



# **MINERALS METABOLISM**

# Classification of minerals in human body:

\* According to body needs, minerals are divided into:

## 1-Major [Macronutrients]:

- They are required in amounts  $>100$  mg/day
- **They include:** calcium, phosphorus, potassium, sodium, magnesium and chloride

## 2-Trace elements [Micronutrients]:

- They are required in amounts  $<100$  mg/day
- **They include:** iron , copper , zinc , manganese , chromium , iodine , fluoride , cobalt , molybdenum , selenium and silicon .

# Ca

## Function

### 1. **B**one mineralization:

Ca is an essential element in bone and teeth.

### 2. **B**lood coagulation and **m**ilk clotting.

### 3. **M**embrane permeability.

### 4. **M**uscle and Nerve excitability.

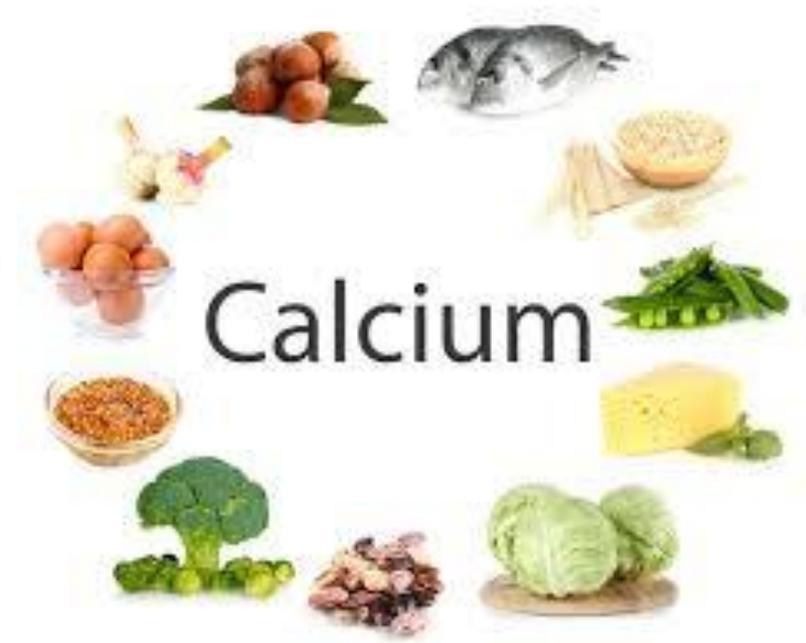
# Ca Function

5. Second messenger of many hormones

6. For activity of some enzymes  
(Lipase, amylase)

# Ca Sources

- \* **Milk and its product,**
- \* **Fish,**
- \* **Egg yolk,**
- \* **cabbage, cauliflower**



# Factors affecting Ca absorption

- \* **1. Active vitamin D (Calcitriol):**

- \* **2. Para thyroid hormone (PTH)**

- They are produced in response to low plasma Ca.

- ↑ intestinal absorption of calcium.

# Factors affecting Ca absorption (cont.)

## 3. pH of intestinal contents:

- Acidic pH: **increase** Ca absorption
- Alkaline pH: **decrease** Ca absorption

## 4. Dietary factors:

- Lactose and high protein diet: **increase** Ca absorption
- Phytate, oxalate (insoluble Ca salts) and fatty acids **decrease** Ca absorption

# Control of blood calcium

-Normal Plasma Ca level is **9-11 mg/dl**

-It is regulated by action of calcitriol,

PTH and calcitonin on intestine, kidney

and bone.

# Control of blood calcium

## 1. Calcitriol:

❑ Produced in response to low calcium & phosphorus level.

❑ It increases their levels by:

- ✓ Increasing their intestinal absorption
- ✓ Increasing their renal tubular reabsorption.
- ✓ Stimulate bone resorption in case of low calcium level

Small Intestine

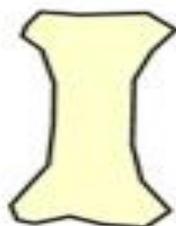


*Ca absorption*

Vitamin D



Bone



*Bone resorption*

Vitamin D

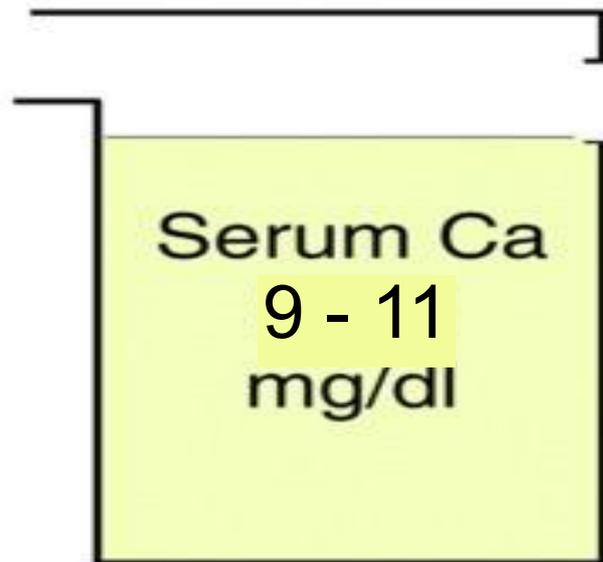


Kidney



*Ca reabsorption*

Vitamin D



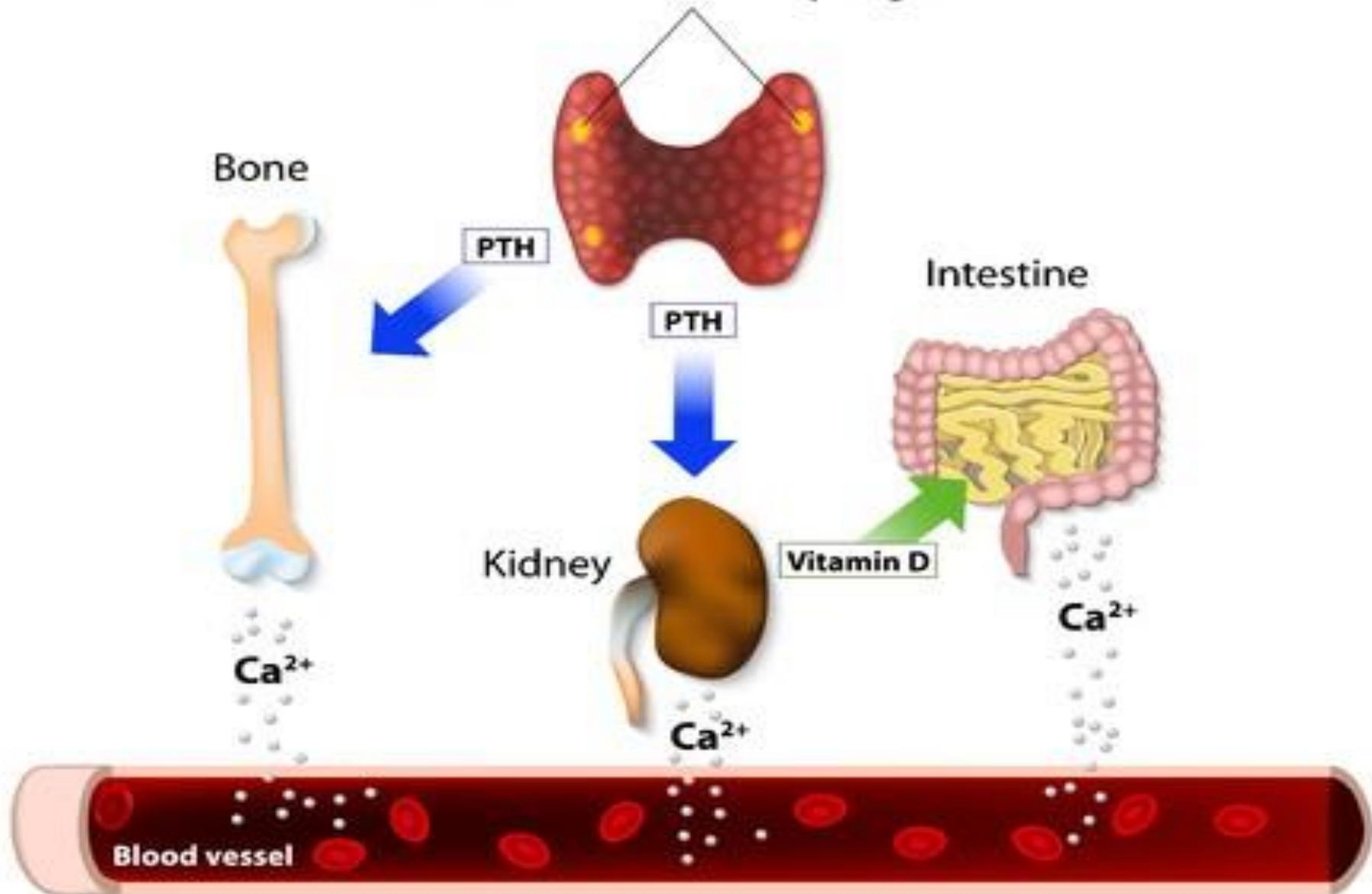
# Control of blood calcium

## 2.PTH:

- secreted from parathyroid gland in response to low plasma calcium level.
- It increases calcium level by the same mechanism as calcitriol + help activation of vit D (Activates renal 1 $\alpha$ -hydroxylase)

# PARATHYROID GLANDS

(located on the back of the thyroid gland)

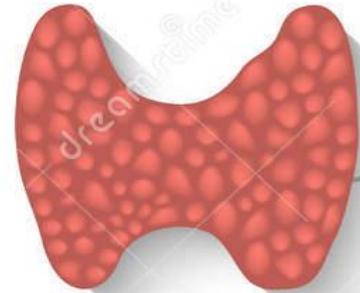


# Control of blood calcium

## 3. Calcitonin:

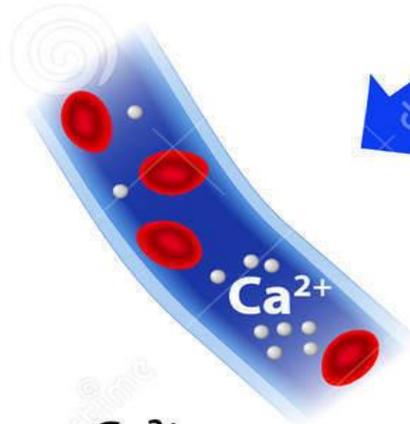
- ❑ Secreted from para follicular cells of thyroid gland
- ❑ Lower both plasma calcium and phosphorus by:
  - ✓ Inhibiting calcium mobilization from bone.
  - ✓ Decreasing renal tubular reabsorption of calcium & phosphorus ( increases Ca and Ph excretion).

## Thyroid gland



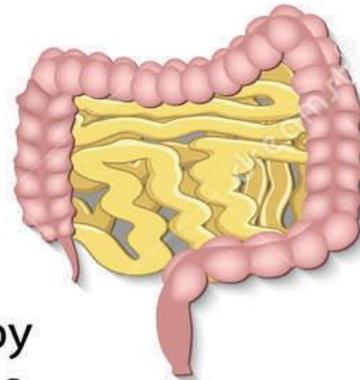
**Calcitonin**

Inhibits  $\text{Ca}^{2+}$  reabsorption in the kidney (excreted in the urine)



Lowers  $\text{Ca}^{2+}$  levels in blood

Inhibits  $\text{Ca}^{2+}$  absorption by the intestines



Promotes deposition of  $\text{Ca}^{2+}$  into bones (inhibits osteoclasts and stimulates osteoblasts)



# Disorders of blood calcium level

## Hypocalcemia

Blood level < 9 mg/dl.

### Causes:

- 1) Hypo-parathyroidism.
- 2) Vit D deficiency.
- 3) Alkalosis.
- 4) Hypoproteinemia.
- 5) Impaired renal function (inability to activate vit D)

→ bone deformity (Rickets and osteomalacia).

## Hypercalcemia

Blood level > 11 mg/dl

### Causes:

- 1) Hyperparathyroidism.
- 2) Vit D toxicity.

→ Pathological bone fracture & Urinary calculi

# Iron

- \* **Sources:**
- \* **Animal sources:** meat, egg yolk, liver, spleen, heart, kidney.
- \* **Plant sources:** dates, spinach, nuts.



# Function

- \* **Formation of: HB, myoglobin, some enzymes (eg: respiratory cytochromes- cytochrome P450 peroxidases and catalases)**

# Control of Iron absorption

## Factors increasing absorption



- \* Gastric HCl.
- \* Reducing substances (e.g. vitamin C)

## Factors decreasing absorption



- \* High dietary phosphate, oxalate, phytate (spinach is poor source)
- \* fatty acids
- \* Increased intestinal pH
- \* Gastrectomy.

# Disorders of iron:

## 1. Iron deficiency

### Causes:

- \* **decrease intake** e.g. high cereal diet, low in meat.
- \* **Decrease absorption** e.g. diarrhea, intestinal diseases.
- \* **Excessive blood losses.**

Leads to **iron deficiency anemia.**

# Iron overload

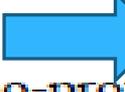
## Causes:

- \* **1. Excessive injectable iron.**
- \* **2. Repeated blood transfusion.**
- \* **3. Inherited anomaly of increased iron absorption.**

Leads to Hemosiderosis : deposition of iron in -**liver** → liver cirrhosis

-**skin** → bronzed pigmentation

-**pancreas** → bronzed diabetes

Trace element	Functions
<u>Copper</u>	<ul style="list-style-type: none"> <li>• Essential for: <u>Hb synthesis, bone formation, maintenance of myelin.</u></li> <li>•  Constituent of: L-ascorbic acid oxidase, cytochrome oxidase, tyrosin hydroxylase, dopamin, lysyl, prolyl hydroxylases.</li> </ul>
<u>Zinc</u>	<ul style="list-style-type: none"> <li>•  Component of some enzymes e.g. alcoholic dehydrogenase, alkaline phosphatase, carbonic anhydrase and retinal reductase.</li> <li>• Important for: <u>-Insulin storage &amp; release.</u></li> <li>- <u>Reproduction, tissue repair and wound healing.</u></li> <li>- Vit A mobilization from liver.</li> </ul>
<u>Manganese</u>	<ul style="list-style-type: none"> <li>• Essential for <u>normal bone structure, function of CNS and spermatogenesis.</u></li> <li>• Involved in activation of many enzymes e.g; <ul style="list-style-type: none"> <li>-  Glycosyl transferase (mucopolysaccharides and glyco-protein synthesis).</li> <li>- Pyruvate carboxylase (in gluconeogenesis).</li> </ul> </li> </ul>
<u>Iodine</u>	<p><u>Formation of thyroid hormones.</u></p>
<u>Chromium</u>	<p>Component of <u>chromodulin protein which act as potentiator of insulin action</u> (facilitate its binding to cell receptor sites and uptake of glucose i.e. it is a glucose tolerance factor).</p>

