
20
Ca
Calcium
40.078

CALCIUM

Total body Calcium 1 – 1.5 kg

99% in Bones & Teeth

1% in body Fluids and tissues

SOURCES

Milk and dairy products

Eggyolk , Fish, G.L.V , beans

Cow's milk	100mg/100ml
Human milk	30mg/100ml

RECOMMENDED DAILY ALLOWANCE (RDA):

Adults – 500 mg /day

Children - 1200 mg /day

Pregnancy & Lactation 1500 mg /day

ABSORPTION

SITE : first part and second part of duodenum

Calcium absorbed against concentration gradient and requires energy and a carrier protein.

Factors affecting absorption:

INCREASE THE ABSORPTION RATE

1.CALCITRIOL

2. PARATHYROID HORMONE

3.ACIDITY

4.AMINOACIDS – Lysine and Arginine

FACTORS THAT DECREASE ABSORPTION RATE:

1.PHYTATES

2.OXALATES

3.HIGH PHOSPHATE CONTENT
OPTIMUM RATIO OF CALCIUM TO PHOSPHATE CONTENT– 1:2 TO 2:1----- allows maximum absorption.

4.FREE FATTY ACIDS (FFA)
Ca+ FFA – In soluble calcium soaps (Steatorrhoea)

5. ALKALINE MEDIUM

6. HIGH DIETARY FIBRE

Functions

Functions

1. Mineralisation of Bones and teeth. **Bone is a mineralized connective tissue.**

It contains organic (collagen – protein) and inorganic (mineral) Component,

HYDROXY APATITE – $Ca_{10}(PO_4)_6(OH)_2$

2. Coagulation of Blood

- Calcium is factor IV in coagulation cascade.

Prothromlin (factor II) contains Gla(γ Carboxy glutamate) Residues.

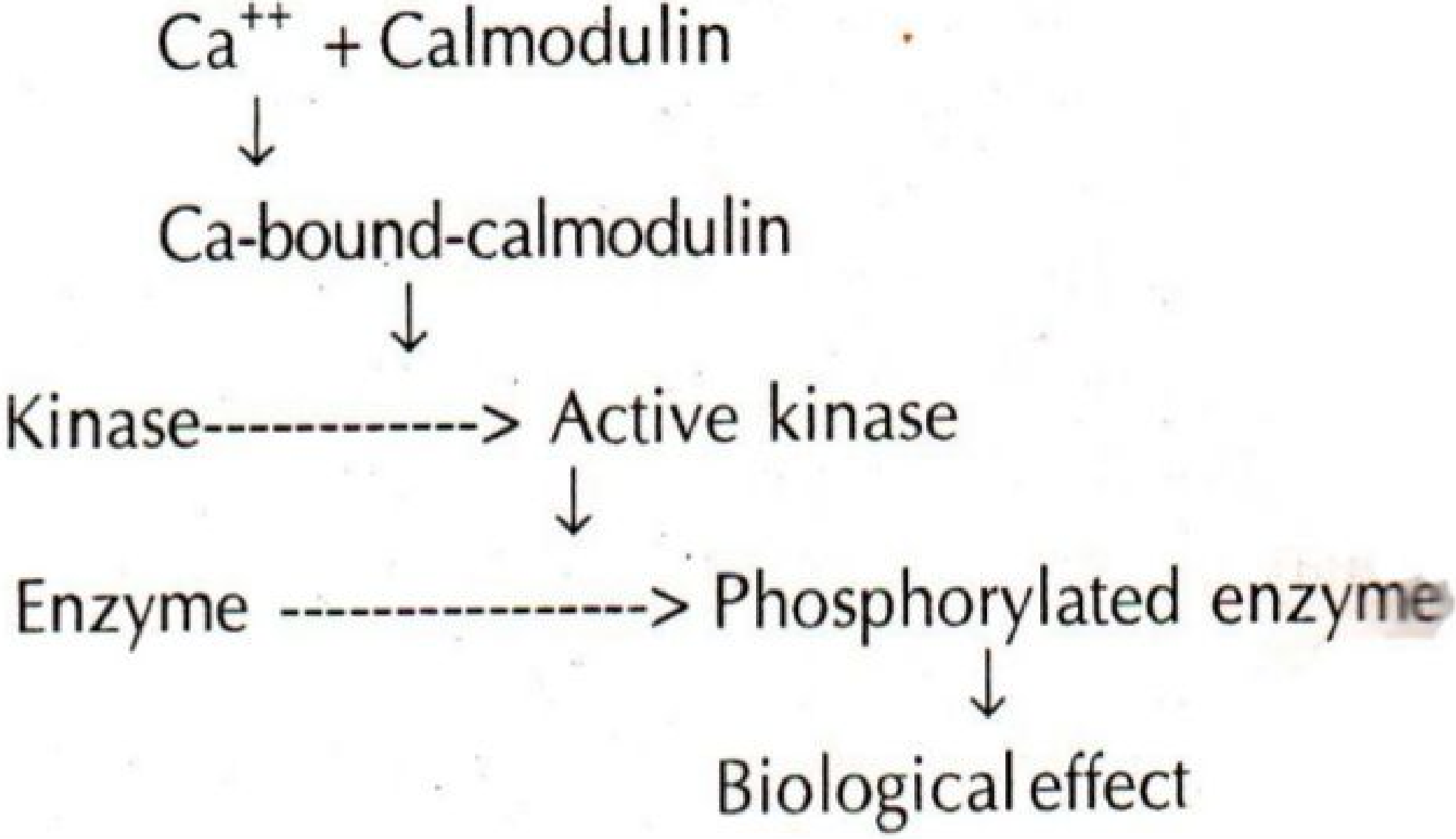
Calcium forms a bridge between Gla residues of prothrombin and membrane phospholipids of platelets

3. Activation of enzymes

Calmodulin is a Calcium binding regulatory protein molwt 17000

Calmodulin can bind with 4 calcium ions

Mechanism of action of Calcium



Mediated by Calmodulin

1. Adenyl cyclase
2. Ca^{++} dependent protein kinases
3. Ca^{++}-Mg^{++} ATPase
4. Glycogen synthase
5. Phospholipase C
6. Phosphorylase kinase
7. Pyruvate carboxylase
8. Pyruvate dehydrogenase
9. Pyruvate kinase.

Mediated by Calmodulin

1. Adenyl cyclase
2. Ca^{++} dependent protein kinases
3. CA^{++}-Mg^{++} ATPase
4. Glycerol – 3 – phosphate dehydrogenase
5. Glycogen synthase
6. Phospholipase C
7. Phosphorylase kinase
8. Pyruvate carboxylase
9. Pyruvate dehydrogenase
10. Pyruvate kinase.

5. Nerves

Calcium is necessary for transmission of nerve impulses from pre-synaptic to post – synaptic region.

6. Secretion of hormones

Calcium mediates secretion of **Insulin, parathyroid hormone, calcitonin, vasopressin,etc**. from the cells

7. Second Messenger in signal Transduction

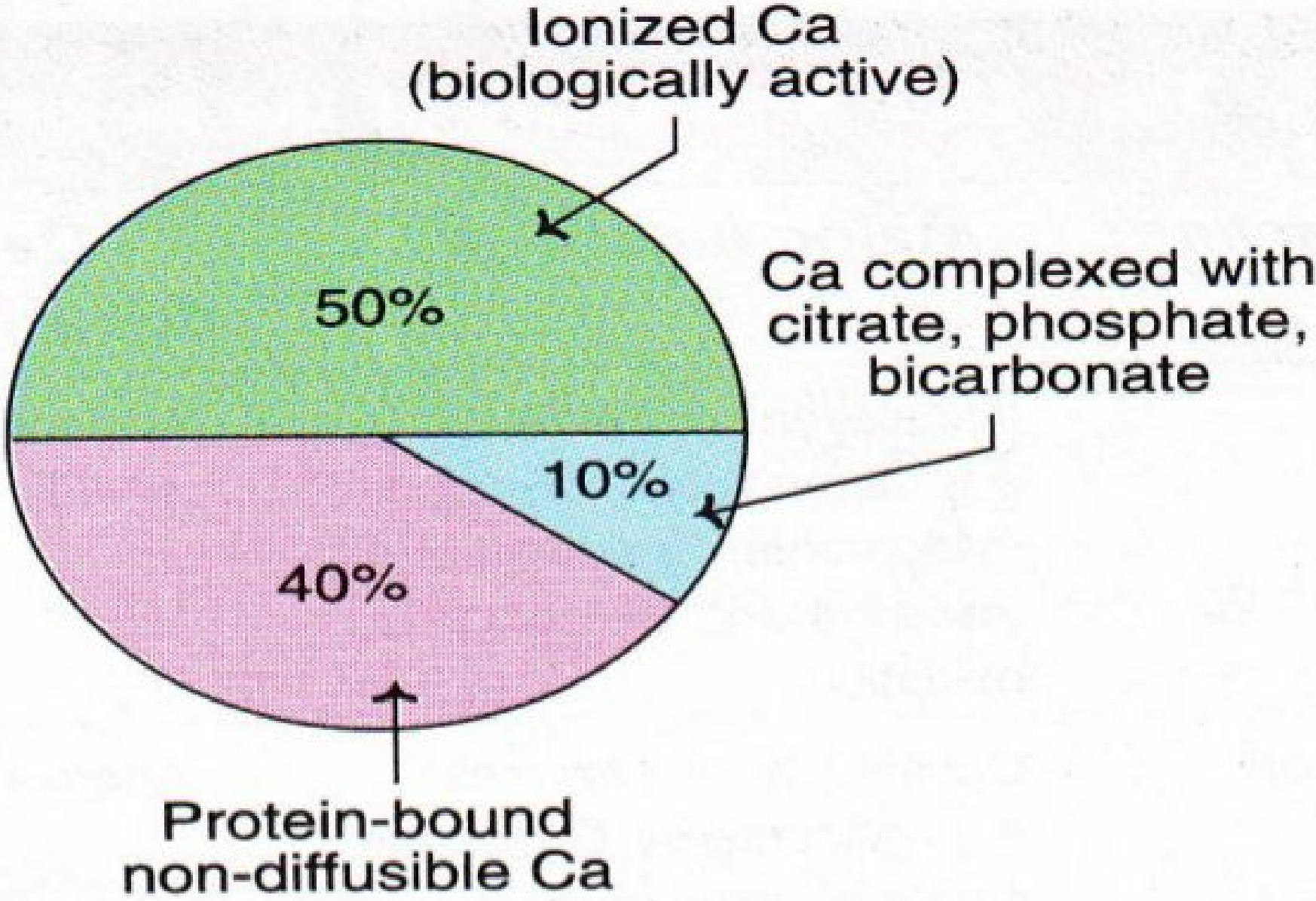
Calcium and cyclic AMP are second messengers of different hormones . One example is glucagon. Calcium is used as second messenger in systems involving G proteins and inositol triphosphate.

8. MYOCARDIUM

In myocardium, Ca^{++} prolongs systole.

In hypercalcemia cardiac arrest is seen in systole.

Caution : when calcium is administered intravenously, it should be given very slowly.



Different forms of circulating calcium.

Normal serum level of calcium -- 9 to 11 mg /dl

Ionized calcium -- 5 mg/dl

Calcium complexed
with Po4, citrate -- 1 mg/dl

Protein bound
Calcium -- 4 mg/dl

IONIZED CALCIUM IS METABOLICALLY / BIOLOGICALLY ACTIVE FORM.

- Hypoalbuminemia results in ↓ of plasma total Calcium levels
- Each 1gm of Albumin ↓ causes ↓ of 0.8mg/dl of Calcium
- Hyperproteinemias (paraproteinemia) are associated with ↑ plasma total Calcium level
- Acidosis favours release of ionized Calcium.
- Alkalosis favours binding of Calcium and decreases ionized Calcium level, but total calcium is normal.

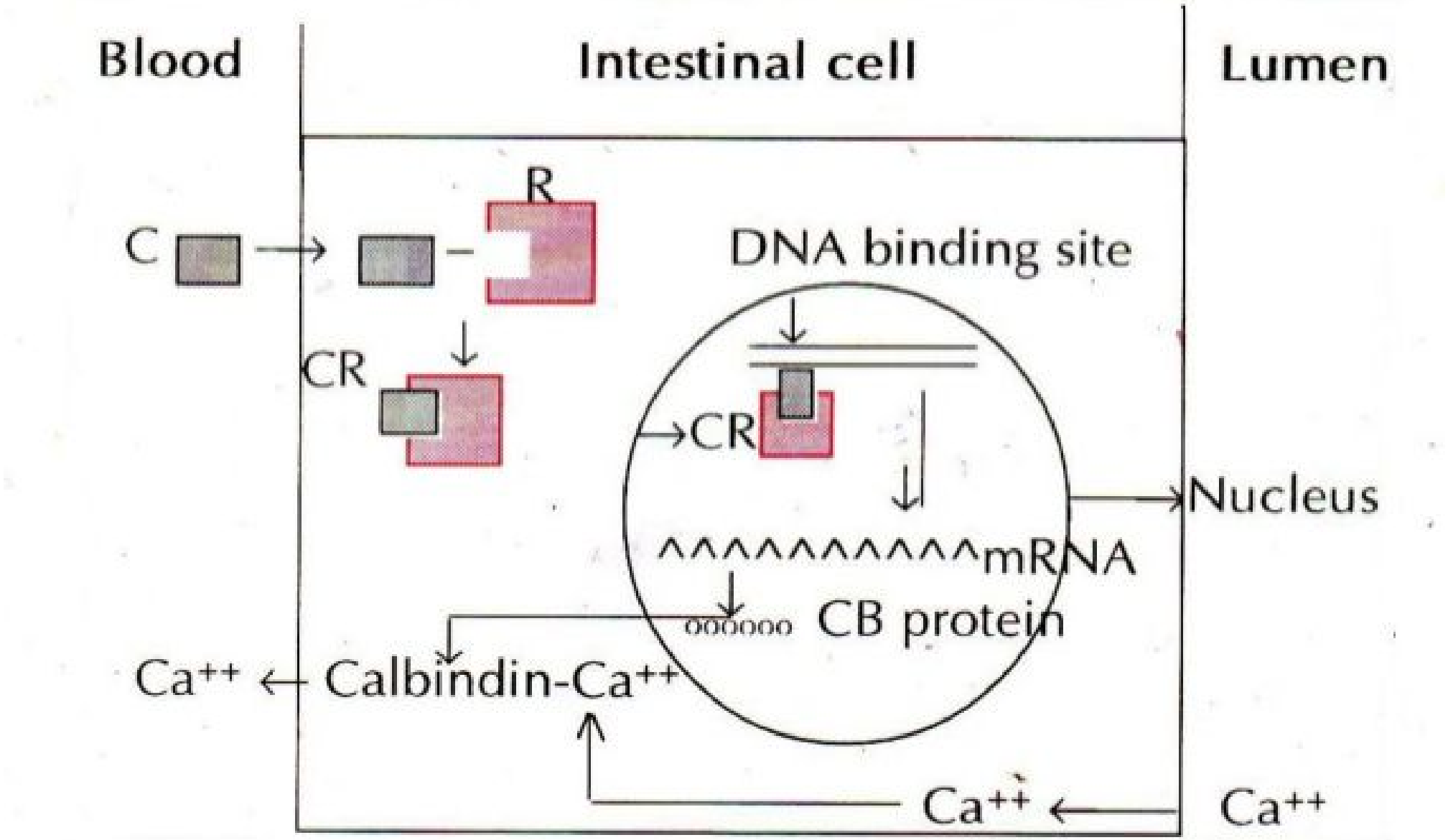
Calcium homeostasis :

Plasma calcium is maintained within narrow limits.

Major factors involved in homeostasis

1.Calcitriol - increase calcium
2.Parathormone - increase calcium

3. Calcitonin - decrease calcium



Calcitriol stimulates calbindin synthesis and increases calcium absorption. C = calcitriol; R = receptor; CR = calcitriol receptor complex; CB = calbindin

Parathormone

- Secreted by chief cells of parathyroid.
- Release of PTH is mediated by c-AMP.
- Three independent sites of action.
  they are **bone , kidney and intestine.**
- **All the 3 actions of PTH increase serum calcium level.**

BONE :

directly

demineralisation /decalcification

induces pyrophosphatase in them.

solubilise calcium

bone

resorption

KIDNEY

PTH has direct action .

- decreases renal excretion of calcium (mainly by increased reabsorption of calcium from distal tubules)and increases phosphate excretion.

Intestine

PTH stimulates 1 –hydroxylation of 25-cholecalciferol

↓

Forms **calcitriol**

↓

Calcitriol induces **synthesis of calbindin**

↓

Calbindin **increase calcium absorption** from intestine

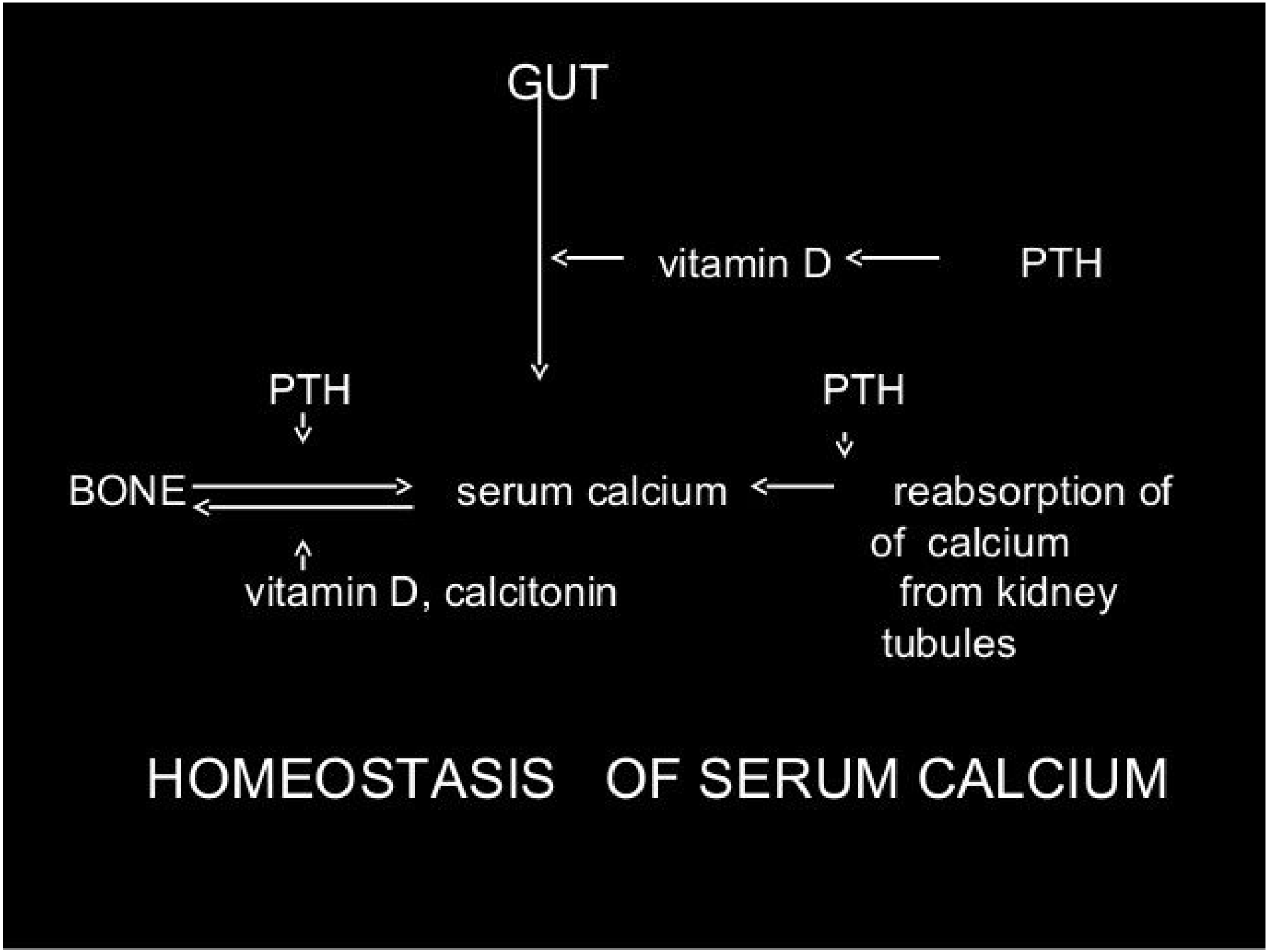
↓

Thereby **increasing calcium level in blood**.

Calcitonin :

secreted by parafollicular cells of thyroid.

- Calcitonin promotes calcification by increasing the activity of osteoblasts.
- Calcitonin decreases bone resorption.
- It increases the excretion of Ca in urine.
- Overall it decreases blood Ca level.


GUT
vitamin D
PTH
PTH
PTH
BONE
serum calcium
reabsorption of
of calcium
from kidney
tubules
vitamin D, calcitonin
HOMEOSTASIS OF SERUM CALCIUM

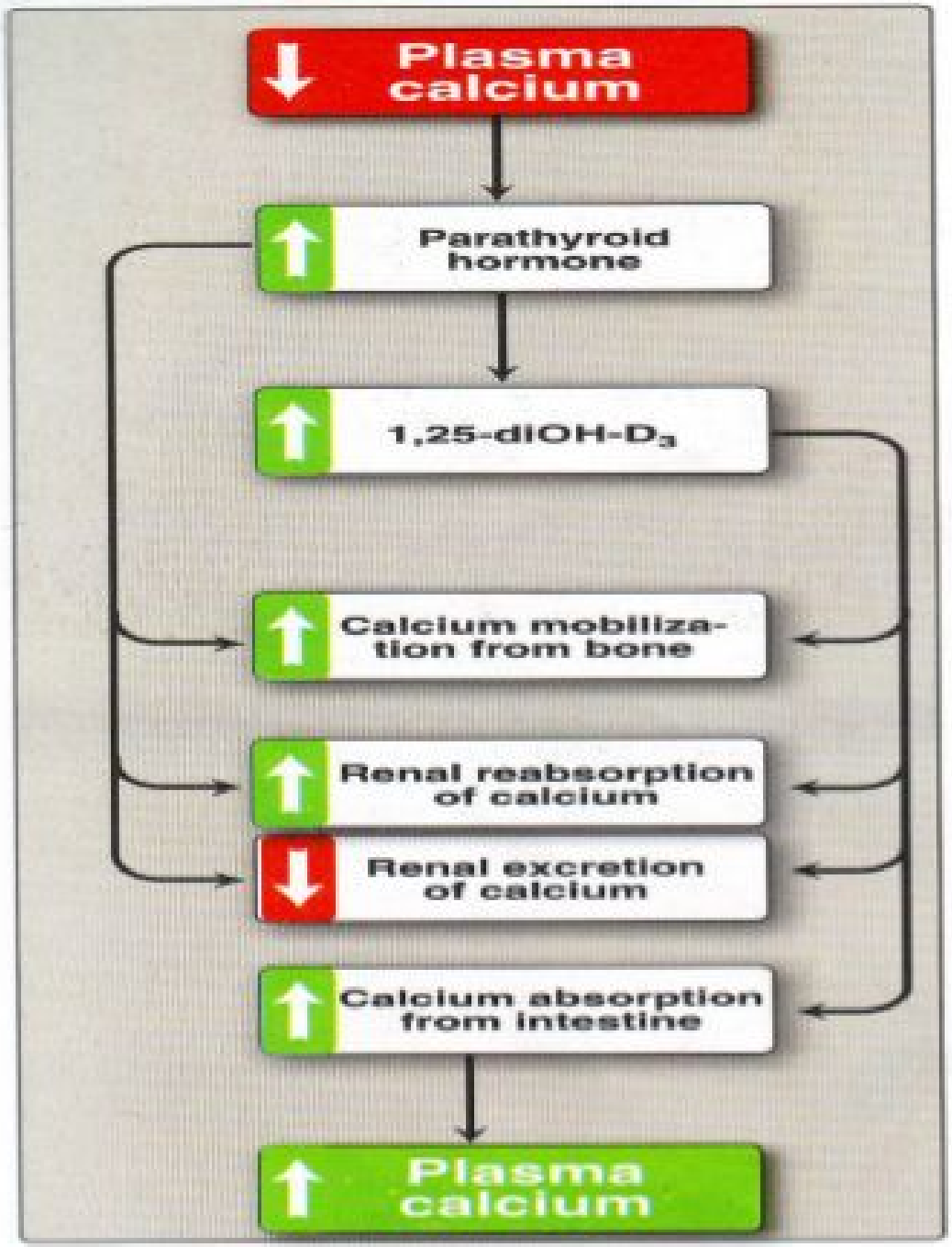


Figure 28.24
Response to low plasma calcium.

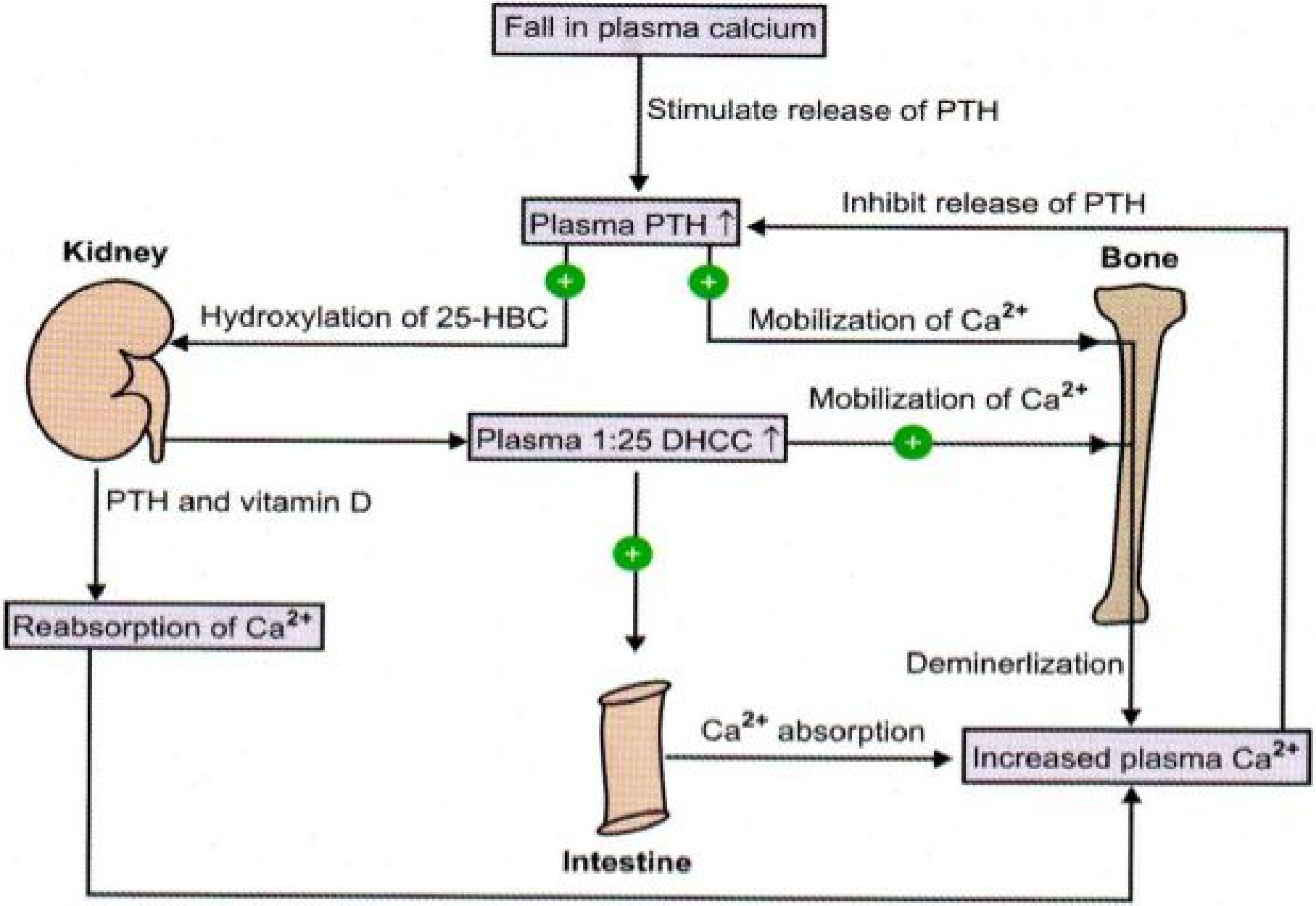


Figure: 17.2: Homeostasis of plasma calcium

25-HCC = 25-Hydroxycholecalciferol and 1:25 DHCC = 1:25 Dihydroxycholecalciferol

Importance of *Ca : P ratio*

Product of Ca x P (10 x 4)

Normal Adults – 40
Children – 50
<30 Rickets

Normal Ca : P ratio is essential for bone mineralisation.

Hypercalcemia :

causes :

1.**hyperparathyroidsm** – characterised by
increase serum calcium
decrease in serum phosphate and
increase in alkaline phosphatse activity.

2. Multiple myeloma

3. Pagets disease

4. Secondary bone cancer

Clinical features of Hypercalcemia

- Neurological symptoms

Depression, Confusion, irritability

- Generalised Muscle Weakness
- GIT : Anorexia
  Abdominal Pain
  Nausea
  Vomiting
- CVS:
  Cardiac arrythmias

Hypocalcemia:

serum calcium level < 8.8 mg/dl ---- hypocalcemia.

Serum calcium level < 7 mg/dl -- TETANY.

Causes:

1.accidental surgical removal of parathyroid

2. Pseudohypoparathyroidism – lack of end organ response

3.Renal disease

4. Liver disease

5. Vitamin D deficiency

6. Malabsorption syndromes
7. Renal rickets
8. osteoporosis

Clinical features of Tetany:

- Neuromuscular irritability
- Spasms- laryngeal spasm lead to death.
- Convulsions
- Muscular cramps

ECG changes –Q-T interval increased


Thank You!