

CALCIUM METABOLISM

Calcium metabolism is the movement and regulation of calcium ions (Ca^{2+}) in (via the gut) and out (via the gut and kidneys) of the body and between body compartments: the blood plasma, the extracellular and intracellular fluids and bones.

- In this process bone tissue acts as a calcium storage center for deposits and withdrawal as needed by the blood via continual bone remodeling.
- An important aspect of calcium metabolism is plasma calcium homeostasis, the regulation of calcium ions in the blood plasma within normal limits.
- Parathyroid hormone regulates calcium levels in the blood largely by increasing the levels when they are too low.

CALCIUM OCCURRENCE:

Calcium is the 5th most abundant element in the earth's crust essential for living organisms.

In nature: Does not exist freely. Occurs mostly in soil systems as limestone ($CaCO_3$), gypsum and fluoride.

In the body: The most abundant mineral average adult body contains approx 1kg.

DISTRIBUTION:

- 2% of body weight
- 99% in bones
- 1% in body fluids
- plasma (extracellular fluid) -2.25 -2.75 mmol/l
- Cell (intracellular fluid) -10 mmol/l

FUNCTION OF CALCIUM: Calcium is one of the most important minerals for the human body. It helps to form and maintain healthy teeth and bones. A proper level of calcium in the body over a lifetime can help prevent osteoporosis.

Calcium helps the body in:

- Building strong bones and teeth
- Clotting blood
- Sending and receiving nerve signals
- Muscle contraction
- Releasing hormones and other chemicals
- Keeping a normal heartbeat
- Nervous system: Calcium is essential for membrane potential and depolarization, synapse use calcium to release neurotransmitters
- Endocrine system: All process that involve exocytosis e.g. hormone secretion require calcium
- Cardiovascular system: Required in contraction of muscle cell

SOURCES OF CALCIUM: Milk, cheese, paneer (Indian cottage cheese), yoghurt, green leafy vegetables – such as curly kale, okra, spinach, broccoli etc.

CALCIUM ABSORPTION:

Calcium is absorbed through dietary sources such as calcium phosphate, carbonate, tartrate, and oxalate.

It is absorbed from the gastrointestinal tract in to blood and distributed to various parts of the body.

Two mechanisms have been proposed for the absorption of calcium by gut mucosa:

1. Simple diffusion
2. An active transport process involving energy and calcium pump.

While passing through the kidney, large quantity of calcium is filtered in the glomerulus, from the filtrate 98 to 99 % of calcium is reabsorbed in the renal tubules in to blood and only a very small quantity is excreted through urine.

In the bone the calcium may be deposited or resorbed depending upon the level of calcium in the plasma.

Factors contributing in absorption: Factors are classified into two ways;

Those acting on mucosal cells: These are;

Vitamin D: Calcitriol (1, 25-DHCC):

- It is the biologically active form of vitamin-D
- It regulates plasma level of ca and P.
- Calcitriol acts on 3 different levels intestine, kidneys & bones.
- In the osteoblasts of bone calcitriol stimulates ca uptake for deposition as $CaPO_4$
- It is involved in minimizing the excretion of ca and p through kidney by decreasing their excretion and enhancing reabsorption

Pregnancy & Growth:

- During later stages of pregnancy greater amount of calcium absorption is seen.
- 50% of this calcium is used for the development of fetal skeleton and the rest is stored in the bones to act as a reserve for lactation.
- This occurs due to increased level of placental lactogen and estrogen which basically stimulates increased hydroxylation of vitamin D.
- There is a increased level of growth hormone. GH acts by increasing calcium absorption .
- It also increases the renal excretion of calcium and phosphate.

Parathyroid hormone:

- Parathyroid hormone is one of the main hormones controlling Ca^{+2} absorption.
- It mainly acts by controlling the formation of 1,25 DHCC which is active form of vitamin D, responsible for increased Ca^{2+} absorption.

Those affecting the availability of calcium and phosphate in the gut:

- pH of the intestine
- Amount of dietary calcium and phosphate,
- Phytic acid and phytates,
- Oxalates,
- Fats,
- Proteins and amino acids,
- Carbohydrates,
- Bile salts.

ABSORPTION OF CALCIUM: Calcium absorption across the intestinal wall into the blood occurs by two major mechanisms:

- **Active transport** (transcellularly): It depends on the action of the calcitriol and the intestinal vitamin D receptor (VDR).
- **Passive diffusion** (paracellularly): It involve the movement between mucosal cells and is dependent on luminal : serosal electrochemical gradients.

Factors increases calcium absorption:

- Vitamin D-calcitriol (includes the synthesis of the carrier protein)
- Parathyroid hormones
- Amino acids
- Lactose

Factors decreases calcium absorption:

- Phytates (substances found in some plant foods that can bind calcium in the intestine and decrease its absorption.
- Oxalates
- In malabsorption syndromes
- High phosphate content
- Absorption is also decreased with increased intake of protein and fiber in diet

CALCIUM EXCRETION:

Calcium is excreted partly through kidneys and mostly through the intestine. The renal threshold for serum calcium is 10mg/ dl. Calcium gets excreted into the urine beyond concentration. Stools (60% to 70% unabsorbed calcium)
Urine 50-200mg/day & Sweat 1 mg/day.