

FLUID DISORDERS

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DEFINITION OF BODY FLUID COMPARTMENTS

- Fifty to seventy percent of total body weight. Greater in lean individuals because fat contains little water, average 60%.
- Intracellular Fluid (ICF) Mostly in skeletal muscle mass, thus slightly lower in females (50%) than males (60%). Cell wall separates the ICF from the ECF and acts as a semipermeable membrane
- Extracellular Fluid (ECF) Made up of plasma and interstitial (extravascular) fluid.
- Capillary membrane separates plasma and interstitial fluid

Intracellular Compartment	Extracellular Compartment	
$\frac{1}{3} = 67\% \text{ TBW}$	$\frac{1}{3} = 33\% \text{ TBW}$	
	Interstitial	Plasma
	$\frac{3}{4} \text{ ECC} = 25\% \text{ TBW}$	$\frac{1}{4} \text{ ECC} = 8\% \text{ TBW}$
In 70-kg man (42 L TBW) = 28 L	11 L	3 L
In 45-kg woman (22.5 L TBW) = 15 L	5.6 L	1.8 L
	↑ Cell membrane	↑ Capillary wall



WATER MOVEMENT BETWEEN ICF AND ECF

Water flows freely between the three compartments, shifting compartments to maintain osmotic equilibrium between them.

Fluid moves towards hyperosmotic compartments and away from hypoosmotic

According to this renal system has a critical role in maintaining the body hemodynamically stable.

RENAL CONTROL OF FLUIDS/ ELECTROLYTES

Distal tubules—reabsorption of Na in exchange for K and H secretion. Affected by adrenocorticotrophic hormone (ACTH) and aldosterone. Aldosterone directly stimulates K secretion and Na reabsorption from the distal tubule.

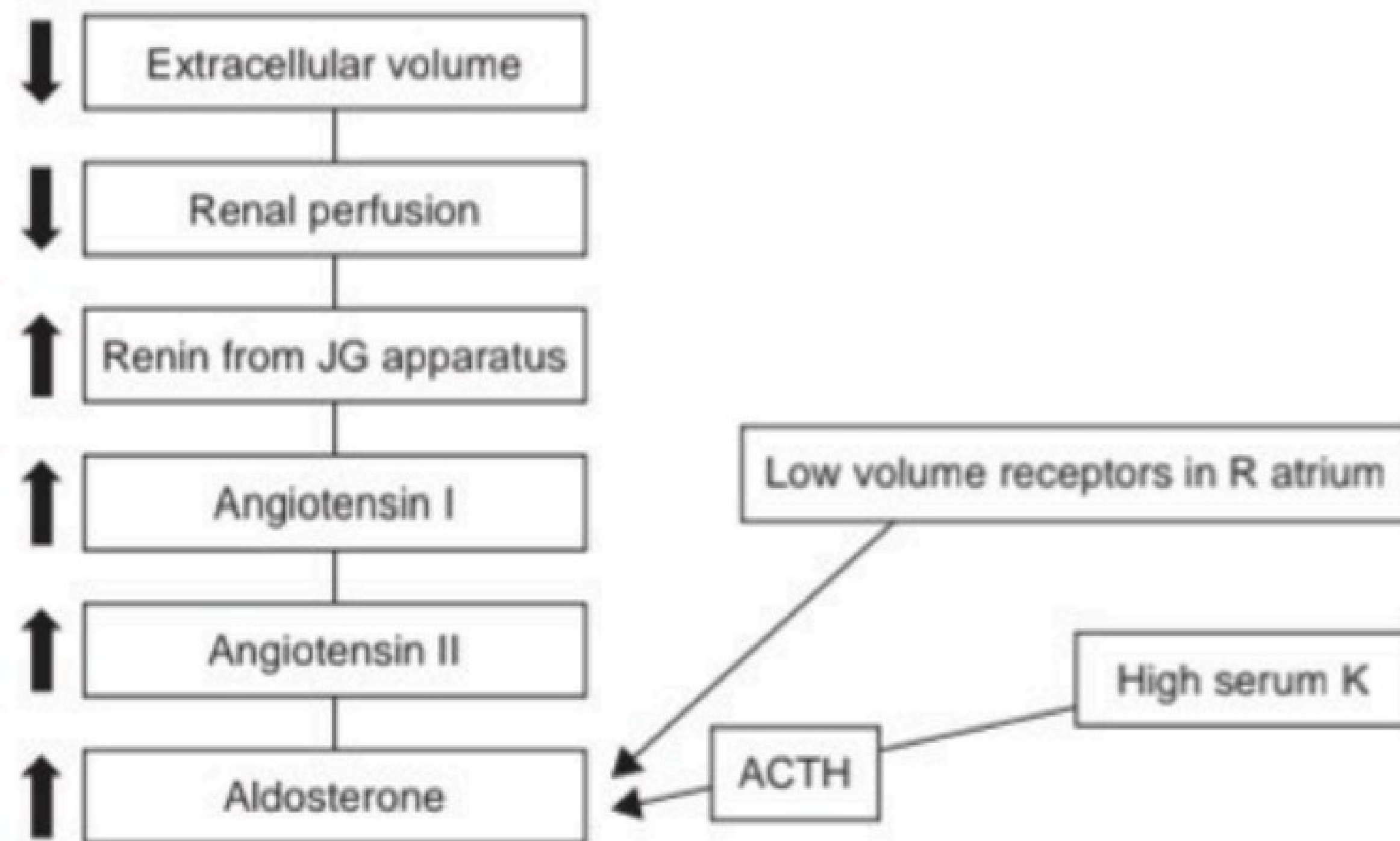


FIGURE 6 - 2. Renal mechanism of fluid and electrolyte balance.

VOLUME DEFICIT

Most common fluid disorder.(dehydration)

CAUSES:Loss of gastrointestinal (GI) fluid — vomiting, nasogastric (NG) suction, diarrhea, fistular drainage.Postoperative fluid sequestration Intra-abdominal and retroperitoneal inflammation Systemic inflammatory response syndrome (SIRS), burns, sepsis, pancreatitis.

VOLUME EXCESS

Causes:isotonic

iatrogenic — intravascular overload of IV fluids with electrolytes.

Increased ECF without equilibration with ICF — especially postoperative or trauma when the hormonal responses to stress are to decrease Na and water excretion by kidney.

hypotonic:inappropriate NaCl-poor solution as a replacement for GI losses (most common).

hypertonic :common cause: excessive Na load without adequate water intake

TABLE 6 - 1. Signs and Symptoms of Volume Disturbances

SYSTEM	VOLUME DEFICIT	VOLUME EXCESS
Generalized	Weight loss	Weight gain
	Decreased skin turgor	Peripheral edema
Cardiac	Tachycardia	Increased cardiac output
	Orthostasis/hypotension	Increased central venous pressure
	Collapsed neck veins	Distended neck veins
		Murmur
Renal	Oliguria	
	Azotemia	
Gastrointestinal	Ileus	Bowel edema
Pulmonary		Pulmonary edema

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IV FLUIDS CLASSIFICATION

Iv fluids are either crystalliod or colloids

A crystalloid or colloids can be isotonic, hypertonic or hypotonic and that directly affects what the solution is used for.

A_crystalloid are solutions contain small molecules that easily flit across semi permeable membrane and it's used to increase fluid volume and intravascular space as in hypovolemia.

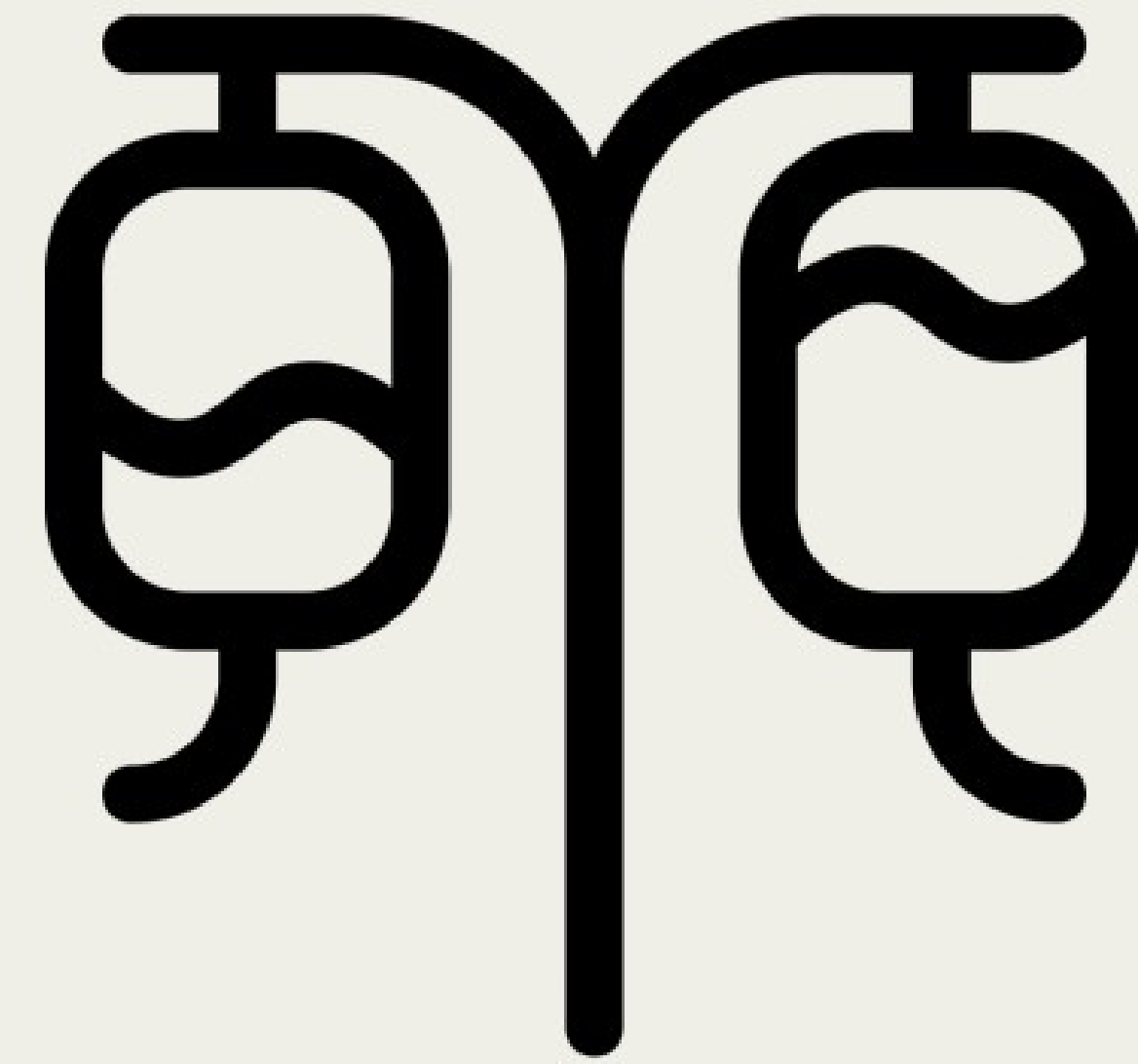
B_colloid solution unlike crystalloid contains larger molecules because of this they do not cross semi permeable membrane

Ex of crystalloid: ISOTONIC CRYSTALLOIDS (E.G., LACTATED RINGER'S SOLUTION, 0.9% NACL)

HYPERTONIC SALINE SOLUTIONS

HYPOTONIC SOLUTIONS (D5W, 0.45% NACL)

EXAMPLES OF COLLOID SOLUTIONS: ALBUMIN / DEXTRAN / HYDROXYETHYL STARCH (HETASTARCH)



CRYSTALLOIDS

Isotonic fluid :1)Normal saline 0.9% :: Replaces water, sodium, chloride / the only solution we administer with blood.Indicated in Intravascular resuscitation and replacement of salt loss e.g. diarrhoea and vomiting. • When we given in large volume can produce Hyperchloremic metabolic acidosis , also be aware of fluid overload in case of kidney and heart failure.

2)LR (lactated Ringer's) :: Lactated Ringer's has water, sodium chloride, sodium lactate, potassium, and calcium. • Because Normal saline has a higher risk of metabolic acidosis than lactated Ringer's, which is better able to reduce acidity thanks to its lactate content. • Not for pts with liver disease or lactic acidosis • Monitor for hyperkalaemia in renal patient.

CRYSTALLOIDS

→ Ex: 3% NS, 5% NS

Hypertonic fluid • Higher osmolarity than the blood, so osmosis will cause water to leave intracellular space (cell shrinks) and expand extracellular space . • Indicated for treatment of hypovolemia, also for brain swelling (cerebral edema) • Be aware that they could overload extracellular space leading to pulmonary edema .

→ Ex: 1/2 NS

Hypotonic solution : • Lower osmolarity than the blood so osmosis causes water to move from extracellular space to intracellular space (cell swells). • It's designed to treat patient suffering from cellular dehydration and can be used for 1-water replacement 2-gastric fluid loss • Be aware that these can cause brain swelling • 5% Dextrose is one example of that (D5W)

COLLOID PRODUCT

Natural – Albumin, FF.

Artificial – Gelatin and Dextran and HES

Albumin : There are 2 solution : 5% leads to 80% initial volume expansion / 25% leads to 200-400% increase in volume expansion • used mainly for emergency treatment of shock especially due to loss of plasma (acute management of burns) and is given with crystalloids , also in hypoalbuminemia. • One of the side effect is pruritis and anaphylactic reactions and coagulation abnormalities. • Disadvantages : cost-effectiveness / volume overload

Dextran : • is a synthetic glucose polymer that expands the intravascular volume by an amount equal to the volume infused. • Side effects include renal failure, osmotic diuresis, bleeding disorder , and laboratory abnormalities (i.e., elevations in blood glucose and protein and interference with blood cross-matching). • There is no clear benefit to the use of dextran over crystalloid solutions.

HES : • Hetastarch, like 5% albumin, increases the intravascular volume by an amount equal to or greater than the volume infused

CALCULATION OF MAINTENANCE FLUIDS

The 4/2/1 rule

maintenance for hourly rate 4ml/kg for the first 10kg 2ml/kg for the next 10kg 1ml/kg for every kg over 20

Ex : calculate maintenance rate for a 70kg man

$$4 \times 10 = 40$$

$$2 \times 10 = 20$$

$$1 \times 50 = 50$$

total = 110ml/hr

Adult maintenance fluid type is D5 1/2NS 20mEq KCL/L

The background is a soft watercolor illustration. It features large, irregular pink washes that create a dreamy, ethereal atmosphere. Scattered throughout these washes are numerous small, delicate pink flowers with five petals and tiny yellow centers. Interspersed among the flowers are small, dark green leaves and stems, adding a touch of natural detail. The overall color palette is pastel, dominated by various shades of pink and light green against a white background.

Common Electrical Disorders

Sodium

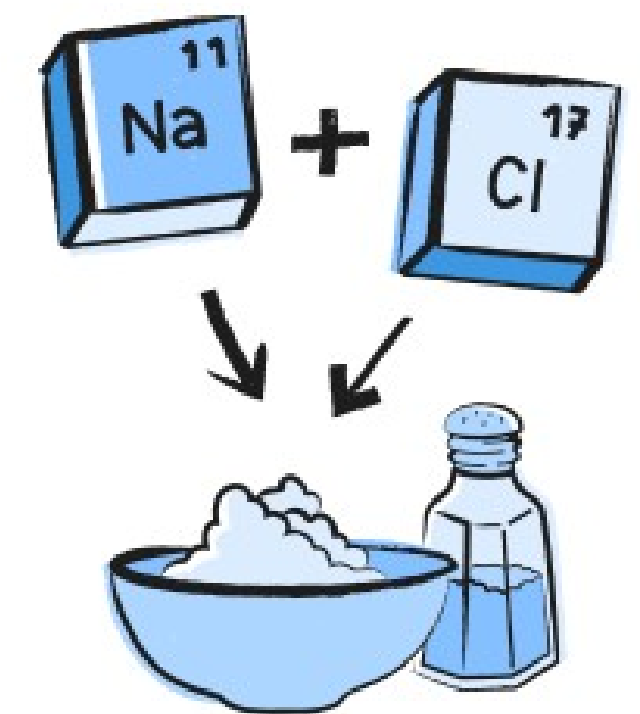
(Normal Range: 135-145 mmol/L)

1. Hyponatremia (Na < 135 mmol/L)

- Causes: Results when water intake or infusion exceeds the kidney's ability to excrete free water.
- Clinical Manifestations:
 - Neurological symptoms are common due to hypoosmolality causing water influx into cells, leading to cerebral edema.
 - Symptoms include lethargy, confusion, nausea, vomiting, seizures, and coma.
- Classified as:
 - Acute: Na levels <120-130 mmol/L.
 - Chronic: Na levels <110-120 mmol/L.

Types of Hyponatremia:

- Hypotonic (most common):
 - Subtypes based on fluid status: hypovolemic, euvolemic, hypervolemic.
- Hypertonic: Caused by osmotically active solutes like glucose or mannitol.
- Isotonic (pseudohyponatremia): Low serum sodium with normal osmolality, seen in hyperlipidemia and hyperproteinemia (e.g., multiple myeloma).



Treatment:

- Isotonic & Hypertonic Hyponatremia: Treat the underlying disorder.
- Hypovolemic: IV 0.9% NaCl to correct volume deficit.
- Hypervolemic: Restrict fluid intake (1,000 ml/day), consider loop diuretics and 3% NaCl if needed.
- SIADH (Syndrome of Inappropriate Antidiuretic Hormone):
 - Persistent secretion or action of ADH, causing hyponatremia and hypo-osmolality despite normal/increased plasma volume.
 - Diagnostic Indicators: Low plasma osmolality (<100 mOsm/kg), elevated urine sodium (>20 mEq/L), and euvolemia.
 - Causes: Pulmonary issues, CNS disorders, certain drugs (e.g., cyclophosphamide), and ectopic ADH production (e.g., small-cell lung cancer).

2. Hypernatremia ($\text{Na} > 145 \text{ mmol/L}$)

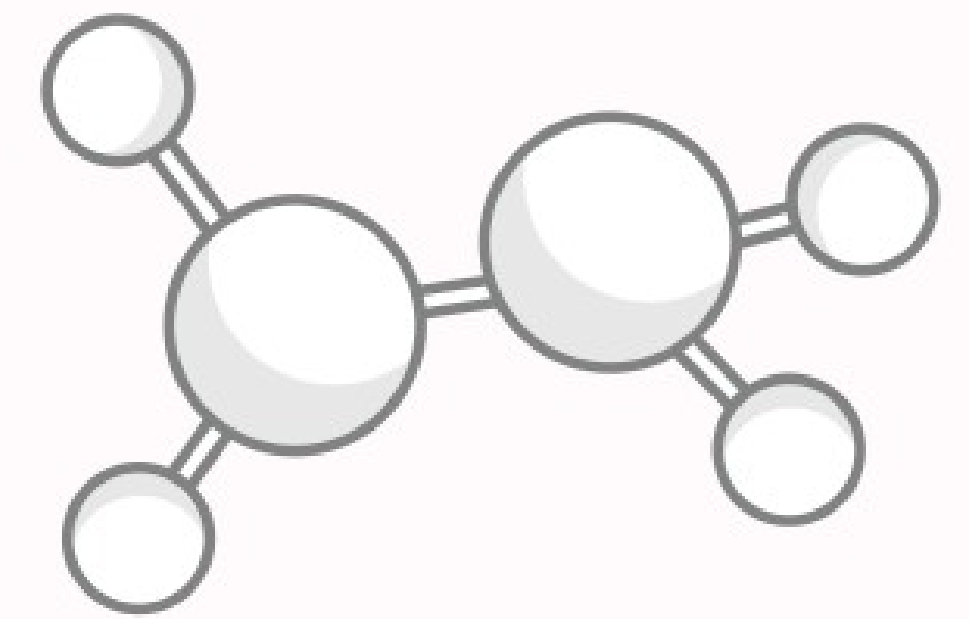
- Causes: Often due to water loss or hypertonic fluid intake, occasionally due to aldosteronism or Cushing's disease.
- Clinical Manifestations: Lethargy, weakness, irritability, progressing to seizures, coma, and possibly permanent neurological damage.
 - Types of Hypernatremia:
 - Hypovolemic: From hypotonic fluid losses (e.g., diuresis, burns).
- Hypervolemic: Often iatrogenic from hypertonic solutions or excessive aldosterone.
 - Isovolemic: Related to hypotonic losses or diabetes insipidus.
- Treatment: Gradual fluid correction with D5W or 0.45% NaCl; avoid rapid correction to prevent cerebral edema.

Potassium

(Normal Range: 3.5-5 mmol/L)

1. Hyperkalemia ($K > 5$ mmol/L)

- Causes:
 - Increased intake (e.g., supplements, transfusions).
 - Shift from cells to serum (acidosis, cell destruction, hyperglycemia).
 - Reduced excretion (K-sparing diuretics, renal failure).
- Clinical Manifestations:
 - GI symptoms: Nausea, vomiting, diarrhea.
 - Neuromuscular: Muscle weakness, paralysis.
- Cardiovascular: Arrhythmias, peaked T waves, possible cardiac arrest.



Treatment:

- Mild ($K < 6$ mmol/L): Reduce intake, consider diuretics.
- Severe ($K > 6.5$ mmol/L): Protect the heart (calcium gluconate), shift K^+ into cells (insulin + glucose, bicarbonate), and reduce total body K^+ (e.g., diuretics, dialysis).

2. Hypokalemia ($K < 3.5$ mmol/L)

- Causes: Low intake, excessive loss (GI, renal), or intracellular shift (alkalosis).
 - Clinical Manifestations: Weakness, fatigue, arrhythmias, decreased reflexes.
- Treatment: Mild cases managed with oral KCl, severe cases with IV KCl under ECG monitoring.

Calcium

(Normal Range: 8.9-10.3 mg/dL)

1. Hypercalcemia

- Causes: Hyperparathyroidism, malignancy, high vitamin D, prolonged immobilization.
- Clinical Manifestations: Fatigue, confusion, QT interval shortening, arrhythmias.
- Treatment:
 - Mild cases with dietary adjustments.
 - Severe cases with IV saline, loop diuretics, and calcitonin.





2. Hypocalcemia

- Causes: Hypoparathyroidism, vitamin D deficiency, low magnesium.
 - Clinical Manifestations: Tetany, seizures, prolonged QT, positive Chvostek's and Trousseau's signs.
 - Treatment: IV calcium in symptomatic cases, with monitoring of related electrolytes (Mg, K, Ph).
- 



Summary of Serum Electrolyte Imbalances

Electrolyte	Increased Serum Levels	Decreased Serum Levels
Potassium	Weakness, arrhythmias, GI symptoms	Weakness, arrhythmias
Magnesium	Weakness, hypotension	Tremors, tetany, seizures
Calcium	Confusion, arrhythmias	Tetany, seizures, cardiac issues

This format highlights key points with improved readability, focusing on causes, symptoms, types, and treatment.

Normal Range

Sodium

135-145 mmol / L

Calcium

3.5-5 mmol /L

POTASSIUM

8.9 - 10.3 mg /dL

Abnormal Range

Hyponatremia
Hypernatremia

Na < 135 mmol / L
Na > 145 mmol /L

Hyperkalemia
Hypokalemia

K > 5 mmol /L
K < 3.5 mmol/ L

Hypercalcemia
Hypocalcemia

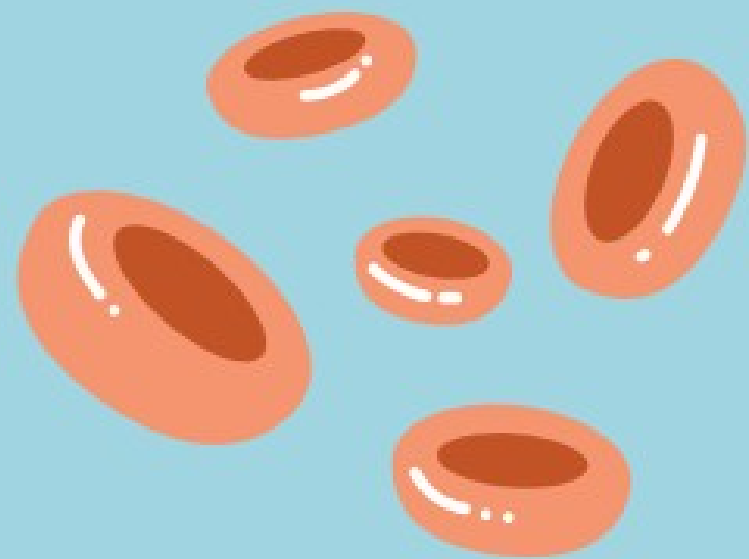
Ca > 5 mmol /L
Ca < 3 mmol /L

The background is a soft watercolor illustration. It features a large, irregular pink wash in the center. Surrounding this wash are clusters of delicate pink flowers with yellow centers and small green leaves. The overall style is gentle and artistic.

THANKYOU

Road Almanaseer

ACID BASE BALANCE

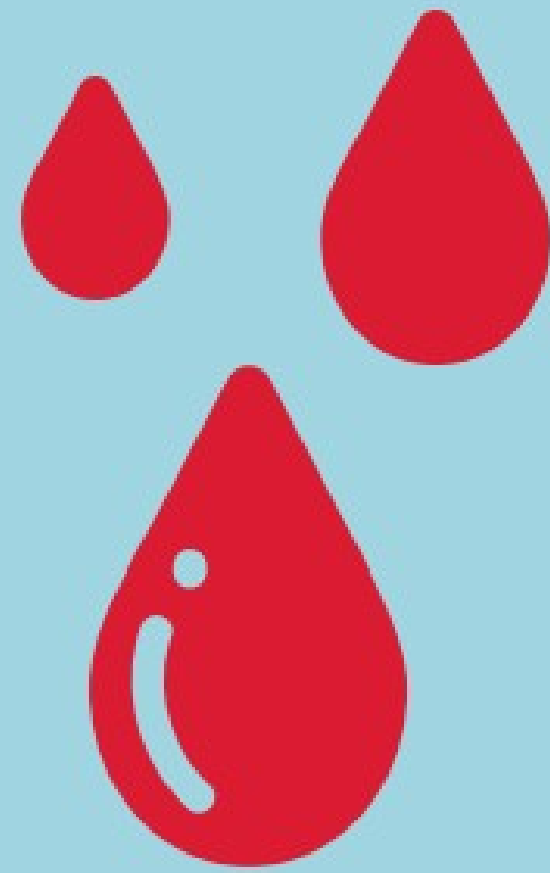
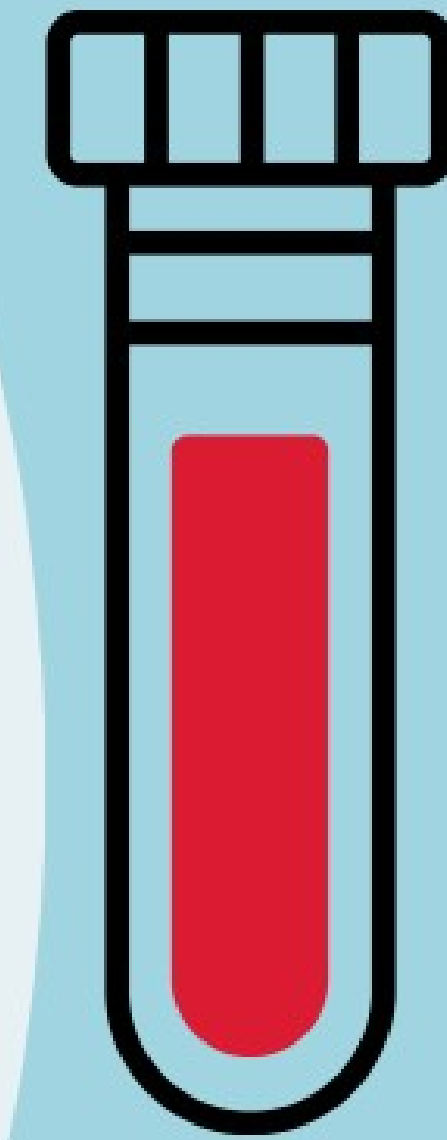


what is acid-base balance



+Acid-base balance is a balance of H concentration in ECF

To achieve homeostasis a balance between the intake or production of hydrogen ions and the net removal of hydrogen ions from the body



AN ACID

Molecules containing hydrogen atoms that can be released (donate), hydrogen ions in solutions are referred to as an acid.

AN BASE

is an ion that can accept a hydrogen ion

An example of a base is is bicarbonate ion
.(HCO₃)



Extra-cellular pH

- * Extra-cellular PH = 7.4 (7.3 to 7.5).

**Homeostasis of pH is important for the
.function of body enzymes**

- * Acid-base balance can also affect
electrolytes. concentration (Nat,K⁺,Cl⁻)
- * Can also affect the function of
.certain hormones

PH OF ARTREIAL BLOOD

Acidosis

decrease of **pH** More than
Normal range (7.4)

Causes

- Liver failure
- low blood sugar
- alcohol use disorder
- cancer

Alkalosis

increase of **pH** More than
Normal range (7.4)

Causes

- Dietary changes
- prolonged vomiting

Diabetes & blood acidity

Diabetic ketoacidosis (DKA)

is a life-threatening problem that affects people with diabetes. It occurs when the body starts breaking down fat at a rate that is much too fast. The liver processes the fat into a fuel called ketones, which causes the blood to become acidic.



Treat of diabetic ketoacidosis

1

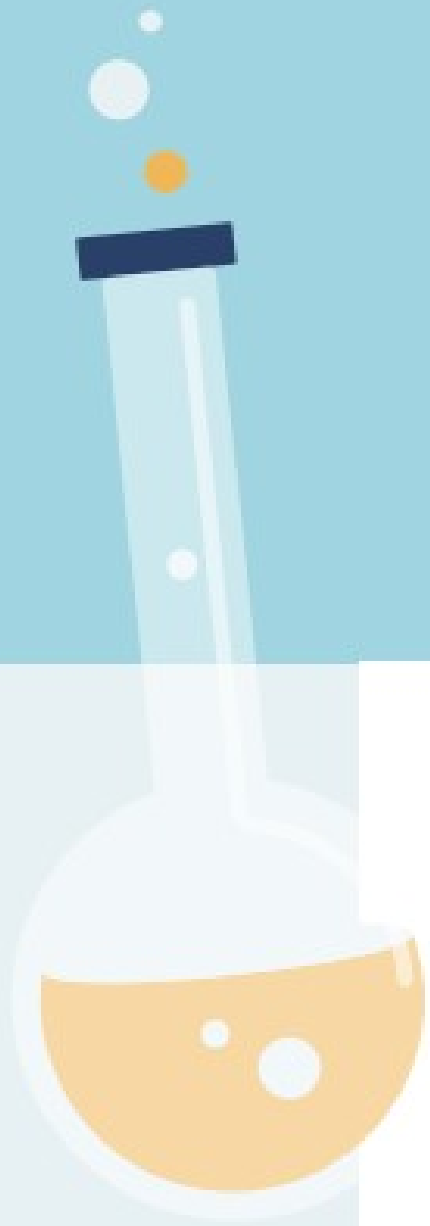
Fluids. Fluids replace those lost through too much urinating

2

Insulin reverses diabetic ketoacidosis. In addition to fluids and electrolytes

3

Electrolyte replacement. Electrolytes are minerals in the blood, such as sodium, potassium and chloride



How the body defends against fluctuations in pH

Three Systems in the body, that buffer any excess base or acid in our bodies to prevent changes in the PH.



1. Blood buffers

These buffer systems serve as a first line of defense against changes in the acid-base balance:

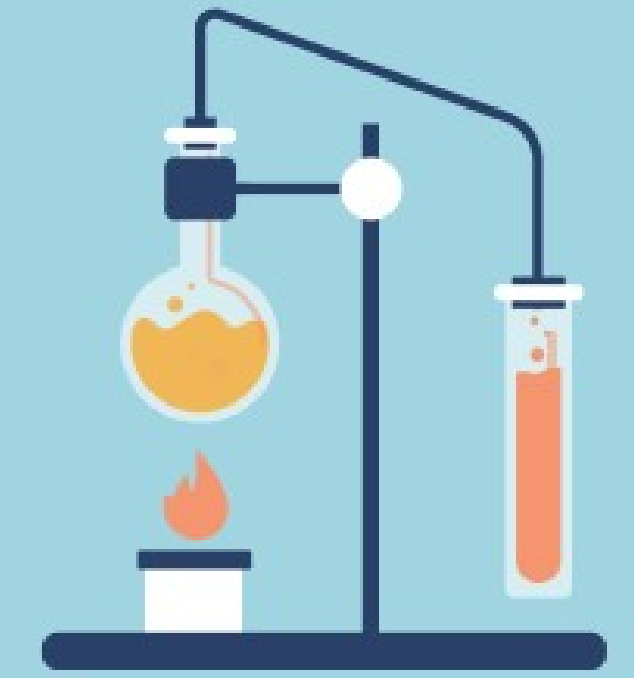
- Bicarbonate
- Protein
- Phosphate
- Hemoglobin

2. Breathing

Respiratory system is the 2nd system will come to work /Gets rid of CO₂,*getting rid of acids* it works faster than the kidneys, but it won't correct the PH completely

How the body defends against fluctuations in pH

Three Systems in the body, that buffer any excess base or acid in our bodies to prevent changes in the PH.



- **3. Excretion by the kidneys**

This system will come late, it takes hours-days, BUT IT CORRECTS THE PH 100%

-

**thank
you**

Abdullah Alenezy

Thank you!
