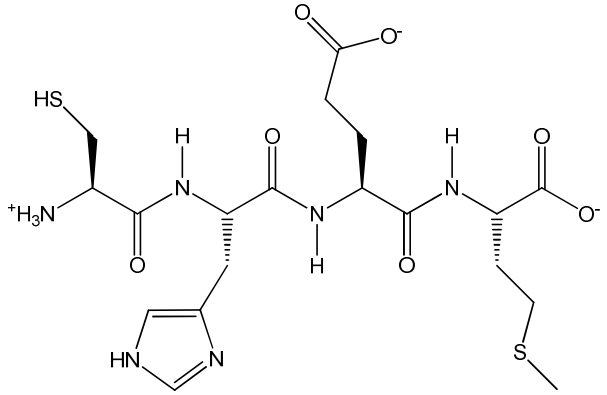
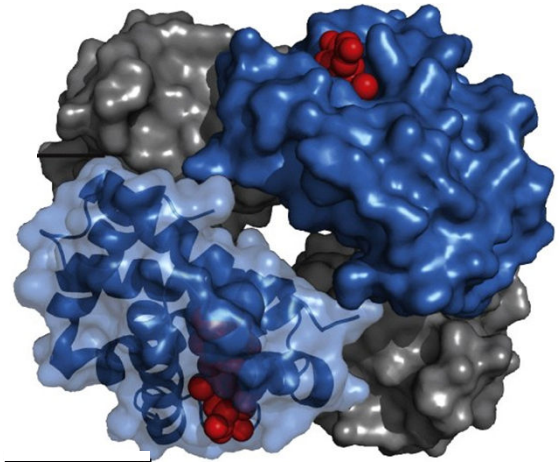
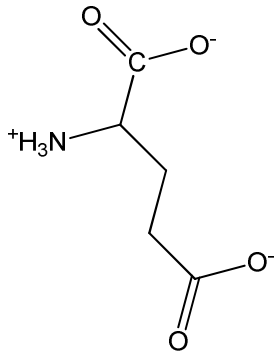
Amino acids have important roles in living organisms



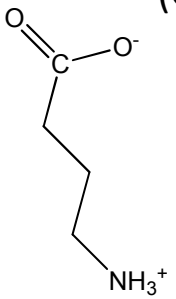


Subunits (building blocks) of peptides and proteins

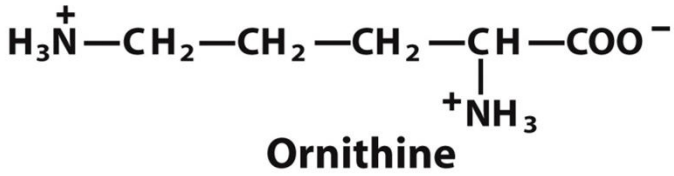
glutamate

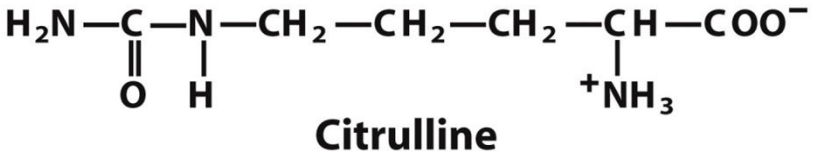


γ-aminobutyric acid (GABA)



Neurotransmitters





Metabolic intermediates

Proteins are synthesized from 20 ‘standard’ α-amino acids. Their names have 3- and 1-letter abbreviations.

Alanine	Ala	A
Cysteine	Cys	C
Aspartate	Asp	D
Glutamate	Glu	E
Phenylalanine	Phe	F
Glycine	Gly	G
Histidine	His	H
Isoleucine	Ile	I
Lysine	Lys	K
Leucine	Leu	L

Methionine	Met	M
Asparagine	Asn	N
Proline	Pro	P
Glutamine	Gln	Q
Arginine	Arg	R
Serine	Ser	S
Threonine	Thr	T
Valine	Val	V
Tryptophan	Trp	W
Tyrosine	Tyr	Y

TABLE 3–1 Properties and Conventions Associated with the Common Amino Acids Found in Proteins

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

Amino acid pKa's vary because of attached functional groups (microenvironment influences acidity)

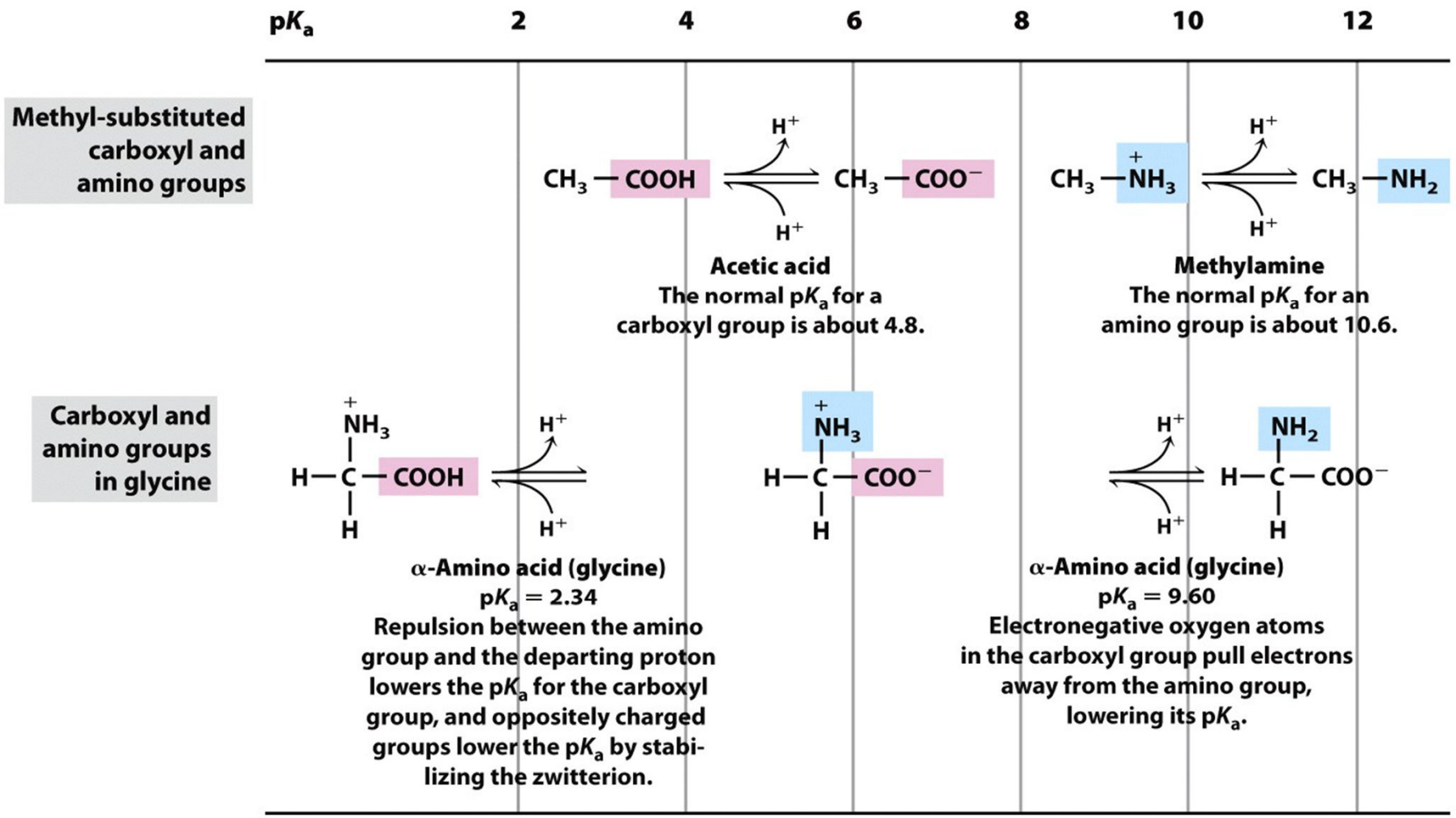
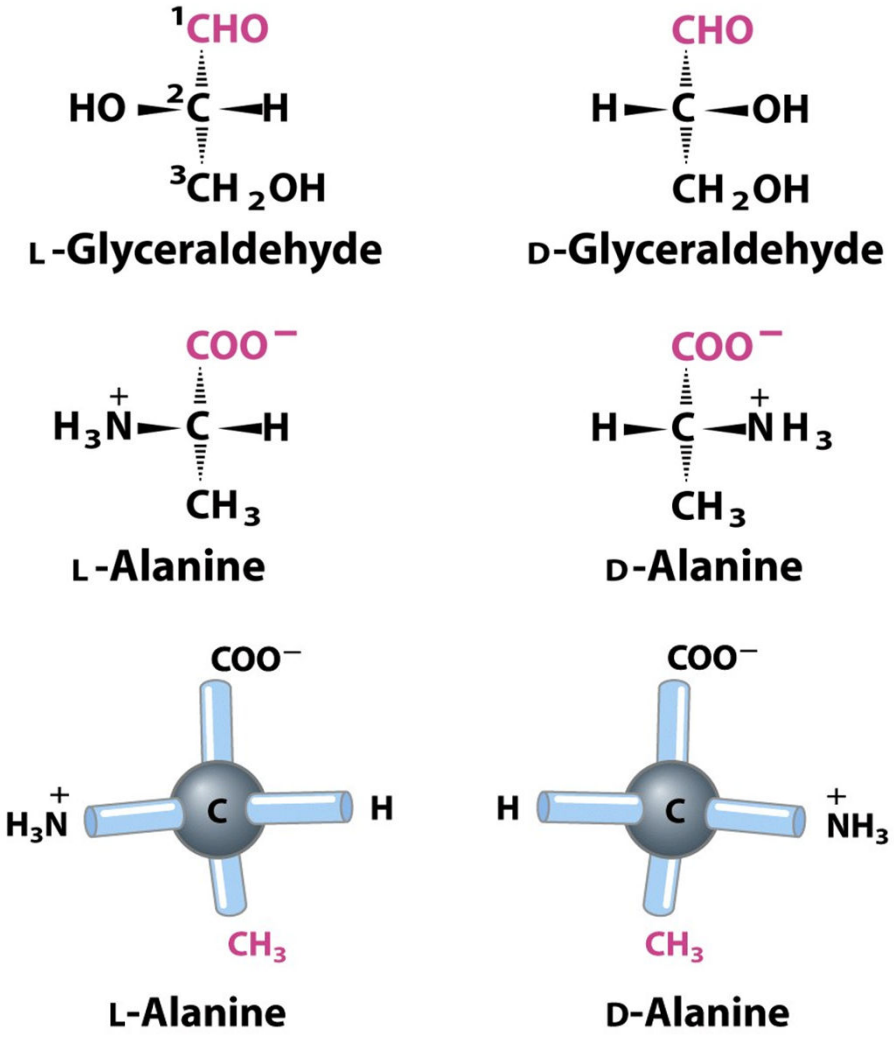
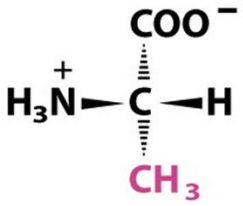


Figure 3-11
Lehninger Principles of Biochemistry, Fifth Edition

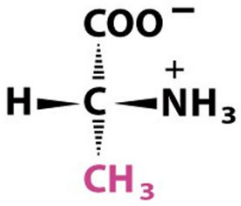
Most amino acids are chiral, and are designated ‘D’ or ‘L’ based on Emil Fischer’s nomenclature



The ‘Fischer projection’ is a simplified way to depict stereochemistry



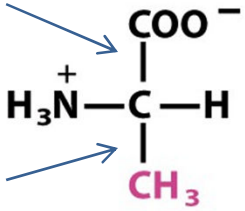
L-Alanine



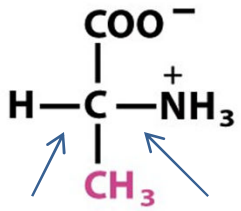
D-Alanine

Fisher projection

Vertical bonds point away from viewer (dashed wedges)

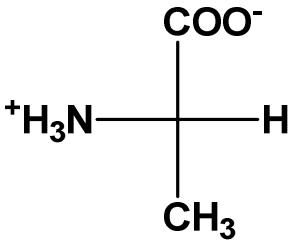


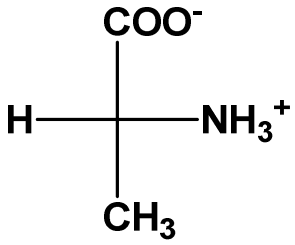
L-Alanine



D-Alanine

Horizontal bonds point toward viewer (filled wedges)



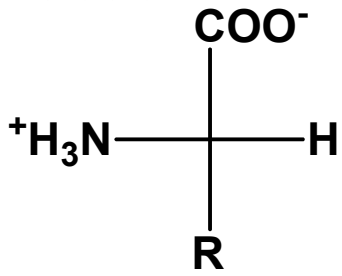


Chiral carbons may be left out entirely

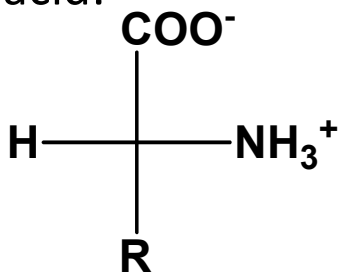
How to identify the stereochemistry of an amino acid (D or L?)

Fisher projection

L-amino acid:



D-amino acid:



If projection is aligned with:

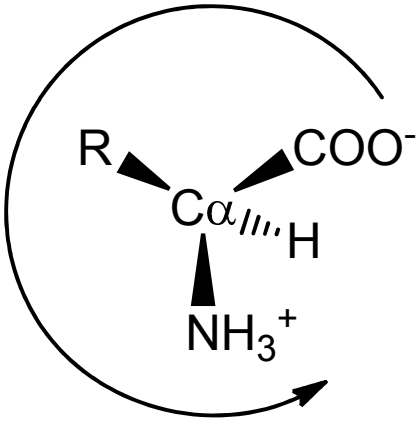
- carbon chain vertical
- carboxylate on top

amino group on left = L

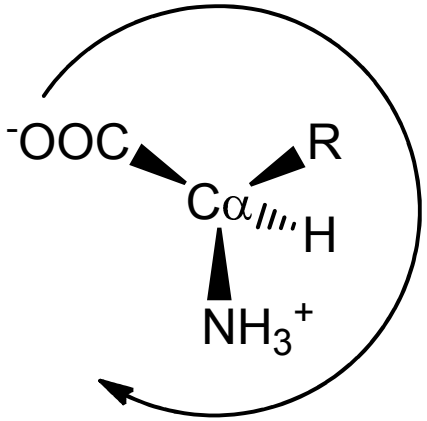
amino group on right = D

The CORN rule

L-amino acid:

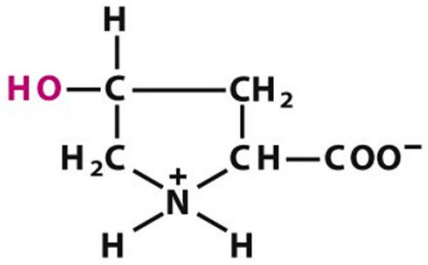


D-amino acid:

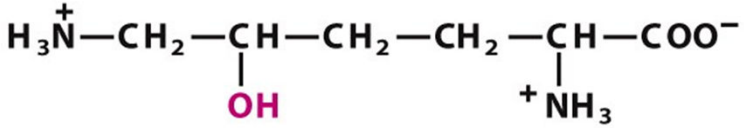


1. Orient the structure to look down the C_α-H bond
2. Follow the other C_α substituents to spell CORN (carboxylate, R-group, amino): counterclockwise is L, clockwise is D

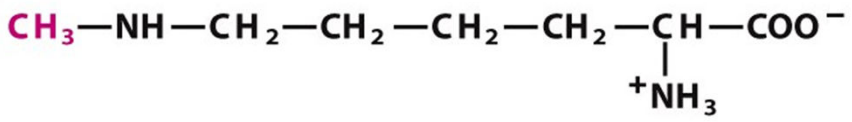
Nonstandard amino acids are found in modified proteins and as free metabolites



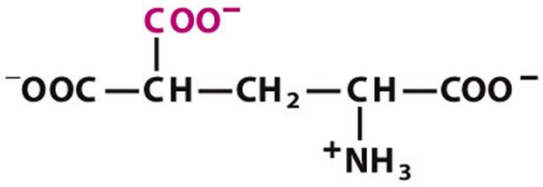
4-Hydroxyproline



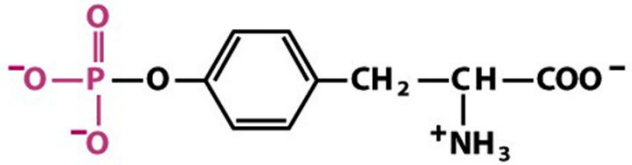
5-Hydroxylysine



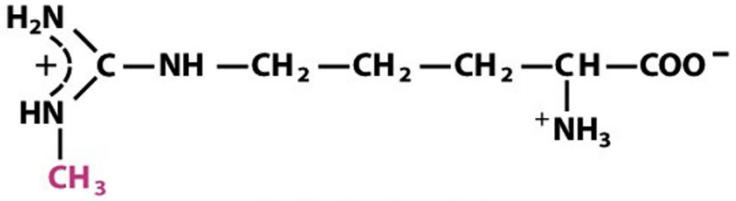
6-*N*-Methyllysine



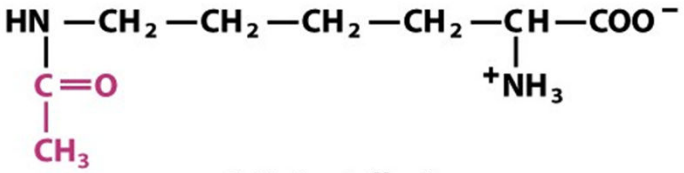
γ-Carboxyglutamate



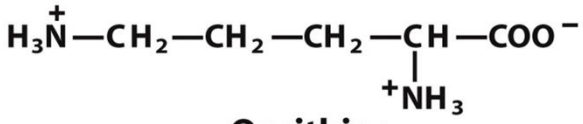
Phosphotyrosine



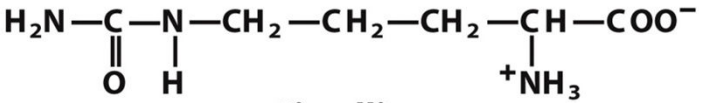
σ-*N*-Methylarginine



6-*N*-Acetyllysine



Ornithine



Citrulline