Water, Electrolyte & Acid-base balance

ECF – ICF
Vital ions
Buffers
ECF & ICF

- **ECF**: Extra-cellular fluid
  - No separation between ECF & plasma
- **ICF**: Intra-cellular fluid

Under normal conditions, fluid volume changes in one chamber produce compensatory changes in the other to equilibrate solute concentrations.
Distribution of ions in ECF & ICF

**CATIONS**

- ECF
  - Plasma: Na⁺, K⁺, Ca²⁺
  - Interstitial fluid: Na⁺, K⁺, Mg²⁺
  - Intracellular fluid: K⁺

- ICF
  - Plasma: Na⁺, K⁺, Ca²⁺
  - Interstitial fluid: Na⁺, K⁺, Mg²⁺
  - Intracellular fluid: K⁺

**ANIONS**

- ECF
  - Plasma: HCO₃⁻, Cl⁻, HPO₄²⁻, SO₄²⁻, Proteins
  - Interstitial fluid: HCO₃⁻, Cl⁻, HPO₄²⁻, SO₄²⁻, Proteins
  - Intracellular fluid: HCO₃⁻, Cl⁻, HPO₄²⁻, SO₄²⁻, Proteins

- ICF
  - Plasma: HCO₃⁻, Cl⁻, HPO₄²⁻, SO₄²⁻, Proteins
  - Interstitial fluid: HCO₃⁻, Cl⁻, HPO₄²⁻, SO₄²⁻, Proteins
  - Intracellular fluid: HCO₃⁻, Cl⁻, HPO₄²⁻, SO₄²⁻, Proteins

© 2012 Pearson Education, Inc.
Hormonal mechanisms of fluid & ion balance

- **Aldosterone**
  - Stimulus?
  - Secreted from?

- **ADH**
  - Stimulus?
  - Secreted from?

- Are these hormones responding to changes in the ECF or the ICF?
- Imagine that Na⁺ concentration increase:
  - Which way will fluids shift?
  - Which hormone will be secreted to correct fluid shift?
Preventing pH changes

- Transporting & eliminating H\(^+\) produced by normal cellular activities

**Buffer Systems**

- **Intracellular fluid (ICF)**
  - **Phosphate Buffer System**
    - The phosphate buffer system has an important role in buffering the pH of the ICF and of urine.
  - **Protein Buffer Systems**
  - **Carbonic Acid-Bicarbonate Buffer System**

- **Extracellular fluid (ECF)**
  - **Protein Buffer Systems**
    - Protein buffer systems contribute to the regulation of pH in the ECF and ICF. These buffer systems interact extensively with the other two buffer systems.
  - **Carbonic Acid-Bicarbonate Buffer System**
    - The carbonic acid-bicarbonate buffer system is most important in the ECF.
Protein buffer system

- Amino acids act as weak acids and weak bases, absorbing or releasing $H^+$ as needed.
Buffering against acidification

- Bicarbonate reserve buffers H⁺ accumulation

![Diagram](image.png)

(a) Basic components of the carbonic acid–bicarbonate buffer system, and their relationships to carbon dioxide and the bicarbonate reserve

(b) The response of the carbonic acid–bicarbonate buffer system to hydrogen ions generated by fixed or organic acids in body fluids
Eliminating H⁺

- **Respiratory compensation**
  - Increased respiratory rate increases CO₂ expulsion @ lungs
  - Increased CO₂ expulsion decreases H⁺ concentration

- **Mechanisms:**
  - Chemoreceptors measuring CO₂.

- **Renal compensation**
  - Increased secretion of H⁺ ions into filtrate