BODY FLUIDS
- Intracellular Fluids (ICF) 70%
- Extracellular Fluids (ECF) 30%
  - Interstitial Fluid 25%
  - Intravascular Fluid 5%
  - Transcellular Fluid (fluids secreted by epithelial cells e.g. digestive juices, pleural fluid, CSF)

Body Water distribution varies with age and sex:
- Infants – 80% of body weight
- Male – 60% of body weight
- Female – 50% of body weight

Functions of BODY WATER:
- Maintenance of Normal Body Temperature
- Elimination of Waste Products
  - ECF (Extracellular Fluids)
    - Maintains blood volume in the body
    - Transport system of nutrients and waste products to and from the cells
  - ICF (Intracellular Fluid)
    - Internal aqueous medium for cellular chemical function

Normal Fluid Intake and Loss in Adults
- INTAKE
  - Water in Food 1000 mL
  - Water in Oxidation 300 mL
  - Water as Liquid 1,200 mL
  - Total 2,500 mL
- OUTPUT
  - Skin 500 mL
  - Lungs 300 mL
  - Feces 150 mL
  - Kidneys 1,500 mL
  - Total 2,500 mL

ELECTROLYTES
What are electrolytes?
- These are chemical compounds in solution that have the ability to conduct an electrical current
- They break into charged particles called ions. Ions may be positively charged (Cations) or negatively charged (Anions).
- Major electrolytes found on the ECF:
  - Cation : Sodium (Na)
  - Anion : Chloride (Cl)
- Major electrolytes found on the ICF:
  - Cation : Potassium (K)
  - Anion : Phosphate (HPO₄²⁻)

Functions of Electrolytes
- Promote neuromuscular irritability by allowing impulse transmission through nerves of the afferent and efferent nervous system
- Maintaining normal body fluid volume and osmolality
- Distribute body fluids between fluid compartments
- Regulate acid-base balance

Normal Laboratory Values for Electrolytes:
- Na  Sodium  135-145 mEq/L
- K  Potassium  3.5-5 mEq/L
- Ca  Calcium  4.5-5.5 mEq/L
- HPO₄²⁻  Phosphate  1.7-2.6 mEq/L
- Cl  Chloride  98-108 mEq/L
- Mg  Magnesium  1.5-2.5 mEq/L

How does my Body regulate water and electrolytes?
Sodium and Water
- Thirst Reflex: the major control of actual fluid intake
- The Osmolality of body fluids depends predominantly on Na and its associate anions
  - OSMOLALITY : an expression of concentration of solution in terms of 1000g of water
  - OSMOLARITY : an expression of concentration of solution in terms of 1000mL of water
- ANTIDIURETIC HORMONE:
  - Activated whenever body fluid levels are severely decreased
  - Promotes increased water reabsorption in the distal
convoluted tubules and collecting ducts

- **RENIN-ANGIOTENSIN ALDOSTERONE MECHANISM**
  - Causes activation of Angiotensin II that causes release of Aldosterone
  - Aldosterone causes reabsorption of Sodium; Sodium causes passive reabsorption of water in the distal convoluted tubules of the kidneys

### How does Fluid move Between Compartments?

**EXTRACELLULAR FLUID ↔ INTRACELLULAR FLUID**

- Passive Transport
  - **DIFFUSION**: transport of solutes from an area of higher concentration to an area of lower concentration across a semi-permeable membrane
  - **OSMOSIS**: transport of solvent from an area of lower concentration to an area of higher concentration across a semi-permeable membrane

- Active Transport

**INTRAVASCULAR SPACE ↔ INTERSTITIAL SPACES**

- **HYDROSTATIC PRESSURE**: caused by the blood pressing against the walls of blood vessels. It has “pushing” force
- **COLLOID ONCOTIC PRESSURE**: pull or absorption of water from the ICS to the IVS due to CHON

### What are examples of Water Imbalances?

- Fluids balance depends largely on Na concentration and its anions CL and HCO3
- Disturbances in Osmolality occurs when the ration of water and sodium is changed
  - **HYPEROSMOLAR IMBALANCES**: Na or solutes are greater compared to water
    - Water deficit
    - Na/ Solute excess
  - **HYPOOSMOLAR IMBALANCES**: Na or solutes are lesser compared to water
    - Water excess
    - Na Deficit

### INTRAVENOUS THERAPY

Many of the problems associated with alterations in fluids and electrolytes require intravenous therapy.

Intravenous therapy is the giving of substances directly into a vein.

Substances that may be infused intravenously include volume expanders, blood-based products, blood substitutes, medications.

*(see separate copy of list of Intravenous fluids and their properties)*

### COMMON ELECTROLYTE SUPPLEMENTS

Note that Medications that act as electrolyte supplements simply mimic the naturally occurring electrolytes in the body.

**Remember the following Relationships among Electrolytes:**

- Sodium and Potassium are inversely proportional
- Phosphorus and Calcium are inversely proportional
- Calcium and Magnesium are inversely proportional

**SODIUM**
- The major ECF electrolyte that acts together with Chloride in the regulation of fluid levels in the body
- Is inversely proportional to the electrolyte potassium
**POTASSIUM**
- The major ICF cation and regulates intracellular osmolality
- Is inversely proportional to the electrolye Sodium
- Important in the conduction of nerve impulses and promotion of proper skeletal and cardiac muscle activity

**SODIUM**
- Important in the conduction of nerve impulses and promotion of proper skeletal and cardiac muscle activity

**CALCIUM**
- An electrolyte needed for blood coagulation, smooth and skeletal muscle function, nerve function and bone and teeth formation
- VITAMIN D: causes increased absorption of Calcium from GIT
- THYROCALTITONIN and PARATHYROID HORMONE

**MAGNESIUM**
- Magnesium is the fourth most abundant cation in the body and the second most abundant intracellular cation after potassium.
- Magnesium is involved in over 300 enzymatic reactions. It is needed in energy metabolism, glucose utilization, protein synthesis, fatty acid synthesis and breakdown and muscle contraction.

**Electrolyte supplements**

The major categories of electrolyte supplements are as follows:

- **Sports drinks.**
  - Most contain flavorings to mask the naturally salty or bitter taste of the electrolytes themselves.
  - Common brand names include eForce, NutriBiotic, and Endurolytes.
  - These products are regarded by the Food and Drug Administration (FDA) as dietary supplements.
  - **Dosage:** one scoopful (or prepackaged envelope) of powder dissolved in 12-16 ounces of water before exercising. Capsules may be taken as follows: 1-3 capsules

- **Over-the-counter electrolyte replenishers for children**
  - Include Pedialyte, Infalyte, Naturalyte, and Rehydralyte.
  - Most come in a powdered form to be mixed with water as well as liquid forms; Pedialyte is also available as fruit-flavored freezer pops.
  - **Dosage:** Children between the ages of 2 and 10 are given 23 mL of electrolyte solution per pound of body weight for the first four to six hours of treatment, followed by 45 mL per pound taken over the next 18-24 hours.

- **Oral rehydration formulae for children and adults.**
  - Oral rehydration salts, which are also known as ORS, have been a staple of treatment for cholera and other diseases accompanied by severe diarrhea in developing countries for almost half a century.
  - First researched in the 1940s, oral rehydration salts were adopted by the World Health Organization (WHO) in 1978 in order to reduce the risk of death from dehydration caused by cholera-related diarrhea.
  - The new formula is a low-glucose and low-sodium mixture.
  - If the WHO packets are unavailable, a comparable form of oral rehydration solution can be made by adding 8 tsp of table sugar, 1/2 tsp of salt, 1/2 tsp of baking soda (bicarbonate of soda), and 1/3 tsp of potassium chloride to a liter (1.05 quarts) of water.
should not be stored in damp places, as moisture can cause the contents to lose their effectiveness.

- **Multiple electrolyte injections.**
  - Various mixtures of electrolytes are available by prescription in injectable form to be added to enteral or parenteral nutrition formulae.
  - Some injectable formulae contain dextrose, a sugar, and acetate or lactate as well as the five major electrolytes.
  - Common brand names include Hyperlite, TPN Electrolytes, Lypholyte, Nutrilyte, Plasma-Lyte 148, and others.
# Intravenous Fluid

## Composition and Use of Commonly Prescribed Crystalloid Solutions

<table>
<thead>
<tr>
<th>SOLUTION</th>
<th>TONICITY</th>
<th>mOsm/Kg</th>
<th>GLUCOSE (g/L)</th>
<th>INDICATIONS AND CONSIDERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dextrose in Water</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>Isotonic</td>
<td>278</td>
<td>50</td>
<td>- Provides free water necessary for renal excretion of solutes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Used to replace water losses and treat hypernatremia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Provides 170 calories/L</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Does not provide any electrolytes</td>
</tr>
<tr>
<td>10%</td>
<td>Hypertonic</td>
<td>556</td>
<td>100</td>
<td>- Provides free water only; no electrolytes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Provides 340 calories/L</td>
</tr>
<tr>
<td><strong>Saline</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.45%</td>
<td>Hypotonic</td>
<td>154</td>
<td>0</td>
<td>- Provides free water in addition to Na⁺ and Cl⁻</td>
</tr>
<tr>
<td>0.9%</td>
<td>Isotonic</td>
<td>308</td>
<td>0</td>
<td>- Used to expand intravascular volume and replace ECF losses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Only solution that may be administered with blood products</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Contains Na⁺ and Cl⁻ in excess of plasma levels</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Does not provide free water, calories, other electrolytes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- May cause intravascular overload or hyperchloremic acidosis</td>
</tr>
<tr>
<td>3.0%</td>
<td>Hypertonic</td>
<td>1026</td>
<td>0</td>
<td>- Used to treat symptomatic hyponatremia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Must be administered slowly and with extreme caution because it may cause dangerous</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>intravascular volume overload and pulmonary edema</td>
</tr>
<tr>
<td><strong>Dextrose in Saline</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5% in 0.225%</td>
<td>Isotonic</td>
<td>355</td>
<td>50</td>
<td>- Provides Na⁺, Cl⁻, and free water</td>
</tr>
<tr>
<td>Light Blue</td>
<td></td>
<td></td>
<td></td>
<td>- Used to replace hypotonic losses and treat hypernatremia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Provides 170 calories/L</td>
</tr>
<tr>
<td>5% in 0.45%</td>
<td>Hypertonic</td>
<td>432</td>
<td>50</td>
<td>- Same as 0.45% except provides 170 calories/L</td>
</tr>
<tr>
<td>5% in 0.9% Yellow</td>
<td>Hypertonic</td>
<td>586</td>
<td>50</td>
<td>- Same as 0.9% NaCl except provides 170 calories/L</td>
</tr>
</tbody>
</table>
## Multiple Electrolyte Solutions

<table>
<thead>
<tr>
<th>Solution</th>
<th>Isotonic</th>
<th>Charge</th>
<th>Osmolality</th>
<th>Uses</th>
</tr>
</thead>
</table>
| Ringer’s Solution                | Isotonic | 309    | 0          | - Similar in composition to plasma except that it has excess Cl⁻, no Mg ²⁺, and no HCO₃⁻  
|                                  |          |        |            | - Does not provide free water or calories  
|                                  |          |        |            | - Used to expand the intravascular volume and replace extracellular fluid losses |
| Lactated Ringer’s Solution        | Isotonic | 274    | 0          | - Similar in composition to normal plasma except does not contain Mg ²⁺  
| (Hartmann’s Solution)            |          |        |            | - Used to treat losses from burns and lower GI  
|                                  |          |        |            | - May be used to treat mild metabolic acidosis but should not be used to treat lactic acidosis  
|                                  |          |        |            | - Does not provide free water or calories |