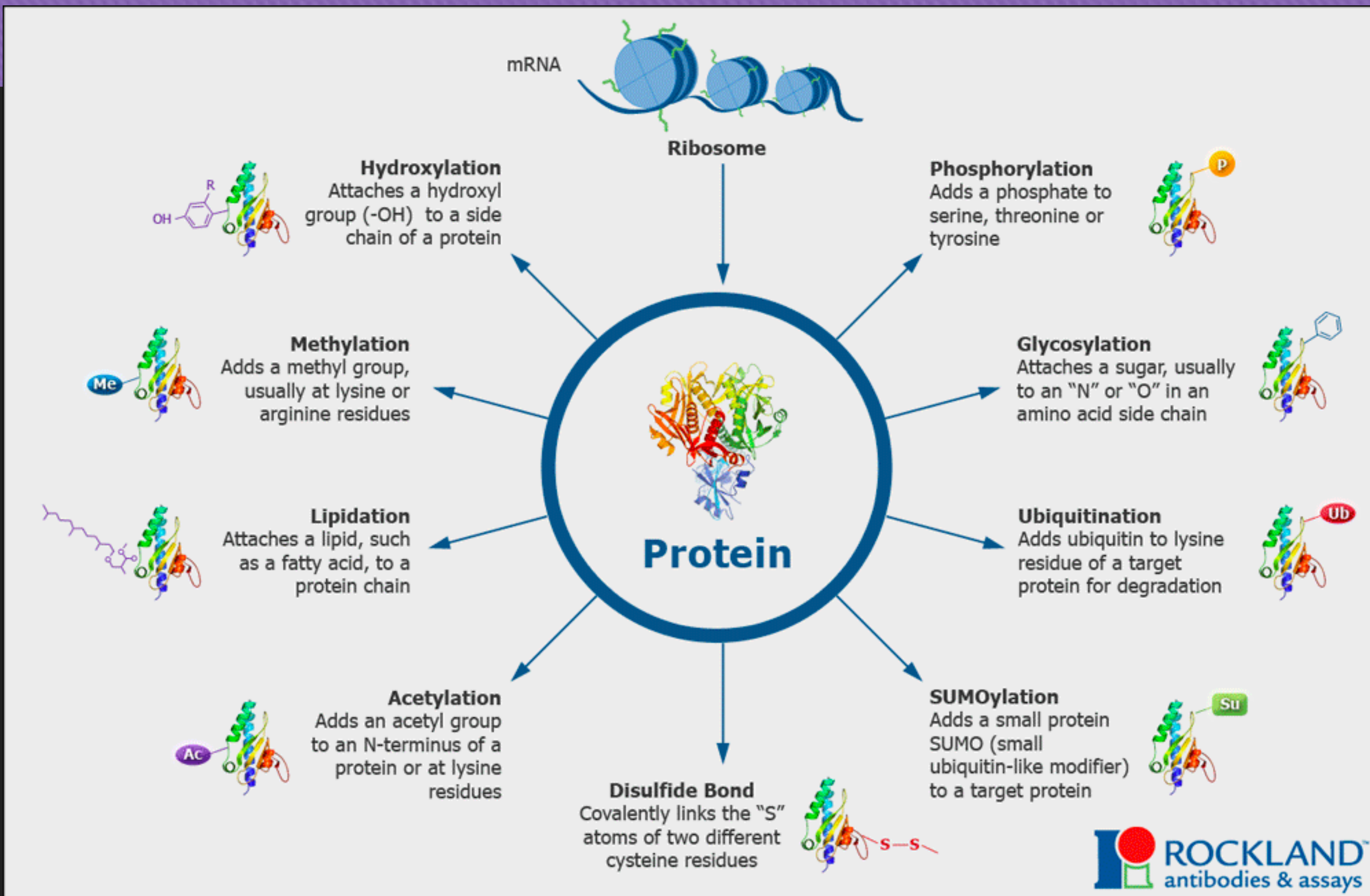


Figure 4-7 **Essential Cell Biology, 2/e. (© 2004 Garland Science)**

Posttranslational modifications of Proteins



	Phosphorylation	Glycosylation	S-nitrosylation	Methylation	N-acetylation	Palmitoylahion	N-myristoylation	Prenylation	Sumoylation	Ubiquitination
Apopostosis			■		■		■			
Protein stability		■	■		■				■	■
Protein-protein	■	■					■	■		
Protein-membrane						■	■	■		
Protein trafficking	■	■				■				
Protein thermodynamic and cinetic		■								
Protein activity		■	■							
Extracellular protein export							■		■	
Cell-signalling			■			■	■		■	
Transcription				■	■					
DNA-repair					■				■	
Cell cycle division	■									■
Immune response	■									■
Chromosome maintenance				■						
Chromosome assembly									■	

Right-handed α-sheets

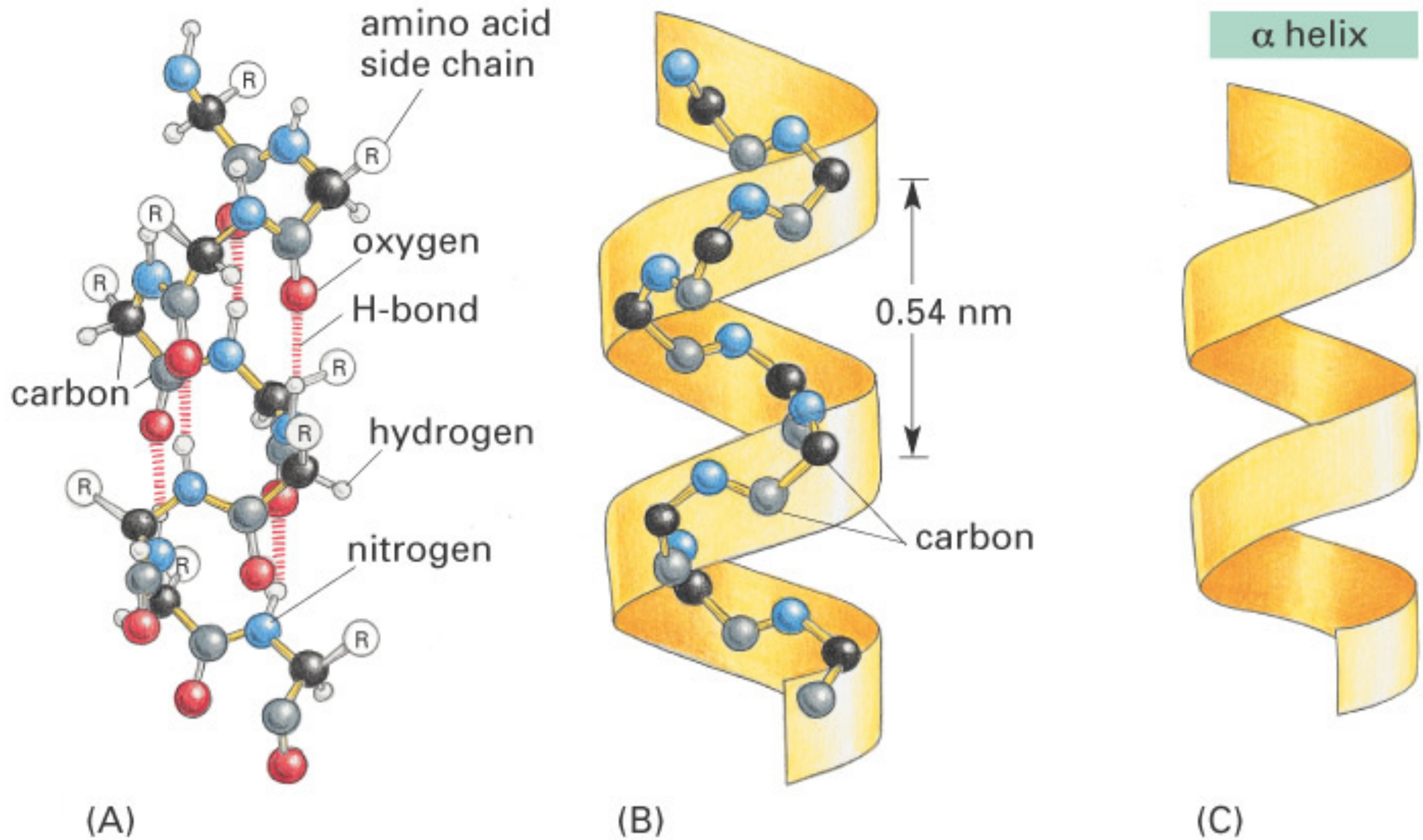
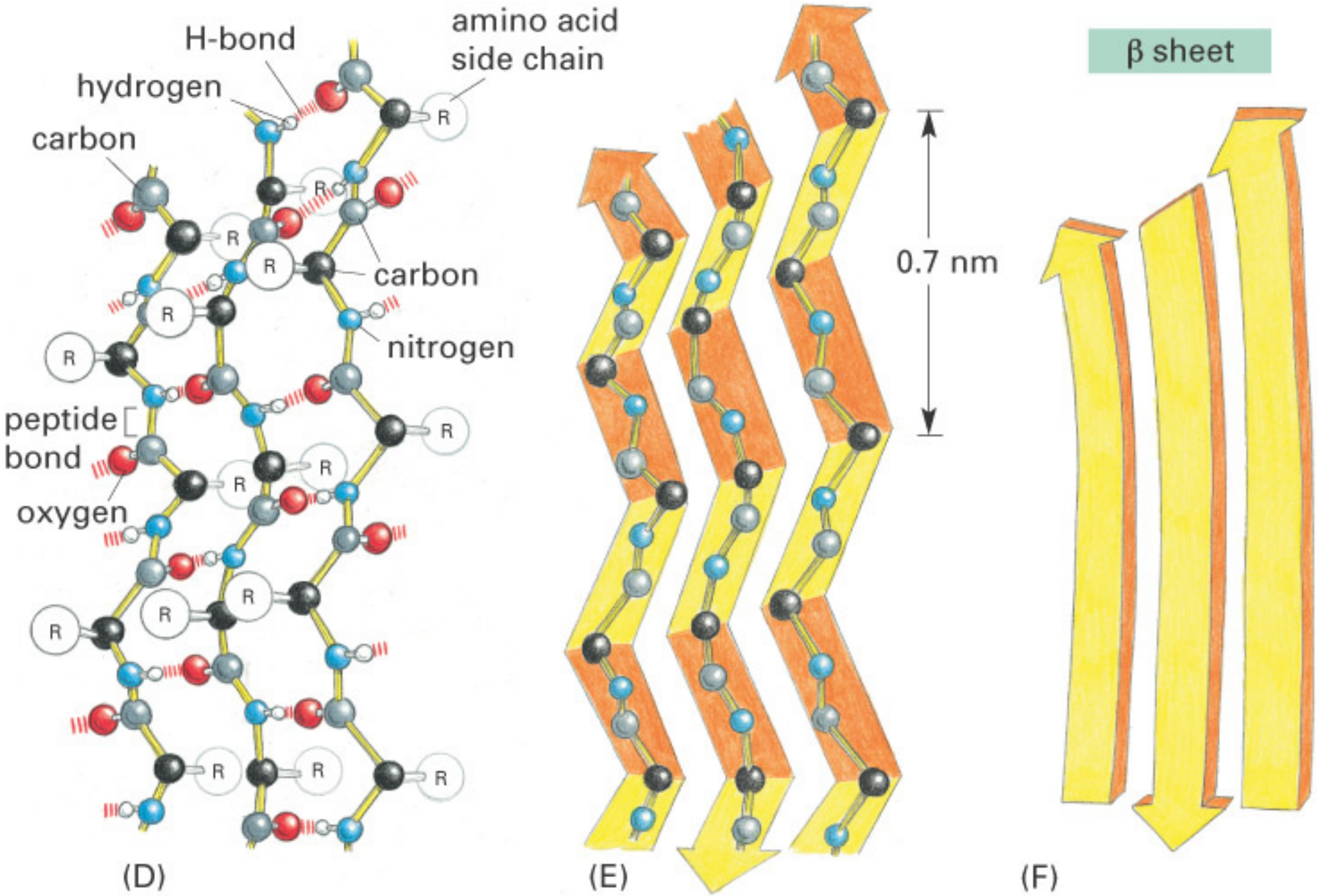
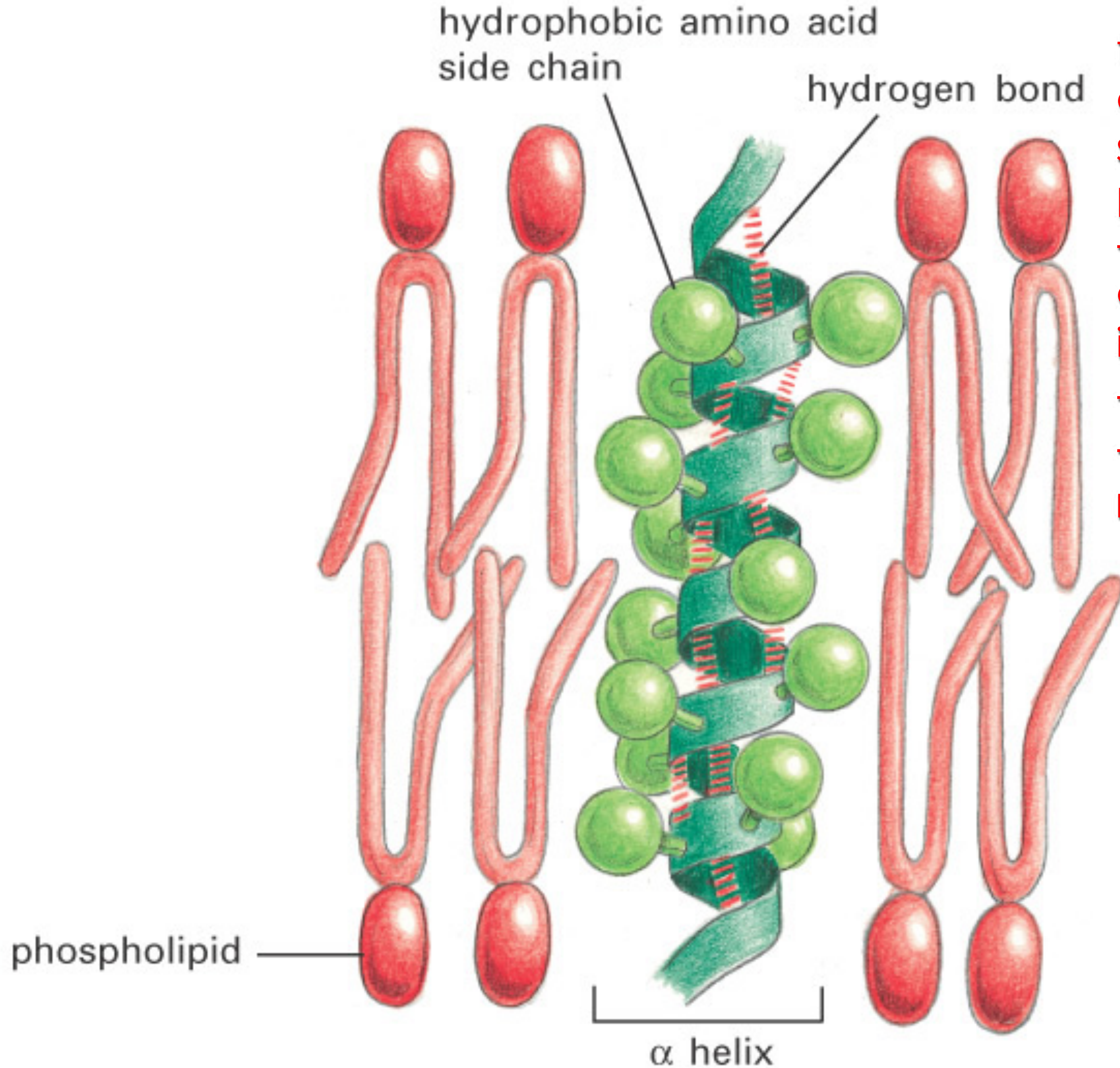


Figure 4-10 part 1 of 2 Essential Cell Biology, 2/e. (© 2004 Garland Science)



Anti-parallel β-sheets

Figure 4-10 part 2 of 2 Essential Cell Biology, 2/e. (© 2004 Garland Science)



The helix is fundamental in allowing Proteins to sit within the plasma membrane
-it is the foundation of many many very important Proteins
- Visual Pigments
- Immune cell receptors

Figure 4-15 **Essential Cell Biology, 2/e. (© 2004 Garland Science)**

Coiled-coil - in which 2-6 alpha-helices are coiled together like the strands of a rope

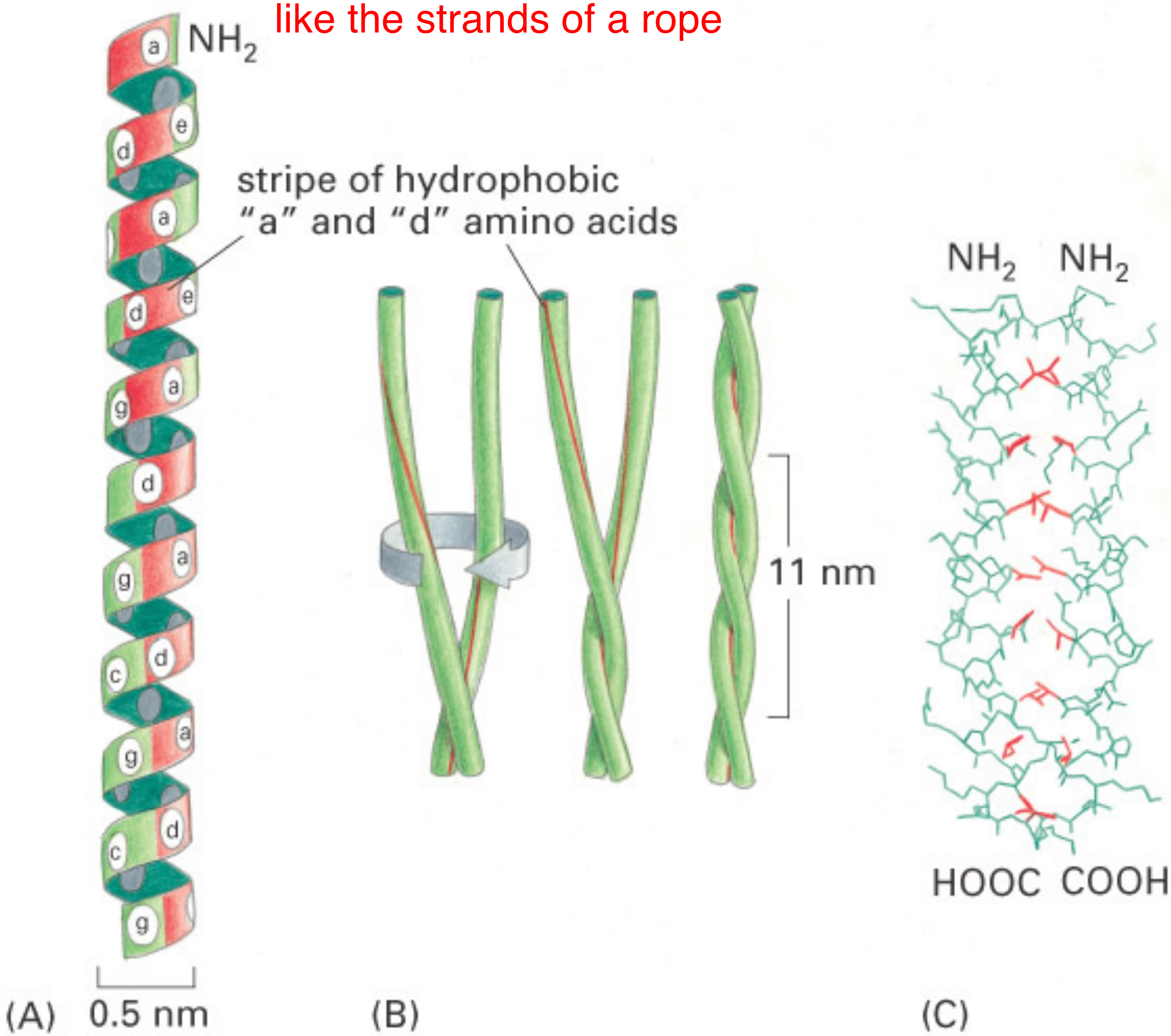


Figure 4-16 Essential Cell Biology, 2/e. (© 2004 Garland Science)

Parallel and anti-parallel sheets

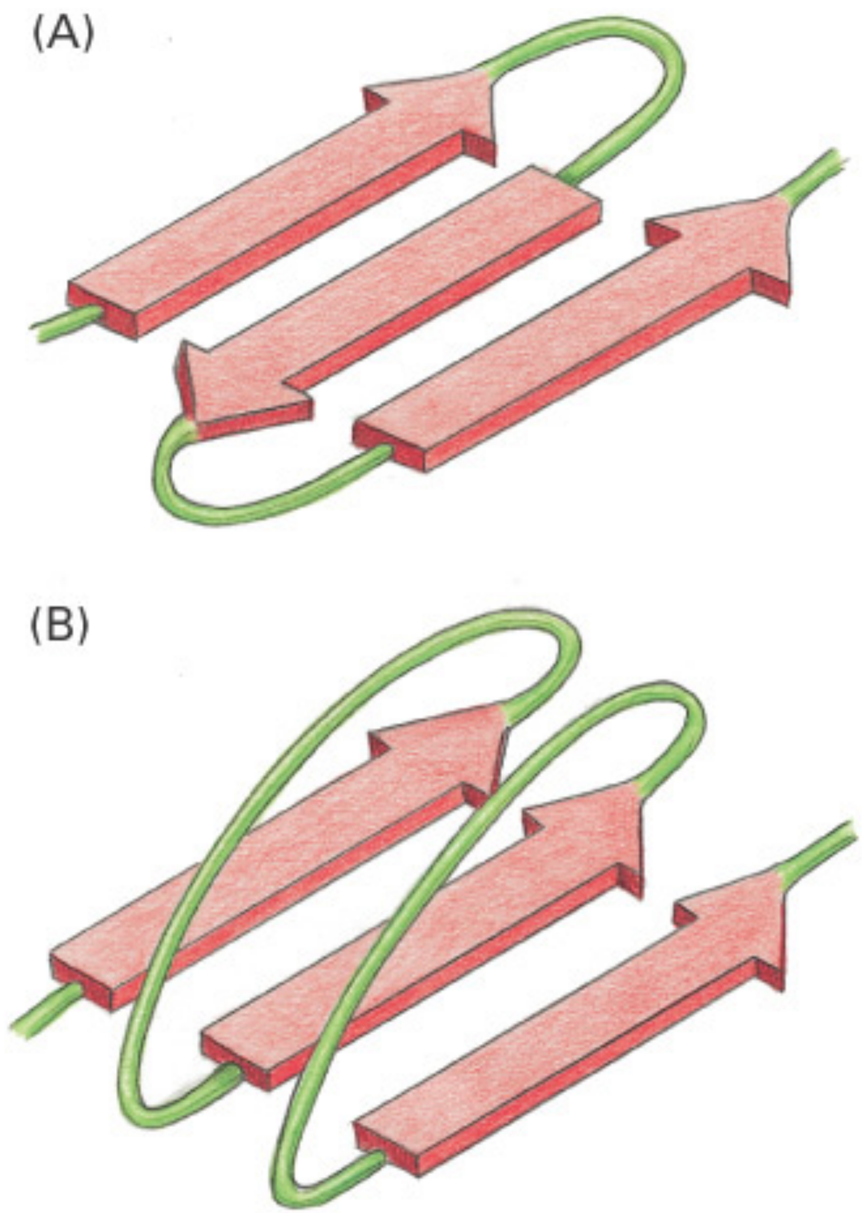


Figure 4-17 **Essential Cell Biology, 2/e. (© 2004 Garland Science)**

Individual Proeins domains may and generally do consist of a combination of secondary structures

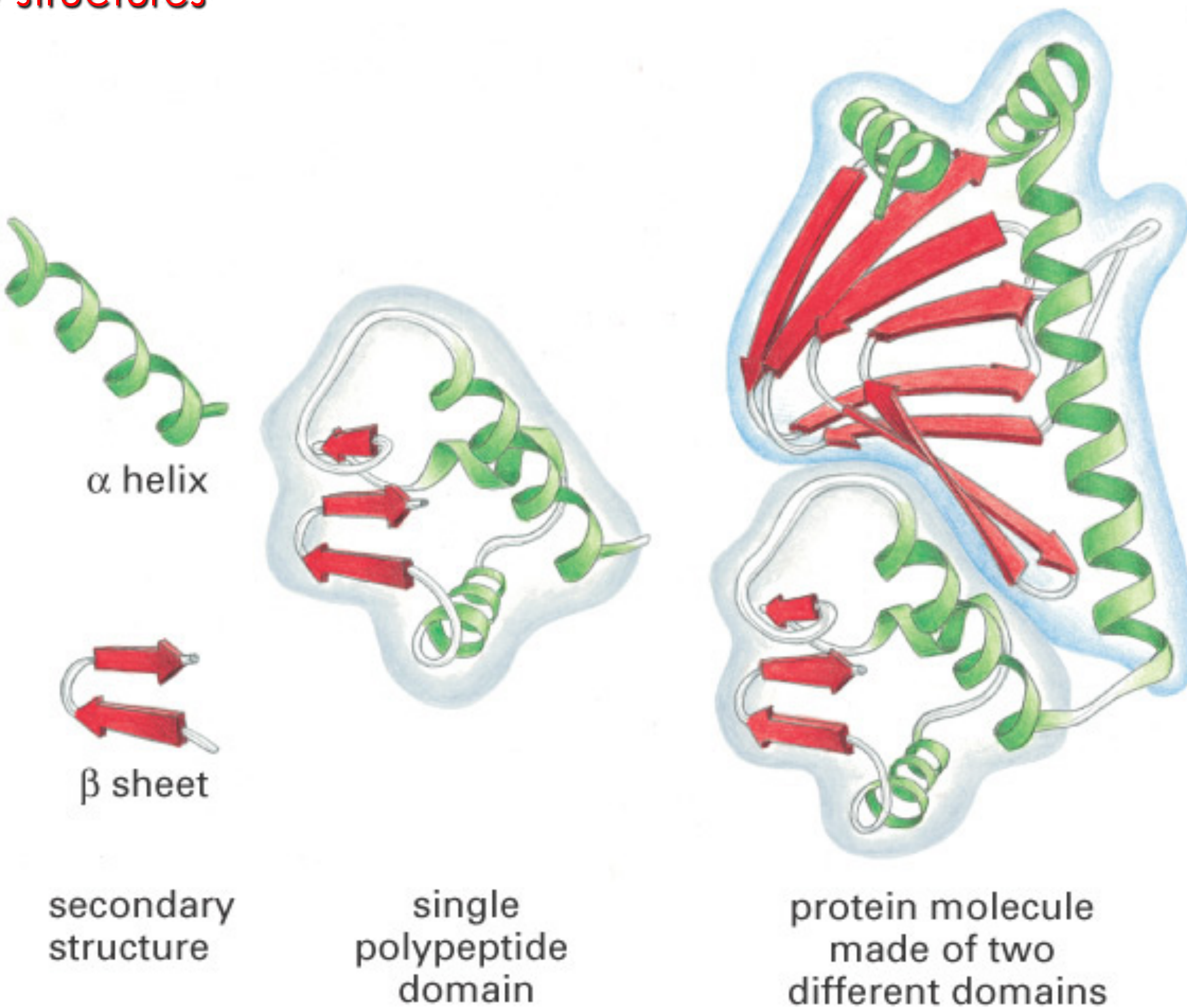


Figure 4-19 **Essential Cell Biology, 2/e. (© 2004 Garland Science)**

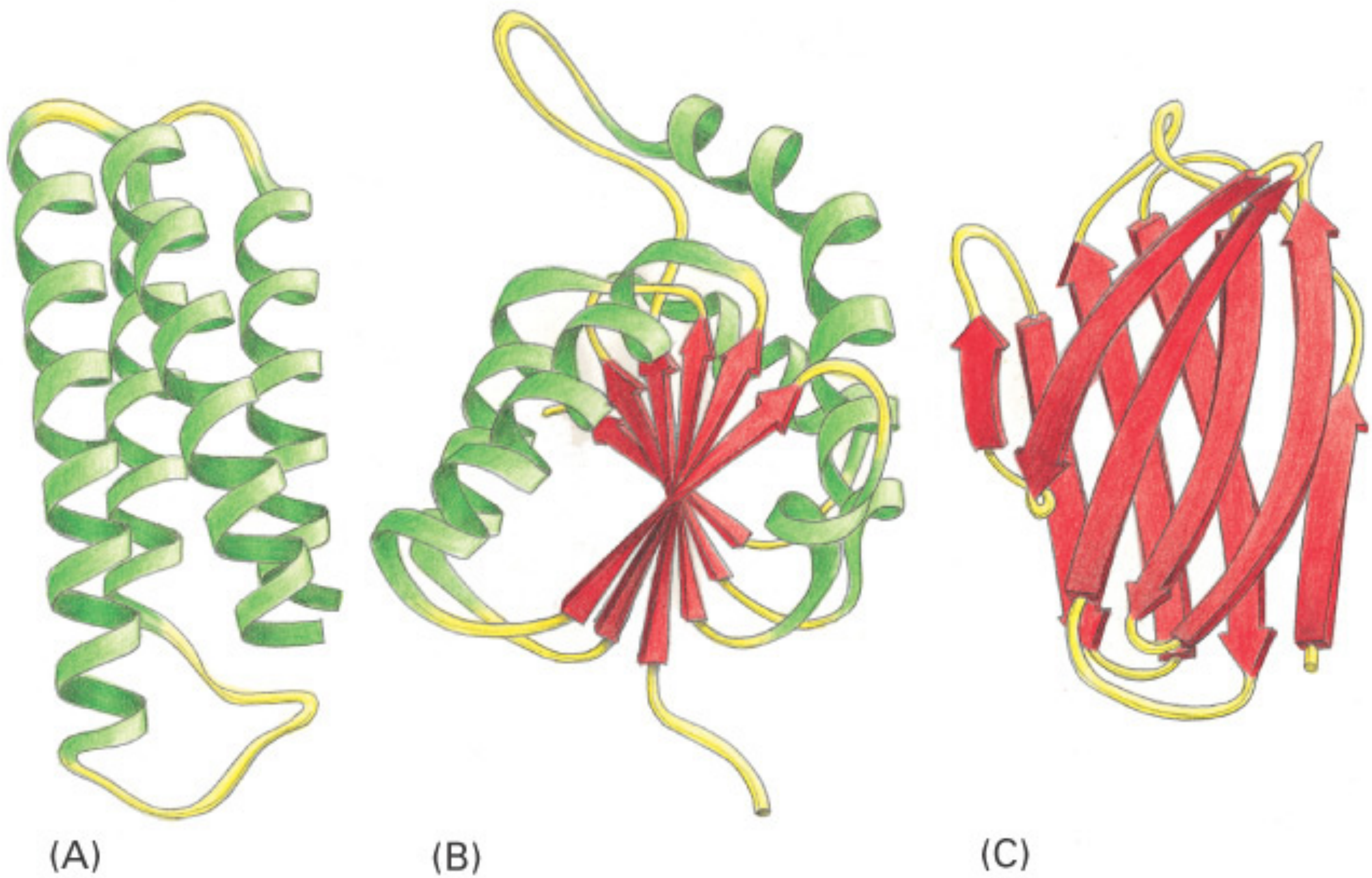
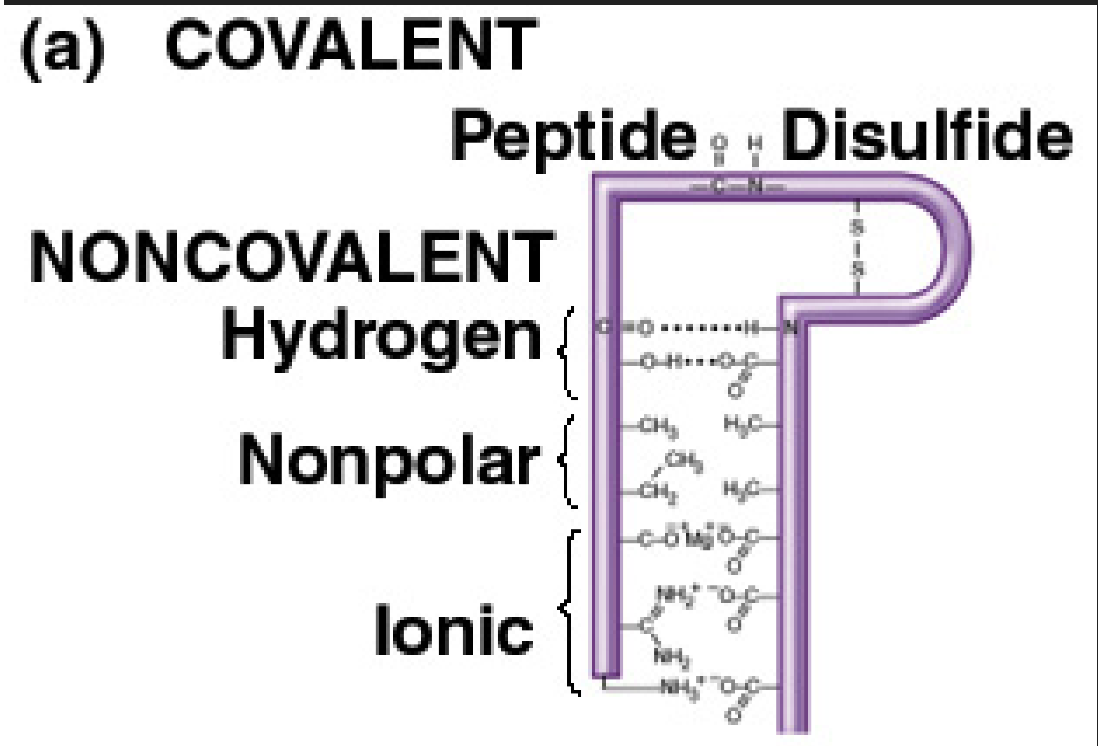
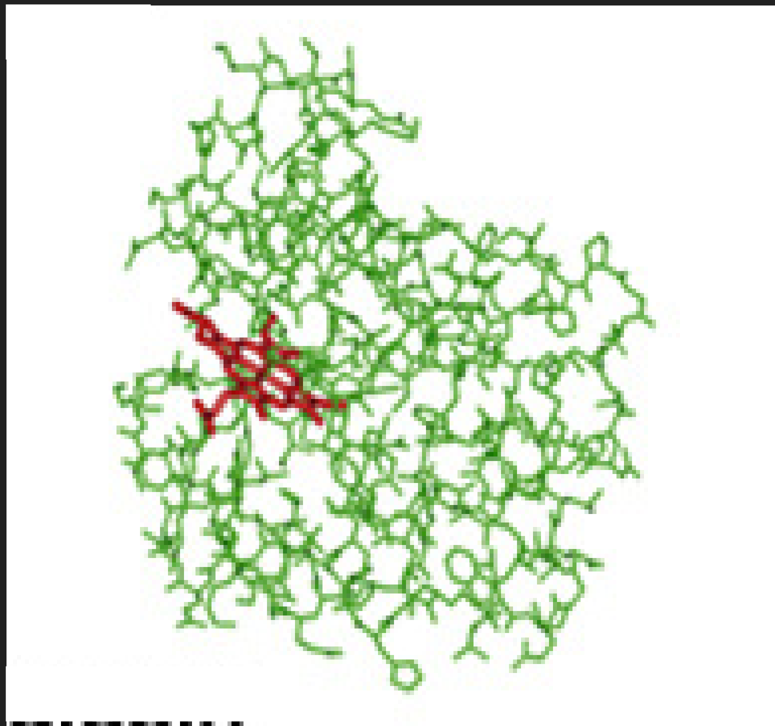


Figure 4-20 **Essential Cell Biology, 2/e. (© 2004 Garland Science)**

Tertiary Structure:

Three dimensional folded structure due to attractions and repulsions between R groups





All but peptide bonds are involved in tertiary structure.

Shapes & Sizes

- There are more varieties of Proteins in a cell than any other macromolecule
- Filamentous & Globular
- Large & Small

Nature is known for reusing structures

- Proteins are no exception. Here two very similar Proteins are built on a common theme but perform very different functions…

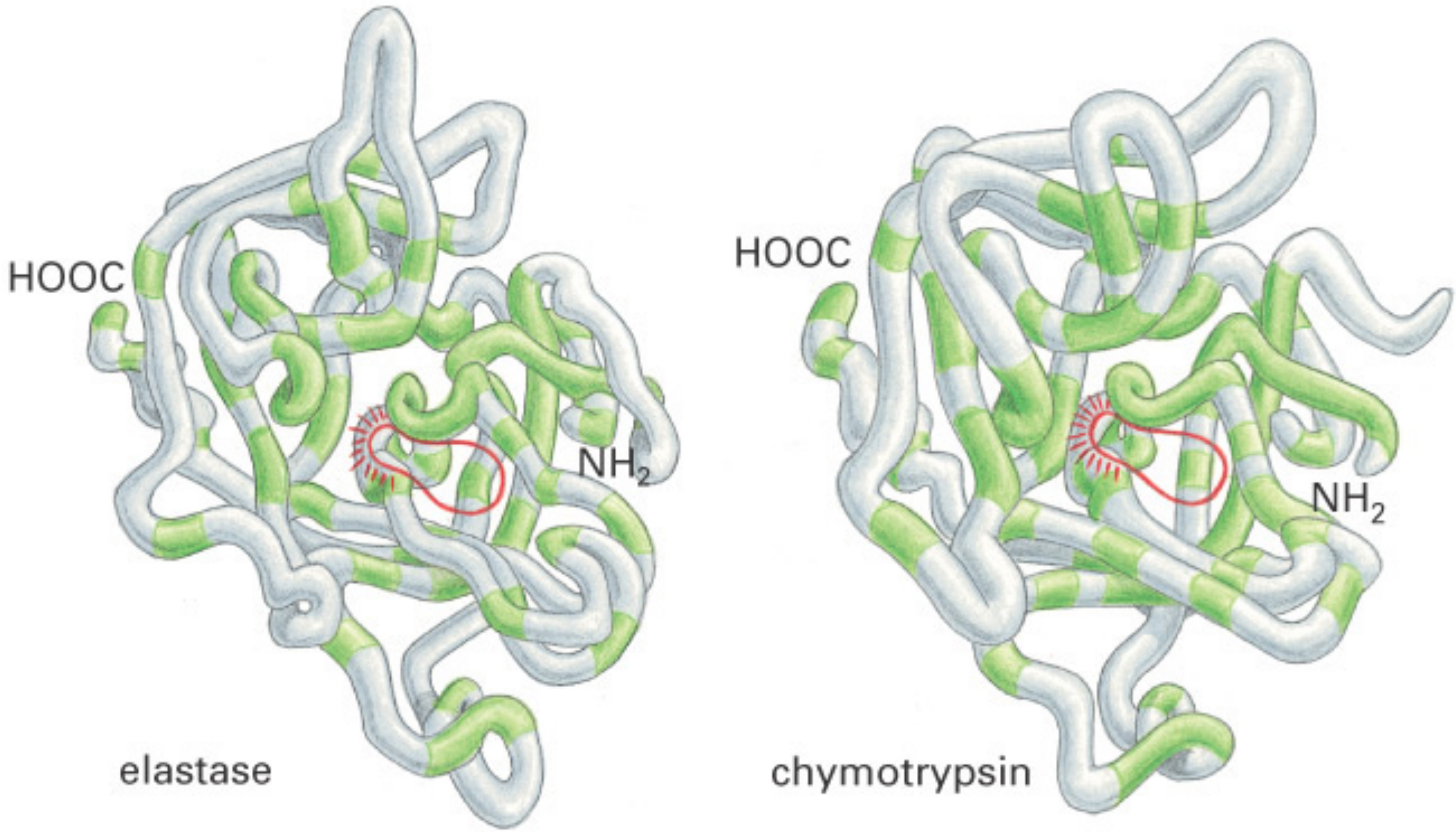


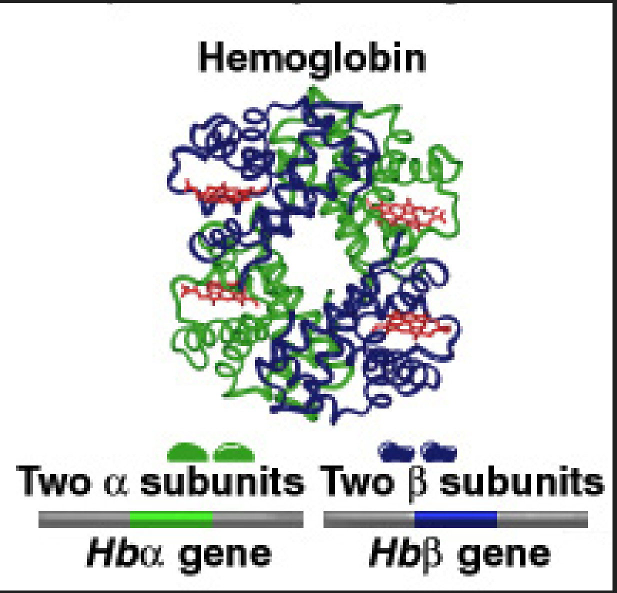
Figure 4-21 **Essential Cell Biology, 2/e. (© 2004 Garland Science)**

Quaternary structure:

Association of two or more protein chains

eg. Hemoglobin is composed of 4 protein chains

2 are called alpha hemoglobin
2 are called beta hemoglobin



• In other instances identical, or nearly identical, polypeptides are used in the final Protein.

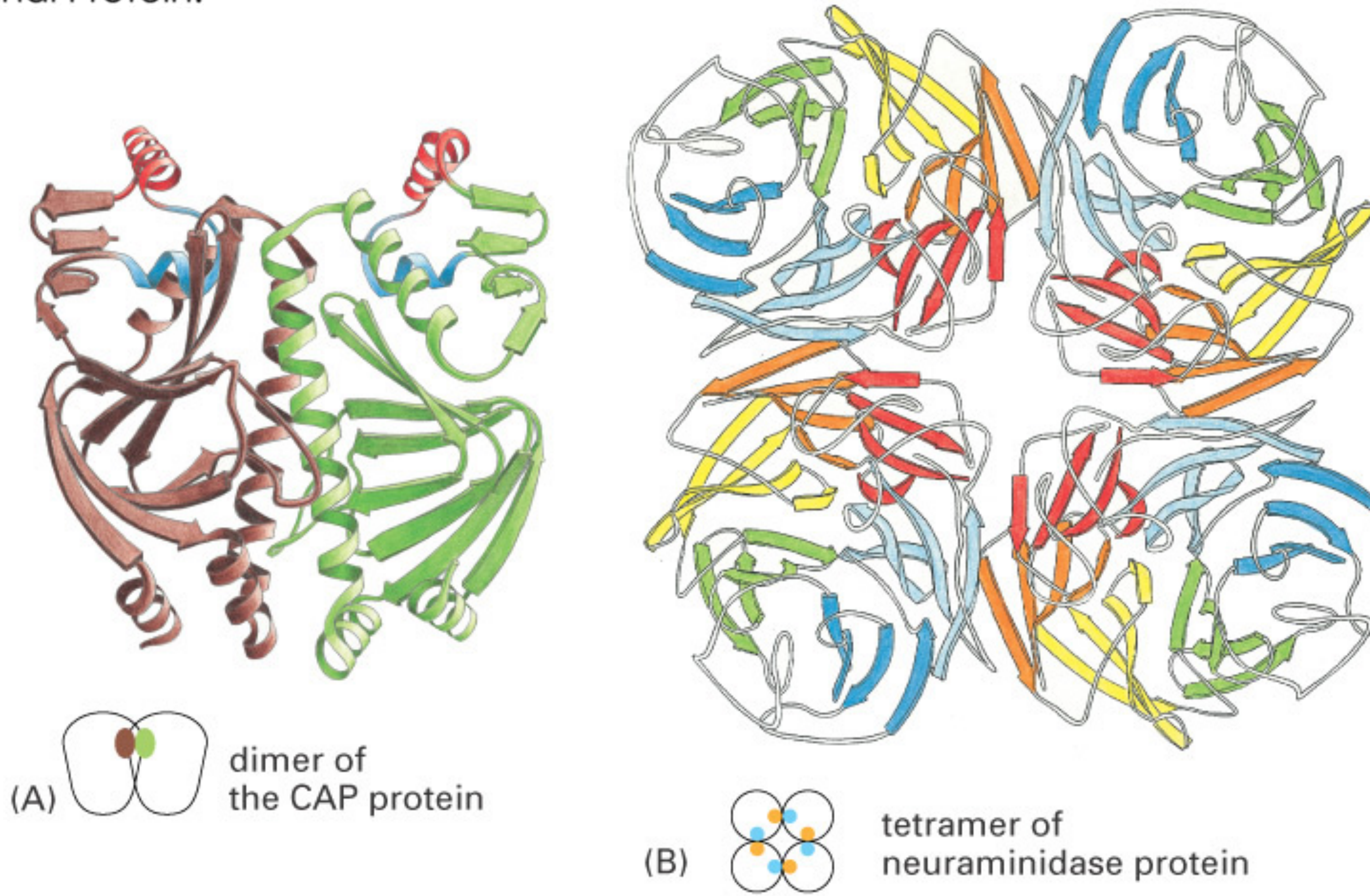
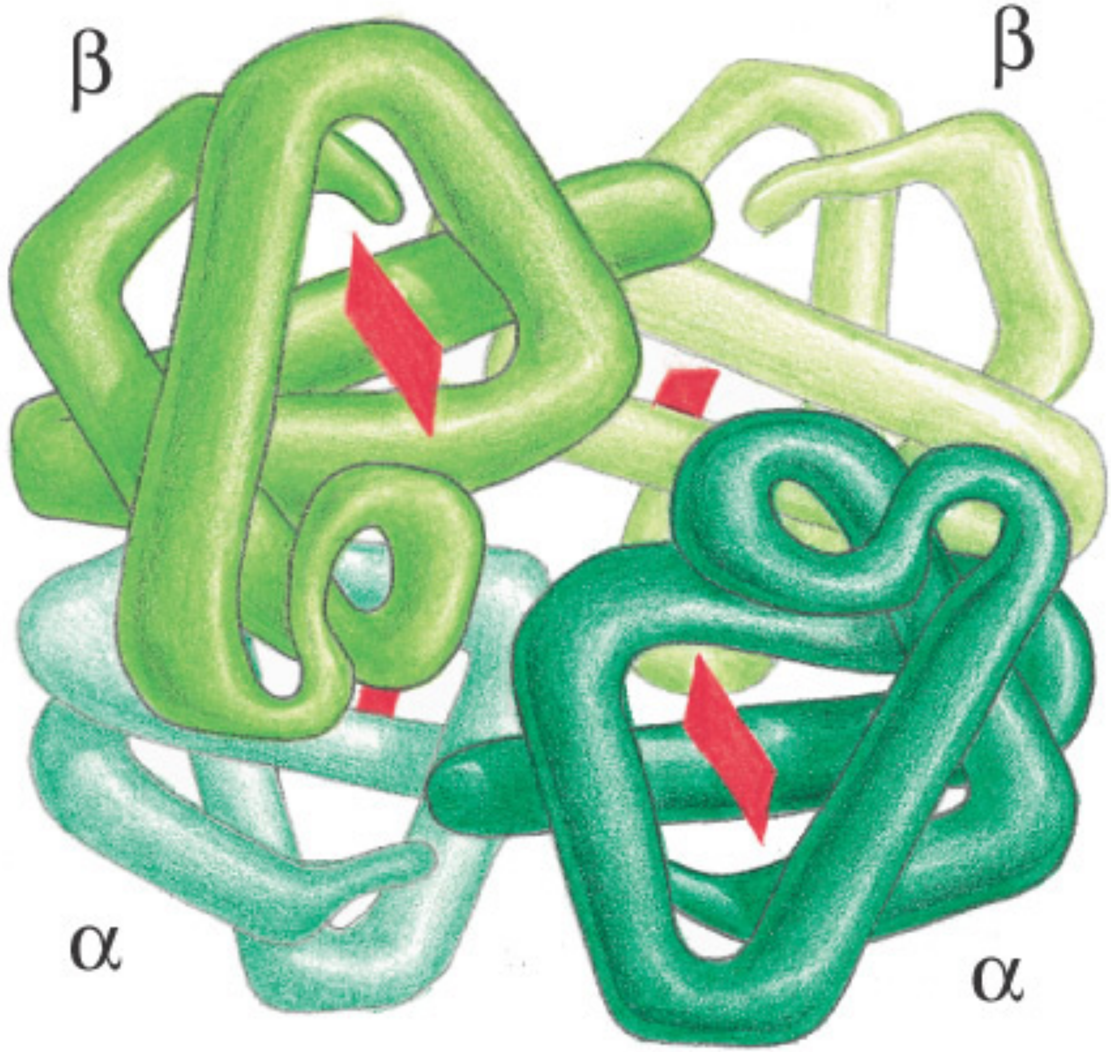


Figure 4-22 Essential Cell Biology, 2/e. (© 2004 Garland Science)

Haemoglobin - is the iron-containing oxygen-transport metalloprotein in the red blood cells of the blood in vertebrates and other animals



Here we see the use of two different polypeptides made by different genes

Figure 4-23 Essential Cell Biology, 2/e. (© 2004 Garland Science)

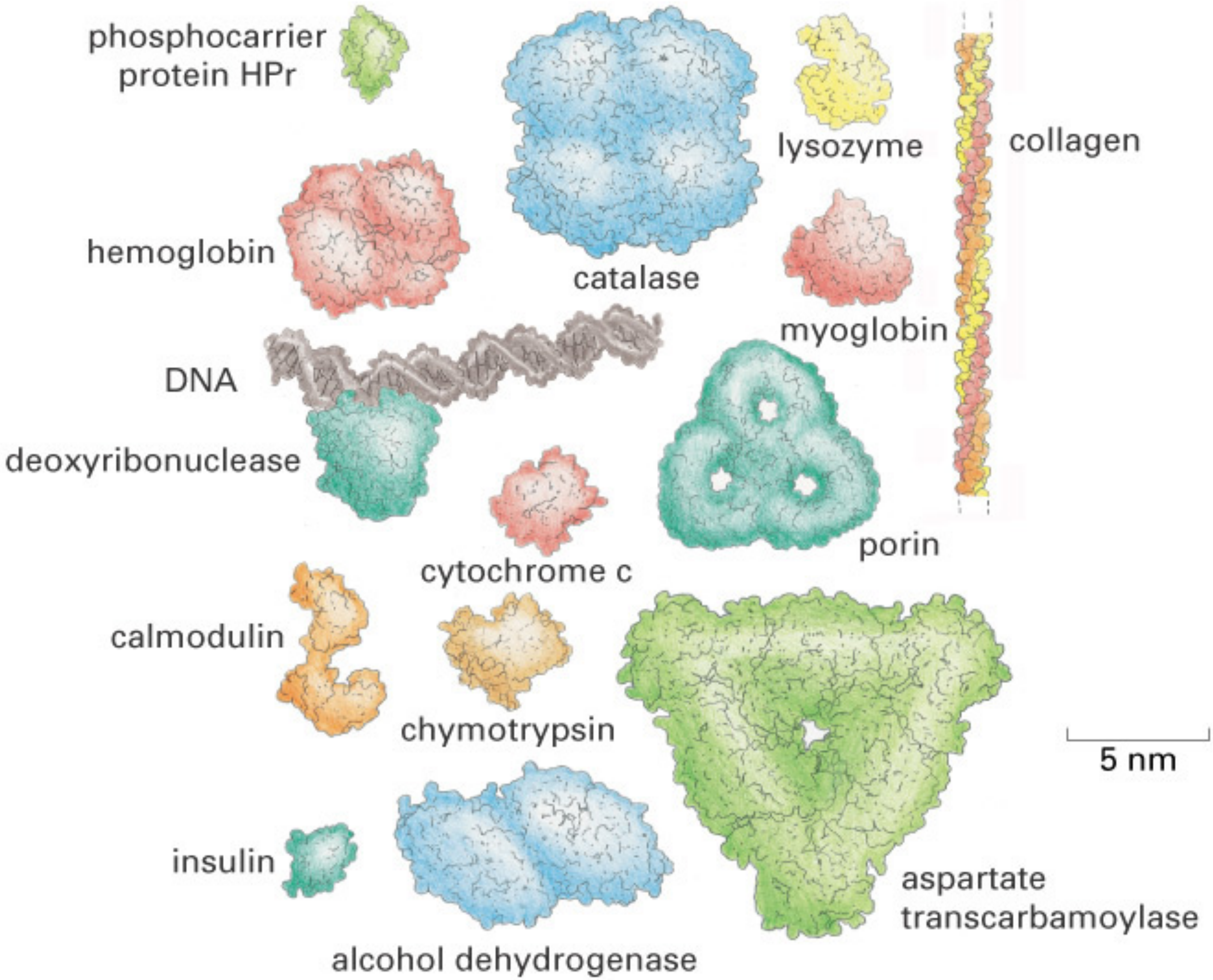


Figure 4-9 Essential Cell Biology, 2/e. (© 2004 Garland Science)