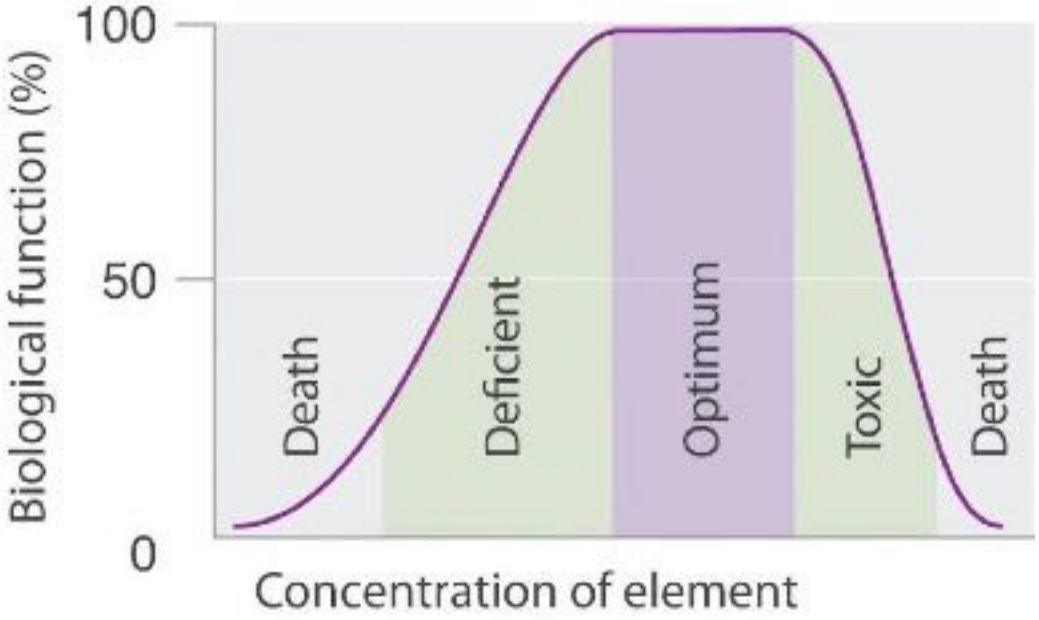

PNU
ESNT
Namaste
مرحبا
Willkommen
Bem Vindo
Selamat Datang
Welcome
Bienvenidos
Benvenuti
Welkom
Bienvenue
Croeso
أهلا وسهلا
Willkommen
добре дошъл
Καλώς ήλθατε

Minerals

Major (bulk) elements

- Na
- K
- Ca
- Cl
- P
- Mg

Trace elements



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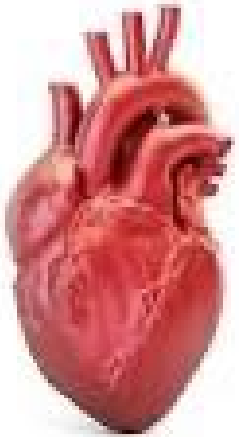


Cations, Na-H2O, small fraction in Plasma Mg??!!

Ca

- Bone mineral
- Factor IV
- Neurotransmission
- Muscle contraction
- Secretion

Ca plasma

- Free ionized
- Albumin bound (ionizable)
- Complexes (P, citrate)

H+ ↑ ionized fraction

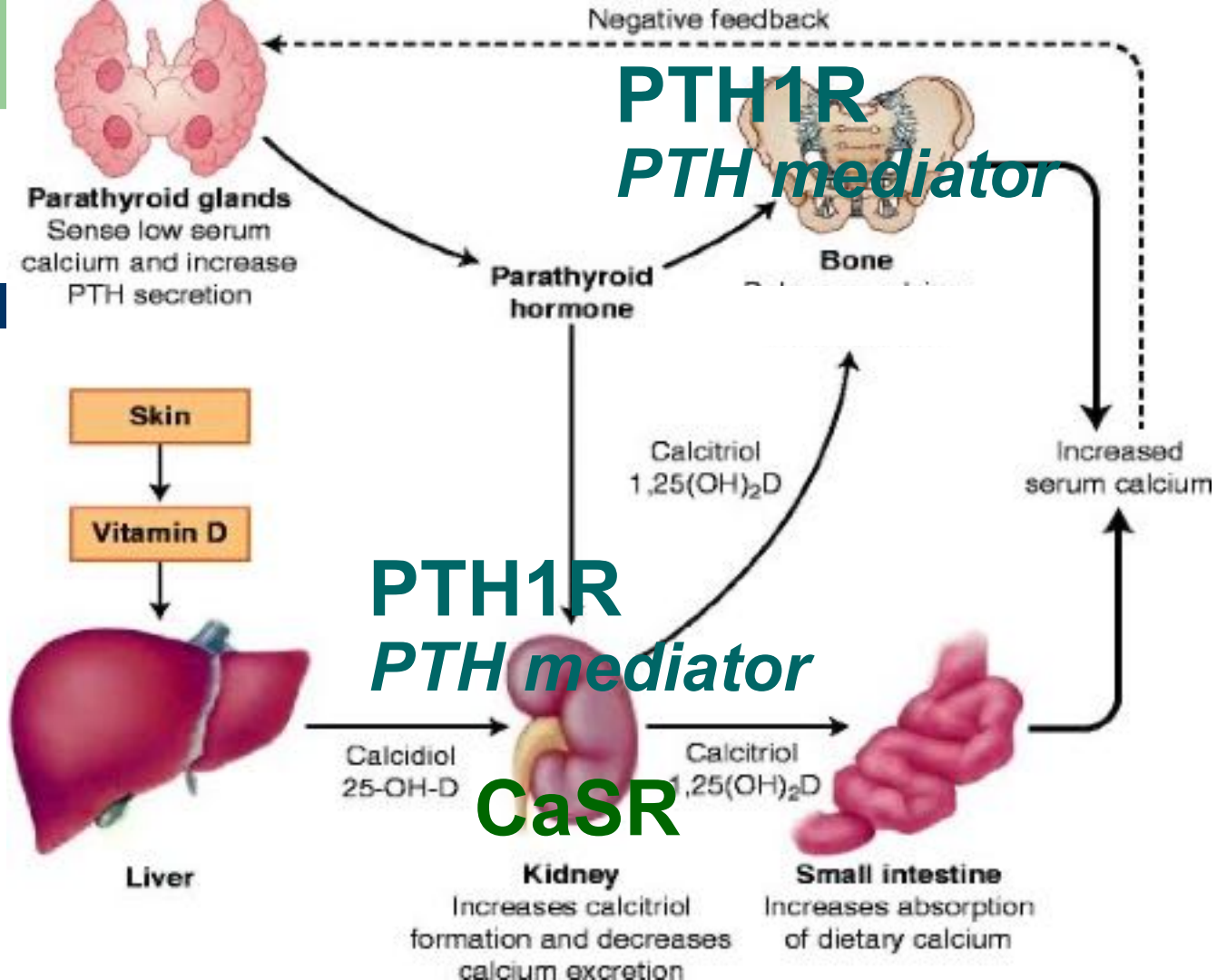
CaSR

PTH

↑Ca↓P

VitD

↑Ca↑P



CaSR

Calcium sensing receptor

Ca

- ↓ PTH
- ↓ tubular Ca reabs

CaSR inactivating mutation

Homozygous →

- **Severe neonatal hyper PTH**

Heterozygous →

- **Familial hypocalcuric hypercalcemia (inappropriately nPTH & low Ca/Cr)**

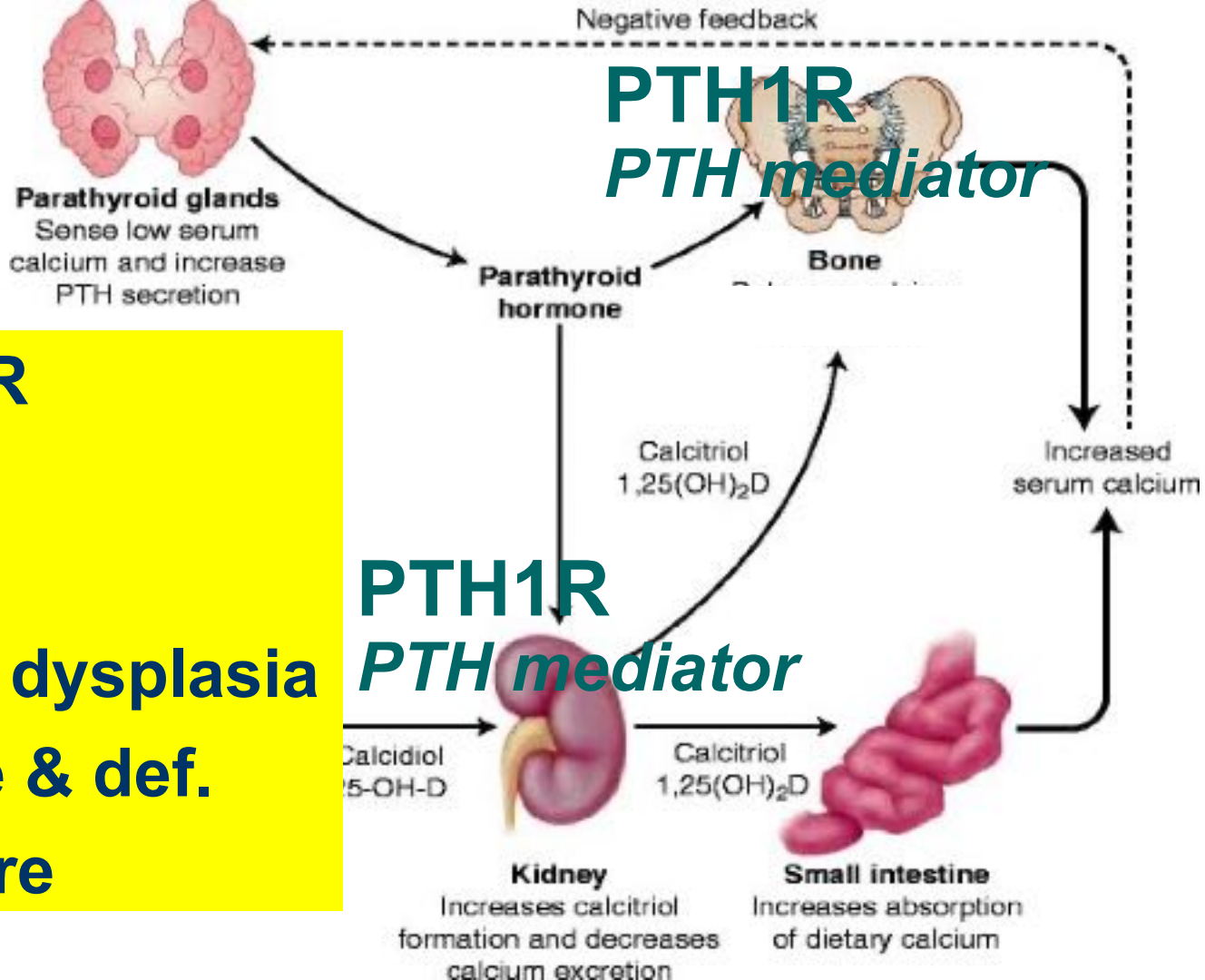
CaSR activating mutation

- Mild asympt. hypoCa & hypercalciuria

AD/ sporadic

Jansen Syndrome

- Active PTH1R
- ↑Ca
- ↓PTH
- Metaphyseal dysplasia
- Short stature & def.
- Extremely rare



Neonatal Ca transition

**** Low fetal PTH & high CT (bone)

- Interrupted maternal Ca supply
- Low tubular Ca reabs

  ➔ rapid ↓ Ca over 24-48h

  ➔ Adaptation
- ↑ PTH secr, tubular responsiveness, Ca intake

•Preterm
•LBW
•Asphyxia
•PIH
•Mat. DM

	Term	Preterm
Hypercalcemia	11 mg/dL iCa>1.4 mmol/L	
Hypocalcemia	8 mg/dL	7 mg/dL
Asymptomatic ttt threshold	7 mg/dL	6 mg/dL

PTH related disorders

↓Ca	↑Ca
Maternal HyperPTH (transient, may prolonged, may be maternal 1st pres.) High maternal Ca intake	Maternal hypoCa ➔ transient neon. hyperPTH
HypoPTH 30% of DiGeorge CaSR act. Mutation	CaSR ➔ severe neonatal hyper PTH
PseudohypoPTH Maternal Vit D def Vit D dependent rickets	Jansen syndrome

Early (First 3 DOL)

- Maternal insulin dependent diabetes
- Prematurity, SGA
- Birth asphyxia
- Toxemia of pregnancy
- Transfusion (citrated blood products)
- Hypomagnesemia
- Sepsis
- Maternal hyperparathyroidism

Phosphates, FFA

Late (DOL 5-10)

- Hypoparathyroidism
  - DiGeorge Syndrome
  - CaSR activating mutations
  - Familial hypoparathyroidism
  - Pseudohypoparathyroidism
- Vitamin D deficiency
  - Nutritional
  - Deficient 1 α-hydroxylase activity
  - VDR mutation
- Ingestion of high phosphate milk
- Nutritional calcium deficiency
- Hypomagnesemia
- Acute/Chronic Renal insufficiency
- Transfusion
- Diuretics (furosemide)

Manifestations

- Asymptomatic
- Jitterness, Irritability, Seizures
- Lethargy, Poor feeding
- Apnea, Cyanosis
- Tachycardia, prolonged QT

Lab. profile

- Ca, iCa, P, Mg
- PTH
- Creatinine, electrolytes, acid-base
- Urine Ca/creatinine
- Vit D metabolites
- Maternal Ca, PTH

Correction

- 1-2 mL/Kg Ca gluconate IV
- Infusion 50-80mg/Kg/24h & taper (6-9 mL/Kg)
- Oral 25-100 mg Ca/kg/d q6h
- Vit D

Neonatal hypercalcemia

- Nutritional: Ca, vit D or low P
- Maternal: Hypo Ca or vit D excess
- PTH: Neonatal severe, familial hypocalciuric, Metaphyseal chondrodysplasia
- Williams, Hypophosphatasia
- Idiopathic infantile hyperCa
- Adrenal insufficiency
- S/C fat necrosis

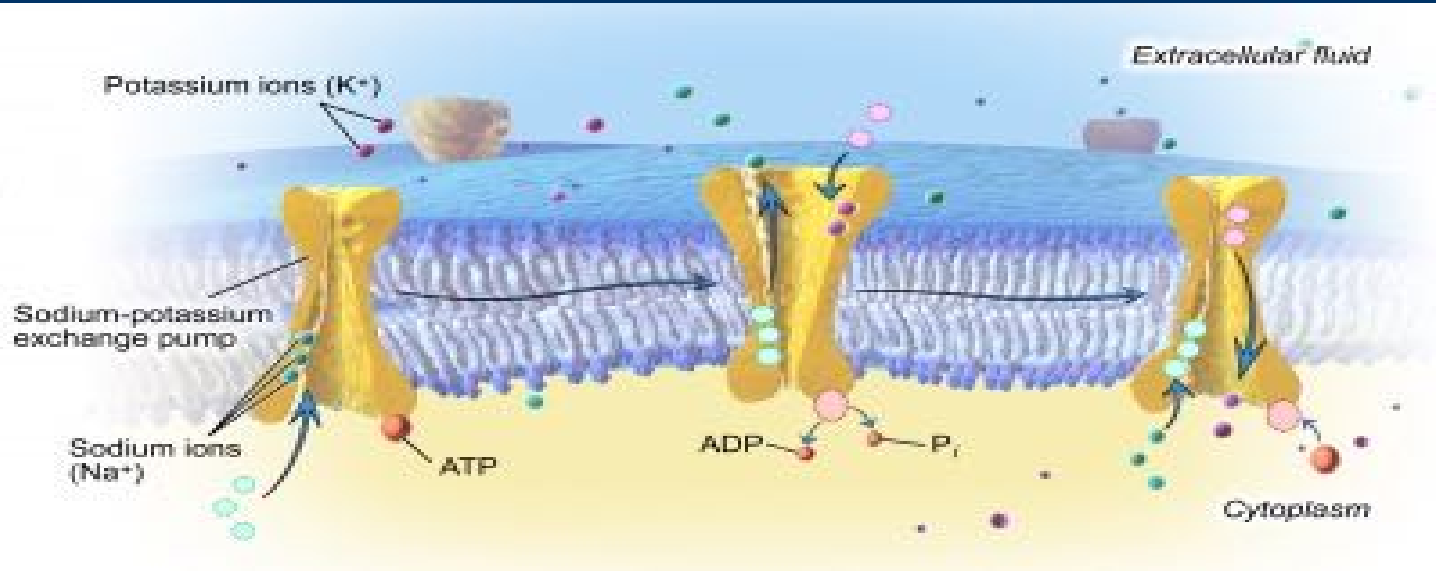
Correction

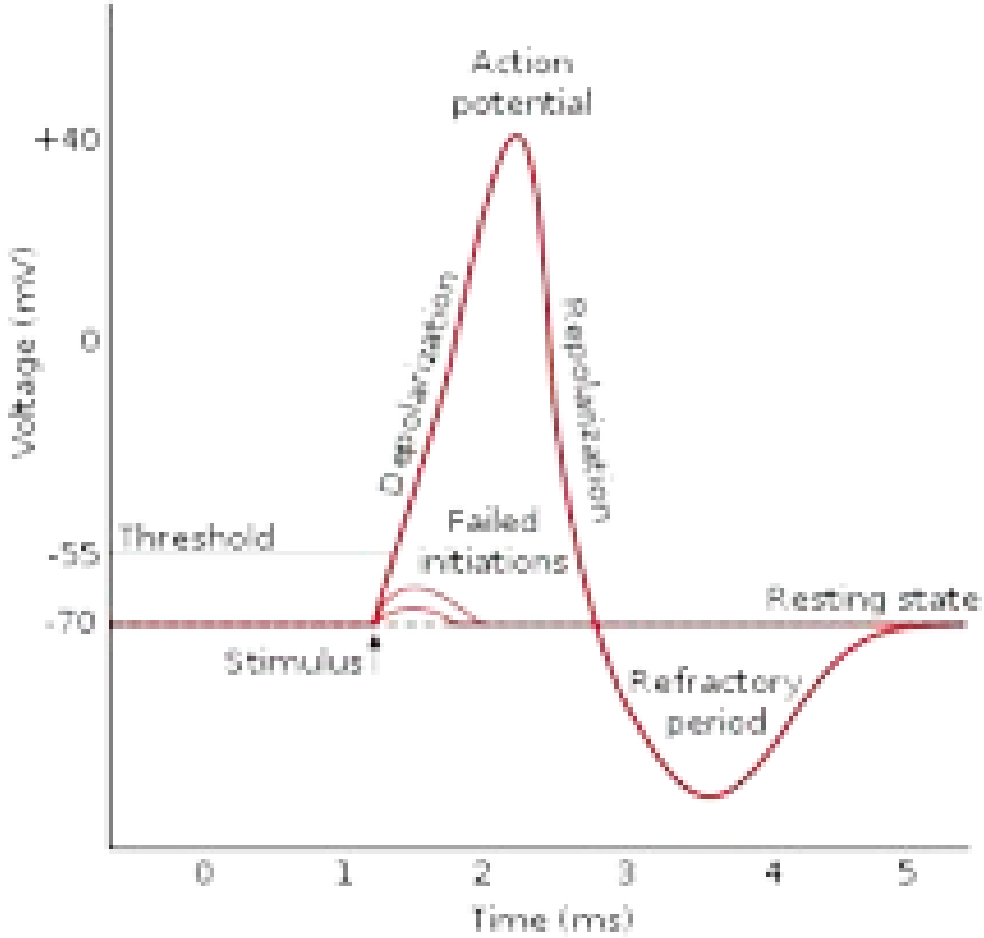
- Reduce/ stop Ca
- Normal saline bolus
- Loop diuretics

+Severe cases:

- Glucocorticoids (inhibit 1-hydroxylase)
- Bisphosphonates
- Dialysis

Main intracellular cation

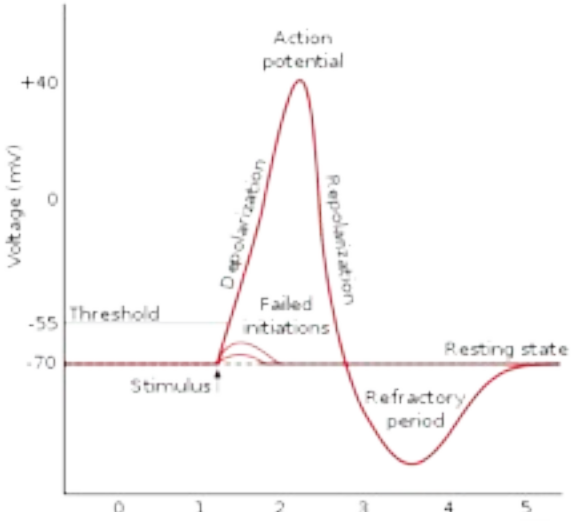


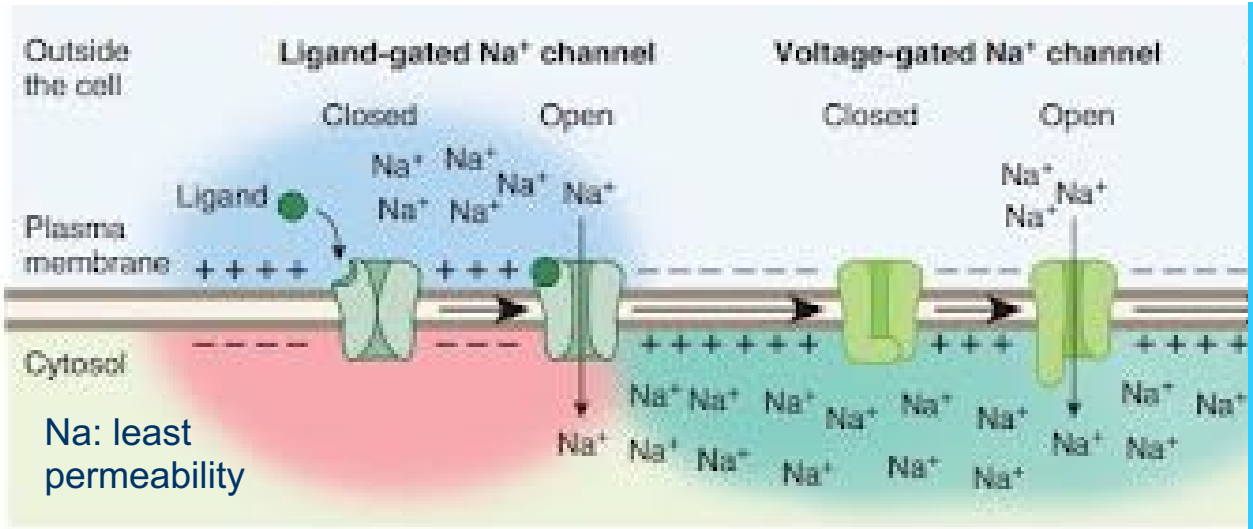

Action potential
+40
0
-55
-70
Voltage (mV)
Depolarization
Repolarization
Threshold
Failed initiations
Resting state
Stimulus
Refractory period
0
1
2
3
4
5
Time (ms)

- **Na depolarisation**
- **K repolarisation**

Electrochemical concordance

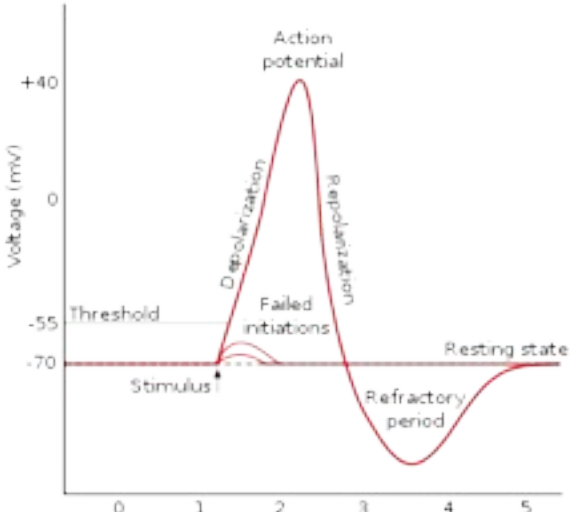
➔ efflux

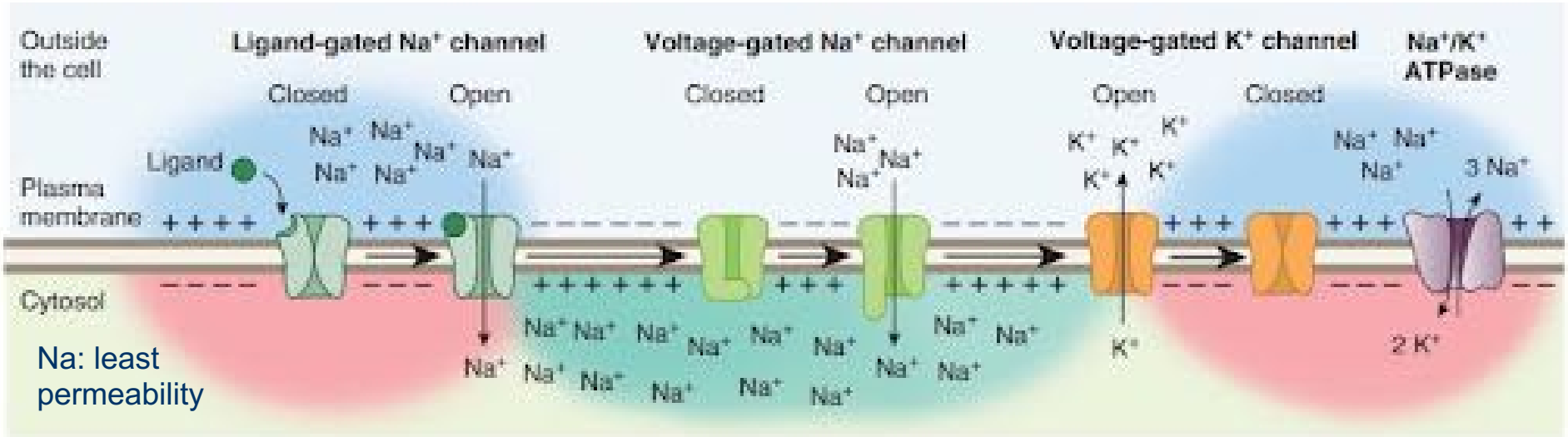




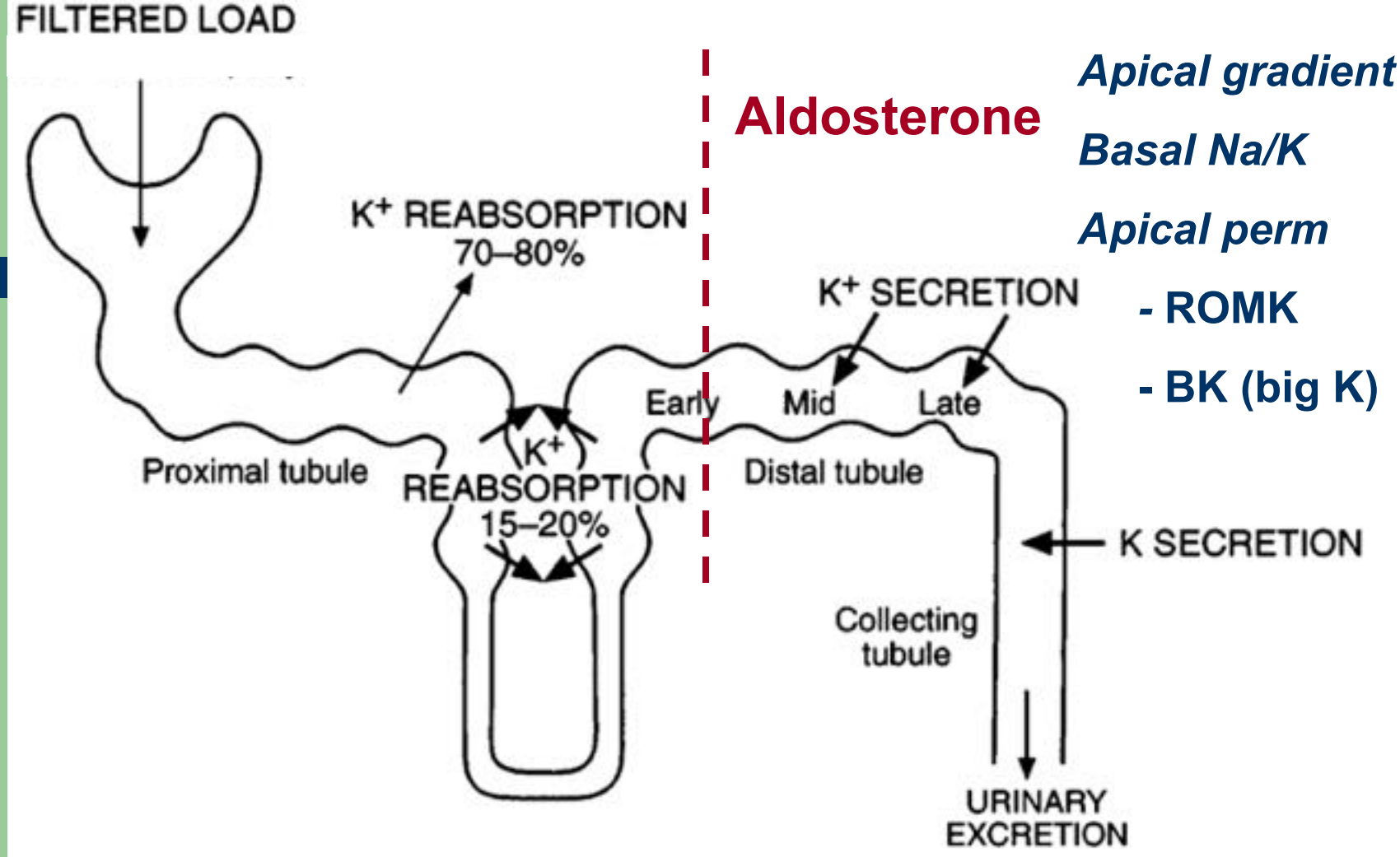
Na: least permeability

- **Calcium (slow) depolarisation**
- **Chloride (muscle) repolarisation**





Na: least permeability



Aldosterone

Apical gradient

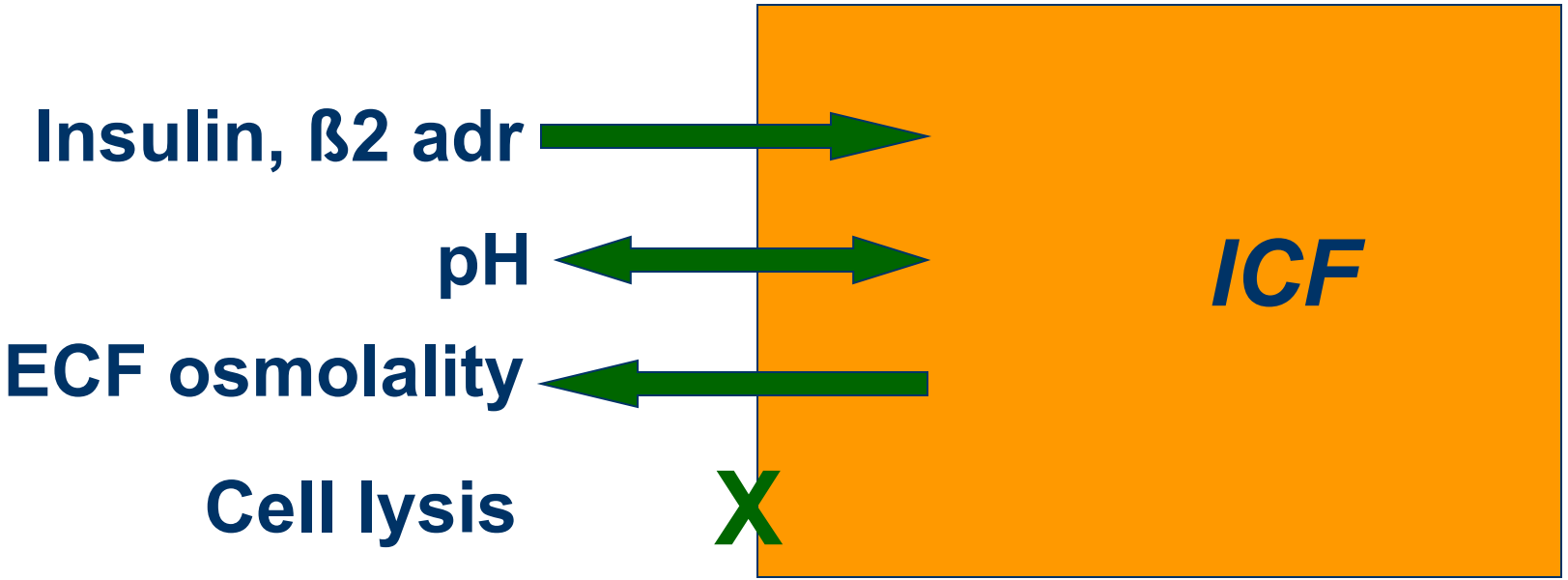
Basal Na/K

Apical perm

- ROMK

- BK (big K)

K: internal balance



Potassium (mEq/L)

!

Neonates:

- **Lower GFR**
- **Lower aldosterone responsiveness**

> 1 year	**3.5-5**
Infants	**4-5.3**
Full-term	**3.7-5.9**
Preterm	**4-6.5**

Precautions

- **Pseudohyperkalemia ?**

Repeat, ECG, manage if expected

- **Interpret with internal balance in mind**
- **Medication errors & high alerts**
- **Massive/ exchange transfusion → K, Ca?**

Hyperkalemia

- Oliguric AKI. Renal anomalies & CKD
- ↓Mineralocorticoid or pseudohypoaldosteronism
- Exogenous: supplements, blood
- Internal: hemolysis, trauma, rhabdomyolysis (crush, inf., seizures, drugs), tumor lysis
- Drugs: ACEs, spironolactone, B blockers, mannitol, NSAIDs, ..

Hyperkalemia

Severe hyper K even asymptomatic with normal ECG can cause sudden death

- **ECG changes, arrhythmias, arrest**
  - ***Peaked T → prolonged PR, flat P →***
  - ***Wide QRS, absent P***
  - ***Sine wave (QRST), asystole***
- **Hypotonia, ileus, resp. depression**

- Stop K & follow
- Nebulized salbutamol 30min
- Bicarbonate for metabolic acidosis 30min
- Exchange resin 0.3-1g/Kg (max.30) q6h 1-6h

(NOT ileus, perforation, intestinal surgery, preterms)

- Corticosteroids (adr insuff.) or diuretics

SEVERE:

- Ca bolus (NOT with HCO_3, digoxin tox.) <3min
- IV salbutamol
- Glucose-insulin (0.5g+1u/Kg bolus → infusion)
- Dialysis 15min

Hypokalemia

- GI (nausea, vomiting, diarrhea, ileus)
- Weakness, hyporeflexia, lethargy, hypoventilation
- Cardiac arrhythmias (rare unless <2.5 mEq/L)
- ECG conduction defects: prominent U wave, prolonged QT, flat or biphasic T, depressed ST. (similar hypoMg)

Intake	
GIT	Vomiting, diarrhea, ileostomy, NG
Renal	Diuretics, polyuria Aminoglycosides, vancomycin, amphotericin, RTA, Bartter, Gitelman, Liddle, Fanconi Hypo Mg (distal secretion)
Endocrine	Steroids CAH, hyperaldosteronism, Cushing, apparent mineralocorticoid excess, hyperthyroidism
Transcellular	Alkalosis, insulin, β agonists

Management points

- HypoK exacerbates digoxin toxicity
- Alkalosis & hypoMg ↑ hypoK
- Correcting acidosis, insulin, glucose & B agonists reduce K further
- ↑ K intake may be all what's needed
- IV correction of deficit
- Rapid correction of deficit or 0.5mmol/Kg/ 1 hr

Thank you

QUESTIONS

Q1

Compared to older children, neonates generally have

A similar GFR when corrected for body size

B higher ratio of intracellular to extracellular fluid

C lower tubular response to aldosterone

D higher serum calcium

Q2

Disorders related to Calcium sensing receptors include the following EXCEPT

A neonatal severe hyperparathyroidism

B familial hypocalcuric hypercalcemia

C AD hypoCa with hypercalciuria

D Jansen syndrome

Q3

Serum potassium can be reduced as a result of

A intravenous calcium injection

B metabolic acidosis

C adrenaline

D exchange transfusion