Biochemistry

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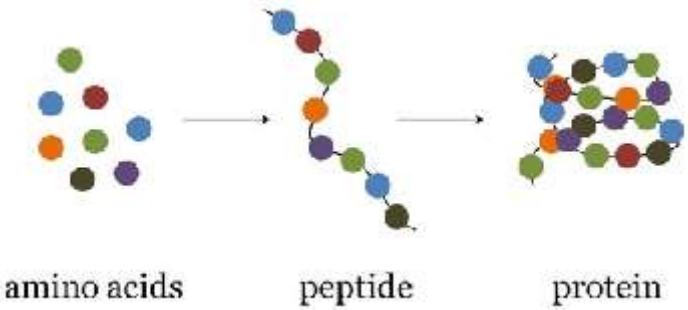
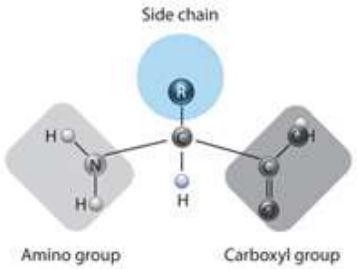
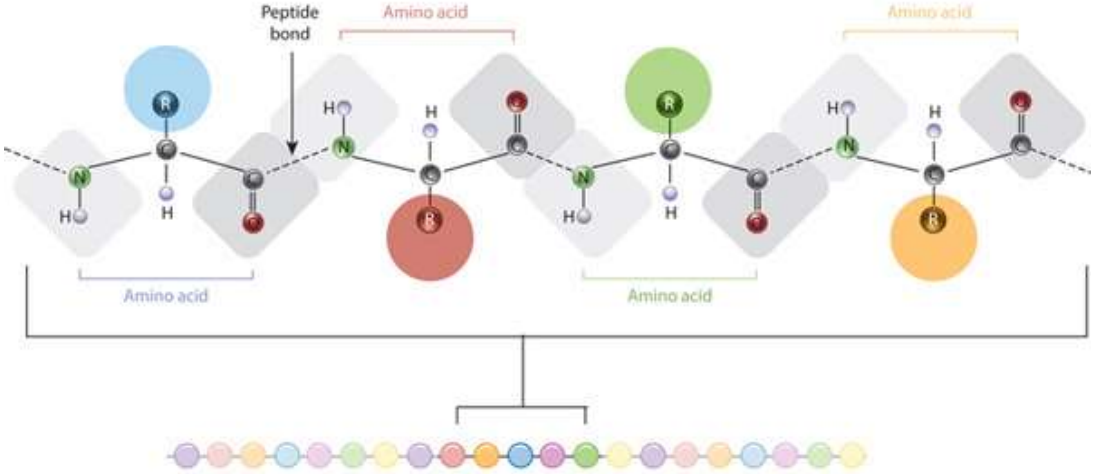
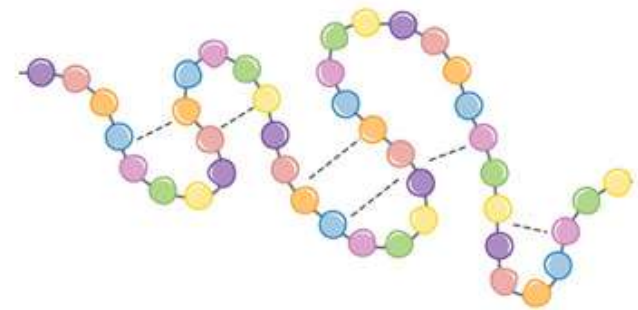
PROTEINS









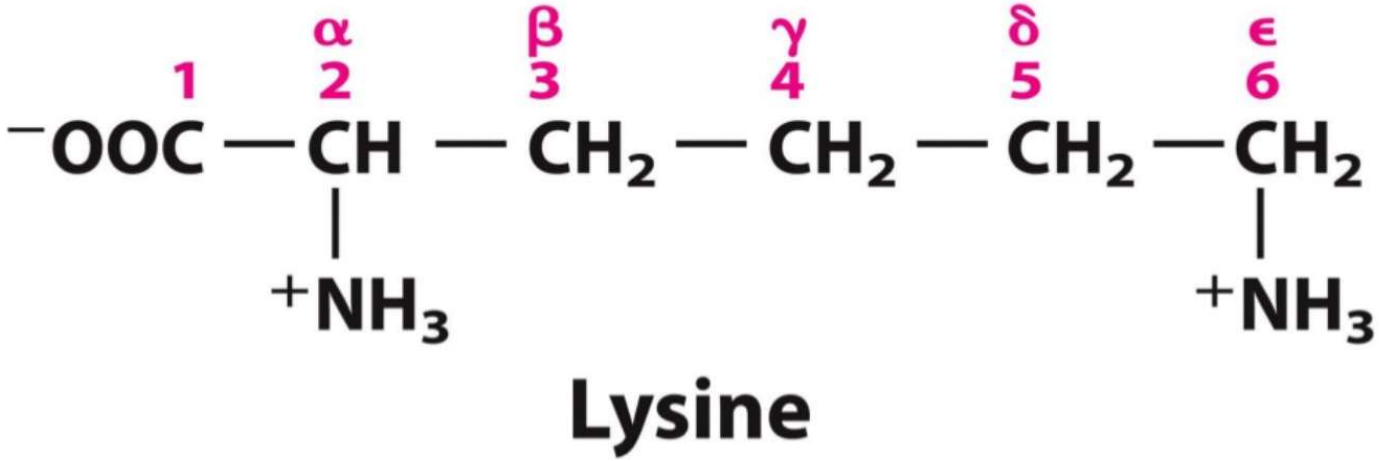
Polypeptides - polymers of amino acids covalently linked through peptide bonds

Natural organic molecules….C, H, O, N

Monomers…….amino acids

Aminoacid – monomer of protein (polypeptide)

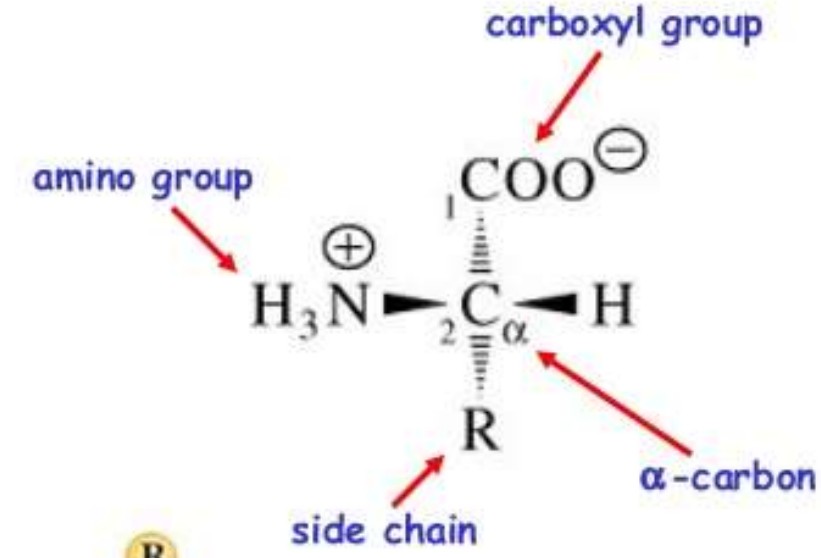
- Organic nomenclature: start from one end
- Biochemical designation:
  - start from α-carbon and go down the R-group

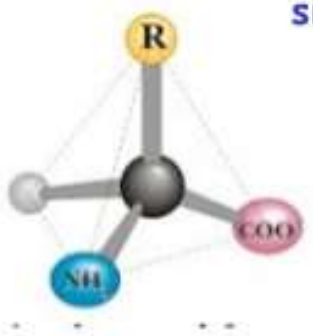


Lysine

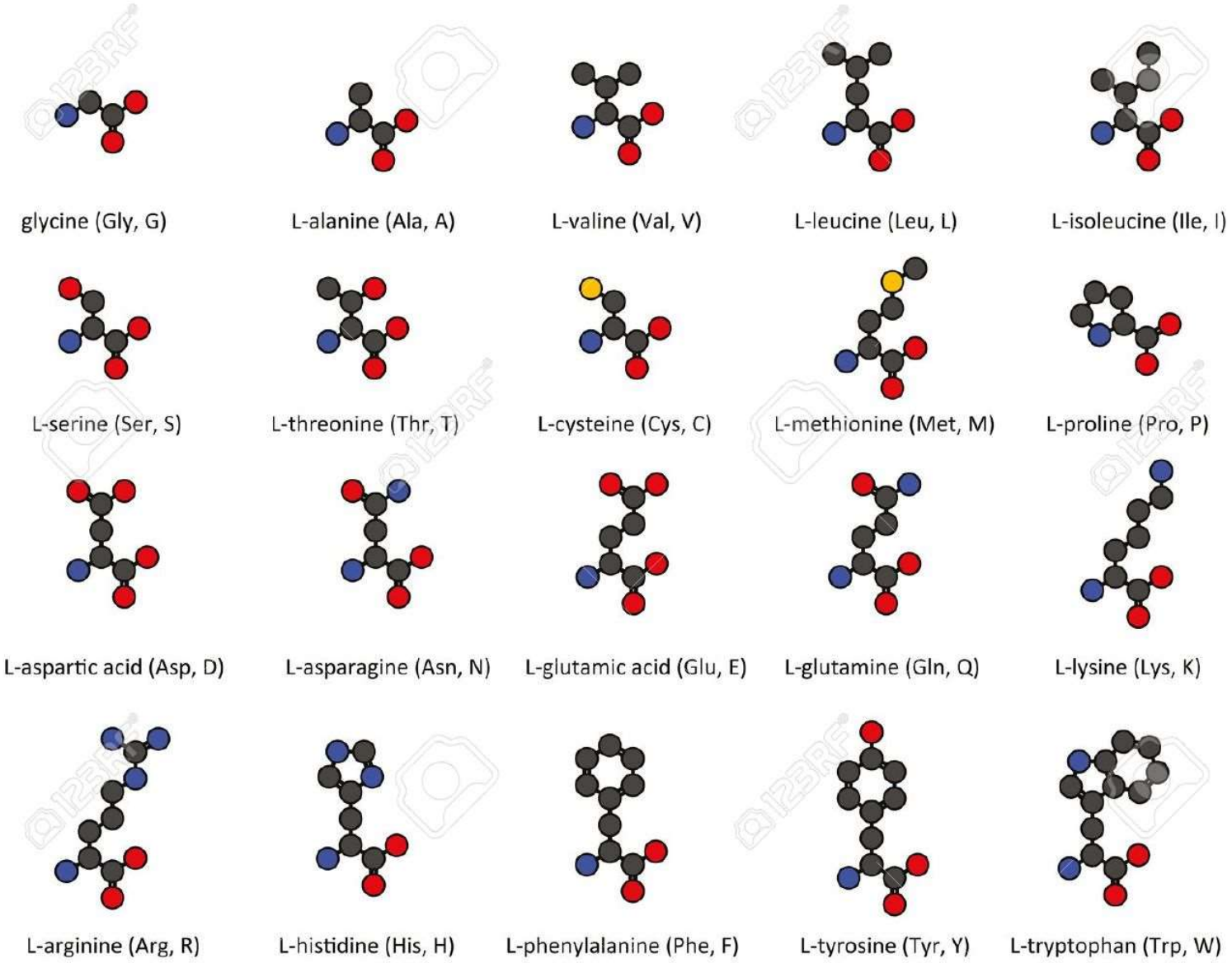
Basic Amino Acid Structure

- α-carbon is chiral (except for glycine)
- at pH 7.0 uncharged amino acids are zwitterions
- amino acids have a tetrahedral structure



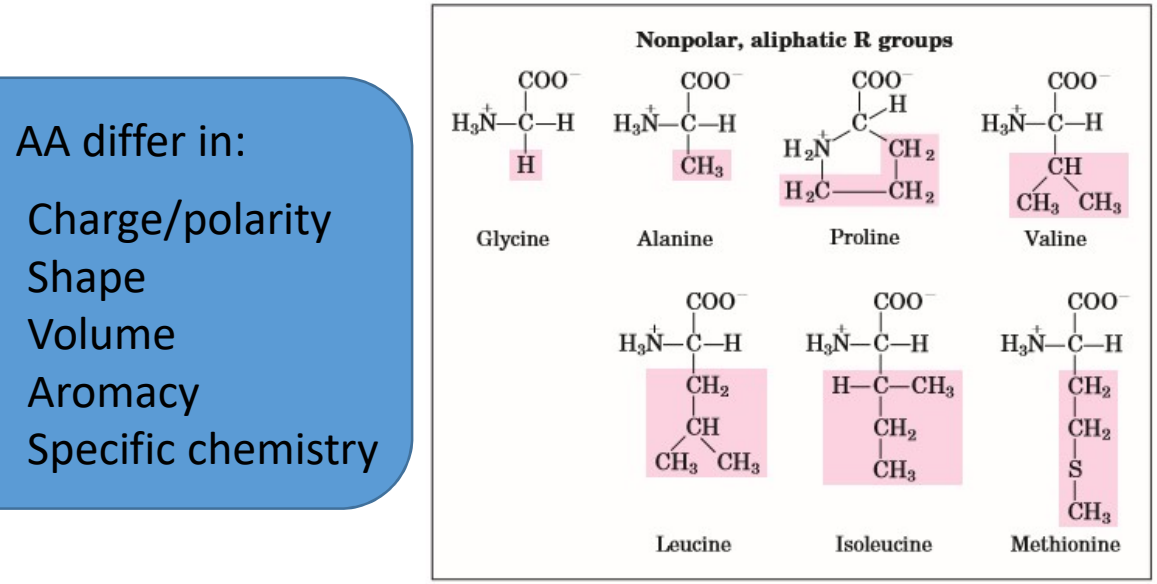


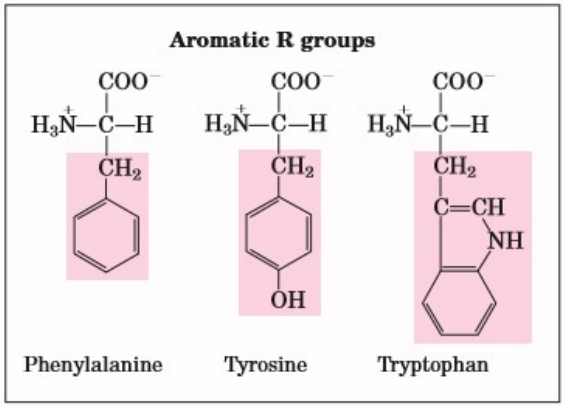
Visual representation of Aminoacids

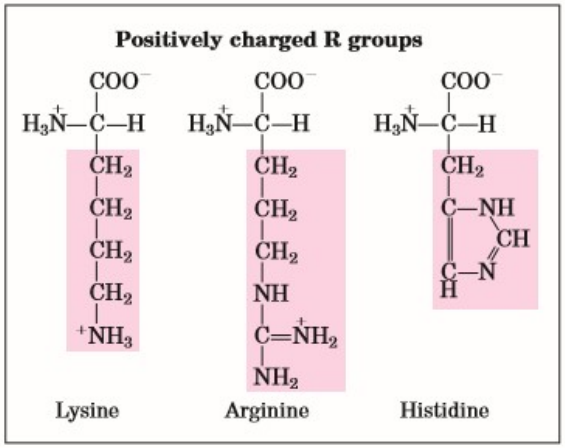


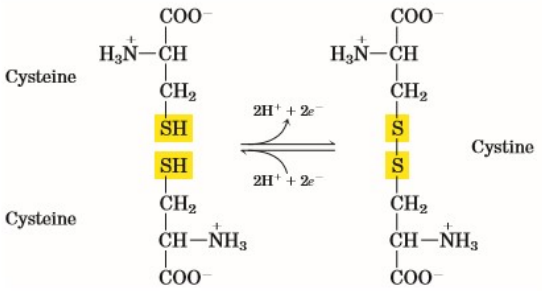
AA differ in:

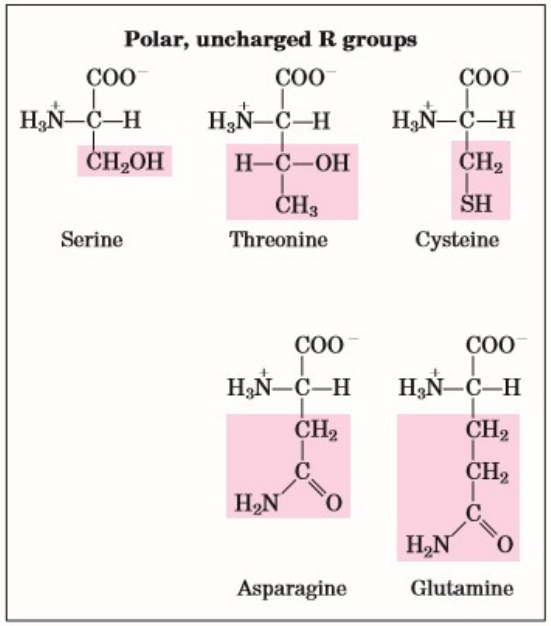
1. Charge/polarity
2. Shape
3. Volume
4. Aromacy
5. Specific chemistry

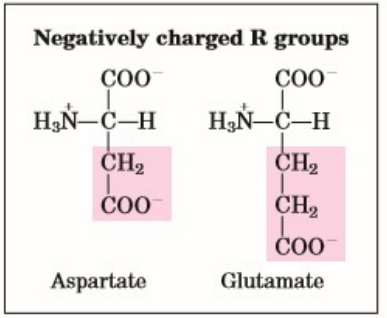






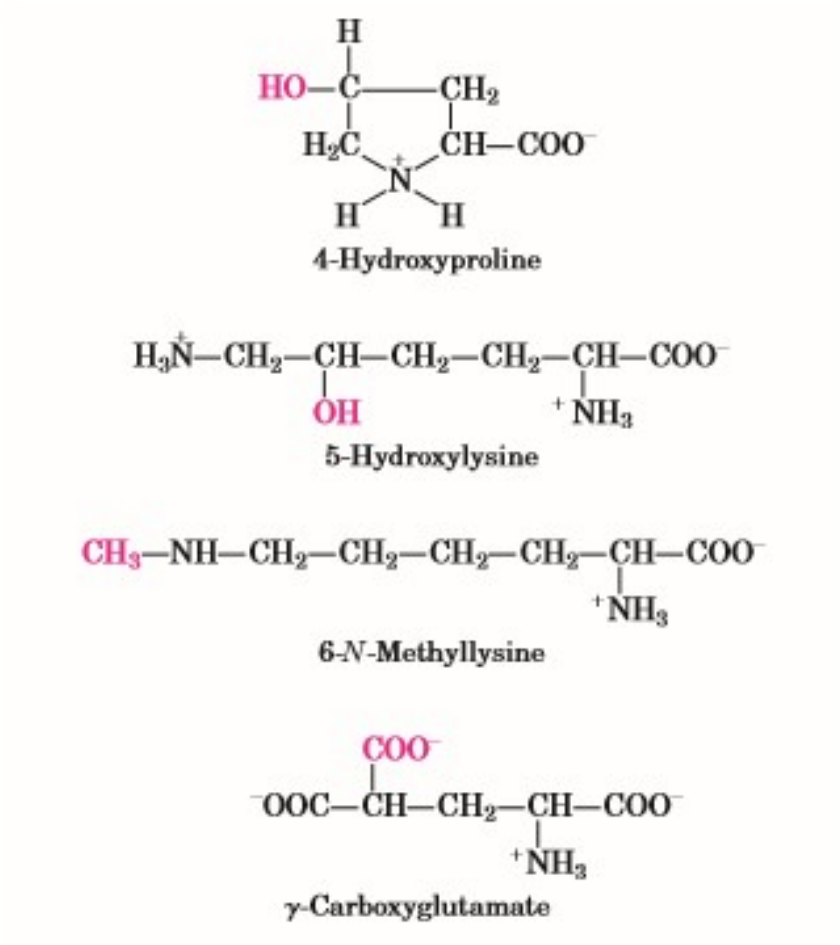


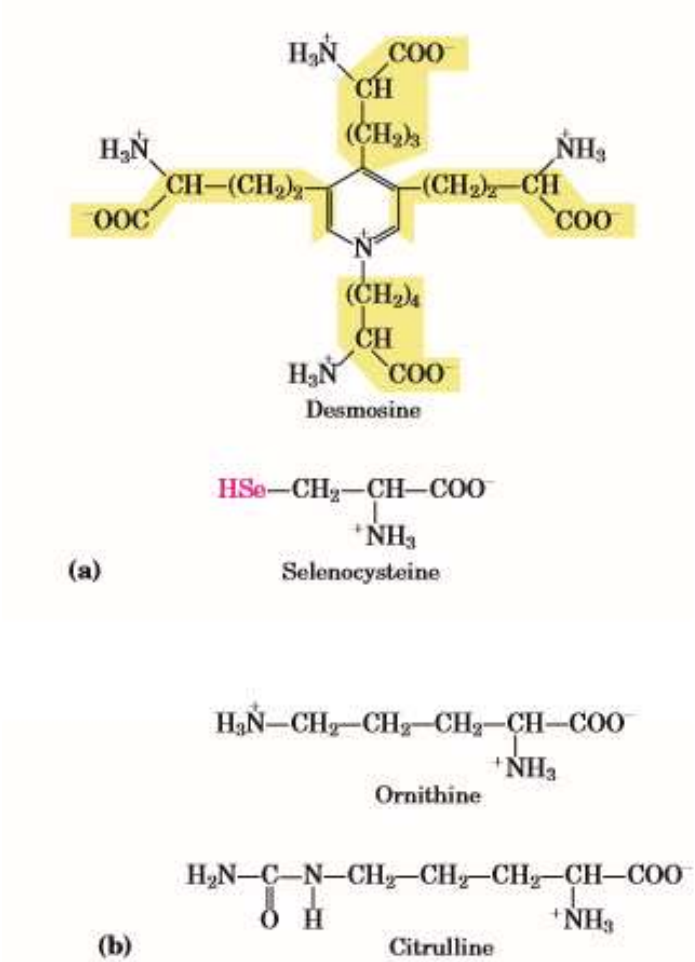




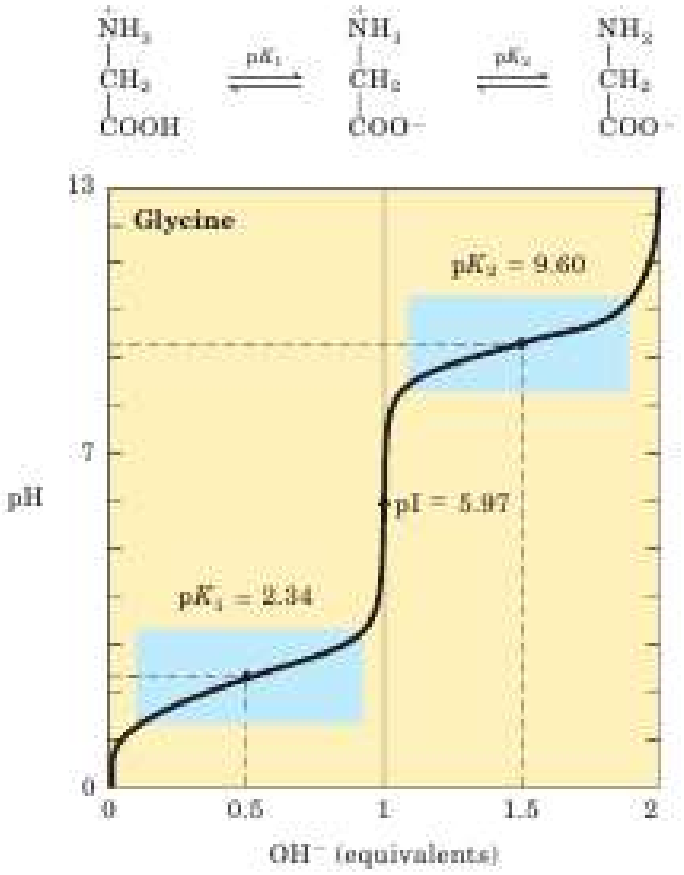
Amino acid	Abbreviation/ symbol	M_r	pK_a values			pI	Hydropathy index*	Occurrence in proteins (%)†
			pK_1 (—COOH)	pK_2 ($—NH_3^+$)	pK_R (R group)			
Nonpolar, aliphatic R groups								
Glycine	Gly G	75	2.34	9.60		5.97	−0.4	7.2
Alanine	Ala A	89	2.34	9.69		6.01	1.8	7.8
Proline	Pro P	115	1.99	10.96		6.48	1.6	5.2
Valine	Val V	117	2.32	9.62		5.97	4.2	6.6
Leucine	Leu L	131	2.36	9.60		5.98	3.8	9.1
Isoleucine	Ile I	131	2.36	9.68		6.02	4.5	5.3
Methionine	Met M	149	2.28	9.21		5.74	1.9	2.3
Aromatic R groups								
Phenylalanine	Phe F	165	1.83	9.13		5.48	2.8	3.9
Tyrosine	Tyr Y	181	2.20	9.11	10.07	5.66	−1.3	3.2
Tryptophan	Trp W	204	2.38	9.39		5.89	−0.9	1.4
Polar, uncharged R groups								
Serine	Ser S	105	2.21	9.15		5.68	−0.8	6.8
Threonine	Thr T	119	2.11	9.62		5.87	−0.7	5.9
Cysteine	Cys C	121	1.96	10.28	8.18	5.07	2.5	1.9
Asparagine	Asn N	132	2.02	8.80		5.41	−3.5	4.3
Glutamine	Gln Q	146	2.17	9.13		5.65	−3.5	4.2
Positively charged R groups								
Lysine	Lys K	146	2.18	8.95	10.53	9.74	−3.9	5.9
Histidine	His H	155	1.82	9.17	6.00	7.59	−3.2	2.3
Arginine	Arg R	174	2.17	9.04	12.48	10.76	−4.5	5.1
Negatively charged R groups								
Aspartate	Asp D	133	1.88	9.60	3.65	2.77	−3.5	5.3
Glutamate	Glu E	147	2.19	9.67	4.25	3.22	−3.5	6.3

UNCOMMON RESIDUES

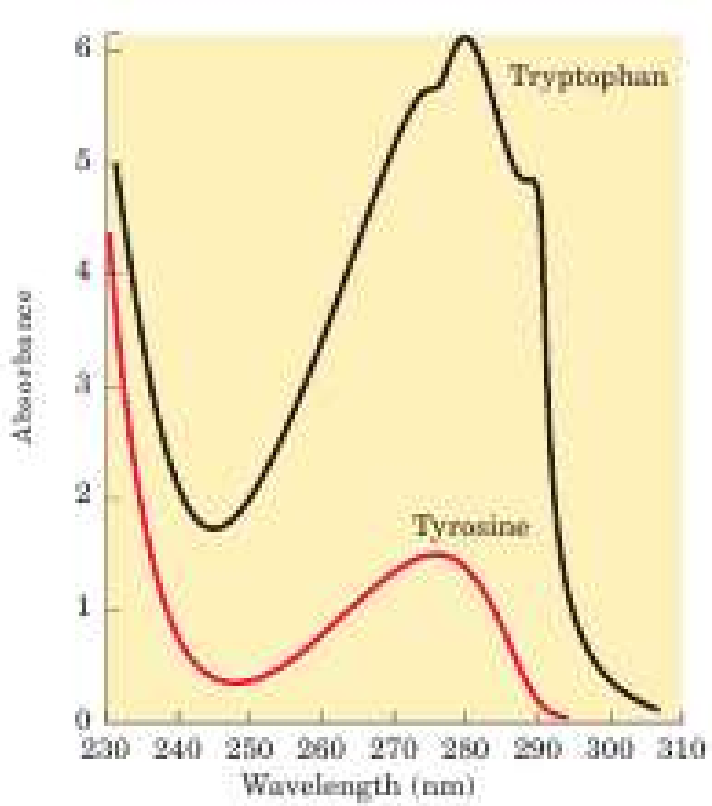




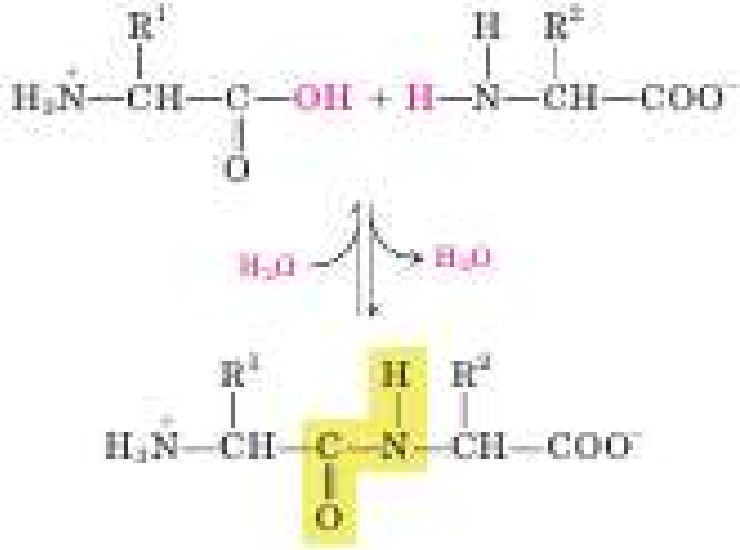
Important physical properties of AA



Titration Curves Predict the Electric Charge of Amino Acids



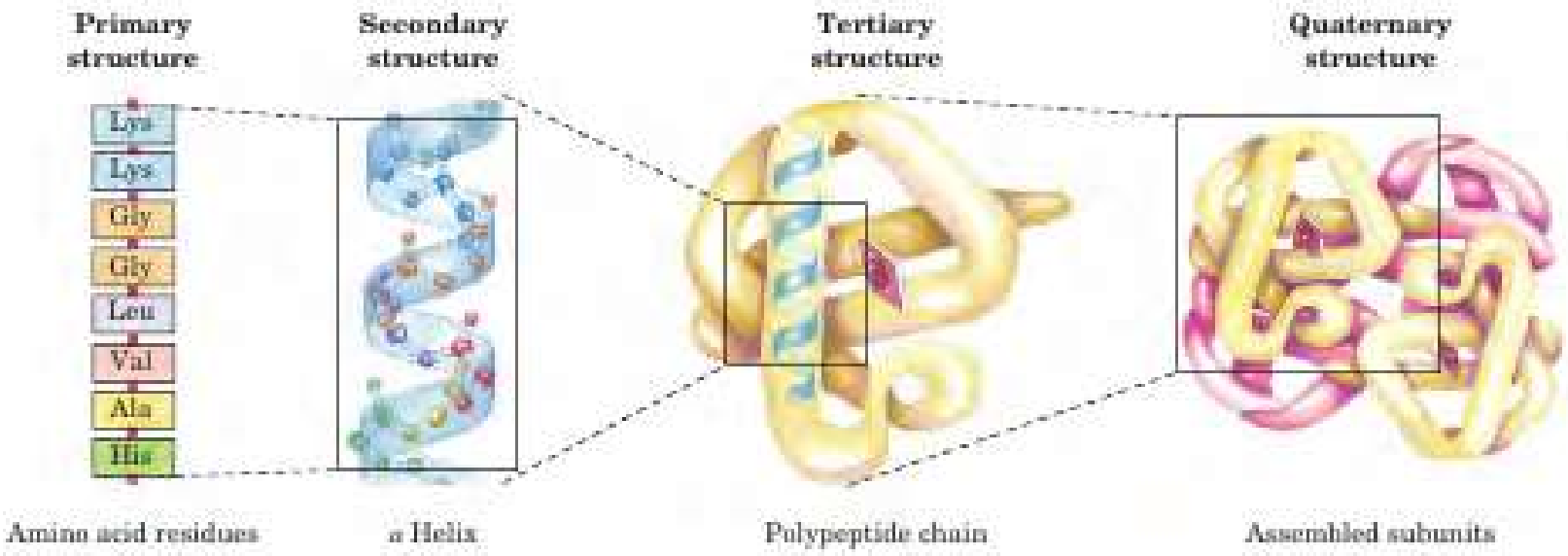
UV absorbance



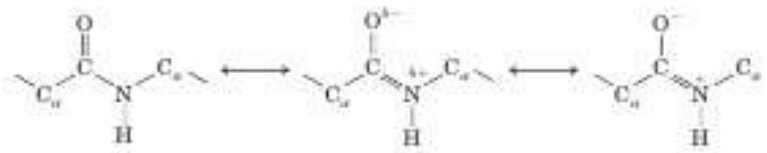
Peptide bond formation, size of the protein

	Molecular weight	Number of residues	Number of polypeptide chains
Cytochrome *c* (human)	13,000	104	1
Ribonuclease A (bovine pancreas)	13,700	124	1
Lysozyme (chicken egg white)	13,930	129	1
Myoglobin (equine heart)	16,890	153	1
Chymotrypsin (bovine pancreas)	21,600	241	3
Chymotrypsinogen (bovine)	22,000	245	1
Hemoglobin (human)	64,500	574	4
Serum albumin (human)	68,500	609	1
Hexokinase (yeast)	102,000	972	2
RNA polymerase (*E. coli*)	450,000	4,158	5
Apolipoprotein B (human)	513,000	4,536	1
Glutamine synthetase (*E. coli*)	619,000	5,628	12
Titin (human)	2,993,000	26,926	1

Levels of protein structure

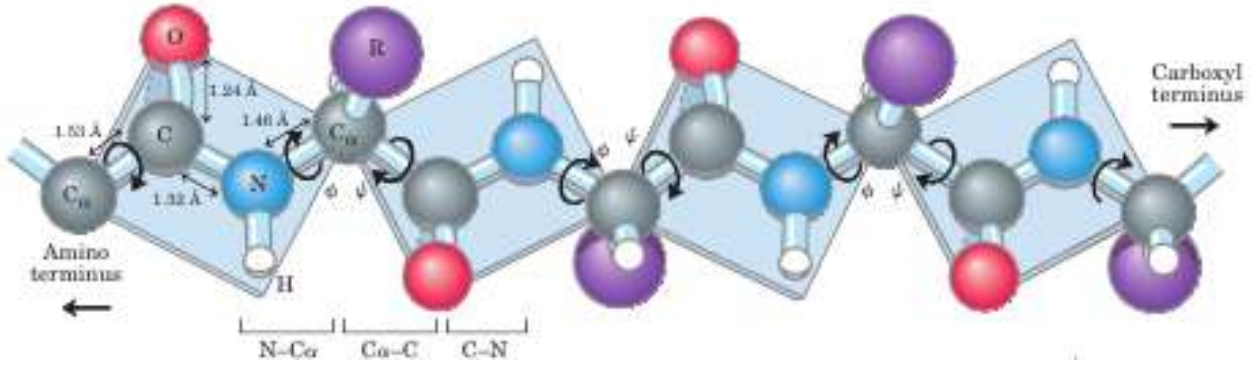


Primary - sequence

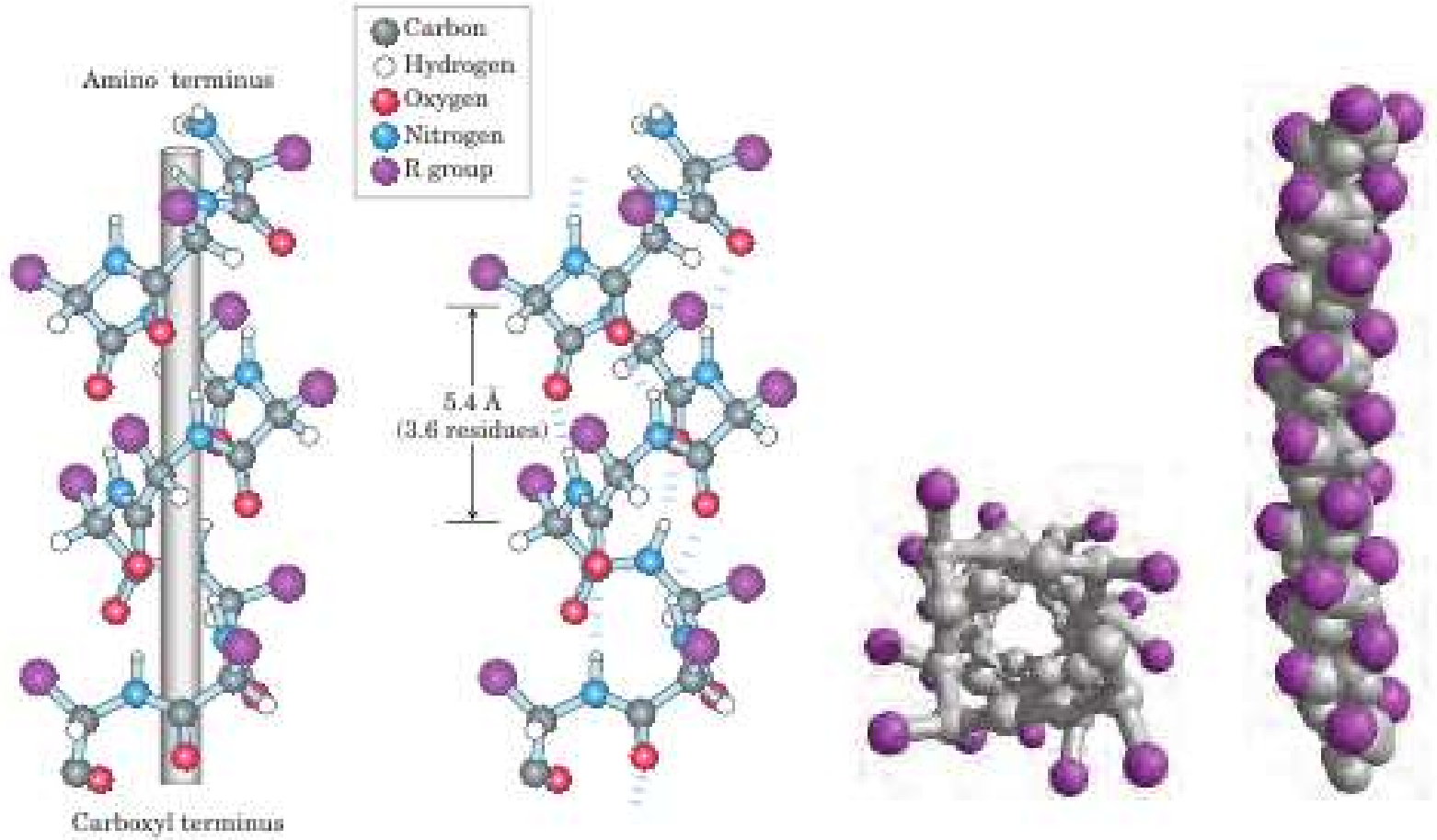


The carbonyl oxygen has a partial negative charge and the amide nitrogen a partial positive charge, setting up a small electric dipole. Virtually all peptide bonds in proteins occur in this trans configuration; an exception is noted in Figure 4–8b.

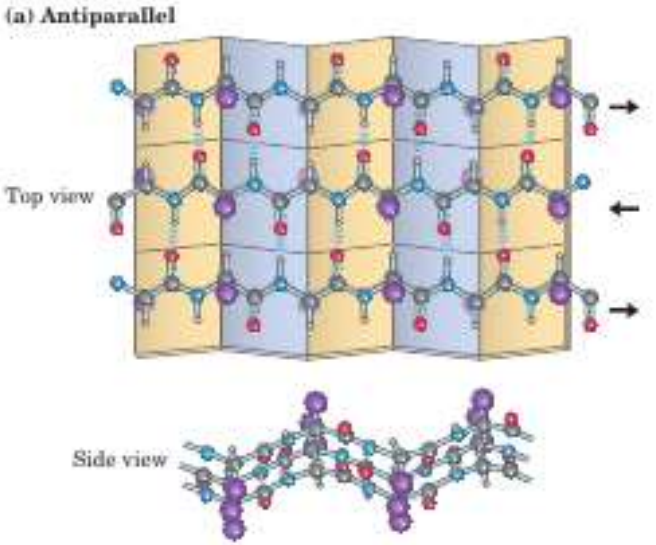
(a)

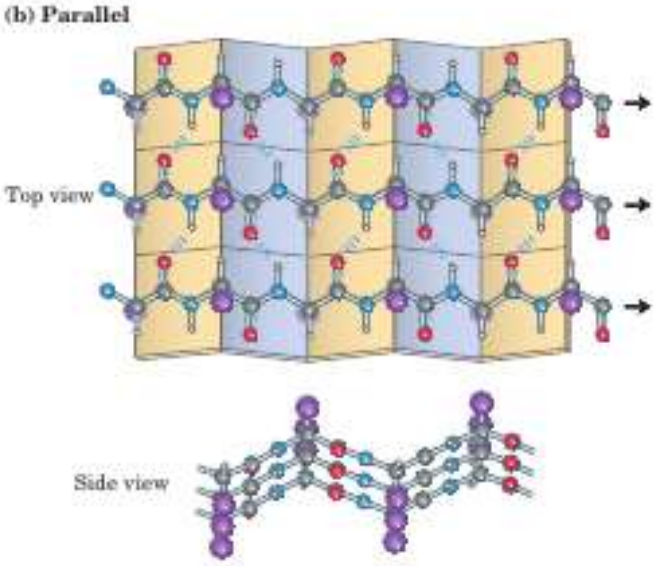


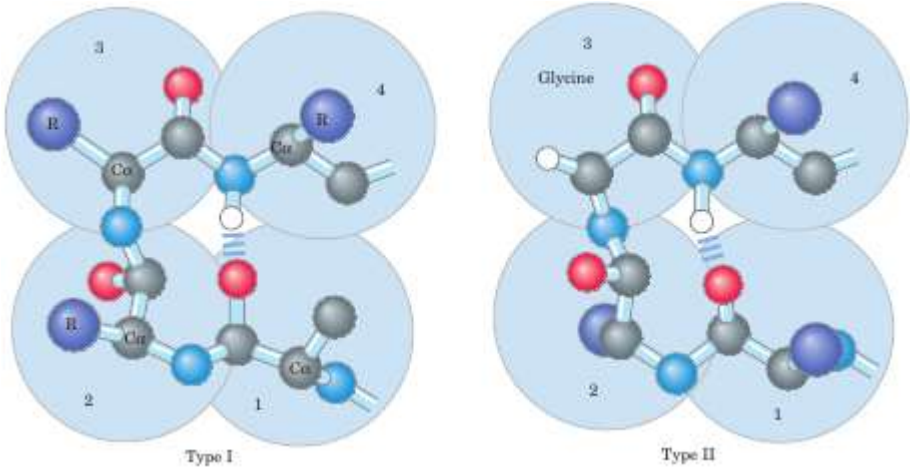
Secondary – a) alpha spiral



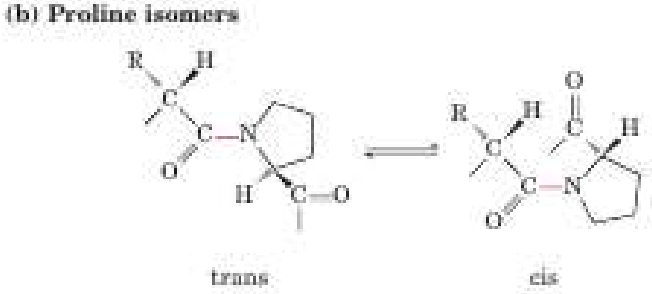
Secondary – b) beta sheets

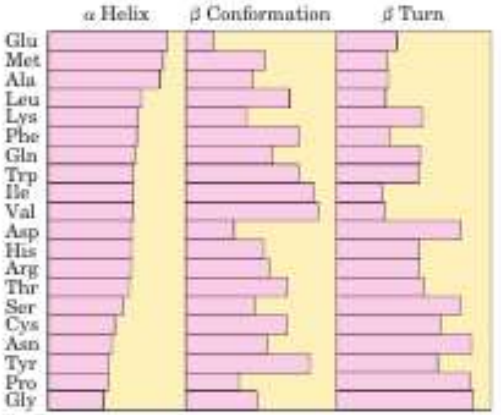






beta sheets turns





Different folds
FOLD classification

(a) β-α-β Loop

α-α Corner

(b) Typical connections in an all-β motif

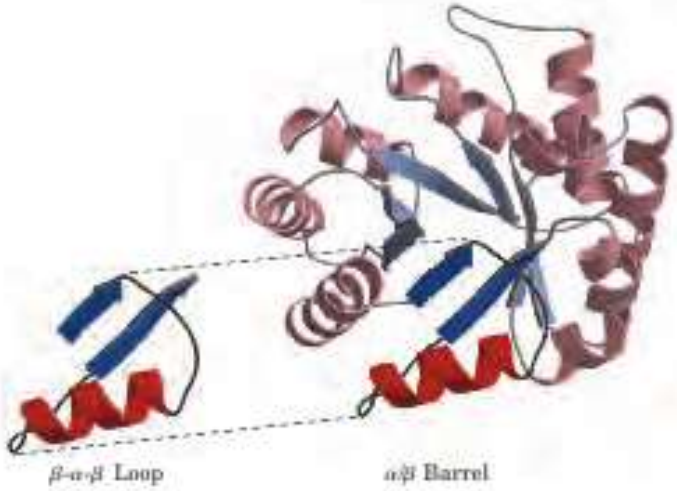
Crossover connection (not observed)

(c) Right-handed connection between β strands

Left-handed connection between β strands (very rare)

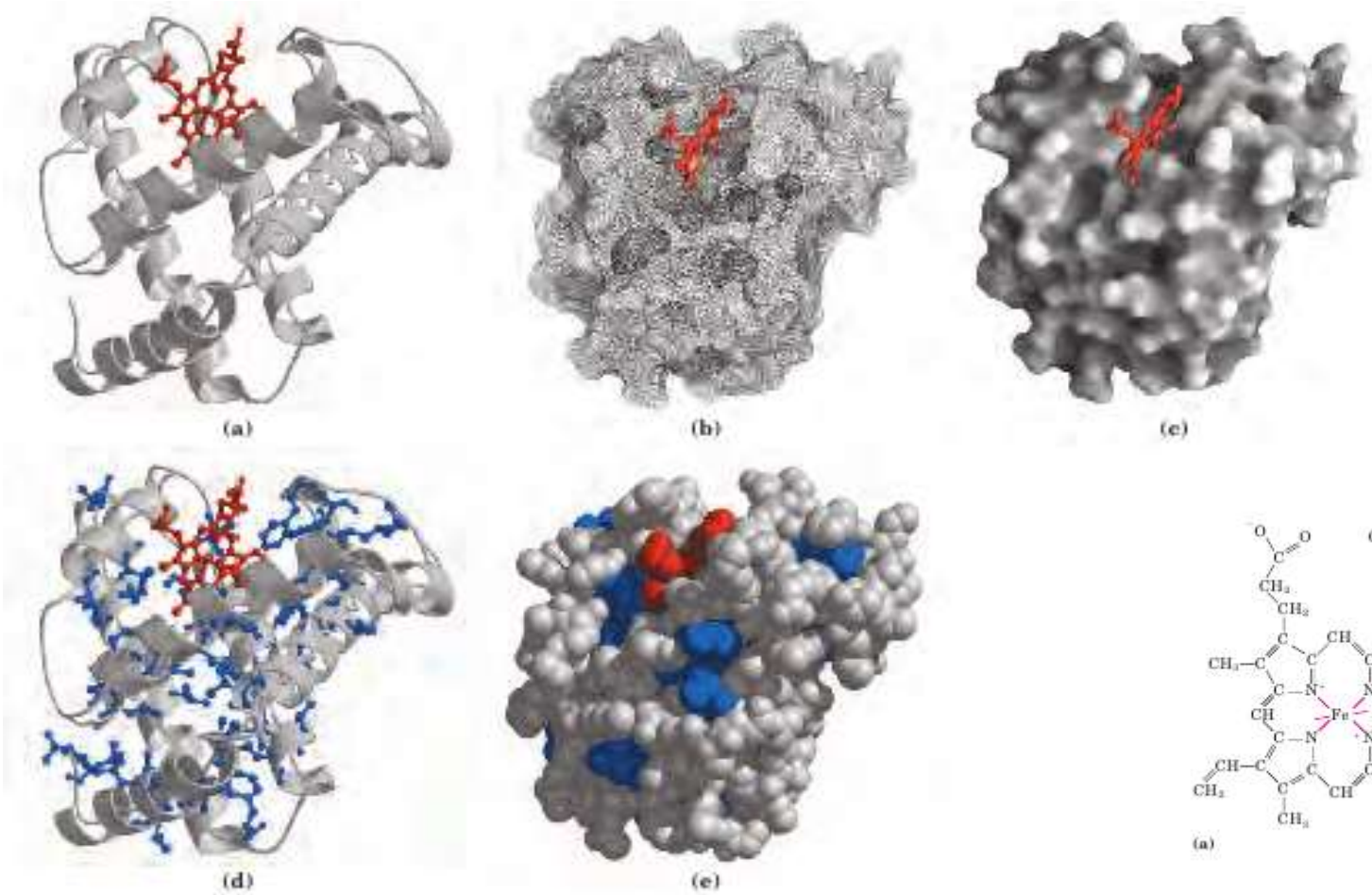
(d) β Barrel

Twisted β sheet



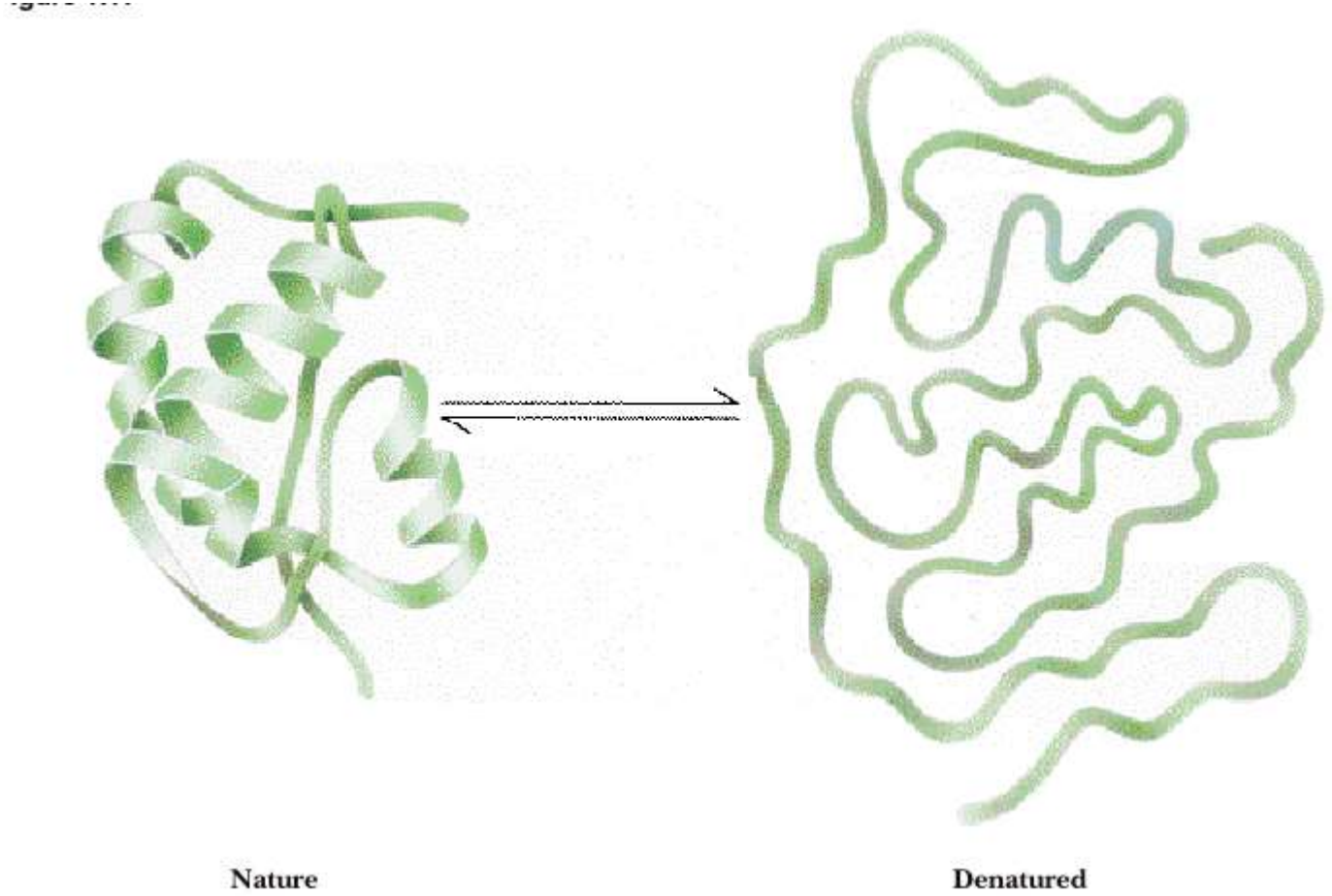
β-α-β Loop

$\alpha\beta$ Barrel



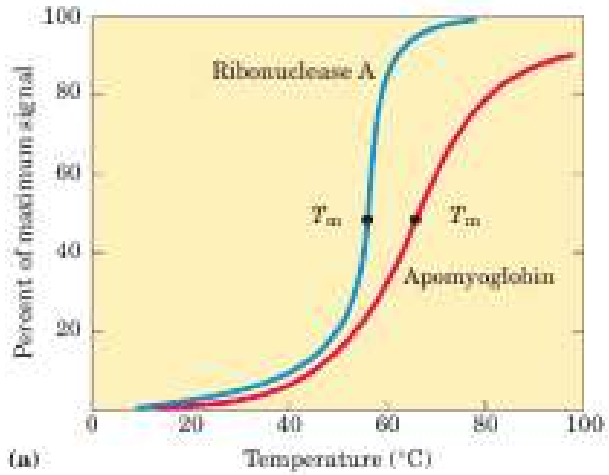
Real globular protein – alpha-beta composition

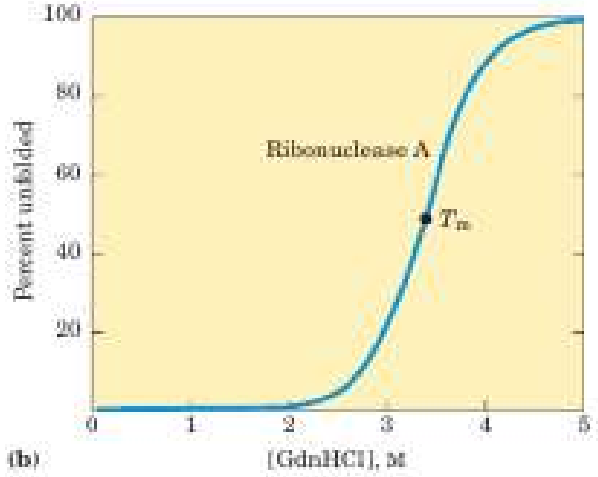
How solid is protein globule?



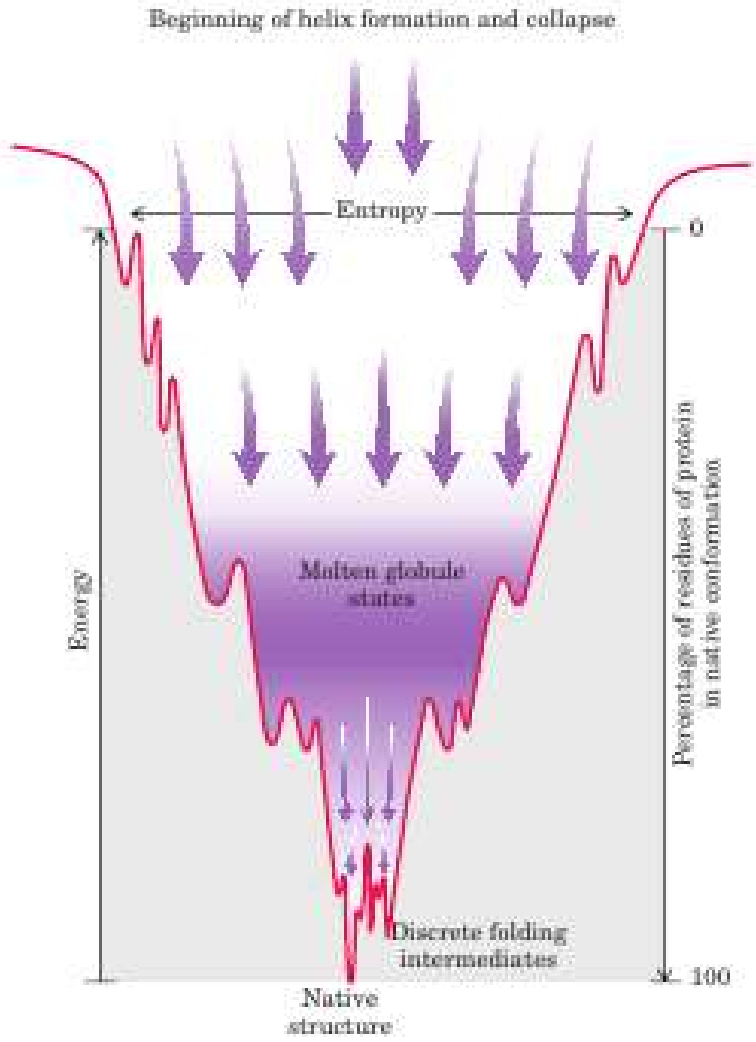
Heat // pH // chaotropic agents, denaturants // salt // …

How solid is protein globule?





Denaturation - renaturation



Energetic profile

Literature biochemistry

1. Lehninger Principles of Biochemistry (Nelson D.L., Cox M.M.)
2. Principles and Techiniques of Biochemistry and Molecular Biology (Wilson K., Walker J.)