January 25, 2002

- **Problem Set Solutions:**
  - Chapters 9 and 11 now online
  - Chapter 15 coming soon!
- **Weekly Problem Session:**
  - Monday, 3-4 pm, A531 Cook
  - *Email me with suggested problems*
- **Quiz today!**

1

Dissolution Energetics

- Three Steps:

1) Overcome *SOLUTE* intermolecular forces (ΔH_1)
2) Overcome *SOLVENT* intermolecular forces (ΔH_2)
3) Allow *solute* and *solvent* to interact (ΔH_3)

$$\Delta H_{soln} = \Delta H_1 + \Delta H_2 + \Delta H_3$$

Hypothesis: If $\Delta H_{soln} > 0$, then solute is *not* soluble

If $\Delta H_{soln} < 0$, then solute is soluble

2

Is Oil *Miscible* in Water?

Oil: *Nonpolar* (London Forces)

Water: *Polar* (Hydrogen Bonding)

Oil/Water: *Nonpolar/Polar* (Dipole-Induced Dipole)

So: $\Delta H_1 + \Delta H_2$ = *large (+)*

ΔH_3 = *very small (-)*

$\Delta H_{sol'n}$ = ***Large (+)*** (> 0)

✓Thus: oil and water are NOT miscible

3

Is Methyl Alcohol *Miscible* in Water?

Methyl Alcohol: *Polar* (Hydrogen Bonding)

Water: *Polar* (Hydrogen Bonding)

Alcohol/Water: *Polar/Polar* (Hydrogen Bonding)

So: $\Delta H_1 + \Delta H_2$ = *large (+)*

ΔH_3 = *large(-)*

$\Delta H_{sol'n}$ = ***small (+/-)***

? Why *is* methyl alcohol miscible in water?

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Will NaCl Dissolve In Water?

NaCl(s): *Strong Ionic Bond*

$NaCl(s) \rightarrow Na^+(g) + Cl^-(g)$ $\Delta H_1 = 786$ kJ/mol

H_2O and NaCl/H_2O: *Ion-Dipole/H-Bonding*

$H_2O(l) + Na^+(g) + Cl^-(g) \rightarrow Na^+(aq) + Cl^-(aq)$

$\Delta H_{hyd} = \Delta H_2 + \Delta H_3 = -783$ kJ/mol

So: $\Delta H_{sol'n} = 786 + (-783) =$ ***+3 kJ/mol***

? So *why* does NaCl dissolve in water?

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Enter: *Entropy*

- "Nature favors disorder"
- *Processes which increase disorder tend to be favored* (spontaneous)

$NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$ *increased disorder*

- Since ΔH_{soln} is very small, process is said to be:

Entropically-Driven

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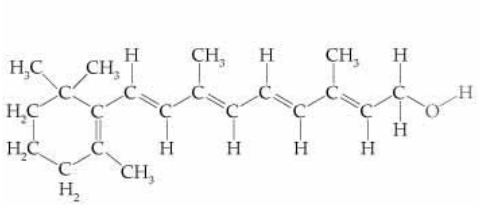
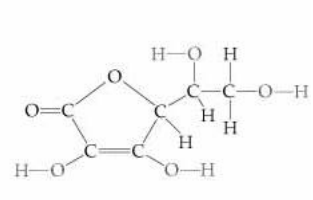
Structure and Solubility

- If solute and solvent *IM Forces* are very different:
  not soluble
- If solute and solvent *IM Forces* are similar:
  soluble
- "Like dissolves like"



Vitamin A



Vitamin C

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