


Amino Acids

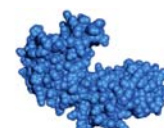
Stryer Short Course
Chapter 3

Amino Acid Structure

- Alpha carbon
- Sidechain
- Proteins
- peptides



Insulin (Zig)
Released from the pancreas to signal the availability of the metabolic fuel glucose (more in Section 13-2)



Phosphoglycerate kinase (yeast)
Catalyzes one of the central reactions in metabolism (more in Section 13-1)

$$\begin{array}{c}
 \text{COO}^- \\
 | \\
 \text{H}-\text{C}-\text{R} \\
 | \\
 \text{NH}_3^+
 \end{array}$$

Stereochemistry

- L-amino acids
 - Glycine
 - R/S vs D/L
 - L-isoleucine
- racemization

$$\begin{array}{c}
 \text{COO}^- \\
 | \\
 \text{H}_3\text{N}^+-\text{C}_\alpha-\text{H} \\
 | \\
 \text{CH}_3
 \end{array}$$

$$\begin{array}{c}
 \text{COO}^- \\
 | \\
 \text{H}-\text{C}_\alpha-\text{NH}_3^+ \\
 | \\
 \text{CH}_3
 \end{array}$$

$$\begin{array}{c}
 \text{O} \\
 || \\
 \text{H}_3\text{N}-\text{C}-\text{H} \\
 | \\
 \text{R}
 \end{array}$$

L-Amino acid

$$\begin{array}{c}
 \text{O} \\
 || \\
 \text{H}_2\text{N}-\text{C}-\text{H} \\
 | \\
 \text{R}
 \end{array}$$

Carbanion

$$\begin{array}{c}
 \text{O} \\
 || \\
 \text{H}-\text{C}-\text{NH}_2 \\
 | \\
 \text{R}
 \end{array}$$

D-Amino acid

$$\begin{array}{c}
 \text{H} \\
 | \\
 \text{C} \\
 / \quad \backslash \\
 \text{CH}_3 \quad \text{COO}^-
 \end{array}$$

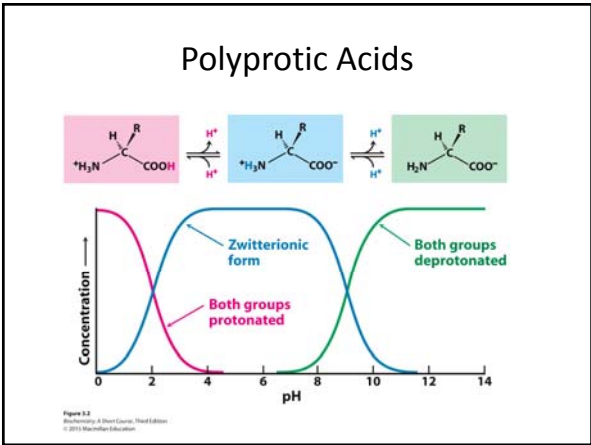
Stereochemical rendering of alanine

Ionization of Amino Acids

- Polyprotic acids
- Alanine
 - $pK_{a1} = 2.4$
 - $pK_{a2} = 9.9$
- Zwitterion
- Isoelectric point
- More acidic than typical carboxylic acid

$$\begin{array}{ccc} \text{CH}_3 & & \text{CH}_3 \\ | & & | \\ \text{NH}_3^+ - \text{CH} - \text{COOH} & \rightleftharpoons & \text{NH}_3^+ - \text{CH} - \text{COO}^- + \text{H}^+ \\ | & & | \\ \text{H} & & \text{H} \end{array}$$

$$\begin{array}{ccc} \text{CH}_3 & & \text{CH}_3 \\ | & & | \\ \text{NH}_3^+ - \text{CH} - \text{COO}^- & \rightleftharpoons & \text{NH}_2 - \text{CH} - \text{COO}^- + \text{H}^+ \\ | & & | \\ \text{H} & & \text{H} \end{array}$$



Common Amino Acids

Hydrophobic amino acids

$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 \\ \\ \text{NH}_2 \end{array}$ <p>Alanine (Ala, A)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}(\text{CH}_3) \\ \\ \text{NH}_2 \end{array}$ <p>Valine (Val, V)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{C}_6\text{H}_5 \\ \\ \text{NH}_2 \end{array}$ <p>Phenylalanine (Phe, F)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{C}_8\text{H}_6\text{N}_2 \\ \\ \text{NH}_2 \end{array}$ <p>Tryptophan (Trp, W)</p>
$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 \\ \\ \text{NH}_2 \end{array}$ <p>Leucine (Leu, L)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}(\text{CH}_3) - \text{CH}_2 - \text{CH}_3 \\ \\ \text{NH}_2 \end{array}$ <p>Isoleucine (Ile, I)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{CH}_2 - \text{S} - \text{CH}_3 \\ \\ \text{NH}_2 \end{array}$ <p>Methionine (Met, M)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{C}_5\text{H}_7\text{N} \\ \\ \text{NH}_2 \end{array}$ <p>Proline (Pro, P)</p>

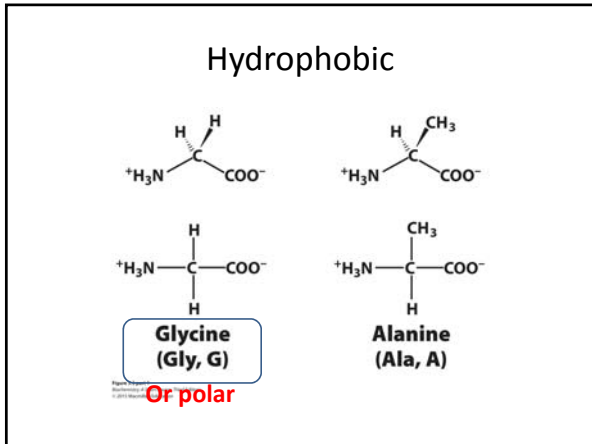
Polar amino acids

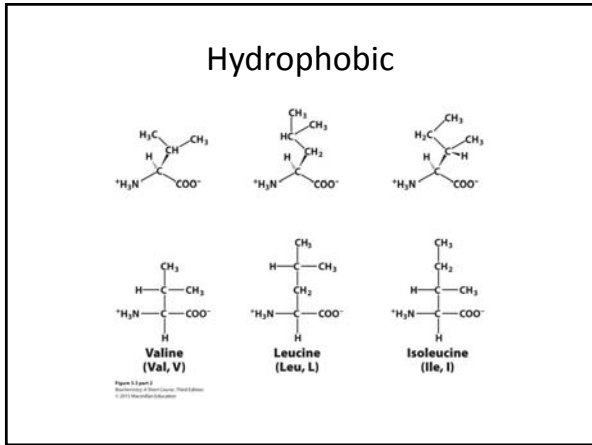
$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{OH} \\ \\ \text{NH}_2 \end{array}$ <p>Serine (Ser, S)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}(\text{OH}) - \text{CH}_2 - \text{OH} \\ \\ \text{NH}_2 \end{array}$ <p>Threonine (Thr, T)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{C}_6\text{H}_4 - \text{OH} \\ \\ \text{NH}_2 \end{array}$ <p>Tyrosine (Tyr, Y)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{SH} \\ \\ \text{NH}_2 \end{array}$ <p>Cysteine (Cys, C)</p>
$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{C}(=\text{O}) - \text{NH}_2 \\ \\ \text{NH}_2 \end{array}$ <p>Asparagine (Asn, N)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{C}(=\text{O}) - \text{CH}_2 - \text{NH}_2 \\ \\ \text{NH}_2 \end{array}$ <p>Glutamine (Gln, Q)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{C}_3\text{H}_3\text{N}_2 \\ \\ \text{NH}_2 \end{array}$ <p>Histidine (His, H)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{NH}_2 \\ \\ \text{NH}_2 \end{array}$ <p>Glycine (Gly, G)</p>

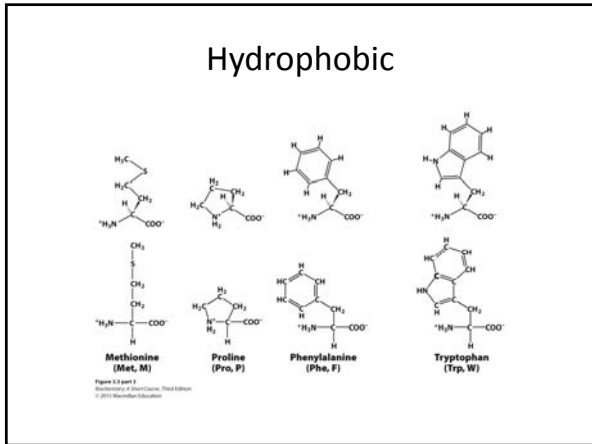
Charged amino acids

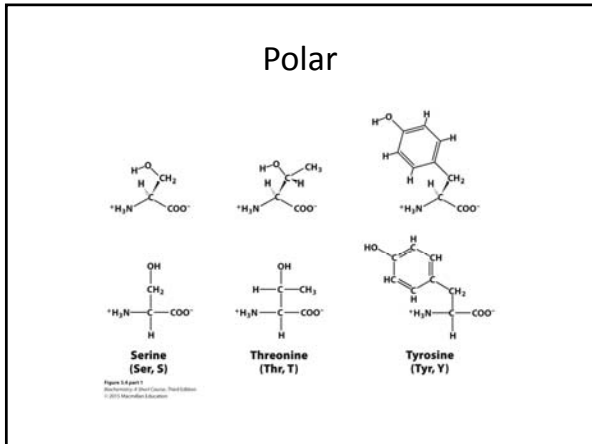
$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{C}(=\text{O}) - \text{O}^- \\ \\ \text{NH}_2 \end{array}$ <p>Aspartate (Asp, D)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{C}(=\text{O}) - \text{O}^- \\ \\ \text{NH}_2 \end{array}$ <p>Glutamate (Glu, E)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{NH}_2 \\ \\ \text{NH}_2 \end{array}$ <p>Lysine (Lys, K)</p>	$\begin{array}{c} \text{COO}^- \\ \\ \text{H} - \text{C} - \text{CH}_2 - \text{CH}_2 - \text{NH} - \text{C}(=\text{NH}_2) - \text{NH}_2 \\ \\ \text{NH}_2 \end{array}$ <p>Arginine (Arg, R)</p>
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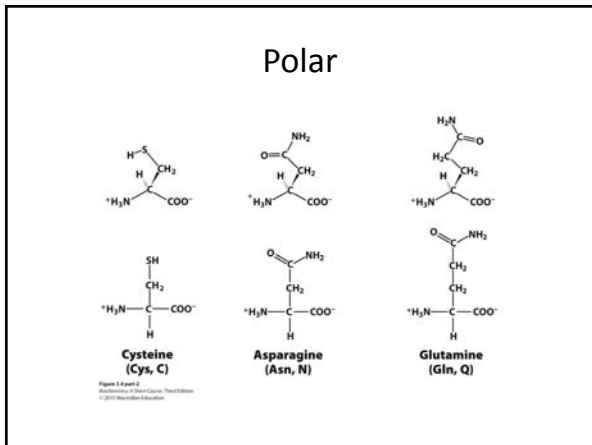
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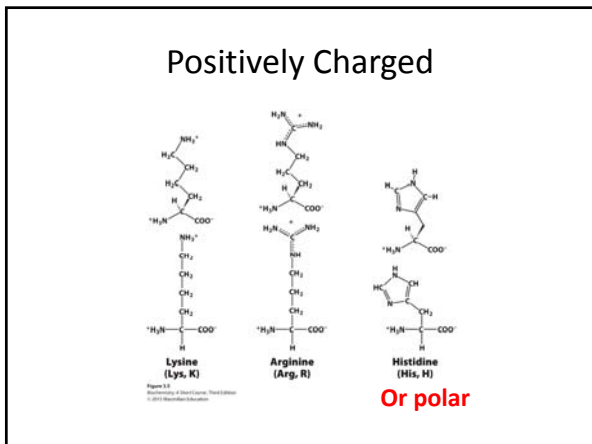


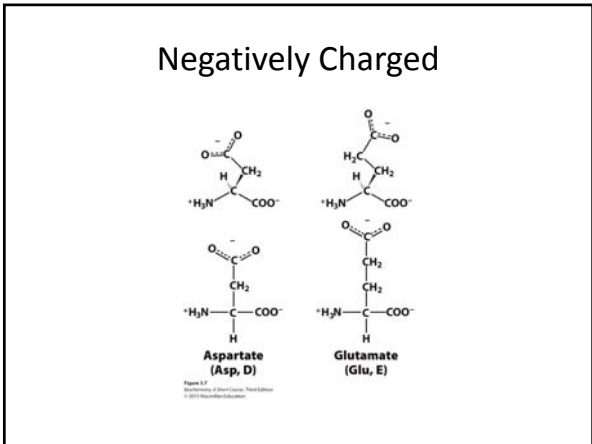












Acid/base chemistry

- Charged amino acids
- Other amino acids are ionizable

Base \rightleftharpoons **Acid**

Table 3.1 Typical pK_a values of ionizable groups in proteins

Group	Acid	Base	Typical pK _a
Terminal α-carboxyl group			3.1
Aspartic acid Glutamic acid			4.1
Histidine			6.0
Terminal α-amino group			8.0
Cysteine			8.3
Tyrosine			10.9
Lysine			10.8
Arginine			12.5

Which amino acid(s)...

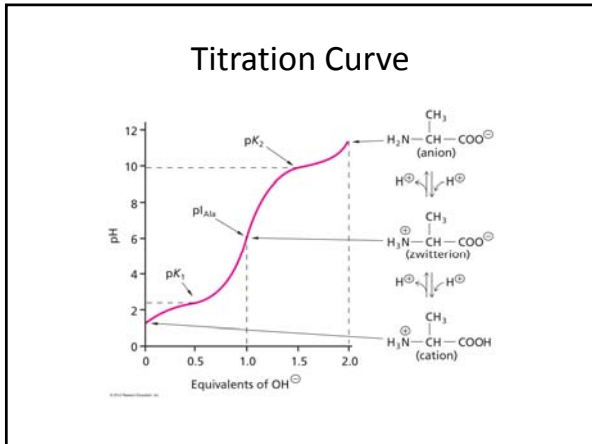
- Is achiral?
- Has a secondary amino group?
- Has a chiral sidechain?
- Form these derivatives:

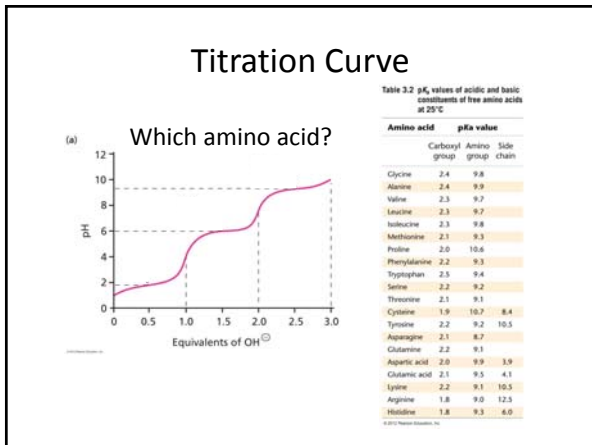
(9) [O-]C(=O)CCNCC[NH3+]
γ-Aminobutyrate (GABA)

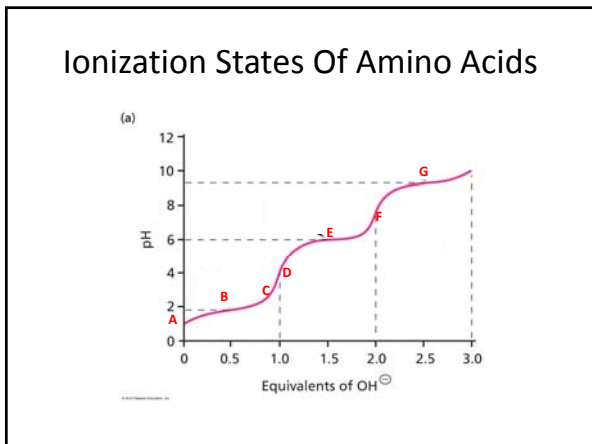
(10) CN1C=NC=C1CCN
Histamine

(11) Oc1ccc(O)cc1CNCC[NH3+]
Epinephrine (Adrenaline)

(12) Cc1cc(O)c(O)c(O)c1CNCC[NH3+]
Thyrosine / Triiodothyronine







Essential Amino Acids

- Dietary Term
- Can change in stage of life
- Depends on definition of biosynthetic building blocks

Table 3.2 Basic set of 20 amino acids

Nonessential	Essential
Alanine	Histidine
Arginine	Isoleucine
Asparagine	Leucine
Aspartate	Lysine
Cysteine	Methionine
Glutamate	Phenylalanine
Glutamine	Threonine
Glycine	Tryptophan
Proline	Valine
Serine	
Tyrosine	

Table 3.2
 Biochemistry & Nutrition, 7th Edition
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