

*Welcome to 3.091*

**Lecture 30**

**November 24, 2004**

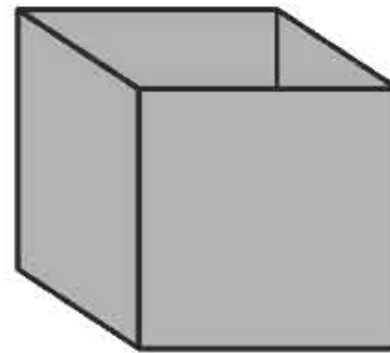
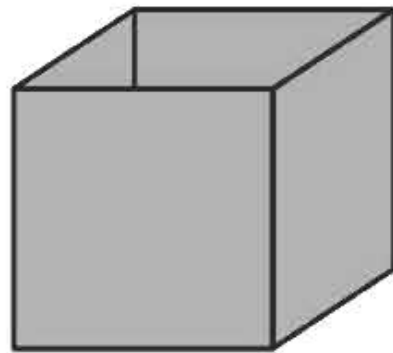
TABLE BIO.1 The 20 Standard Amino Acids

Name	Structure (at neutral pH)	Name	Structure (at neutral pH)
<b>Nonpolar (Hydrophobic) R Groups</b>		<b>Polar (Hydrophilic) R Groups</b>	
Glycine (Gly)	$\begin{array}{c} \text{H} \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$	Serine (Ser)	$\begin{array}{c} \text{CH}_2\text{OH} \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$
Alanine (Ala)	$\begin{array}{c} \text{CH}_3 \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$	Threonine (Thr)	$\begin{array}{c} \text{CH}_3 \quad \text{OH} \\ \diagdown \quad / \\ \text{CH} \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$
Valine (Val)	$\begin{array}{c} \text{CH}_3 \quad \text{CH}_3 \\ \diagdown \quad / \\ \text{CH} \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$	Tyrosine (Tyr)	$\begin{array}{c} \text{OH} \\   \\ \text{C}_6\text{H}_4 \\   \\ \text{CH}_2 \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$
Leucine (Leu)	$\begin{array}{c} \text{CH}_3 \quad \text{CH}_3 \\ \diagdown \quad / \\ \text{CH} \\   \\ \text{CH}_2 \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$	Cysteine (Cys)	$\begin{array}{c} \text{CH}_2\text{SH} \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$
Isoleucine (Ile)	$\begin{array}{c} \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \\   \\ \text{H}_2\text{C} - \text{CH}_2 \\   \quad   \\ \text{H}_2\text{C} \quad \text{CH} \\ \diagup \quad \diagdown \\ \text{N} \quad \text{CO}_2^- \\   \quad   \\ \text{H} \quad \text{H} \end{array}$	Asparagine (Asn)	$\begin{array}{c} \text{O} \\    \\ \text{C} - \text{NH}_2 \\   \\ \text{CH}_2 \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$
Proline (Pro)	$\begin{array}{c} \text{CH}_3 \\   \\ \text{S} \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$	Glutamine (Gln)	$\begin{array}{c} \text{O} \\    \\ \text{C} - \text{NH}_2 \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$
Methionine (Met)	$\begin{array}{c} \text{C}_6\text{H}_5 \\   \\ \text{CH}_2 \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$	<b>Negatively Charged R Groups</b>	
Phenylalanine (Phe)	$\begin{array}{c} \text{C}_6\text{H}_5 \\   \\ \text{CH}_2 \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$	Aspartic acid (Asp)	$\begin{array}{c} \text{CO}_2^- \\   \\ \text{CH}_2 \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$
Tryptophan (Trp)	$\begin{array}{c} \text{C}_8\text{H}_6\text{N} \\   \\ \text{CH}_2 \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$	Glutamic acid (Glu)	$\begin{array}{c} \text{CO}_2^- \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 \\   \\ \text{H}_3\text{N}^+ - \text{CH} - \text{CO}_2^- \end{array}$

(continued)

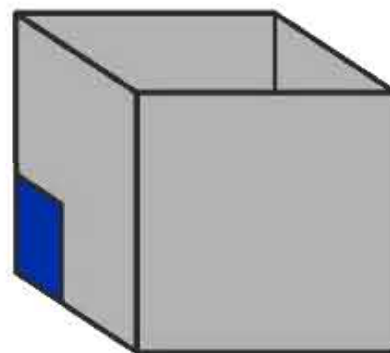
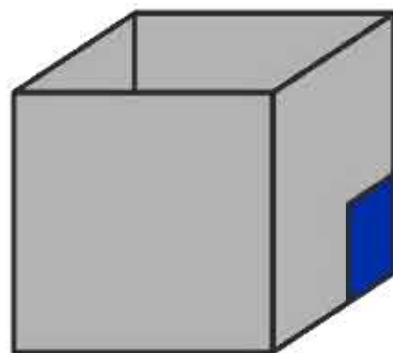
<i>Name</i>	<i>Structure (at neutral pH)</i>	<i>Name</i>	<i>Structure (at neutral pH)</i>
<b>Positively Charged R Groups</b>		<b>Positively Charged R Groups</b>	
Arginine (Arg)	$  \begin{array}{c}  \text{NH}_2 \\    \\  \text{C}=\text{NH}_2^+ \\    \\  \text{NH} \\    \\  \text{CH}_2 \\    \\  \text{CH}_2 \\    \\  \text{CH}_2 \\    \\  \text{H}_3\text{N}^+-\text{CH}-\text{CO}_2^-  \end{array}  $	Lysine (Lys)	$  \begin{array}{c}  \text{NH}_3^+ \\    \\  \text{CH}_2 \\    \\  \text{CH}_2 \\    \\  \text{CH}_2 \\    \\  \text{CH}_2 \\    \\  \text{H}_3\text{N}^+-\text{CH}-\text{CO}_2^-  \end{array}  $
		Histidine (His)	$  \begin{array}{c}  \text{H} \\    \\  \text{H}-\text{C}=\text{N}^+-\text{H} \\    \\  \text{N}-\text{H} \\    \\  \text{CH}_2 \\    \\  \text{H}_3\text{N}^+-\text{CH}-\text{CO}_2^-  \end{array}  $

Mirror



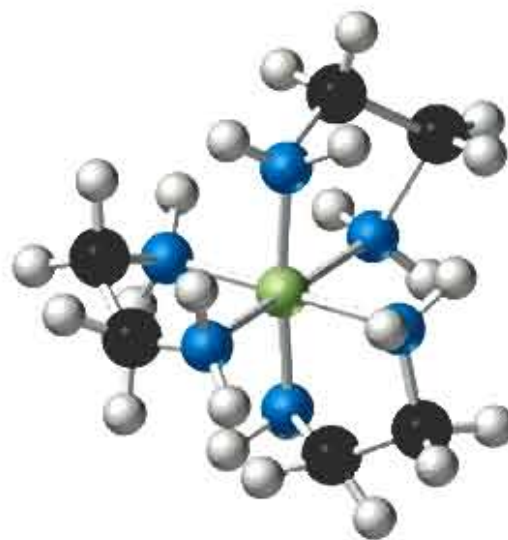
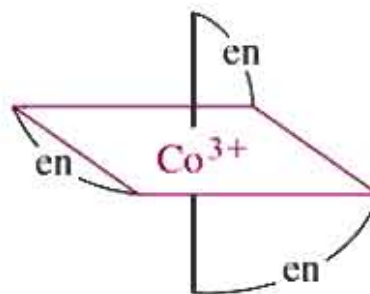
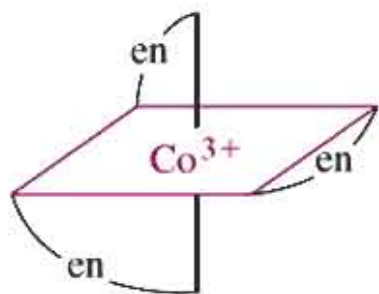
(a)

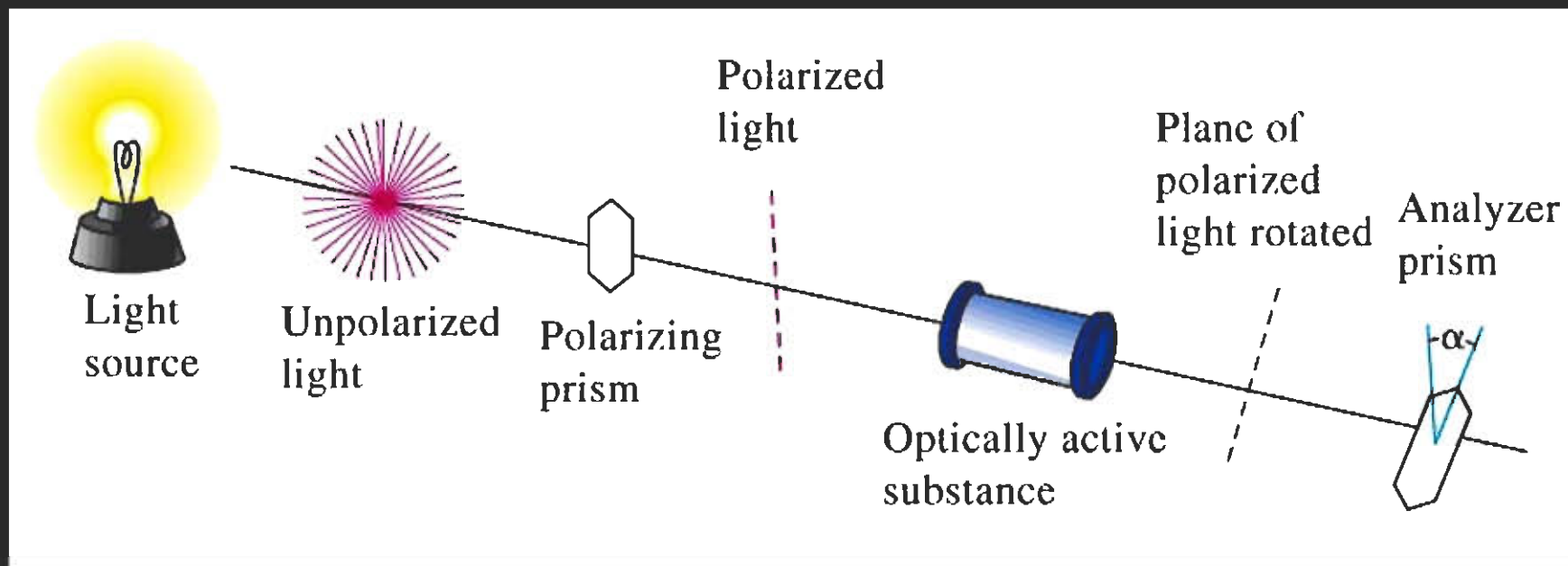
Mirror



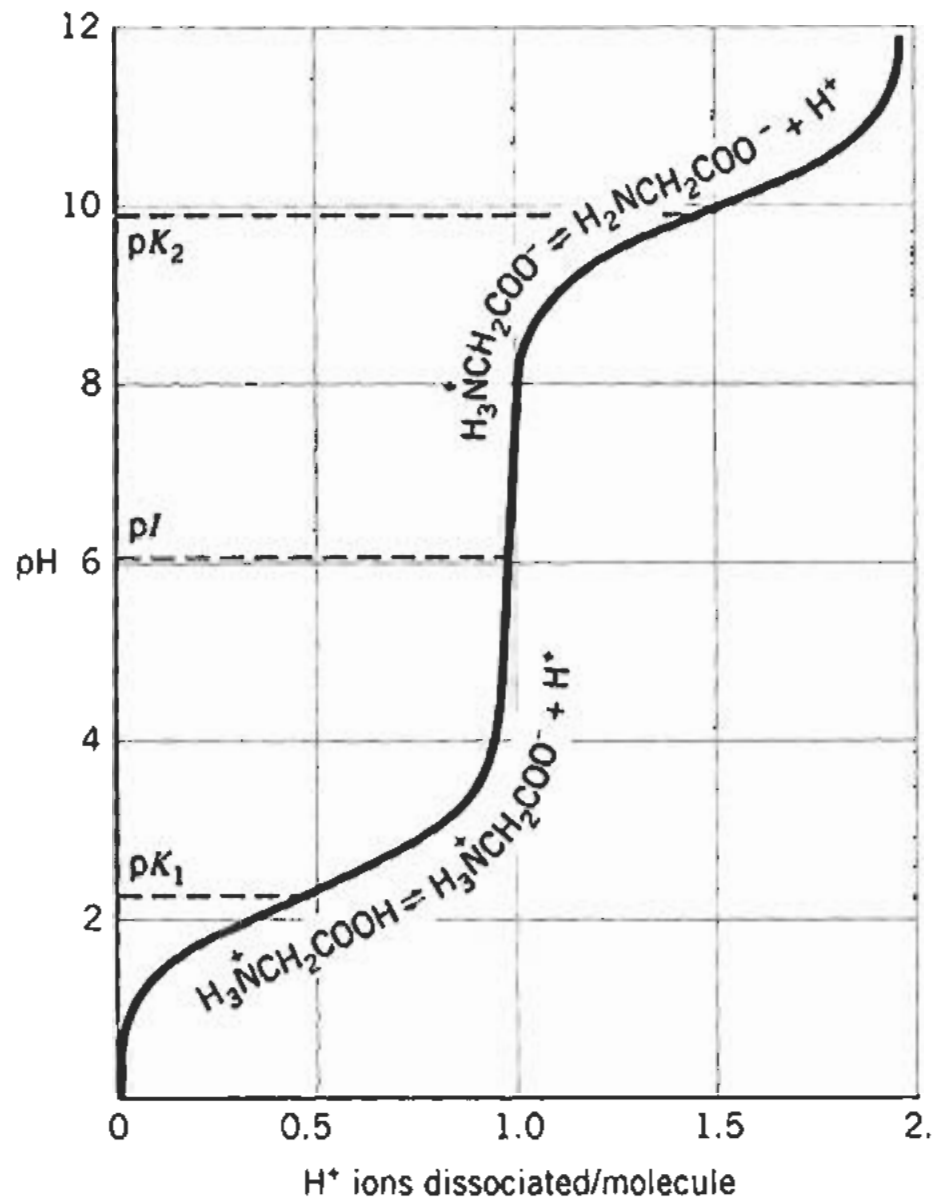
(b)

Mirror






$\alpha \propto$  ① conc. of chiral species  
 ② path length through same



*glycine*  
*R = H*

# extreme kinetics: the Halifax Explosion

- \* Thursday, December 6, 1917
- \* *Imo*, Belgian, relief ship
- \* *Mont Blanc*, French, supply ship:
  - 35 tons benzol
  - 300 rounds ammunition
  - 10 tons gun cotton
  - 2,300 tons picric acid (used in explosives)
  - 20,000 tons TNT 
- \* at 8:45 a.m. *Imo* hits *Mont Blanc*, missing TNT, striking picric acid stored directly beneath drums of benzol on deck, sparks