Fluid, Electrolyte, and Acid-Base Homeostasis

- Edema – review discussion from capillary exchange as to causes

- Electrolyte Balance – usually pertains to salts in the body – most important

  Sodium

  Potassium

  Calcium
Fluid, Electrolyte, and Acid-Base Homeostasis

- Central Role of Sodium in the Body and Fluid and Electrolyte Balance
  - Involved in
    - Impulse transmission
    - Muscle contraction
    - Creates most of the osmotic pressure in the extracellular fluid
  - Average daily intake far greater than required, kidneys excrete the excess
  - Levels in blood regulated by
    - Aldosterone
    - Antrial Natriuretic Peptide (ANP)
    - Antidiuretic Hormone (ADH)
Fluid, Electrolyte, and Acid-Base Homeostasis

- ↓ Na⁺ or ↑ K⁺ concentration in blood plasma
- Renin-angiotensin mechanism
  - Stimulates
  - Adrenal cortex
    - Releases
    - Aldosterone
      - Targets
      - Kidney tubules
        - Effects
          - ↑ Na⁺ reabsorption
          - ↑ K⁺ secretion
            - Restores
            - Homeostatic plasma levels of Na⁺ and K⁺
Fluid, Electrolyte, and Acid-Base Homeostasis

- Regulation of Potassium Ions – most abundant cation in intracellular fluid
  - Involved in:
    - Maintaining fluid volume
    - Impulse conduction
    - Muscle contraction
    - Regulating pH
  - Regulated by:
    - Mostly aldosterone
  - Hyperkalemia – can cause death by inducing fibrillation
Fluid, Electrolyte, and Acid-Base Homeostasis

- Regulation of Calcium Ions – most abundant ion in the body, mostly extracellular in nature
  - Involved in:
    - Structural portion of bones and teeth
    - Blood coagulation
    - Maintenance of muscle tone
    - Excitability of nervous and muscle tissue
  - Regulated by:
    - Parathyroid Hormone (PTH, Parathormone)
    - Calcitonin (CT)
  - Hypocalcemia – causes
    - Increased calcium loss
    - Reduced calcium intake
    - Elevated levels of phosphate in blood
    - Impaired parathyroid function
  - Hypercalcemia – causes
    - Opposite of above
Fluid, Electrolyte, and Acid-Base Homeostasis

- Regulation of Anions
  - Cl⁻
    - Typically follows Na⁺
    - Aids in maintaining osmolarity of blood
    - During acidosis kidneys reabsorb more HCO₃⁻ (more in a bit) and excrete more Cl⁻
  - Most other anions have their own carrier molecules and as such demonstrate renal thresholds for reabsorption
Fluid, Electrolyte, and Acid-Base Homeostasis

Acid – Base Balance

Norma range 7.35 – 7.45

Alkalosis above 7.45
Acidosis below 7.35

• Chemical Buffer Systems
  
  – Resist a change in pH upon the addition of an acid or a base
  
  – Composed of a weak acid and a salt of that acid
Fluid, Electrolyte, and Acid-Base Homeostasis

- Bicarbonate Buffer System
  - Made up of
    - Carbonic acid and salt of carbonic acid (sodium bicarbonate)
      \[ \text{H}_2\text{CO}_3 \text{ and NaHCO}_3 \]
    - Very important in buffering the extracellular fluid

- Phosphate Buffer System
  - Made up of
    - Dihydrogen Phosphate and Monhydrogen Phosphate
      \[ \text{NaH}_2\text{PO}_4 \text{ and Na}_2\text{HPO}_4 \]
    - Very important intracellular buffer
Fluid, Electrolyte, and Acid-Base Homeostasis

- Protein Buffer System
  - Are amphoteric – one end can act like a base and the other an acid
  - Example – Hb as discussed earlier with the chloride shift

- Respiratory Regulation of H⁺
  - Respiratory acidosis
  - Respiratory alkalosis
Fluid, Electrolyte, and Acid-Base Homeostasis

• Renal Mechanisms of Acid-Base Balance – used to remove fixed (metabolic) acids [lactic acid, ketone bodies, etc.]

  – Involves

  • Secretion of $\text{H}^+$

  • Regeneration of $\text{HCO}_3^-$
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- Abnormalities of Acid-Base Balance
  - Respiratory Acidosis and Alkalosis
  - Metabolic Acidosis and Alkalosis
  - Normal Values
    - pH 7.35 – 7.45
    - $P_{CO_2}$ 35 – 45 mmHg
    - $HCO_3^-$ 22 -26 mEq/L
Fluid, Electrolyte, and Acid-Base Homeostasis

• Problem Solving

  – Patient 1 Values

    • pH 7.5
    • $P_{CO_2}$ 24 mmHg
    • $HCO_3^-$ 18 mEq/L

  – Patient 2 Values

    • pH 7.48
    • $P_{CO_2}$ 46
    • $HCO_3^-$ mEq/L