Chapter 23  Amino Acids, Peptides & Proteins

1. Substituent

\[ \text{R} \] 
\[ \text{OH} \] 
\[ \text{H} \] 
\[ \text{2} \] 
\[ \text{NH} \] 
\[ \text{CH}_2 \text{COOH} \] 
\[ \text{amino acid} \] 
\[ \text{sterogenic center} \] 

There are 20 common naturally occurring amino acids

\( R = 20 \) different subs

2. Protein: polymers of \( \alpha \)-amino acids (2 about 30)

Peptides: polymer of \( \leq \) about 30 \( \alpha \)-amino acids

3. Stereochemistry:

\[ \text{CH}_2 \text{COOH} \] 
\[ \text{H} \] 
\[ \text{N} \] 
\[ \text{2} \] 
\[ \text{OH} \] 
\[ \text{all but 2 of 20 have S-configuration} \] 

Further Projection

\[ \text{CO}_2\text{H} \] 
\[ \text{amino acid on left} \] 
\[ \text{natural amino acids are (L)} \] 

4. Common \( \alpha \)-amino acids

<table>
<thead>
<tr>
<th>Structure</th>
<th>Name</th>
<th>Stereochemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{H} ) ( \text{H} ) ( \text{OH} ) ( \text{gly} )</td>
<td>Glycine</td>
<td>None</td>
</tr>
</tbody>
</table>

See page 1176

\( \* \) = essential amino acid

\( \* \) must inject; body cannot make

5. A \(-\) alkyl

\[ \text{H}_2\text{N} \] 
\[ \text{CH}_2 \text{OH} \] 
\[ \text{alanine} \] 
\[ \text{A} \] 

\[ \text{H}_2\text{N} \] 
\[ \text{CH}_3 \text{OH} \] 
\[ \text{valine} \] 
\[ \text{V} \] 

\[ \text{H}_2\text{N} \] 
\[ \text{CH}_2 \text{OH} \] 
\[ \text{leucine} \] 
\[ \text{L} \] 

\[ \text{H}_2\text{N} \] 
\[ \text{CH}_2 \text{COOH} \] 
\[ \text{isoleucine Ile} \] 
\[ \text{I} \]
<table>
<thead>
<tr>
<th>Structure</th>
<th>Name(s) / Codes</th>
<th>Stereochemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aromatics</td>
<td>Phenylalanine, Phe, F</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Tyrosine, Tyr, Y</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Histidine, His, H</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Tryptophan, Trp, W</td>
<td>S</td>
</tr>
<tr>
<td>Alcohols</td>
<td>Serine, Ser, S</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Threonine, Thr, T</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Cysteine, Cys, C</td>
<td>R (only one)</td>
</tr>
<tr>
<td></td>
<td>Methionine, Met, M</td>
<td>S</td>
</tr>
<tr>
<td>Sulfur-containing</td>
<td>Aspartic Acid, Asp, D</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Glutamic Acid, Glu, E</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Asparagine, ASN, N</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Glutamine, Glu, Q</td>
<td>S</td>
</tr>
</tbody>
</table>
### Amino Groups

<table>
<thead>
<tr>
<th>Lysine*</th>
<th>Lys</th>
<th>K</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arginine*</td>
<td>Arg</td>
<td>R</td>
<td>S</td>
</tr>
<tr>
<td>Proline*</td>
<td>Pro</td>
<td>P</td>
<td>S</td>
</tr>
</tbody>
</table>

### Protonation state vs pH

<table>
<thead>
<tr>
<th>pH</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2</td>
<td>Ammonium form</td>
</tr>
<tr>
<td>~7</td>
<td>Neutral form</td>
</tr>
<tr>
<td>&gt;9-10</td>
<td>Carboxylate form</td>
</tr>
</tbody>
</table>

### Synthesis of amino acids

#### a) Alkylation of ammonia

![Chemical reaction diagram]

#### b) General malonic ester synthesis

![Chemical reaction diagram]
Protein Structure

1. Primary structure
   Amino acid sequence

2. Secondary structure
   Local environment / fold
   (random coil, α-helix, β-sheet)

3. Tertiary structure
   Overall topology of protein
   fold at 3D structure
   (globular, etc.)

4. Quaternary structure
   Protein subunits
Notes on floating:
- Driven by hydrophobic effect
- Greasy (alkyl & aryl) side chains avoid water & are pushed to interior
- Polar residues stay on surface near water

Recall biological problems are mainly in aqueous environment.

Glycolate - I

from

Elastidium
acetobutylicum