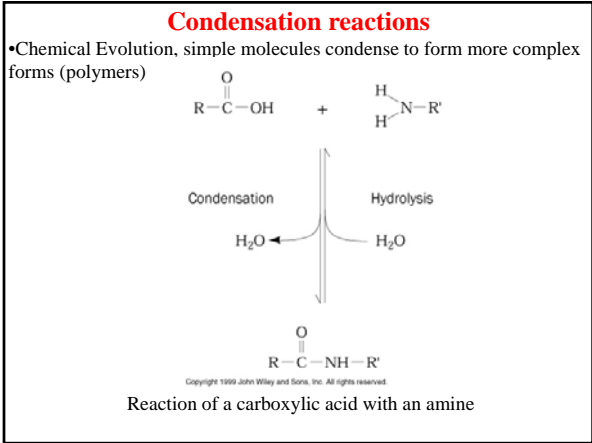


**University of Houston**  
**BCHS 3304: General Biochemistry I - Fall 2008**  
**Section 12697**  
**Tuesday/Thursday 11:30 AM – 1:00 PM 102 SW**

**Exam 1 Overview**

Compound Name	Structure*	Functional Group or Linkage
Alcohol	R-OH or R <sub>2</sub> NH R <sub>2</sub> NH or R <sub>3</sub> NH	-OH (hydroxyl group) -NH- (secondary amine group) -NR <sub>2</sub> (tertiary amine group)
Aldehyde	R-CHO	-CHO (aldehyde group)
Thiol	R-SH	-SH (sulfhydryl group)
Ester	R-COOR	-COO- (ester linkage)
Alkyl halide	R-X	-X (halogen group)
Ketone	R-CO-R	-CO- (carbonyl group)
Carboxylic acid†	R-COOH or R-COO <sup>-</sup>	-COOH (carboxyl group) or -COO <sup>-</sup> (carboxylate group)
Amine	R-NH <sub>2</sub> R <sub>2</sub> NH R <sub>3</sub> N	-NH <sub>2</sub> (primary amine group) -NH- (secondary amine group) -NR <sub>2</sub> (tertiary amine group)
Amide	R-CO-NH <sub>2</sub> R-CO-NH-R'	-CONH <sub>2</sub> (amide group) -CONH-R' (amide group)
Imine (Schiff base)†	R <sub>2</sub> C=NR R <sub>2</sub> C=N-R	>C=N- (imine group)
Disulfide	R-S-S-R	-S-S- (disulfide linkage)
Phosphate ester†	R-O-PO <sub>3</sub> <sup>n-</sup>	-O-PO <sub>3</sub> <sup>n-</sup> (phosphate group)
Diphosphate ester†	R-O-PO <sub>2</sub> -O-PO <sub>3</sub> <sup>n-</sup>	-O-PO <sub>2</sub> -O-PO <sub>3</sub> <sup>n-</sup> (pyrophosphate group)
Phosphate diester†	R-O-PO <sub>2</sub> -O-R'	-O-PO <sub>2</sub> -O- (phosphodiester linkage)

\*R represents any carbon-containing group in a molecule with more than one R group, the group may be the same or different.  
†These phosphorylated molecules have groups not covered and hence have a positive or negative charge.  
‡Indicated by an asterisk after their names.



**Replication through complementarity**

- Specific pairing of functional groups gives rise to complementarity
- More complex molecules increases chemical versatility
- Complementarity makes it possible for macromolecules to replicate
- Over time natural selection favored molecules that made accurate copies of themselves

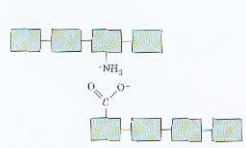


Figure 1-4. Association of complementary molecules.

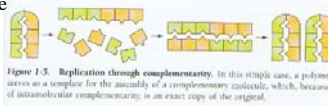


Figure 1-5. Replication through complementarity. In this simple case, a polymer serves as a template for the assembly of a complementary molecule, which, because of intramolecular complementarity, is an exact copy of the original.

**Gibb's Free Energy**

- Is a state function (a property of a system that depends only on the current state of the system *and not its history*)
- Gibb's Free Energy is determined at constant **T** and **P**:

$$G = H - TS$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

- The **Gibbs free energy (G)** of a **system** is defined by an **enthalpy term (H)** (change of the total energy with the system), and the **entropy term (S)** (change in the disorder) at **temperature (T)**

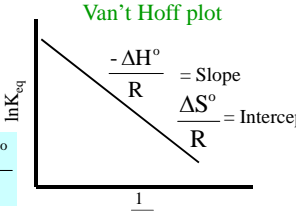
**The van't Hoff Relationship**

- Methodology of finding  $\Delta H$  and  $\Delta S$  from experimental data.

$$\ln K_{eq} = -\frac{\Delta G^\circ}{RT} = -\left(\frac{\Delta H^\circ - T\Delta S^\circ}{RT}\right)$$

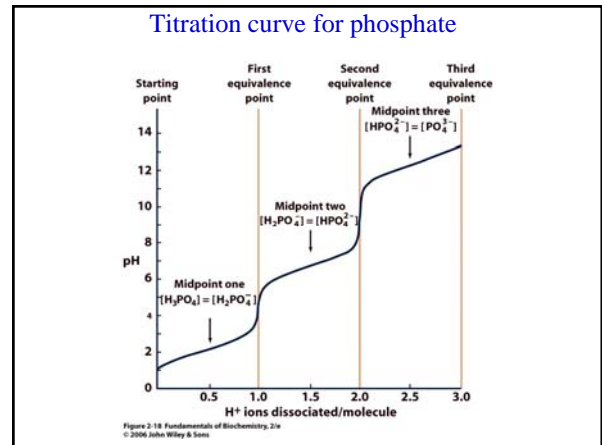
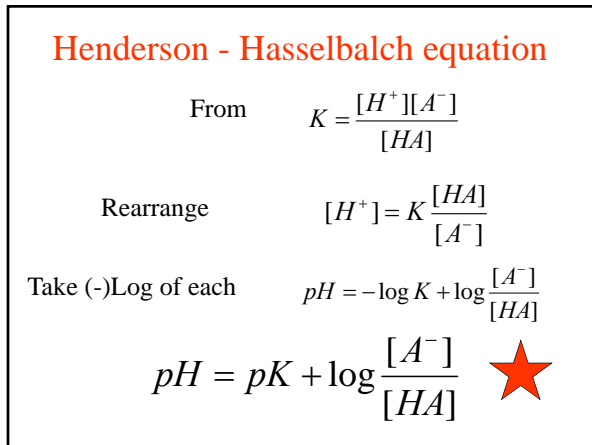
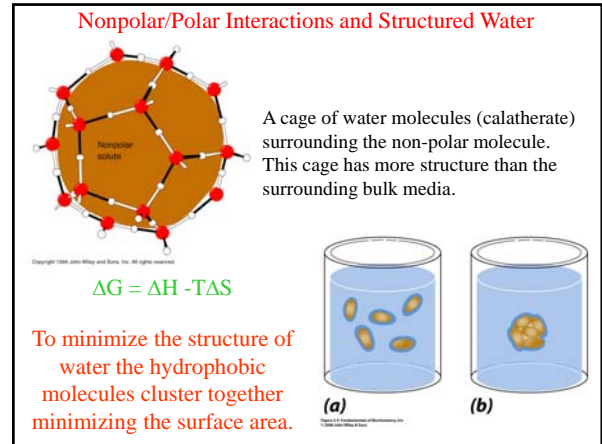
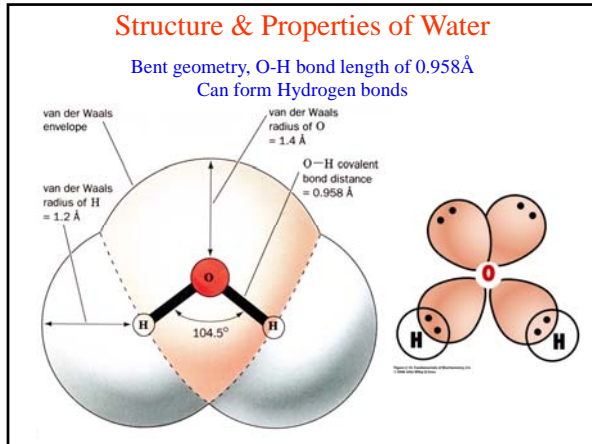
$$\ln K_{eq} = \frac{1}{R}\left(\Delta S^\circ - \frac{\Delta H^\circ}{T}\right)$$

**Van't Hoff plot**



$-\frac{\Delta H^\circ}{R} = \text{Slope}$   
 $\frac{\Delta S^\circ}{R} = \text{Intercept}$

$$\ln K_{eq} = \frac{-\Delta H^\circ}{R} \left(\frac{1}{T}\right) + \frac{\Delta S^\circ}{R}$$



### Key to structure (1)

Name, Three-letter Symbol, and One-letter Symbol	Structural Formula	Residue Mass (Da)	Average Occurrence in Proteins (%)	pKa α-COOH*	pKa α-NH3+	pKa Side Chain*
<b>Amino acids with uncharged side chains</b>						
Glycine	COO <sup>-</sup>	57.8	7.2	2.35	9.78	
Ala	H-C(H)-R	71.1	7.6	2.35	9.67	
Val	COO <sup>-</sup>   H-C(H)-CH(CH <sub>3</sub> )	99.1	6.6	2.29	9.74	
Leu	COO <sup>-</sup>   H-C(H)-CH <sub>2</sub> -CH(CH <sub>3</sub> )	113.2	9.1	2.33	9.74	
Ile	COO <sup>-</sup>   H-C(H)-CH(CH <sub>3</sub> )-CH <sub>2</sub> -CH <sub>3</sub>	132.2	5.3	2.32	9.76	
Met	COO <sup>-</sup>   H-C(H)-CH <sub>2</sub> -CH <sub>2</sub> -S-CH <sub>3</sub>	147.2	2.2	2.10	9.28	
Pro	COO <sup>-</sup>   H-C(H)-CH <sub>2</sub> -NH-CH <sub>3</sub>	97.1	3.2	1.95	10.64	
Pha	COO <sup>-</sup>   H-C(H)-CH <sub>2</sub> -CH <sub>2</sub> -Ph	147.2	3.9	2.20	9.31	
Tyr	COO <sup>-</sup>   H-C(H)-CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> -Ph	180.2	1.4	2.46	9.41	

### (2)

Name, Three-letter Symbol, and One-letter Symbol	Structural Formula	Residue Mass (Da)	Average Occurrence in Proteins (%)	pKa α-COOH*	pKa α-NH3+	pKa Side Chain*
<b>Amino acids with uncharged polar side chains</b>						
Ser	COO <sup>-</sup>   H-C(H)-CH <sub>2</sub> -OH	87.1	6.8	2.19	9.21	
Thr	COO <sup>-</sup>   H-C(H)-CH(CH <sub>3</sub> )-OH	101.1	5.9	2.09	9.10	
Asp	COO <sup>-</sup>   H-C(H)-CH <sub>2</sub> -COO <sup>-</sup>	114.1	4.3	7.14	8.77	
Glu	COO <sup>-</sup>   H-C(H)-CH <sub>2</sub> -CH <sub>2</sub> -COO <sup>-</sup>	128.1	4.3	2.17	9.13	
Tyr	COO <sup>-</sup>   H-C(H)-CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> -Ph	180.2	3.2	2.20	9.21	10.46 (phenol)
Cys	COO <sup>-</sup>   H-C(H)-CH <sub>2</sub> -SH	133.1	1.9	1.92	10.70	8.37 (sulfhydryl)

(3)

	Name, Three-letter Symbol, and One-letter Symbol	Structural Formula <sup>a</sup>	Residue Mass (Da) <sup>b</sup>	Average Occurrence in Proteins (%) <sup>c</sup>	pK <sub>a</sub> of COOH <sup>d</sup>	pK <sub>a</sub> of NH <sub>2</sub> <sup>e</sup>	pI <sub>iso</sub> (iso Charge) <sup>f</sup>
K	<b>Amino acids with charged polar side chains</b>						
	Lysine	CH <sub>2</sub> <sup>+</sup>	146.2	5.9	2.14	9.06	10.54 (α-NH <sub>2</sub> )
	Arginine	CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> -NH <sub>2</sub> <sup>+</sup>	174.2	5.1	1.82	8.99	12.48 (guanidino)
R	<b>Amino acids with uncharged polar side chains</b>						
	Asparagine	CH <sub>2</sub> -CONH <sub>2</sub>	132.1	2.3	1.88	8.33	6.04 (imidic)
	Glutamine	CH <sub>2</sub> -CH <sub>2</sub> -CONH <sub>2</sub>	146.2	2.3	1.89	9.00	5.90 (p-COOH)
H	<b>Amino acids with nonpolar side chains</b>						
	Alanine	CH <sub>3</sub>	89.1	6.7	2.10	9.41	4.01 (γ-OH)
	Valine	CH(CH <sub>3</sub> ) <sub>2</sub>	99.1	6.7	2.10	9.41	4.01 (γ-OH)

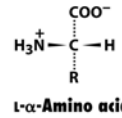
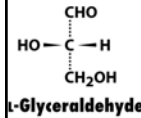
## The Fischer Convention

Absolute configuration about an asymmetric carbon

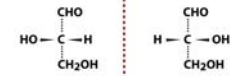
related to glyceraldehyde

(+) = D-Glyceraldehyde

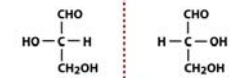
(-) = L-Glyceraldehyde



**Geometric formulas**

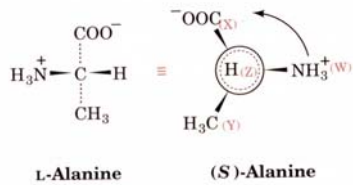
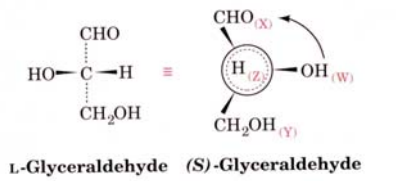


**Fischer projection**



**Mirror plane**

**L-Glyceraldehyde D-Glyceraldehyde**



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
H <sub>3</sub> N <sup>+</sup>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
															-COO <sup>-</sup>
															<b>A-T</b>
															<b>F-M-A-T</b>
															<b>A-K-F-M</b>
															<b>Q-M-A-K</b>
															<b>D-I-K-Q-M</b>
															<b>G-M-D-I-K</b>
															<b>Y-R-G-M</b>
															<b>Y-R</b>

Cyanogen Bromide (CNBr) Cleaves after Met i.e M - X  
**D-I-K-Q-M**  
**A-T**  
**A-K-F-M**  
**Y-R-G-M**

Trypsin cleaves after K or R (positively charged amino acids)  
**Q-M-A-K**  
**G-M-D-I-K**  
**F-M-A-T**  
**Y-R**