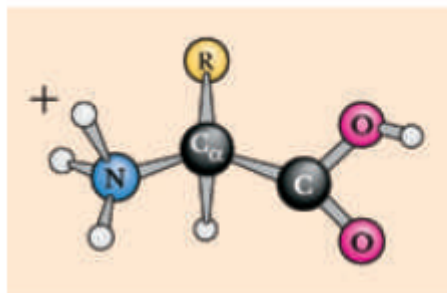


# Amino Acids and pI

# Amino Acids are Amphoteric

+1 net charge



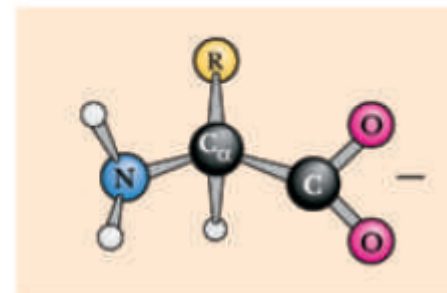
Cationic form

0 net charge



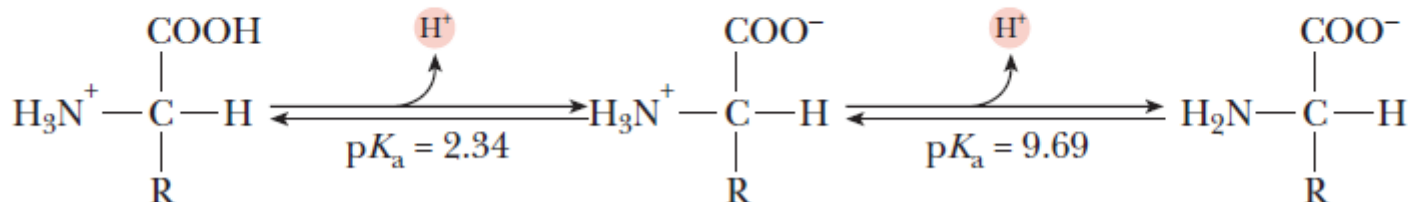
Neutral

-1 net charge

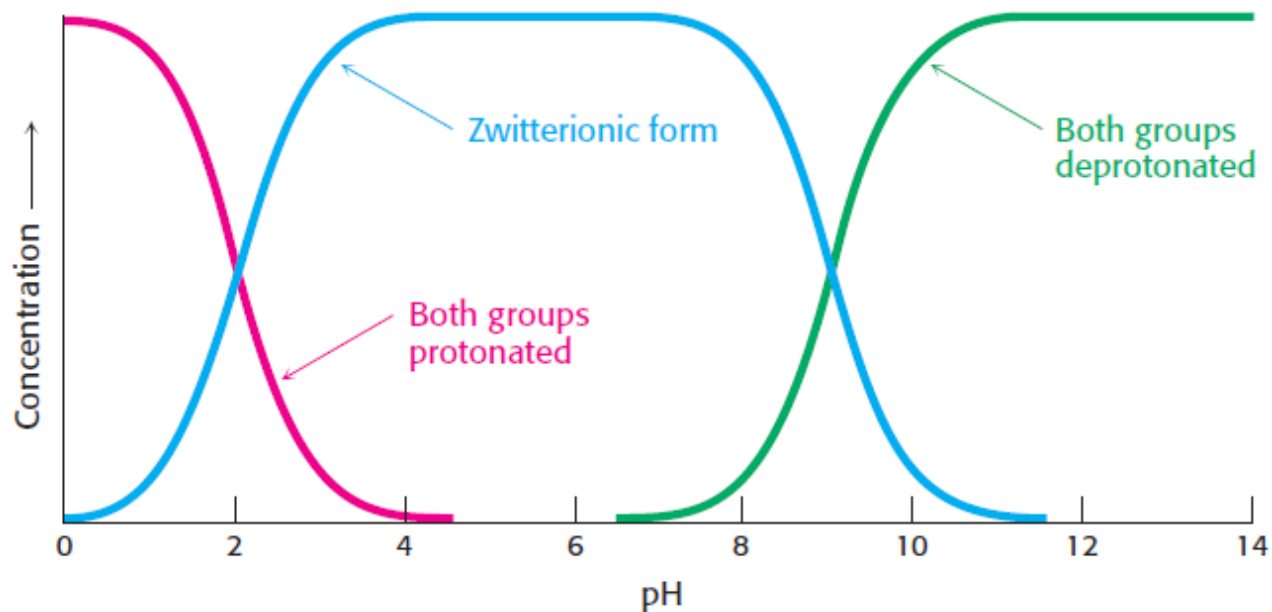
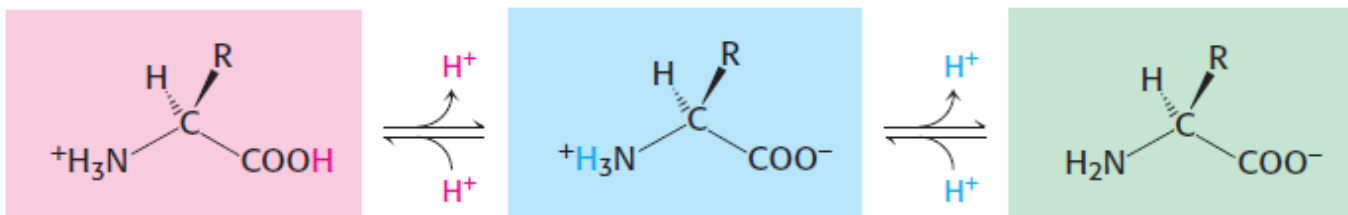


Anionic form

Isoelectric zwitterion

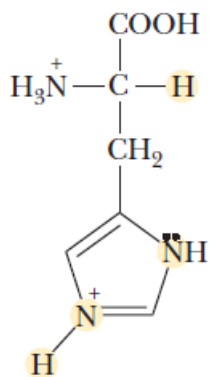


# Amino Acids are Amphoteric

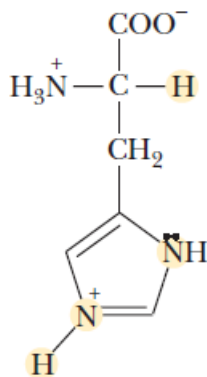


# Titration of Amino Acids

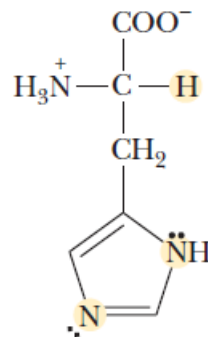
+2 net charge



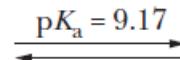
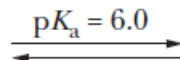
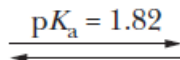
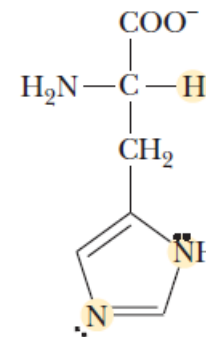
+1 net charge



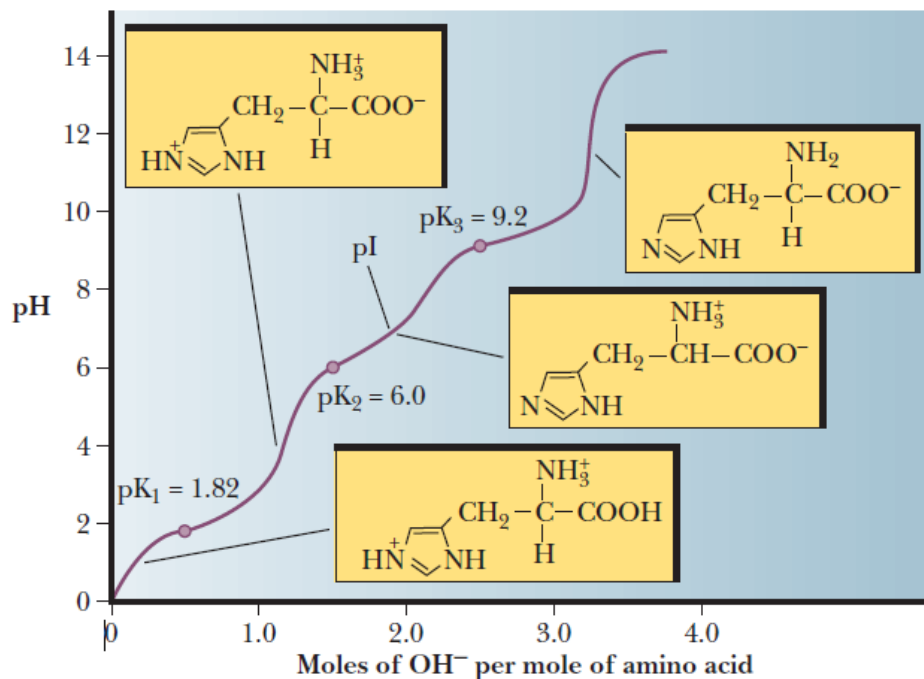
0 net charge



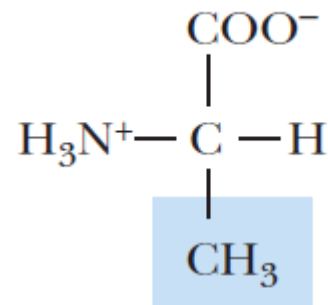
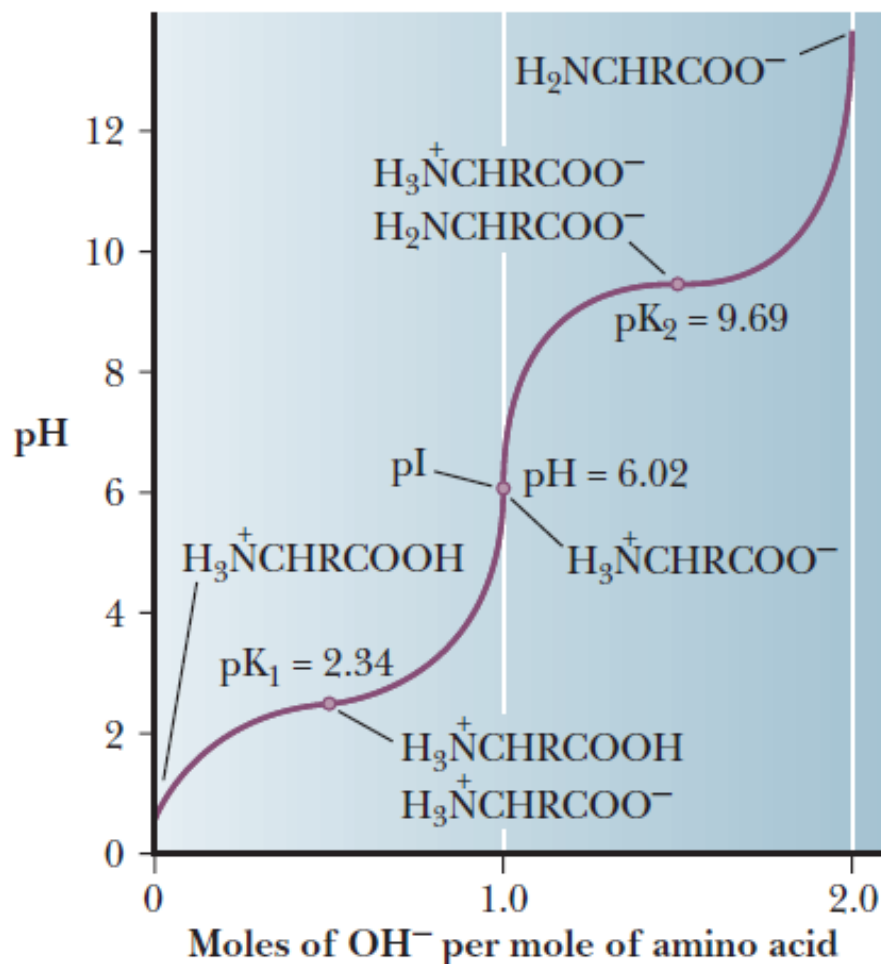
-1 net charge



Isoelectric zwitterion



# Titration of Amino Acids



Alanine (Ala, A)

$$\text{pI} = \frac{\text{p}K_{\text{a}1} + \text{p}K_{\text{a}2}}{2}$$



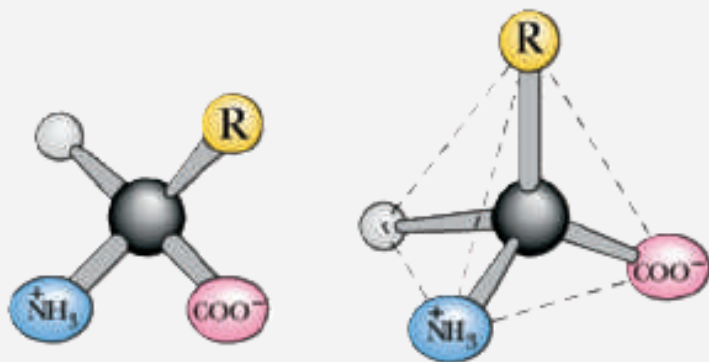
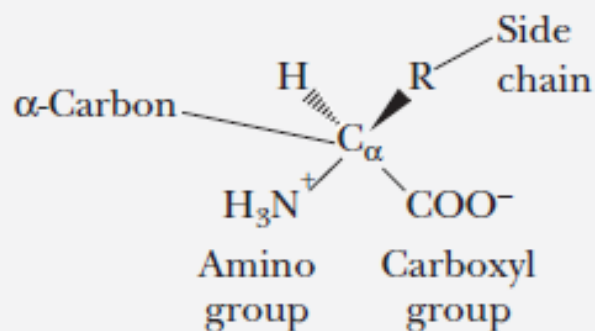
# pKa values of common AAs

Acid	$\alpha$ -COOH	$\alpha$ -NH <sub>3</sub> <sup>+</sup>	RH or RH <sup>+</sup>
Gly	2.34	9.60	
Ala	2.34	9.69	
Val	2.32	9.62	
Leu	2.36	9.68	
Ile	2.36	9.68	
Ser	2.21	9.15	
Thr	2.63	10.43	
Met	2.28	9.21	
Phe	1.83	9.13	
Trp	2.38	9.39	
Asn	2.02	8.80	
Gln	2.17	9.13	
Pro	1.99	10.6	
Asp	2.09	9.82	3.86*
Glu	2.19	9.67	4.25*
His	1.82	9.17	6.0*
Cys	1.71	10.78	8.33*
Tyr	2.20	9.11	10.07
Lys	2.18	8.95	10.53
Arg	2.17	9.04	12.48

Bring out ¼ sheet:

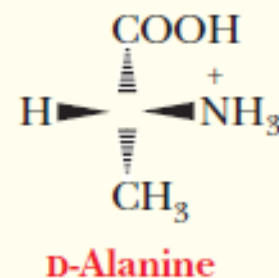
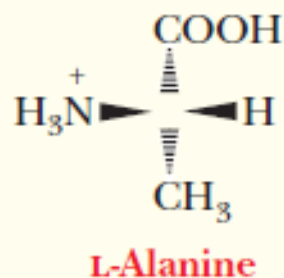
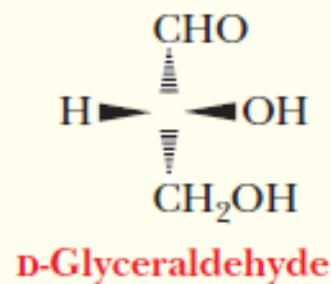
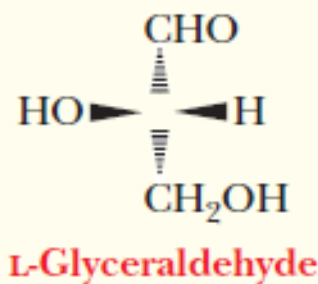
Generate the titration curve for lysine. Label the pKas, the equivalence points. Lastly, calculate the pl.

# Structure of Amino Acids



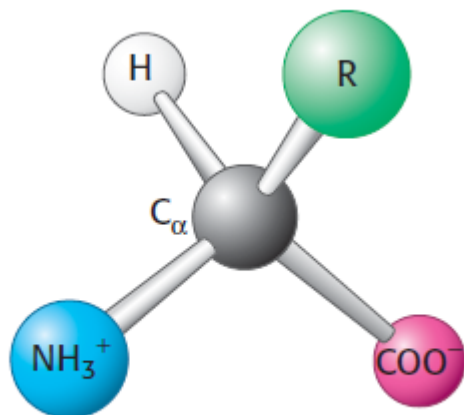
Ball-and-stick model

Amino acids are tetrahedral structures

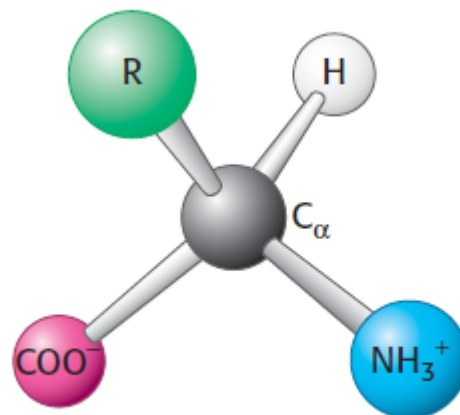


*Only L amino acids are constituents of proteins.*

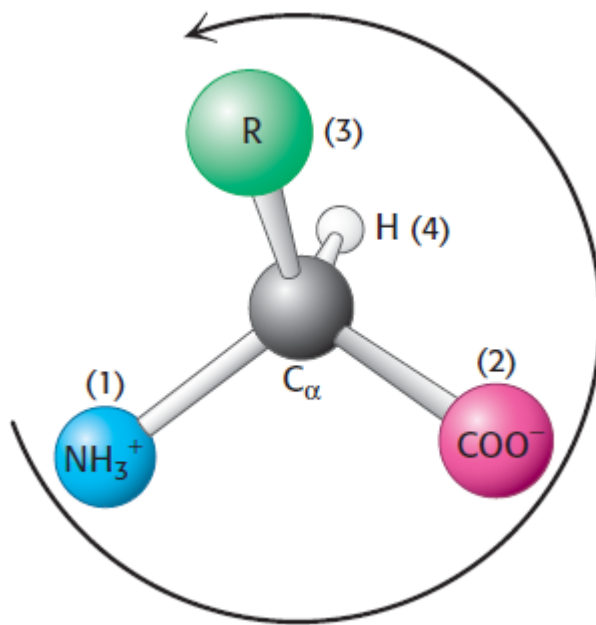
# Structure of Amino Acids



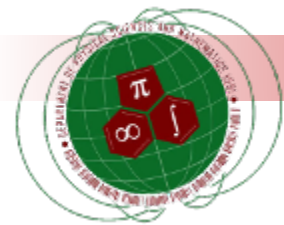
L isomer



D isomer







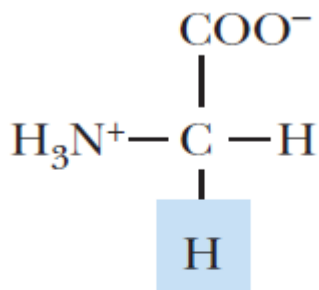
# Amino acids

Amino acids vary in *size*, *shape*, charge, H-bonding capacity, *hydrophobic character*, and *chemical reactivity*.

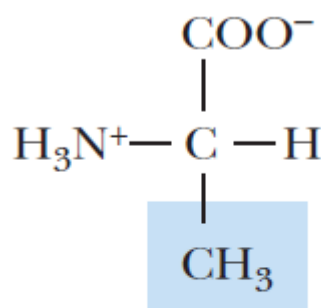
Four groups:

1. Nonpolar (Hydrophobic) amino acids
2. Polar, uncharged amino acids
3. Acidic amino acids
4. Basic amino acids

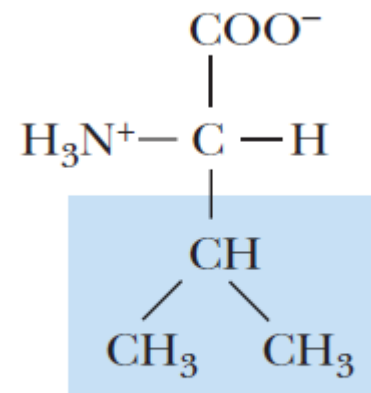
# Nonpolar (Hydrophobic AAs)



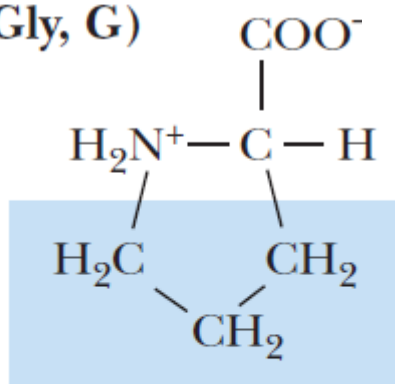
Glycine (Gly, G)



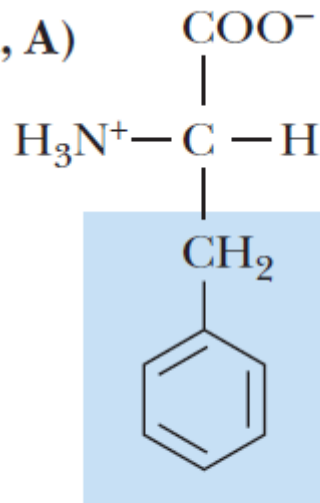
Alanine (Ala, A)



Valine (Val, V)

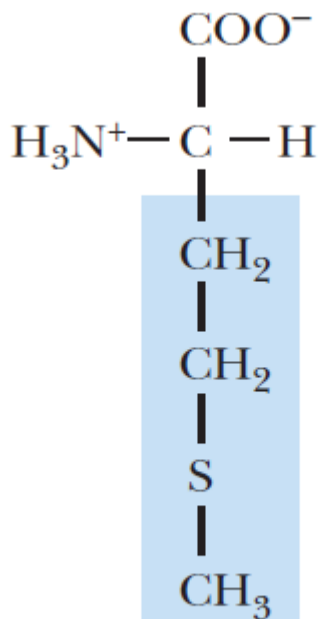


Proline (Pro, P)

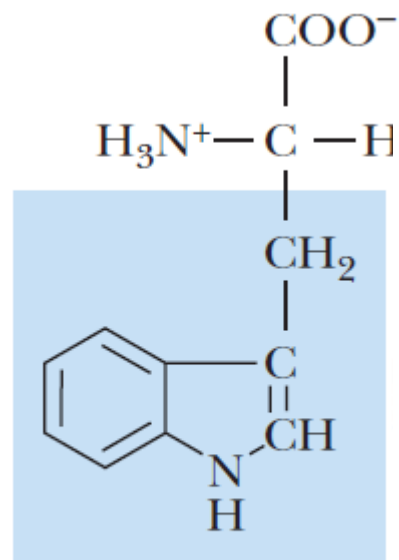


Phenylalanine (Phe, F)

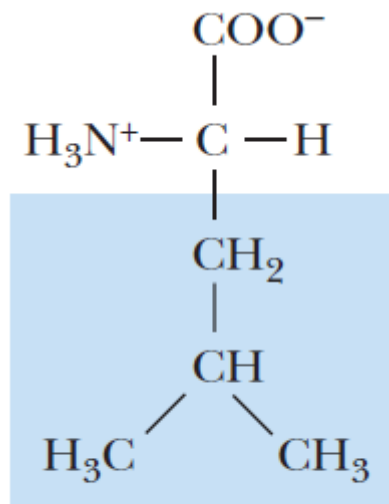
# Nonpolar (Hydrophobic AAs)



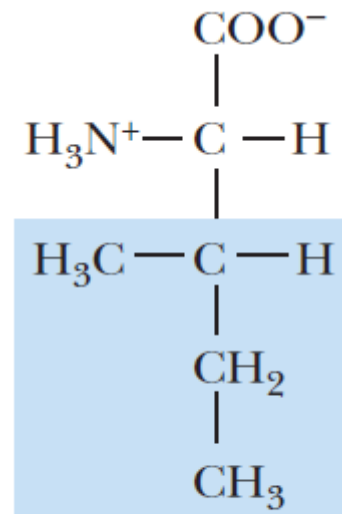
Methionine (Met, M)



Tryptophan (Trp, W)

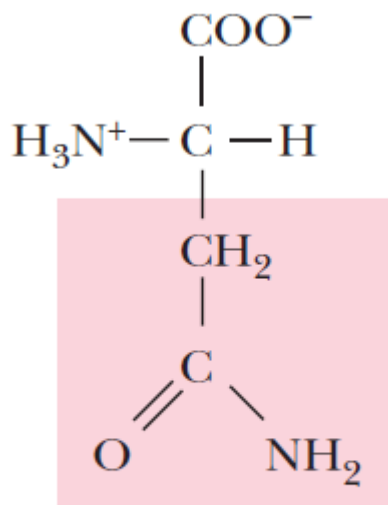


Leucine (Leu, L)

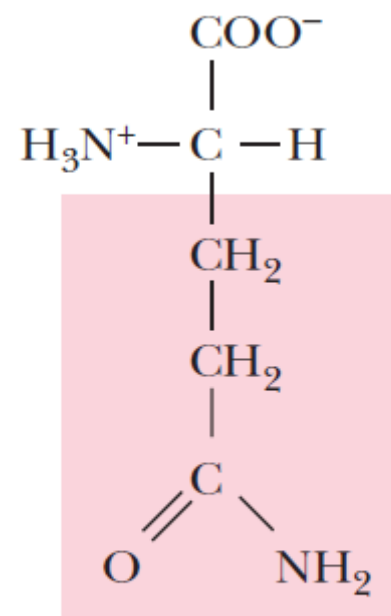
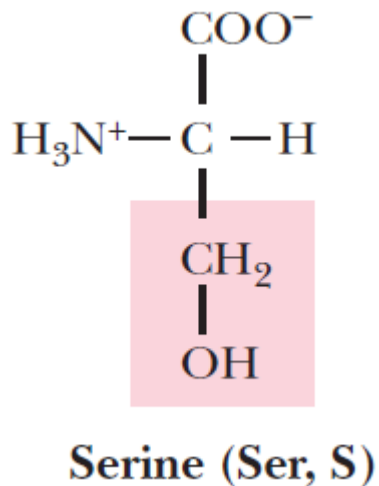


Isoleucine (Ile, I)

# Polar, uncharged AAs

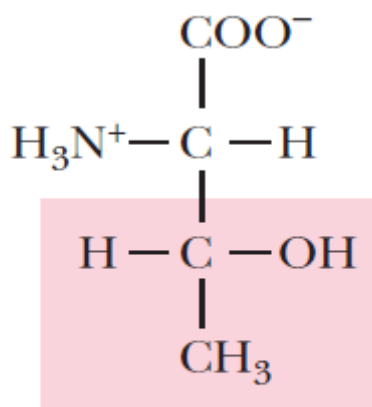


Asparagine (Asn, N)

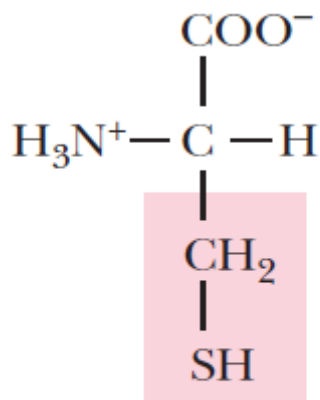


Glutamine (Gln, Q)

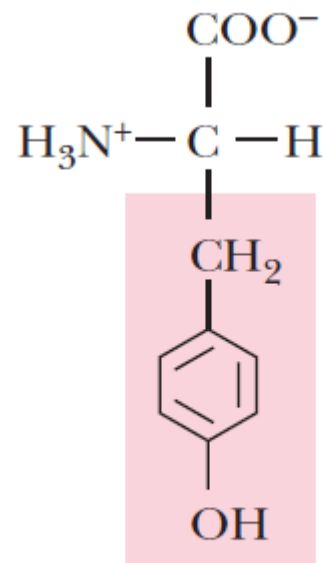
# Polar, uncharged AAs



Threonine (Thr, T)

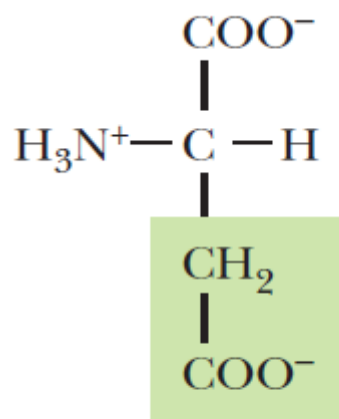


Cysteine (Cys, C)

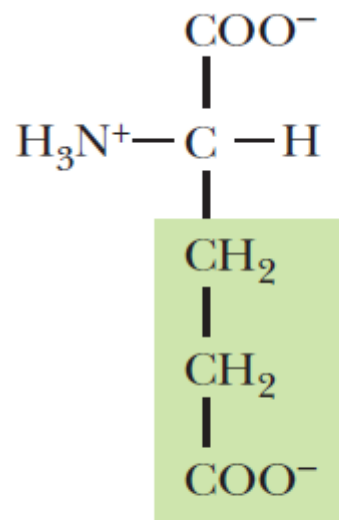


Tyrosine (Tyr, Y)

# Acidic Amino Acids

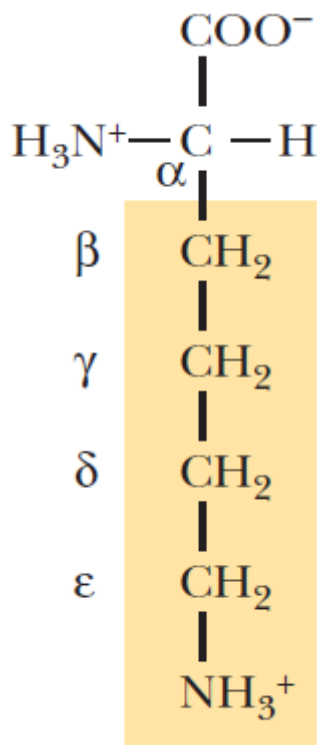


Aspartic acid (Asp, D)

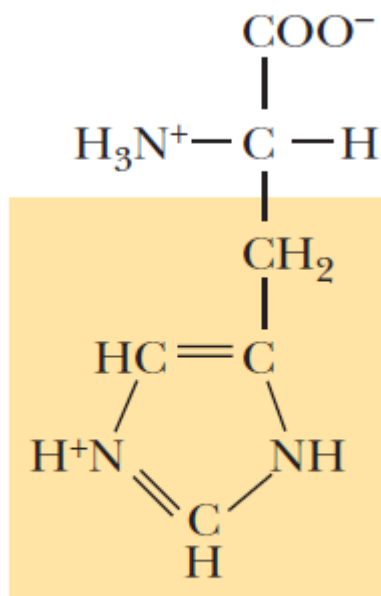


Glutamic acid (Glu, E)

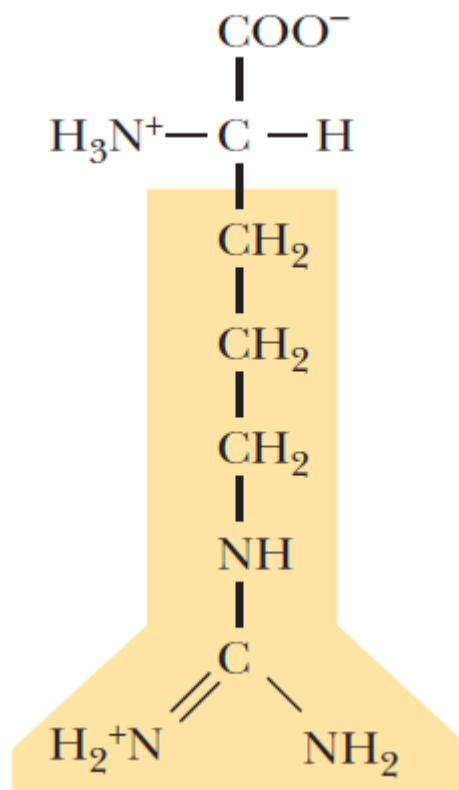
# Basic Amino Acids



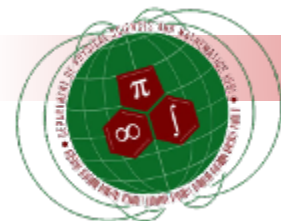
Lysine (Lys, K)



Histidine (His, H)



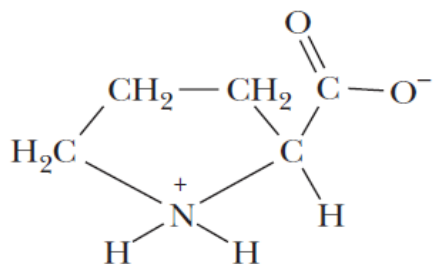
Arginine (Arg, R)

**Table 2.2** Abbreviations for amino acids

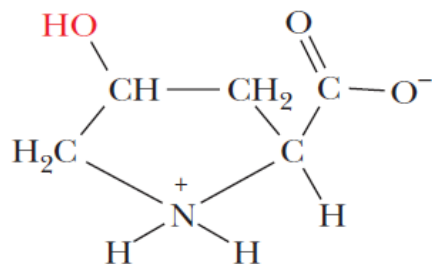
Amino acid	Three-letter abbreviation	One-letter abbreviation	Amino acid	Three-letter abbreviation	One-letter abbreviation
Alanine	Ala	A	Methionine	Met	M
Arginine	Arg	R	Phenylalanine	Phe	F
Asparagine	Asn	N	Proline	Pro	P
Aspartic acid	Asp	D	Serine	Ser	S
Cysteine	Cys	C	Threonine	Thr	T
Glutamine	Gln	Q	Tryptophan	Trp	W
Glutamic acid	Glu	E	Tyrosine	Tyr	Y
Glycine	Gly	G	Valine	Val	V
Histidine	His	H	Asparagine or aspartic acid	Asx	B
Isoleucine	Ile	I	Glutamine or glutamic acid	Glx	Z
Leucine	Leu	L			
Lysine	Lys	K			



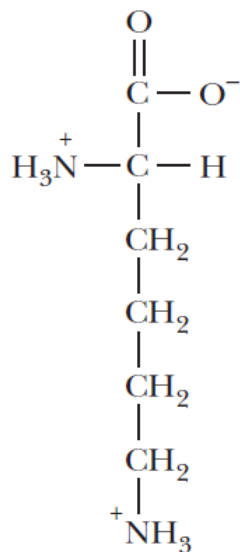
# Uncommon Amino Acids



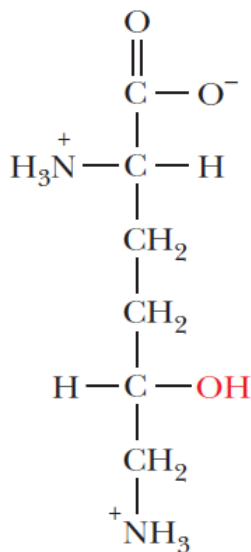
Proline



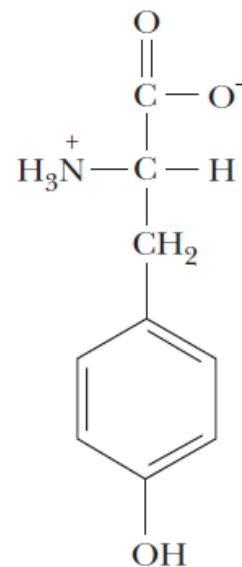
Hydroxyproline



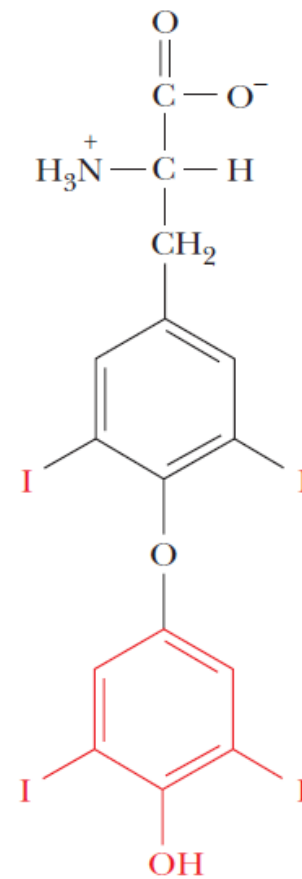
Lysine



Hydroxylysine



Tyrosine



Thyroxine