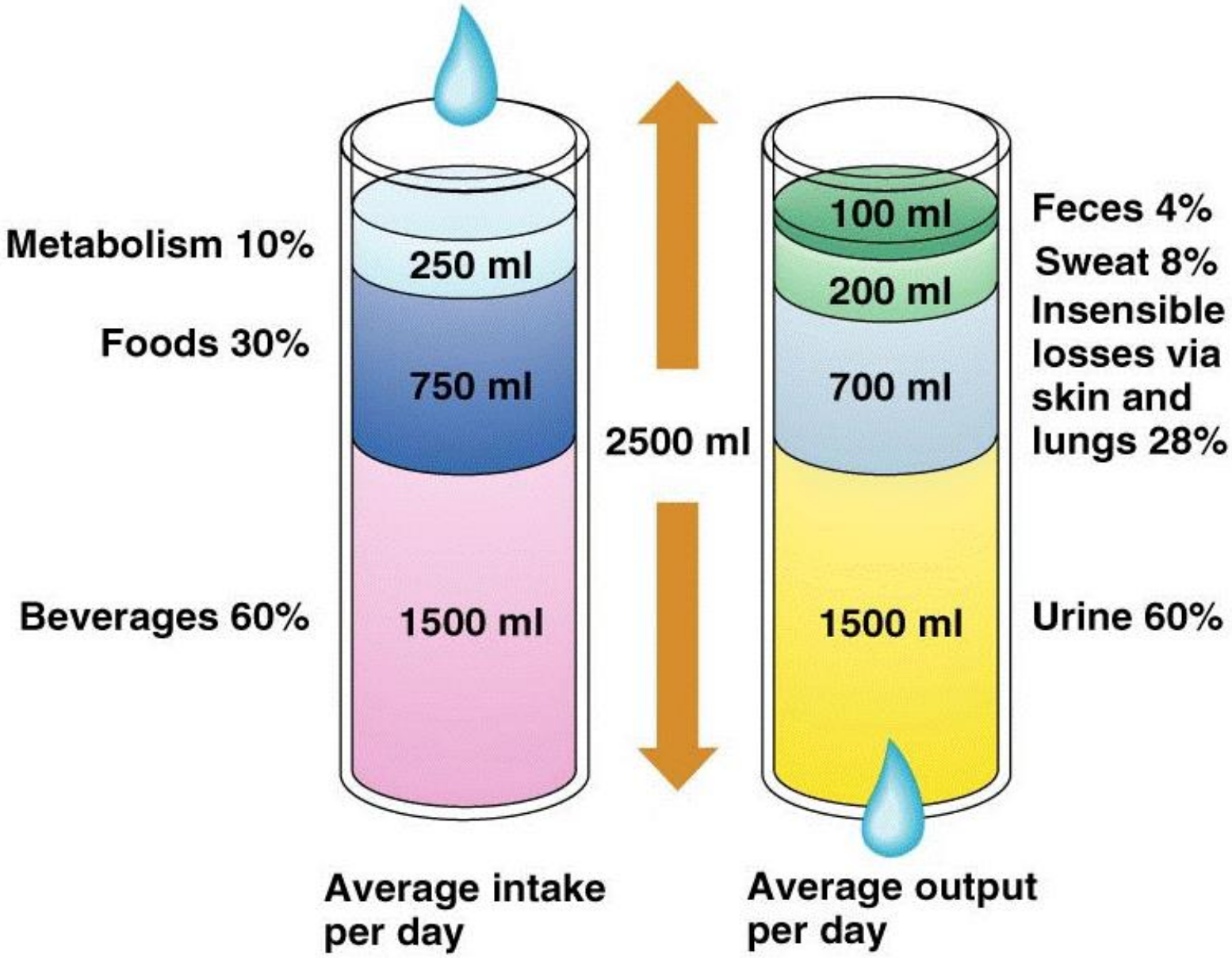
Fluid and Electrolytes

Homeostasis

- State of equilibrium in body
- Naturally maintained by adaptive responses
- Body fluids and electrolytes are maintained within narrow limits

- 60% of body weight in adult
- 45% to 55% in older adult
- 70% to 80% in infants
  - Varies with gender, body mass, and age


Metabolism 10%
Foods 30%
Beverages 60%
250 ml
750 ml
1500 ml
2500 ml
100 ml
200 ml
700 ml
1500 ml
Feces 4%
Sweat 8%
Insensible losses via skin and lungs 28%
Urine 60%
Average intake per day
Average output per day

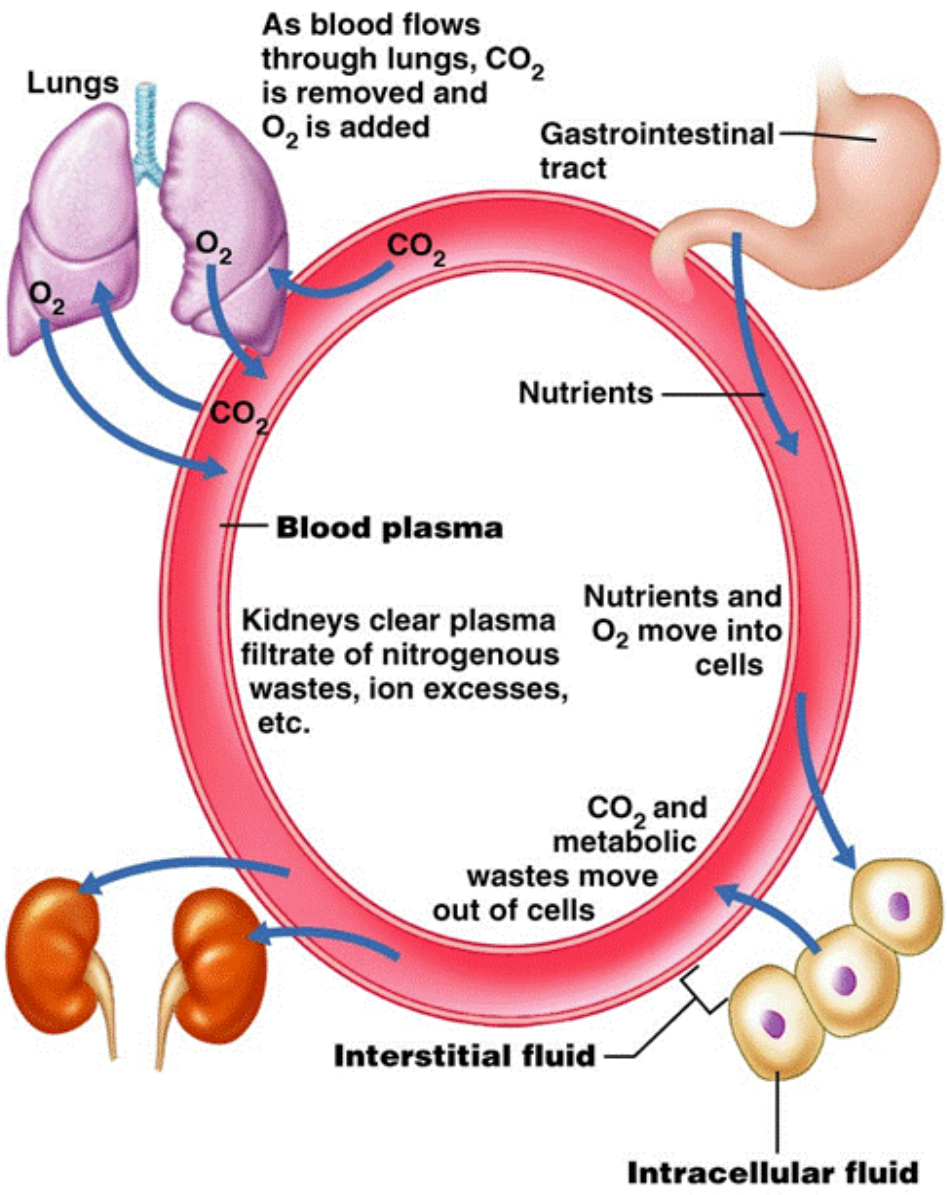
- Compartments
- Intracellular fluid (ICF) (cell membrane)
- Extracellular fluid (ECF)
  - Interstitial = tissue capillary membrane
  - Intravascular (plasma)

Extracellular Fluid (ECF)

- One third of body fluid
- 3 major components
  1) Interstitial fluid
  2) Intravascular
  3) Trans cellular fluid
     - over or across the cells

Interstitial Component

- Fluid between cells
  - Surrounds cells
  - Transport medium for nutrients, gases, waste products and other substances between blood and body cells
  - Also acts as a back up fluid reservoir



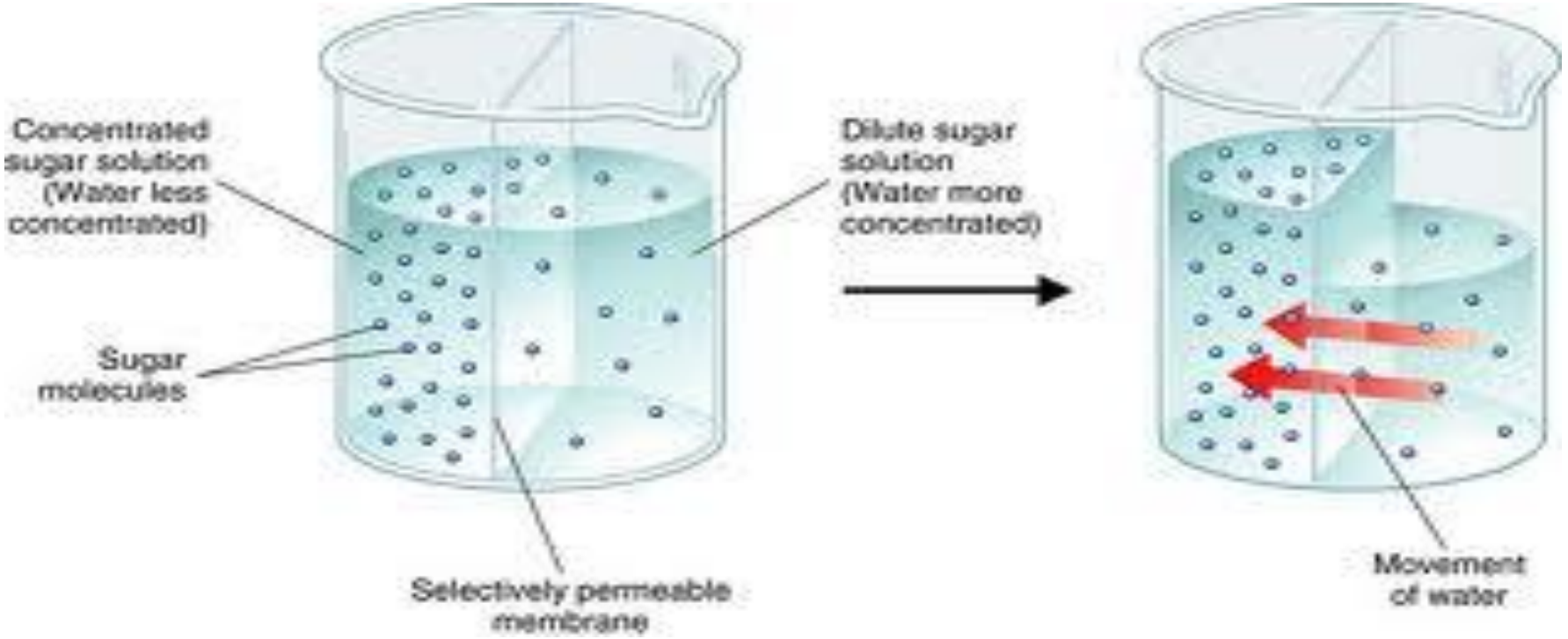
Fluid Regulation

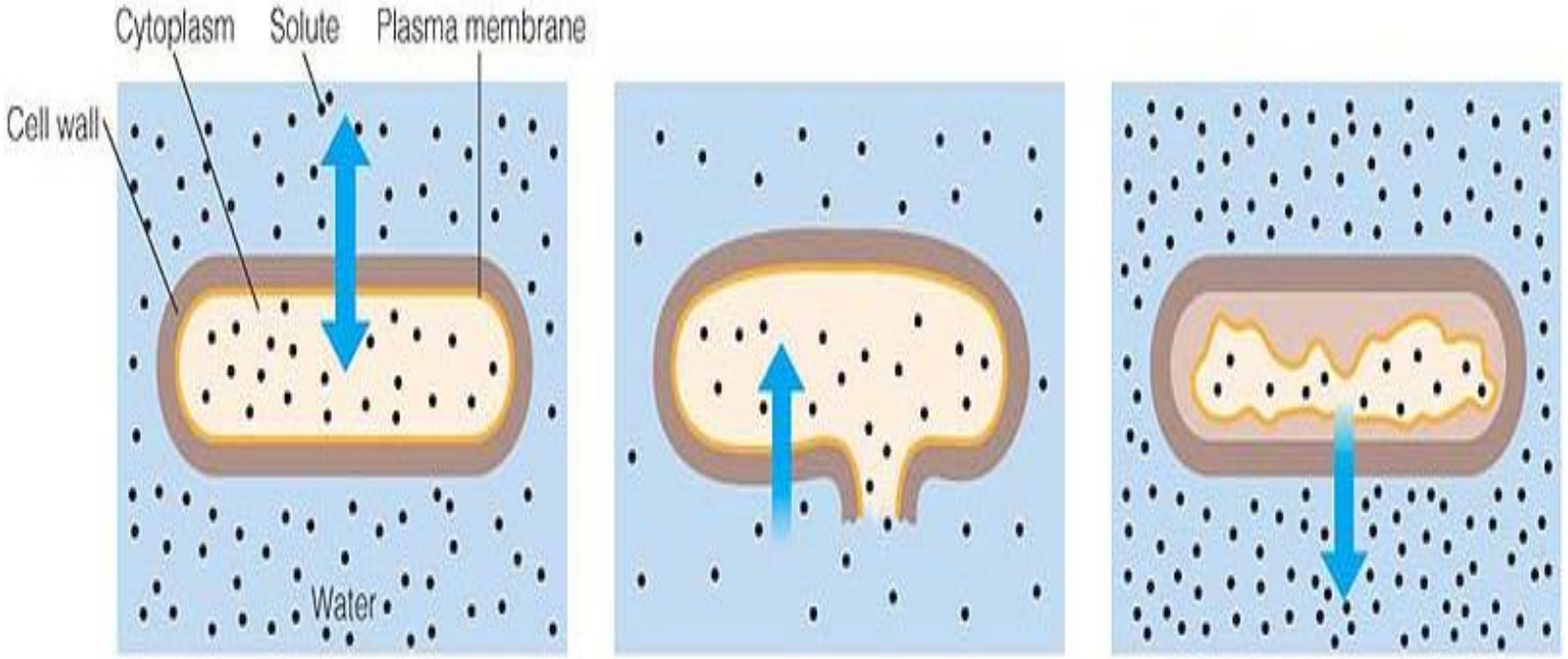
- How does movement from space to space occur?
  - Diffusion
  - Osmosis
  - Filtration
  - Active transport

- Diffusion
  - Movement of solutes from an area of higher concentration to an area of lower concentration in a solution and or across a permeable membrane
  - This movement occurs until near equal state

Fluid Regulation

- Osmosis
  - Now with water.





(c) Isotonic solution—
no net movement of water

(d) Hypotonic solution—
water moves into the cell and may cause the cell to burst if the wall is weak or damaged (osmotic lysis)

(e) Hypertonic solution—
water moves out of the cell, causing its cytoplasm to shrink (plasmolysis)

Osmosis VS. Diffusion

- Osmosis
  - Low to high
  - Water potential
- Diffusion
  - -High to low
  - -Movement of particles

Fluid Regulation

- Filtration
  - Water pushing against the confining walls of a space

Electrolytes

- Substances whose molecules dissociate into ions (charged particles) when placed into water
  - Cations: positively charged
  - Anions: negatively charged

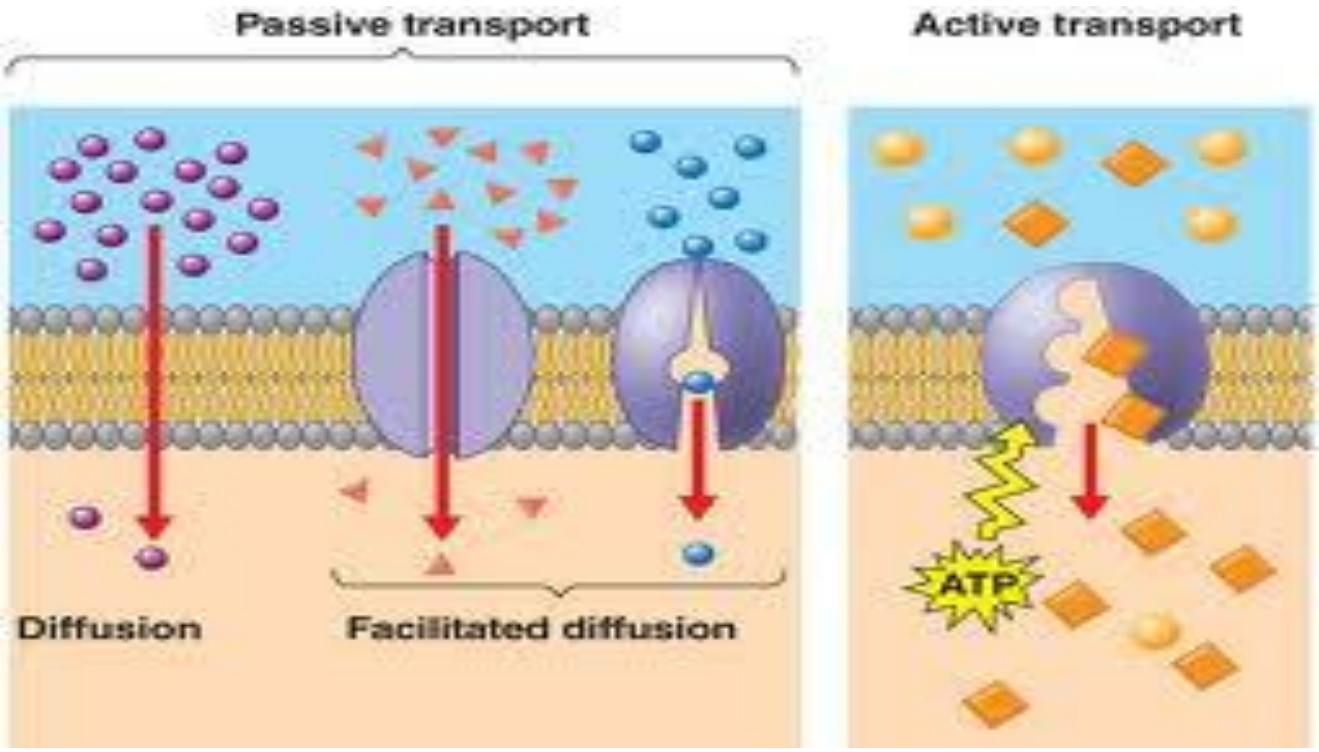
Electrolyte Composition

- ICF
  - Prevalent cation is K^+
  - Prevalent anion is PO_4^{3-}
- ECF
  - Prevalent cation is Na^+
  - Prevalent anion is Cl^-

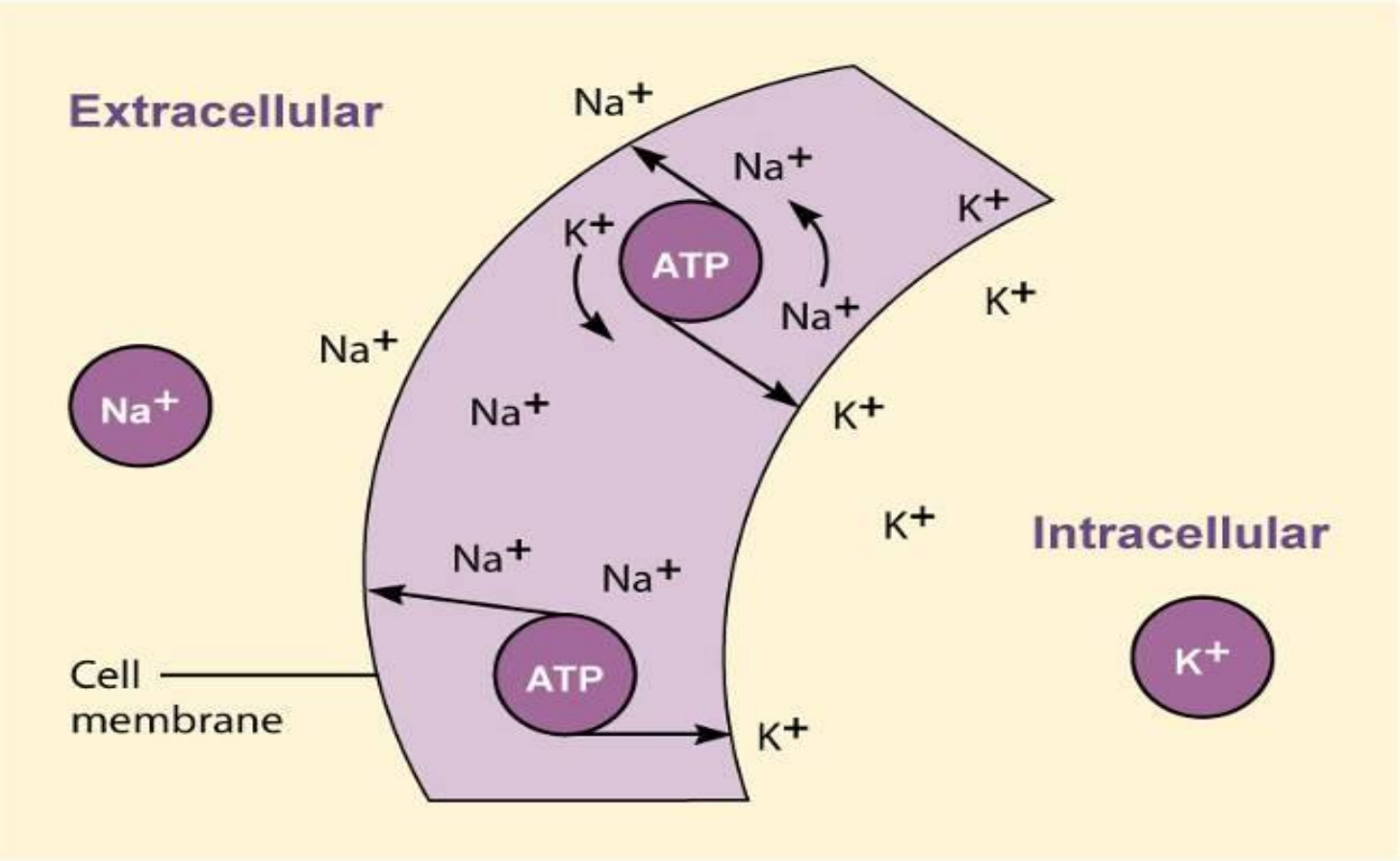
Regulation of Electrolytes

Active transport

Allows *molecules* to move against concentration and osmotic pressure to areas of higher concentration



Active Transport:
Sodium–Potassium Pump



Fluid Movement in Capillaries

- Amount and direction of movement determined by
  - Capillary hydrostatic pressure
  - Plasma oncotic pressure
  - Interstitial hydrostatic pressure
  - Interstitial oncotic pressure

Osmolality

- Concentration of body fluids- affects movement of fluid by osmosis.
- Reflects hydration status
- Measured by serum and urine
- Solutes measured-mainly urea, glucose, & sodium

Osmolality

- Serum value 280-300 mOsm/kg
- Urine value 250-900 mOsm/kg

- Increases in serum level
  - Free water loss
  - Elevated Na
  - Hyperglycemia
  - Uremia

Fluid Volume Shifts

- Normally fluid shifts between intracellular and extracellular compartments to maintain equilibrium between spaces

-Fluid not lost from body, but not available for use in either compartment- considered third-space fluid shift (third-spacing)

-Enters interstitial compartment

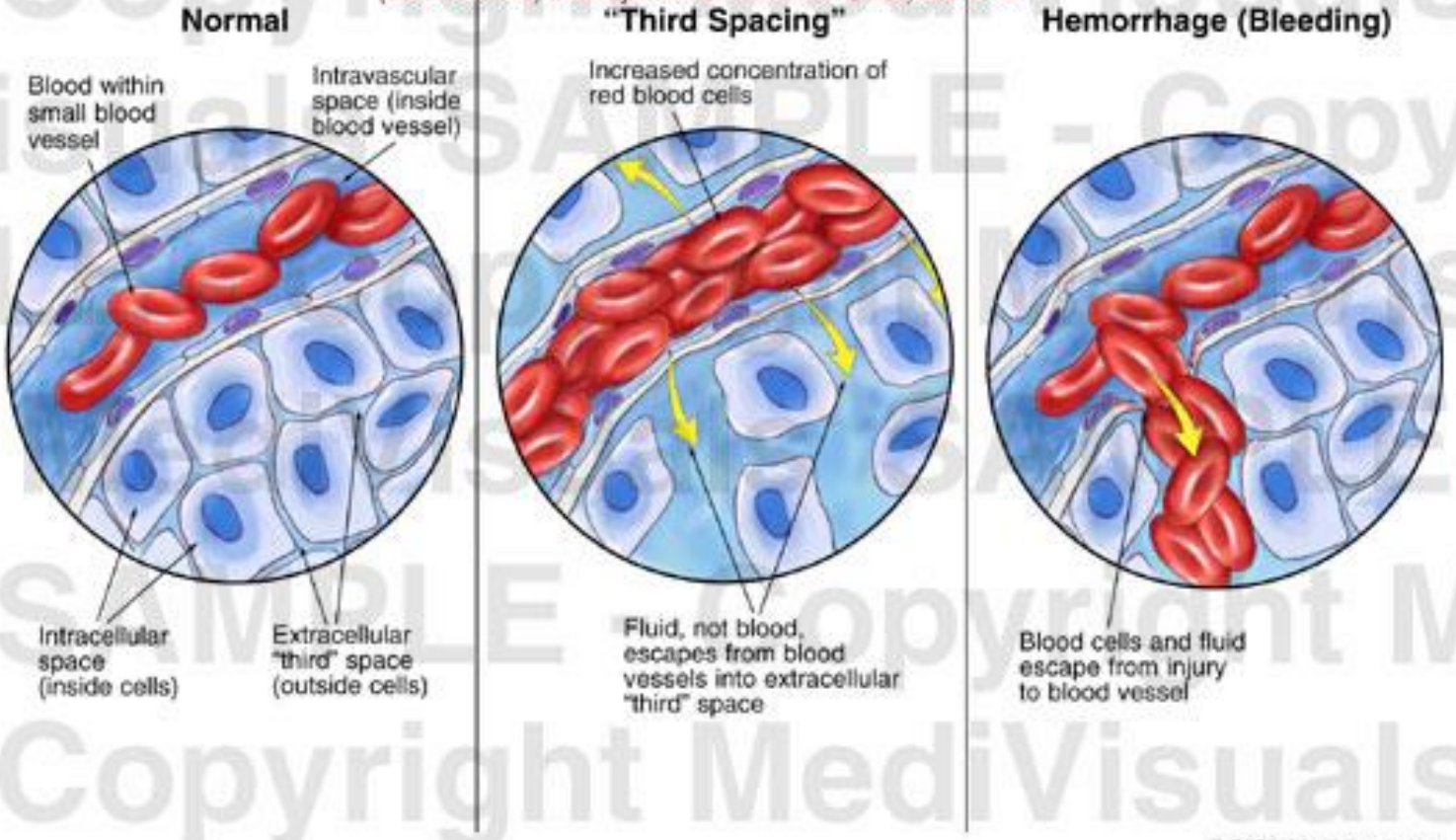
Causes of Third-Spacing

- Burns
- Peritonitis
- Bowel obstruction
- Massive bleeding into joint or cavity
- Liver or renal failure
- Lowered plasma proteins
- Increased capillary permeability

Assessment of Third-Spacing

- More difficult – fluid sequestered in deeper structures
- Signs/Symptoms
  - Decreased urine output with adequate intake
  - Increased HR
  - Decreased BP
  - Increased weight
  - Pitting edema, ascites

Blood Vessel with Surrounding Tissue



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Phases of Third-Spacing

1-Loss phase
- Lasts 48-72 hours
- Symptoms of FVD

2-Reabsorption phase
- Fluid gradually reabsorbed after problem subsides
- FVO possible
- Monitor VS, I&O, Wt, and breath sounds

Treatment

- Treat underlying cause if possible
- Close observation of VS
- Monitor I & O more frequently
- Daily weights
- Measure abdominal girth in ascites
- Measure extremities if necessary
- Monitor lab values
  - albumin level important

Extracellular Fluid Volume Imbalances

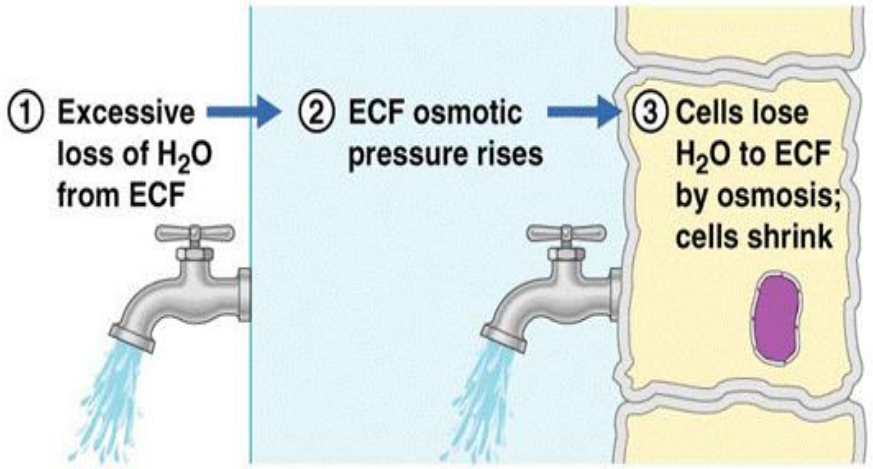
- ECF volume deficit (hypovolemia)
  - Abnormal loss of normal body fluids (diarrhea, fistula drainage, hemorrhage), inadequate intake, or plasma-to-interstitial fluid shift
  - Treatment: replace water and electrolytes with balanced IV solutions

Fluid Volume Deficit(FVD)

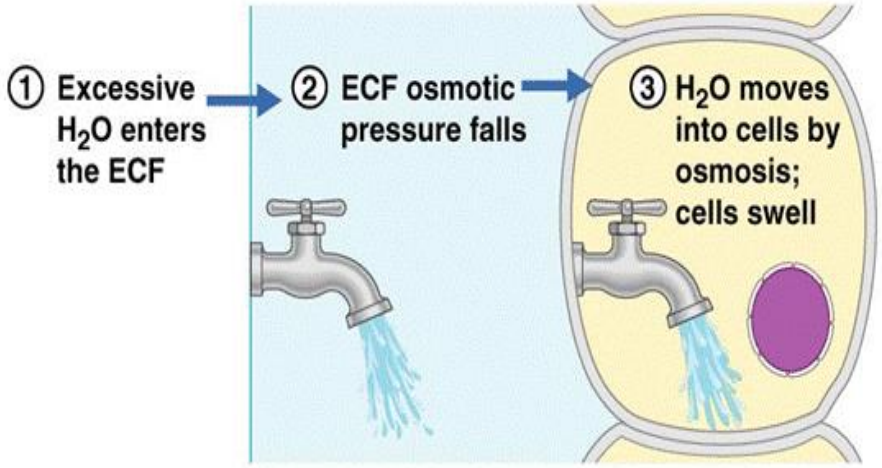
- **Hypovolemia**
- Abnormally low volume of body fluid in intravascular and/or interstitial compartments
- **Causes**
  - Vomiting
  - Diarrhea
  - Fever
  - Excess sweating
  - Burns
  - Diabetes insipidus
  - Inadequate intake
  - Hemorrhage
  - Overuse of diuretics
  - Third spacing

Fluid volume deficit

- What happens
  - Output > Intake →Water extracted from ECF
    - ECF hypertonic (water moves out of cell → cell dehydration) + osmotic pressure increased (stimulates thirst preceptor in hypothalamus)
    - ICF hypotonic with decreased osmotic pressure → posterior pituitary secretes more ADH
    - Decreased ECF volume →adrenal glands secrete Aldosterone



(a) Mechanism of dehydration



(b) Mechanism of hypotonic hydration

Signs and Symptoms

- Acute weight loss
- Decreased skin turgor
- Oliguria
- Concentrated urine
- Weak, rapid pulse
- Capillary filling time elongated
- Decreased BP
- Increased pulse
- Sensations of thirst, weakness, dizziness, muscle cramps

Labs

- Increased HCT (Hematocrit)
- Increased BUN(Blood urea nitrogen)
- Increased serum osmolality
- Increased urine osmolality
- Increased specific gravity
- Decreased urine volume, dark color

Nursing Management

Nursing Diagnoses

- Hypovolemia
  - Deficient fluid volume
  - Decreased cardiac output
  - Potential complication: hypovolemic shock

Interventions

- Major goal prevent or correct abnormal fluid volume status before ARF occurs
- Encourage fluids
- IV fluids
  - Isotonic solutions (0.9% NS or LR) until BP back to normal, then hypotonic (0.45% NS)
- Monitor I & O, urine specific gravity, DAILY WEIGHTS

- Monitor skin turgor
- Monitor VS and mental status
- Goal:
  - Normal skin turgor, increased UOP with normal specific gravity, normal VS, clear sensorium, good oral intake of fluids, labs WNL (within normal limits)

Extracellular Fluid Volume Imbalances

- **Fluid volume excess (hypervolemia)**
- Excessive intake of fluids, abnormal retention of fluids (CHF) Congestive heart failure, or interstitial-to-plasma fluid shift
- Treatment: remove fluid without changing electrolyte composition or osmolality of ECF

Causes

- Excessive isotonic or hypotonic IV fluids
- Heart failure
- Renal failure- urinary
- Liver failure, cirrhosis
- Long-term use corticosteroids

Signs/Symptoms

- Headache, confusion, lethargy
- Edema
- Distended neck veins
- Bounding pulse,
- Polyuria
- Dyspnea, crackles, pulmonary edema
- Wt. Gain
- Seizures, coma

Nursing Management

Nursing Diagnoses

- **Hypervolemia**
  - Excess fluid volume
  - Ineffective airway clearance
  - Risk for impaired skin integrity
  - Disturbed body image
  - Potential complications: pulmonary edema, ascites

Nursing implementation

- I&O
- Monitor cardiovascular changes
- Assess respiratory status and monitor changes
- Daily weights
- Skin assessment

Nursing Implementation

- Neurologic function
- LOC (level of consciousness)
- PERLA (Pupils equal, reactive to light) and accommodation
- Voluntary movement of extremities
- Muscle strength
- Reflexes

Electrolyte Disorders
Signs and Symptoms

Electrolyte	Excess	Deficit
Sodium (Na)	**Hypernatremia** **Thirst** **CNS deterioration** **Increased interstitial fluid**	**Hyponatremia** **CNS deterioration**
Potassium (K)	**Hyperkalemia** **Ventricular fibrillation** **ECG changes** **CNS changes**	**Hypokalemia** **Bradycardia** **ECG changes** **CNS changes**

Electrolyte	Excess	Deficit
Calcium (Ca)	Hypercalcemia Thirst CNS deterioration Increased interstitial fluid	Hypocalcemia Tetany Chvostek's, Trousseau's signs Muscle twitching CNS changes ECG changes
Magnesium (Mg)	Hypermagnesemia Loss of deep tendon reflexes (DTRs) Depression of CNS Depression of neuromuscular function	Hypomagnesemia Hyperactive DTRs CNS changes

IV Fluid Reference

Intravenous Fluid Comparison

Type	Solution	Uses	Special Considerations
Isotonic	Dextrose 5% in water (D5W)	• Fluid loss • Dehydration • Hypernatremia	• Use cautiously in renal and cardiac patients • Can cause fluid overload
Isotonic	0.9% sodium chloride (Normal Saline) (NaCl)	• Shock • Hyponatremia • Blood transfusions • Resuscitation • Fluid challenges • DKA	• Can lead to overload • Use with caution in patients with heart failure or edema
Isotonic	Lactated Ringer's (LR)	• Dehydration • Burns • Lower GI fluid loss • Acute blood loss • Hypovolemia due to third spacing	• Contains potassium, don't use with renal failure patients • Don't use with liver disease, can't metabolize lactate
Hypotonic	0.45% sodium chloride (1/2 normal saline)	• Water replacement • DKA • Gastric fluid loss from NG or vomiting	• Use with caution • May cause cardiovascular collapse or increased intracranial pressure • Don't use with liver disease, trauma, or burns
Hypertonic	Dextrose 5% in ½ normal saline	• Later in DKA treatment	• Use only when blood sugar falls below 250 mg/dL
Hypertonic	Dextrose 5% in normal saline	• Temporary treatment for shock if plasma expanders aren't available • Addison's crisis	• Don't use n cardiac or renal patients
Hypertonic	Dextrose 10% in water	• Water replacement • Conditions where some nutrition with glucose is required	• Monitor blood sugar levels