CALCIUM

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Calcium is the most abuandant among the minerals in the body. The total content of calcium in an adult man 1 to 1.5kg. 99% of it is present in the bones and teeth and small fraction (1%) of the calcium, found outside the skeletal tissue, perform a wide variety of fucnctions.

BIOCHEMICAL FUNCTIONS

1. **Development of bone and teeth:** Ca^{+2} along with phosphate is required for the formation of (hydroxyapatite) and physical strength of skeletal tissue. Bone is regarded as a mineralized connective tissue. Bone which are in a dynamic state serve as reservoir of Ca^{+2}
2. **Muscle contraction:** Ca^{+2} interacts with troponin C to trigger muscle contraction. Ca^{+2} also activates ATPase, increases the interaction between actin and myosin .

BIOCHEMICAL FUNCTIONS

3. **Blood coagulation:** several reactions in the cascade of blood clotting process are are dependent on Ca^{+2}
4. **Nerve transmission:** Ca^{+2} is necessary for the transmission of nerve impulse.
5. **Membrane integirty and permeability:** Ca^{+2} influences the membrane structure and transport of water and several ions across it
6. **Activation of enzymes:** Ca^{+2} is needed for the direct activation of enzymes such as lipase (pancreatic), ATPase and succinate dehydrogenase

BIOCHEMICAL FUNCTIONS

7. Calmodulin mediated action of Ca^{+2} : Calmodulin (mol. Wt. 17,000) is a Ca^{+2} binding regulatory protein.ca-calmodulin complex activates certain enzymes e.g adenylate cyclase, Ca^{+2} dependent protein kinases.

8. Calcium as intracellular messenger: certain hormones exert their action through the mediation of Ca^{+2}(instead of cAMP). Calcium is regarded as a second messenger for such hormonal action e.g. epinephrine in liver glycogenolysis. Ca^{+2} serves as a third messenger for some hormones e.g. antidiuretic hormone (ADH) acts through cAMP, and then Ca^{+2}

9. Release of hormones: The release of certain hormones (insulin, PTH,calcitonin) from the endocrine glands is facilitated by Ca^{+2}

BIOCHEMICAL FUNCTIONS

10. **Secretory processes:** Ca^{+2} regulates microfilament and microtubule mediated processes such as endocytosis and exocytosis and cell motility.

SOURCES / ABSORPTION

Best sources ------ Milk and milk products

Good sources ---------- Beans, leafy vegatables,fish, cabbage, egg yolk.

Absorption: The absorption of Ca^{+2} mostly occurs in the duodenum by an energy dependent active process.

DIETARY REQUIRMENTS

Adult men and women ---------- 800 mg/day

Woman during

Pregnancy, laction

and post-menopause ---------- 1.5g/day

Children (1-18 yrs) ---------- 0.8- 1.2 g/day

FACTORS PROMOTING CA ABSORPTION

1. Vitamin D (through its active from calcitriol) induces the synthesis of Ca^{+2} binding protein in the intestinal epithelial and promotes Ca absorption.
2. Parathyroid hormone enhances Ca absorption through the increase synthesis of calcitriol.
3. Acidity (low pH) is more favourable for Ca absorption
4. Lactose promotes Ca^{+2} uptake by intestinal cells.
5. The amino acids lysine and arginine facilitate Ca absorption.

FACTORS INHIBITING CA ABSORPTION

1. Phytates and oxalates form insoluble salts and interfere with Ca absorption
2. High content of dietary phosphate results in the formation of insoluble Ca^{+2} phosphate and prevents Ca uptake. The dietary ratio of Ca and P----- between 1 : 2 and 2 : 1-----is ideal for optimum Ca absorption by intestinal cells
3. Alkaline condition (high pH) is un-favourable for Ca absorption
4. High content of dietary fiber interferes with Ca absorption.

PLASMA CALCIUM

Most of Ca^{+2} is present in the plasma since the blood cells content very little of it. The normal concentration of plasma or serum Ca is 9–11 mg/dl (4.5–5.5 mEq/l).

FACTORS REGULATING PLASMA CA LEVEL:

The hormones ------- Calcitriol, parathyroid hormone (PTH) and calcitonin are the major factors that regulate the plasma calcium.

ROLE OF PTH

- Stimulates renal reabsorption of calcium
- Inhibits renal reabsorption of phosphate
- Stimulates bone resorption
- Inhibits bone formation and mineralization
- Stimulates synthesis of calcitriol

Net effect of PTH
→

↑ serum calcium
↓ serum phosphate

REGULATION OF PTH

Low serum [Ca^{+2}] → Increased PTH secretion

High serum [Ca^{+2}] → Decreased PTH secretion

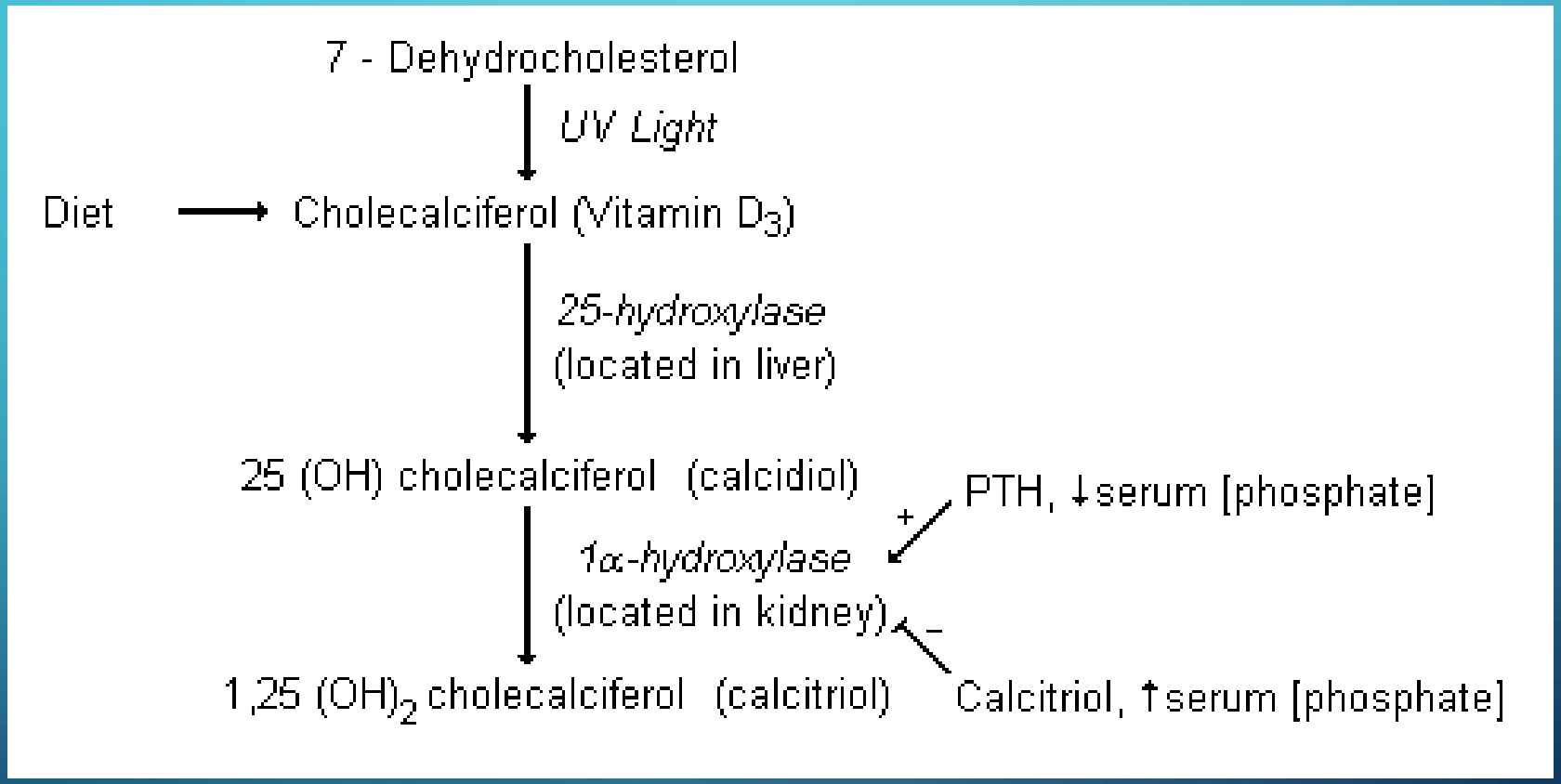
ROLE OF CALCITRIOL

- Stimulates GI absorption of both calcium and phosphate
- Stimulates renal reabsorption of both calcium and phosphate
- Stimulates bone resorption

Net effect of calcitriol →

↑ serum calcium
↑ serum phosphate

REGULATION OF CALCITRIOL



CALCITONIN

Calcitonin is peptide containing 32 amino acids. It is secreted by parafollicular cells of thyroid gland. The action of CT on calcium metabolism is antagonistic to that of PTH. Calcitonin promotes calcification by increasing the activity of osteoblasts.

Importance of Ca : P ratio: The ratio of plasma Ca : P is important for calcification of bones. The product of Ca x P (in mg/dl) in children is around 50 and in adults around 40. This product is less then 30 in Rickets.

DISEASE STATES HYPERCALCEMIA

Elevation in serum Ca level

(normal 9-11mg/dl) is hypercalcemia. Hypercalcemia is associated with hyperparathyroidism caused by increased activity of parathyroid glands. Decreased in serum phosphate (due to increased renal losses) and increase in alkaline phosphate activity are also found in hyperparathyroidism. Elevation in the urinary excretion of Ca and P, often resulting in the formation of urinary calculi, is also observed in these patients.

- In urine calcium is excreted which may cause inhibition of elimination of chloride , this may lead to hyperchloremic acidosis
- Calcium may be precipitated in urine leading to recurrent bilateral urinary calculi.
- Ectopic calcification may be seen in renal tissue , pancreas , arterial walls and muscle tissues (myositis ossificans)
- RENAL RICKETS