### **Solubility in Biological Systems**



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### Solubility

Generally refers to a solid in a liquid

 $K_{sp}$  = equilibrium relationship between solid and its constituent ions in Solution.

 $K_{sp}$  = value whereby a solute dissolves in solution

aA = bB + cC

 $K_{sp} = [B]^{b}[C]^{c}$ 



# Miscibility

Property of substances to completely mix



$$K_i = []_{Organic} / []_{Water}$$



"K<sub>sp</sub> Problems"

Calculate the approximate concentration of lithium ions when lithium phosphate reaches its molar solubility ( $K_{sp} = 2.7 \times 10^{-9}$  at 25°C).

 $Li_3(PO_4) \rightarrow 3Li + PO_4$  Phosphate has a -3 charge K<sub>sp</sub> = [Li]<sup>3</sup>[PO<sub>4</sub>] Solubility Product Constant  $2.7 \times 10^{-9} = [3Li]^3 [PO_4]$  $x = 3.0 \times 10^{-3}$  $3x = 9.0 \times 10^{-3}$  $2.7 \times 10^{-9} = [3x]^{3}[x]$  $[Li^{+1}] = 3X!!$  $2.7 \times 10^{-9} = [27x]^4$  $1.0 \times 10^{-2} = [Li]$  $0.1 \times 10^{-9} = x^4 = 1.0 \times 10^{-10}$  $x = \sqrt{1} x \sqrt{10^{-10}}$  $x = 1.0 X 10^{-2.5}$ 

#### **The Common Ion Effect**



How does the addition of NaCl change the solution?



#### **The Common Ion Effect**



Chloride is the common ion: Addition of NaCl will push the equilibrium to the left.

Common Ion Effect: Decrease in solubility; Le Chatelier's Principle



**Solubility Rules** 

Group I Salts: Na<sup>+</sup>, K<sup>+</sup>, Li<sup>+</sup> Soluble Nitrates: soluble

Salts containing Cl<sup>-</sup> l<sup>-</sup>, and Br<sup>-</sup> are generally soluble

Silver salts: generally insoluble

 $Ca_3(PO_4)_2$  insoluble



Calcium phosphate is insoluble in water ( $K_{sp} = 10^{-33}$ ).

Parathyroid hormone (PTH) promotes absorption of Ca<sup>+2</sup> and secretion of  $PO_4^{-3}$  from the kidneys. Indeed, the parathyroid hormone (PTH) is also known as the "Phosphate Trashing Hormone"





Which of the following graphs describes the relationship between serum levels of phosphate (HPO<sub>4</sub><sup>-</sup>) and ionized calcium (Ca<sup>+2</sup>)?





### Like Dissolves Like: The Hydrophobic Effect



Less ordered Water structure; More entropy More ordered Water structure; Less entropy



### **Solubility of Gases in Solution**

## Henry's Law:

The amount of gas dissolved in a liquid is directly proportional to its partial pressure above the liquid.

#### **S** = **KP**

where S = the solubility of the gas, P = the pressure, and K = Henry's constant.



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#### Effervescence: escape of gas from a liquid



### **Free Floating Drug Delivery**





Carbonate + Acid =  $CO_2$ 

#### **Formation of Micelles**





#### **Biological Transport**



### **Recycling of Bile Salts**



#### **Bile Salts & Micelles**



#### **Solubility & Jaundice**



Excretion



#### **Solubility & Jaundice**





#### **Solubility & Jaundice**





### **Uric Acid & Gout**









### 1. Bile Salts & Gallstones

### 2. Medical Marijuana in Glaucoma

## 3. Uric Acid & Gout



#### **Workshop Passages**

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