Notes 10/3

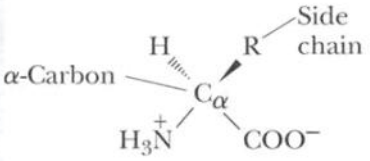
Wednesday, October 03, 2007
10:00 AM

Amino Acids: Acid-Base Properties

Oct. 3, 2007

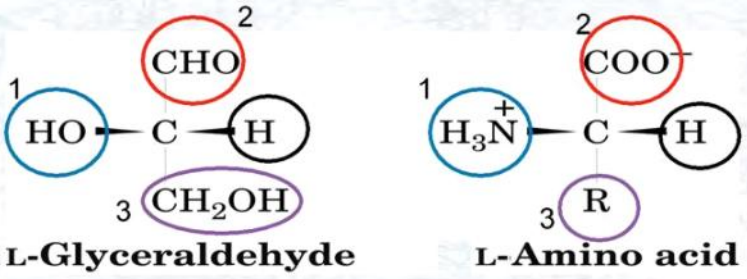
Review

- Amino acids:
  - tetrahedral α carbon
  - amino group
  - carboxyl group
  - side chain (R group)



- Peptide bonds
- Classification: nonpolar, polar, acidic, basic

L-amino acid configuration is based on L-glyceraldehyde's configuration



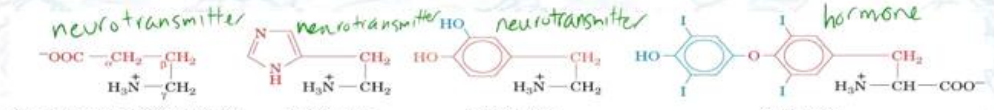
Priorities

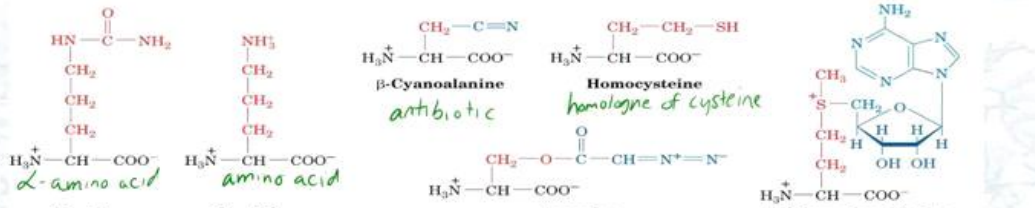
$SH>OH>NH_2>CH_2SH>COOH>CHO>CH_2OH>C_6H_5$

$>C_6H_5>C_6H_{11}>CH_3>H$

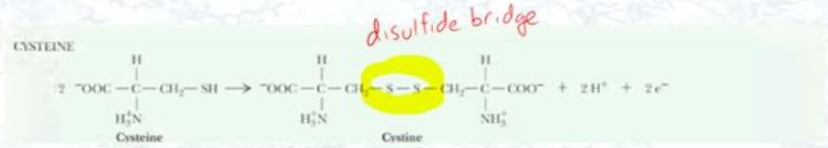
Some biologically produced derivatives of "standard" amino acids and amino acids that are not components of proteins.

should be able to recognize structures - give name and significance





Structure of cystine



has e⁻ Do not confuse them ~ doesn't have e⁻ in name, loses e⁻

Oxidative rxn

What Are Acid-Base Properties of Amino Acids?

- *Amino Acids are Weak Polyprotic Acids*
- $H_2A^+ + H_2O \rightarrow HA^0 + H_3O^+$
- $K_{a1} = \dfrac{[HA^0][H_3O^+]}{[H_2A^+]}$

$Gly^+ + H_2O \rightarrow Gly^0 + H_3O^+$

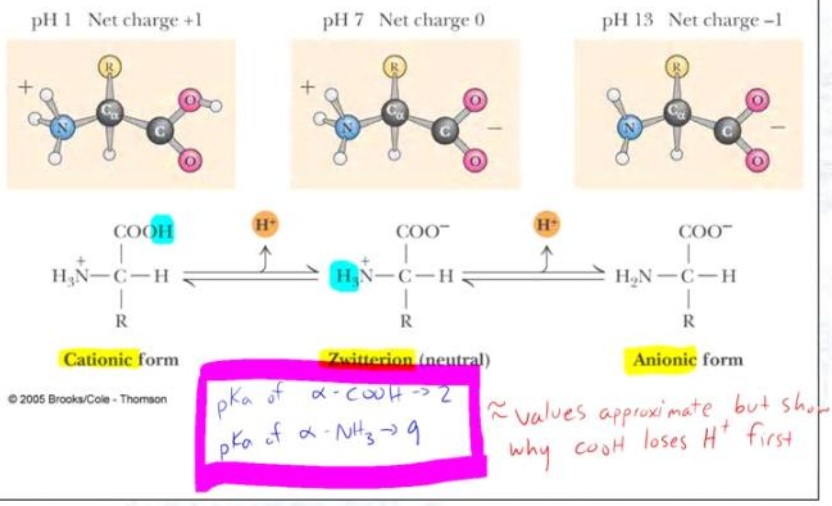
$K_{a_1} = \dfrac{[Gly^0][H_3O^+]}{[Gly^+]}$

The second dissociation (the amino group in the case of glycine):

- $HA^0 + H_2O \rightarrow A^- + H_3O^+$
- $K_{a2} = \dfrac{[A^-][H_3O^+]}{[HA^0]}$

- $Gly^0 + H_2O \rightarrow Gly^- + H_3O^+$
- $K_{a_2} = \dfrac{[Gly^-][H_3O^+]}{[Gly^0]}$

The ionic forms of the amino acids, shown without consideration of any ionizations on the side chain



pKa of α-COOH → 2
pKa of α-NH_3 → 9

≈ values approximate but show why COOH loses H^+ first

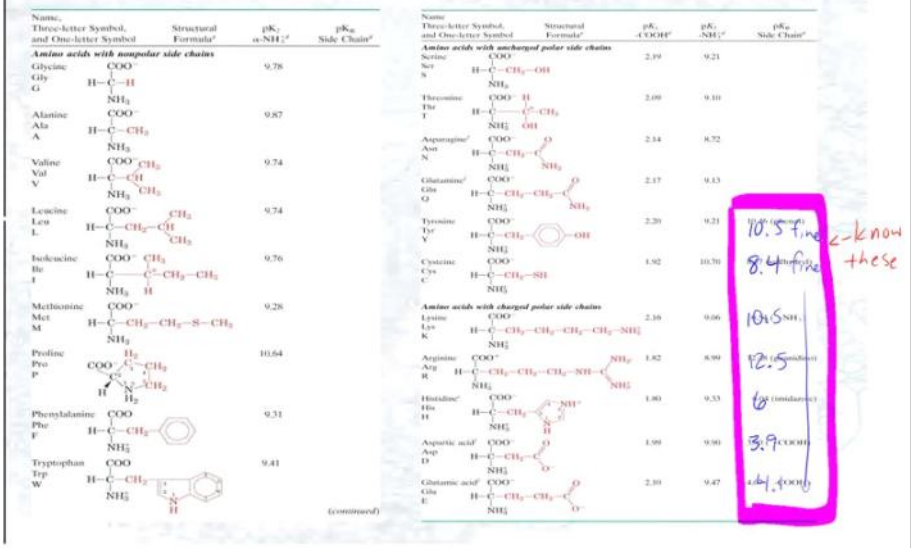
pK_a Values of the Amino Acids and their ionizable R-groups

Depend on T, ionic strength, and microenvironment of ionizable group

You should know these numbers and know what they mean!

- Alpha carboxyl group - $pK_a = 2$
- Alpha amino group - $pK_a = 9$
- These numbers are approximate, but entirely suitable for our purposes.

Covalent Structures and Abbreviations of the "Standard" Amino Acids of Proteins and the pK Values of Their Ionizable Groups.

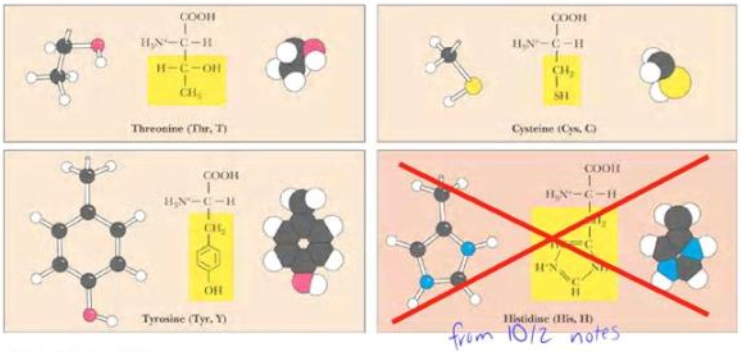


Name, Three-letter Symbol, and One-letter Symbol	Structural Formula[a]	pK_1 α-NH_3^+[a]	pK_R Side Chain[a]
Amino acids with nonpolar side chains			
Glycine Gly G		9.78	
Alanine Ala A		9.87	
Valine Val V		9.74	
Leucine Leu L		9.74	
Isoleucine Ile I		9.76	
Methionine Met M		9.28	
Proline Pro P		10.64	
Phenylalanine Phe F		9.31	
Tryptophan Trp W		9.41	

(continued)

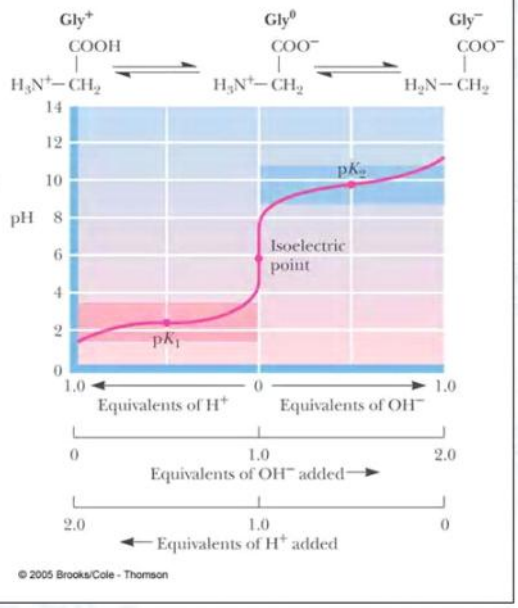
Name, Three-letter Symbol, and One-letter Symbol	Structural Formula[a]	pK_1 -$COOH$[a]	pK_2 -NH_3^+[a]	pK_R Side Chain[a]
Amino acids with uncharged polar side chains				
Serine Ser S		2.19	9.21	
Threonine Thr T		2.09	9.10	
Asparagine[c] Asn N		2.14	8.72	
Glutamine[c] Gln Q		2.17	9.13	
Tyrosine Tyr Y		2.20	9.21	
Cysteine Cys C		1.92	10.70	
Amino acids with charged polar side chains				
Lysine Lys K		2.16	9.06	
Arginine Arg R		1.82	8.99	
Histidine[c] His H		1.80	9.33	
Aspartic acid[c] Asp D		1.99	9.90	
Glutamic acid[c] Glu E		2.10	9.47	

Polar, neutral

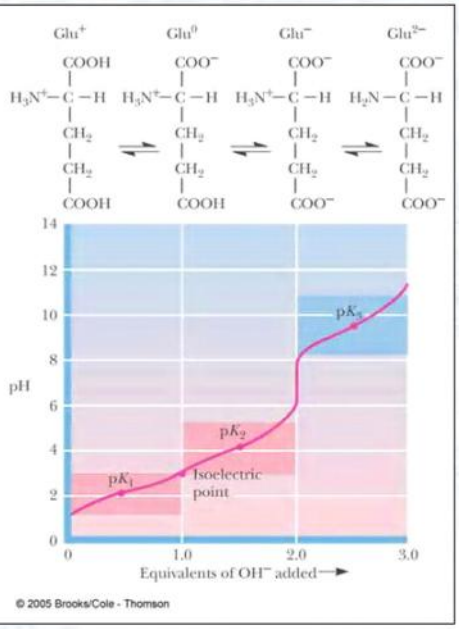


from 10/2 notes

Titration of glycine, a simple amino acid.



Titration of glutamic acid.

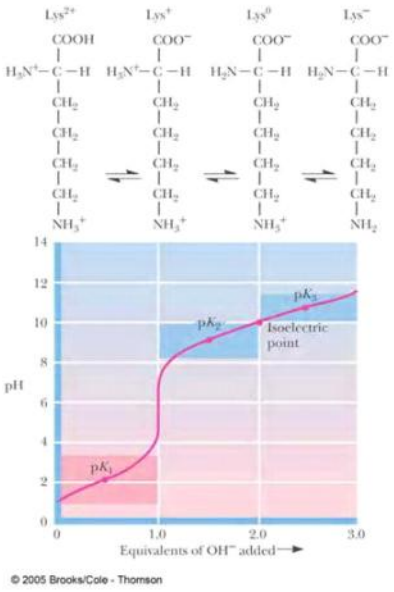


A Sample Calculation

What is the pH of a glutamic acid solution if the alpha carboxyl is 1/4 dissociated?

- $pH = 2 + \log \frac{[1]}{[3]}$
- $pH = 2 + (-0.477)$
- $pH = 1.5$

Titration of lysine.



Another Sample Calculation

What is the pH of a lysine solution if the side chain amino group is 3/4 dissociated?

- $pH = 10.5 + \log \frac{[3]}{[1]}$ $\frac{A^-}{HA}$
- pH = 10.5 + (0.477)
- pH = 10.977 ≈ 11