

Major Extra and Intracellular Electrolyte

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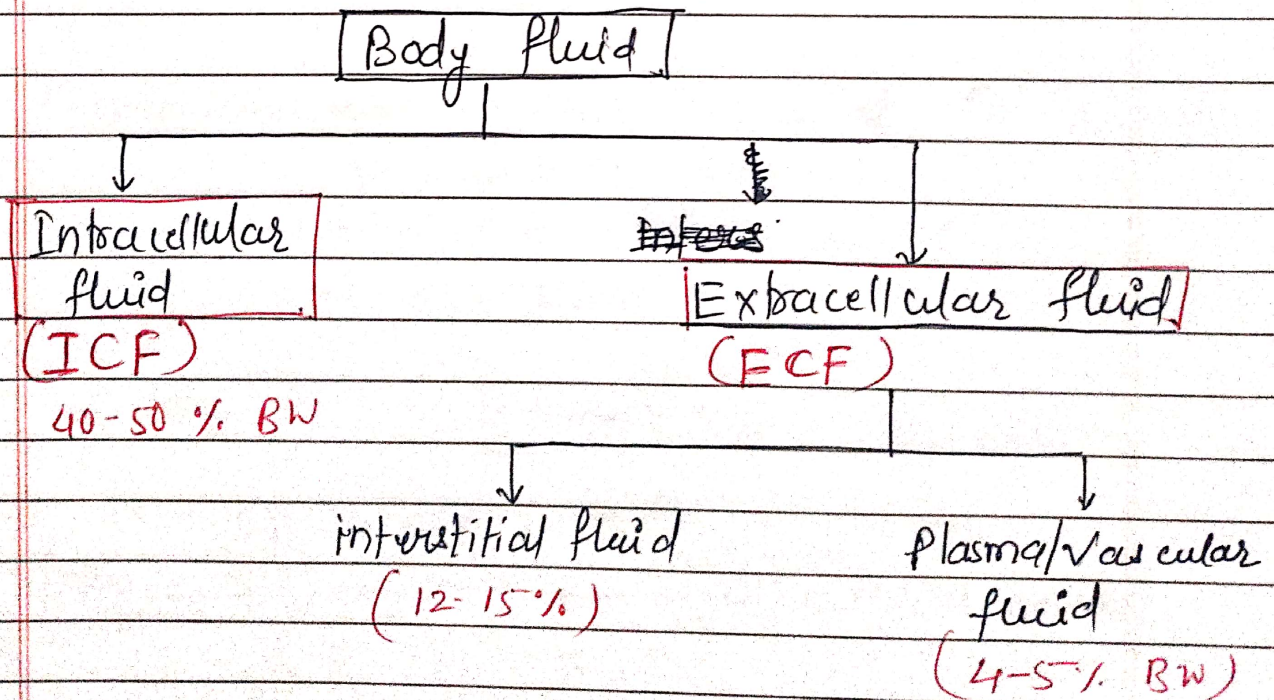
Electrolyte: These are substance that dissociate into ions when dissolved in solution & carry electrical current.

* Electrolyte concentration are maintain in body by homeostasis mechanism.

* Electrolytes are used for correction of acid-base balance in various fluid of body.

Body fluid

→ These are solution of inorganic and organic compounds mainly water.



(I) Intracellular fluid (ICF) (40-50%), (30 litres)

The fluid present inside the cell or cytoplasm.

e.g. K^+ , Mg^{2+} , HPO_4^{2-} , $H_2PO_4^-$

(II) Extracellular fluid (ECF)

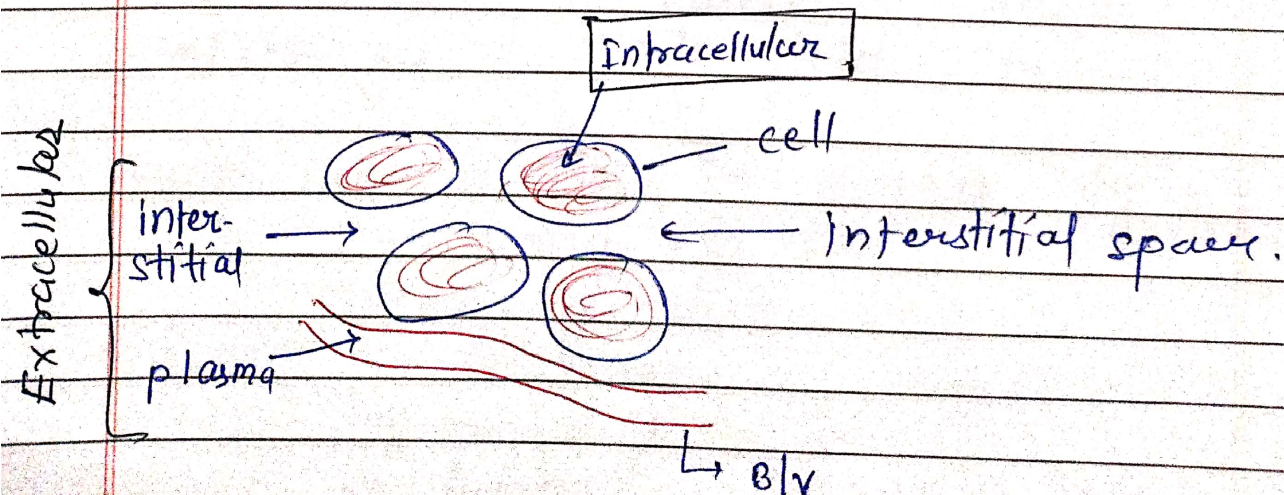
Interstitial + Plasma or Vascular fluid commonly k/as ECF

⇒ Interstitial fluid = fluid present b/w the cell.

→ 12-15% of B.W.
→ 10 litre. volume.

⇒ Plasma/Vascular = fluid present in blood vascular system

→ 4-5% BW
→ 3-5 litres



→ All three compartment are separated by a membrane & is semi permeable / selective permeable.

⇒ Body fluid have various inorganic ions as.

(i) Anionic = HCO_3^- , Cl^- , SO_4^{2-} , HPO_4^{2-}

(ii) Cationic = Na^+ , K^+ , Ca^{2+} , Mg^{2+}

☆ ECF in addition to plasma & interstitial fluids also includes

- CSF - cerebrospinal fluid
- lymph
- peritoneal fluid
- pleural & synovial fluid.

ELECTROLYTE IMBALANCE

→ When the limits ~~of~~ amount of H_2O along \bar{c} electrolyte get disturbed or disbalance. It cause imbalance in electrolyte in body fluid.

→ water can be loss in excess by

- Urinary excretion
- Dehydration
- Diarrhoea
- vomiting
- Diabetes insipidus & DM
- In thirst condition.

Function of Electrolyte

- 1) Maintain Electrolytic balance, including acid-base & osmotic equilibrium in body fluids.
- 2) To facilitate specific metabolic function
- 3) To regulate total amount of bod. H₂O in body.
- 4) Heart, muscle & nerve uses electrolyte to maintain voltage across cell membrane

ELECTROLYTE IMBALANCE

When the level of amount of the electrolyte in body fluids is disturbed, it causes imbalance in body fluids.

Water can be lost in excess by sweating, vomiting, diarrhoea, etc. This leads to dehydration and electrolyte imbalance.

so they can be balanced by the Replacement therapy.

Replacement therapy

The electrolyte imbalance and fluid loss can be corrected by appropriate administration of various products. like.

- (1) Electrolytes
- (2) Acid base
- (3) Blood product
- (4) Carbohydrates
- (5) Amino acids
- (6) Proteins

PHYSIOLOGICAL SIGNIFICANCE OF IONS.

(A) Major Extracellular ions \rightarrow Na^+ , Cl^- , Ca^{2+}
 HCO_3^-

(B) Intracellular ions \rightarrow PO_4^{3-} , K^+ , Mg^{2+}

(A) Major Extracellular ions

① SODIUM (Na^+)

Location : Extracellular compartment as salt

Intake : 5-10 gm/day

function : Maintenance of hydration, osmotic pr. electrolyte balance, acid-base balance.

→ Na^+ level controlled by "Aldosterone"

Clinical conditions

(1) Hyponatremia → ↓ Na^+ level

Reason → extreme urine loss

Diarrhoea, vomiting, excess sweat
kidney damage

Symptom: Headache

weakness.

respiratory depression

(2) Hypernatremia → ↑ Na^+

Reason → High sodium intake
Dehydration.

Symptom → fatigue

intense thirst

Chloride (Cl^-)

→ Major ion (extracellular)

→ Daily requirement → 5-10 gm/day.

→ Source → common table salt.

→ excretion through urine & skin.

function

→ osmotic balance maintenance

→ maintain acid-base balance

→ Proper hydration maintenance.

Clinical significance

① Hyperchloremia $\rightarrow \uparrow \text{Cl}^-$
 \rightarrow due to dehydration, \downarrow renal blood flow, Renal damage, CHF.

Hypochloremia \rightarrow Due to kidney disease, metabolic acidosis, Renal failure.

CALCIUM (Ca^{2+})

- \rightarrow Daily requirement \rightarrow 0.8 gm
- \rightarrow 99% Ca^{2+} found in bone, 1% in ECF.
- \rightarrow Source \rightarrow Milk, cheese, green vegetables, eggs, some fish.
- \rightarrow Absorption \rightarrow from all part of intestine. by active transport.
- \rightarrow Greater amount needed in children & during pregnancy & lactation.
- \rightarrow Function
 - 1) Normal functioning of CNS.
 - 2) Used for cardiac function
 - 3) Important for blood coagulation
 - 4) muscle contraction
 - 5) Nerve transmission & release of neurotransmitter

Clinical condition

(1) Hypocalcemia →

Symptoms → Rickets in children
Osteoporosis
Hyper-excitability
Vit D deficiency

it is associated with Hypothyroidism
Para

(2) Hypercalcemia →

Symptoms → Muscle weakness,
fatigue
constipation,
Cardiac irregularities.

it is associated with Hyperparathyroidism

BICARBONATES (HCO_3^-)

→ Second largest anion in E.C.F.

→ Source : citrus fruits, milk

→ function : maintenance of physiological Acid-base balance

→ maintenance of proper hydration, gastric acid & electrolyte balance.

Deficiency

→ Metabolic acidosis especially uncontrolled diabetes & ketosis

→ Renal disease

→ poisoning by acid salt.

→ loss of interstitial fluid by vomiting.

→ Hypernea (↑ Respiration)

Excess :

→ Metabolic Alkalosis due to ingestion of large quantity of alkalis in treatment of acidity.

→ Peptic ulcer

→ High intestinal obstruction

→ Prolonged Vomiting.

MAJOR INTRACELLULAR IONS

(1) Phosphate (PO_4^{3-})

(2) Potassium (K^+)

(3) Magnesium (Mg^{++})

① PHOSPHATE (PO_4^{3-})

Amount present in body → 12g/kg.

Daily requirement → 800 mg.

Major food source

- milk & milk product
- whole grain, legumes
- nuts, egg etc.

Absorption :

: by intestine

Excretion : via Urin & small amount from faeces.

Metabolic function

- It is predominant constituent of bone & teeth.
- Acts as building blocks of several important substance including those used by cell for ATP, cell membrane DNA & RNA, secondary messenger etc.

Deficiency (Hypophosphatemia)

- May be associated to vit D deficiency,
- Hyperparathyroidism
- Rare osteomalacia & cardiac arrhythmia.

Excess (Hyperphosphatemia)

- Hypervitaminosis D, Renal failure,
- Hypoparathyroidism.
- formation of kidney stone

Potassium (K^+)

- Amount in body = 2.6 g/kg
- Daily requirement = 1.5 - 4.5 g

- Major food source
 - milk, fruits,
 - vegetables, legume.
 - whole grain.

- Absorption - fast
- excretion → Urine

⇒ function

- 1) electrolyte, acid-base & H_2O balance
- 2) muscle contraction
- 3) membrane transport

COMPLICATION

Hyperkalemia

- If occur \bar{E} impaired renal function & K^+ retention due to acidosis

Hypokalemia

- leading to ↓ myocardial function, flaccid & feeble muscle,
- Hypotension may occur.

Magnesium (Mg^{++})

→ amount present in body → 0.5 g/kg
 Daily requirement → 350 mg.

Major Source:

Green vegetable, legumes,
 whole grain, nuts, beans, meat
 milk. etc.

→ Absorption - Not really absorb from GIT.
 → Absorption is retarded by alkaline
 media

→ Excretion - t/h Urine, Bile & intestinal
 secretion.

⇒ Function:

- 1) Essential component of ^{some} Enzymes
- 2) Constituents of bones & teeth.
- 3) Essential for protein synthesis
- 4) Smooth functioning of N-M junctions.

Complications

Hypo	Hyper
→ it is due to malnutrition & GIT disorders.	1) Depress the Nervous system.
→ it leads to confusion, tremor & cardiac disorder	2) Higher level can induce anaesthesia and paralysis of skeletal muscles.

ELECTROLYTES USED IN REPLACEMENT THERAPY

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Normally electrolyte concentration remains unchanged in body but due to surgery or other condition, the body can not maintain or correct body electrolyte balance, then this can be maintained by external administration of electrolytes this is called "Electrolyte replacement therapy".

⇒ Types of Electrolyte used for E.R.T.

Solution for rapid initial Replacement	Solution for Subsequent replace.
It have following composition	It have following comp.
1) Na^+ → 130-150 mEq/L	Na^+ → 40-120 mEq/L
2) Cl^- → 98-110 mEq/L	Cl^- → 30-105 mEq/L
3) HCO_3^- → 24-35 mEq/L	HCO_3^- → 16-53 mEq/L
4) K^+ → 4-12 mEq/L	K^+ → 16-35 mEq/L
5) Ca^{2+} → 3-5 mEq/L	Ca^{2+} → 1-15 mEq/L
6) Mg^{2+} → 3 mEq/L	Mg^{2+} → 3-6 mEq/L
	pH → 7.35-7.45

Sodium chloride (NaCl)

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Formula \rightarrow NaCl

M.W. \rightarrow 58.5

Synonyms \rightarrow Rock salt, Table salt

Natural source \rightarrow Rock salt, sea water

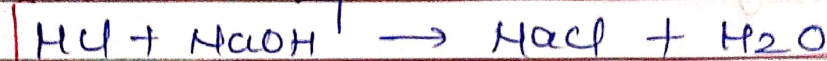
Standard

: NaCl contain not less than 99.0%.

Not more than 100.5% NaCl

Method of Preparation

① \Rightarrow By the reaction of HCl & NaOH



\rightarrow evaporate it now to dry.

② In Industries it is prepared by.

a) evaporating purified saline (sea H₂O)

b) Purifying rock salt.

Properties

1) colour \rightarrow white crystals

2) odour \rightarrow odourless

3) Taste \rightarrow salty

4) Solubility \rightarrow soluble in H₂O / insoluble in Ca(OH)₂

⑤

USES

1) Source of Na⁺ & Cl⁻

2) 0.9% solution of NaCl is isotonic to blood.

2) It is used alone or in combination of other salt.

4) Used as electrolyte replenisher

5) Hypertonic solution induced vomiting.

Preparation of Nacl

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(1) Sodium chloride Eye lotion (B.P.)

- It have 0.85-0.95% w/v Nacl
- It is prepared by dissolving Nacl in purified H₂O, then autoclave

(2) Nacl (B.P.)

- 0.9% w/v Nacl, Prepared by purified H₂O & filtration.
- Use sterile solution

(3) Nacl Injection

- ⇒ It is sterile isotonic solution of sodium chloride in water for injection.
- ⇒ It contain not less than 0.85% & not more than 0.95% w/v of Nacl.

⇒ composition

Nacl → 9 gm

WFI → 1000 ml

⇒ Preparation

- Dissolve above quantity of Nacl into W.F.I.
- filter and sterilize by autoclaving
- It is clear & colourless solution
- stored in single dose container of glass/plastic
- ⇒ Use
As electrolyte replenisher.

④ Nacl & Dextrose injection

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→ It is sterile solution of Nacl & dextrose in ~~H₂O~~ W.F.I.

→ It contain not less than 95% & not more than 105% w/v of stated amount of Nacl & Dextrose.

Preparation

→ Dissolve calculated amount of Nacl & Dextrose in purified water, sterilize & filter it.

Property

→ It is clear and colorless solution.

Use

used as fluid, nutrient and electrolyte

⑤ Mannitol and Nacl Injection

→ It is sterile solution of mannitol and sodium chloride.

→ It is used as electrolyte replenisher cum diuretics.

Potassium chloride (KCl)

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Molecular formula = KCl

M. wt. = 74.55 g/mol

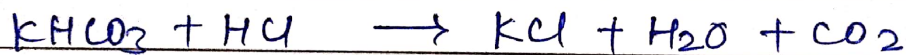
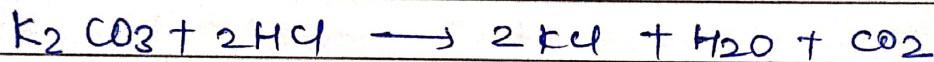
Natural source = Sylvite & Carnallite (minerals)

Standards

KCl contains not less than 99.0% and not more than 100.25% of KCl, calculated on dried basis.

Method of preparation

① Lab: Prepared by reaction of



② From salt

⇒ It is prepared by (KCl.MgCl₂.6H₂O) Carnallite raw salt.

Properties

- 1) It is colorless, prismatic / cubic crystal.
- 2) Odour → Odourless
- 3) Taste → Saline
- 4) Solubility → in water

Uses

- 1) As electrolyte replenisher
- 2) As diuretic, antidote in digitalis poisoning.
- 3) In physiological salt solution (Ringer's)

Preparations of KCl

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① KCl and NaCl I.V. Infusion (B.P.)

⇒ It is a sterile solution containing 95.0 to 105.0% of stated amount of NaCl and KCl.

⇒ The solution is prepared in water for injection, sterilized by autoclave.

⇒ Strength available are.

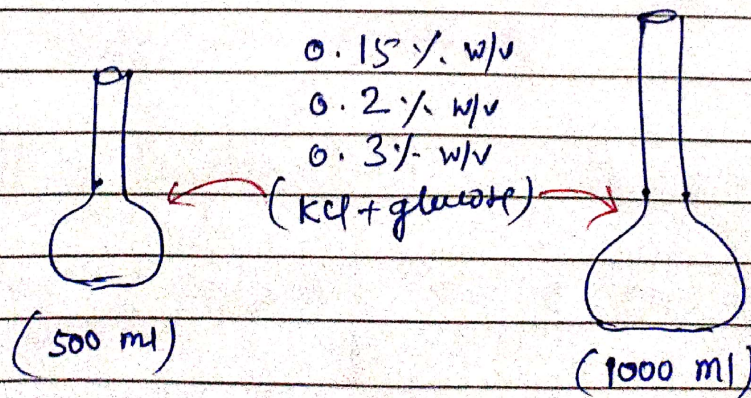
1) 0.15, 0.20, 0.30% w/v KCl each contains 0.9% w/v NaCl in 500 ml & 1000 ml containers.

② KCl and Glucose Intravenous Infusion

→ Sterile solution in water for injection containing KCl 95.0 to 105.0% of stated amount of glucose & KCl.

→ Available strength solutions are

0.15, 0.2 & 0.3% w/v KCl each contain 5.0% w/v glucose in 500 ml and 1000 ml containers.



(3) KCl, NaCl, Glucose Intravenous (B.P.)

sterile solution of w.f.i. containing

KCl \rightarrow 0.3% w/vNaCl \rightarrow 0.18% w/vGlucose \rightarrow 40% w/v

(4) Effervescent KCl Tablet

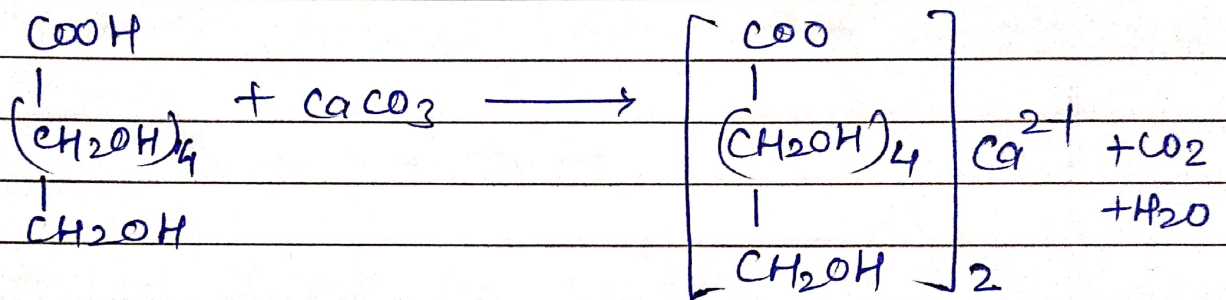
It contains.

KCl \rightarrow 600 mg.KHCO₃ \rightarrow 400 mg.Calcium Gluconate \rightarrow m. formula = C₁₂H₂₂O₁₄Ca.H₂O \rightarrow m. wt. = 448.40 \rightarrow synonym = Calcium D Gluconate
Gluconic acid
Calcium salt. \rightarrow standard

Calcium gluconate contains not less than 98.0% & not more than 102% of calcium gluconate.

 \rightarrow method of PreparationBoiling of Gluconic acid & CaCO₃

↓
 Precipitate is filtered
 ↓
 Product is concentrated.
 ↓
crystallize



Gluconic acid

Calcium Gluconate

* Properties

- It is white, tasteless, odourless, crystalline
- stable in air but loose H₂O on heating.
- soluble in H₂O.

* Uses

- 1) As calcium replenisher
- 2) Injection is useful in urticaria & black widow spider bite.

Preparation

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① Calcium gluconate injection

- It is sterile solution of calcium gluconate in w.f.f.
- calcium gluconate amount must be 8.5-9.4% w/v.
- Calcium D-saccharate is added as stabilizer.

② Calcium Gluconate tablet

- Chewable tablets are available in strength of 0.325g, 0.5g, 0.65g & 1.0 gm.