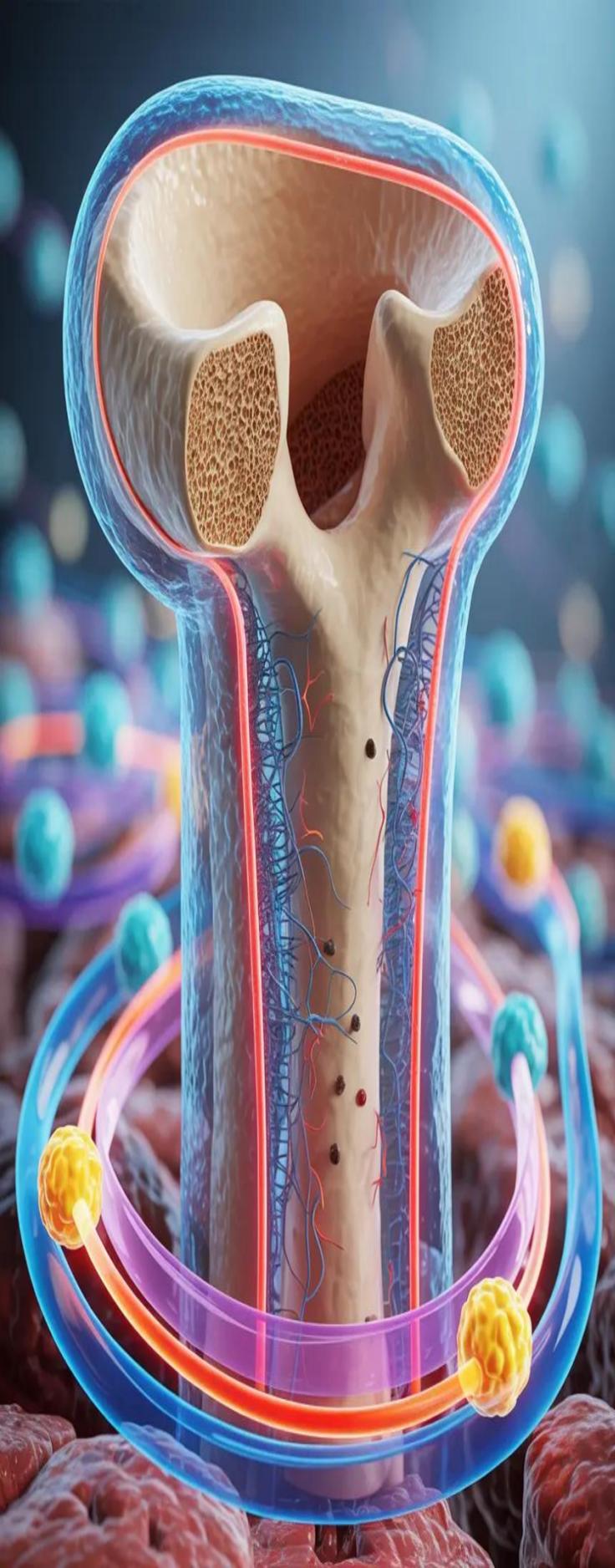


BONE & Calcium metabolism

Ass. Prof. Noura Bakr



□ Bone serves two critical functions :

- it provides the structural framework for the body (facilitation of movement, protection of internal organs, **storage of minerals** and fat, and hematopoiesis)
- acts as the primary reservoir for maintaining calcium homeostasis (balance) in the blood

Bone as a Calcium Reservoir

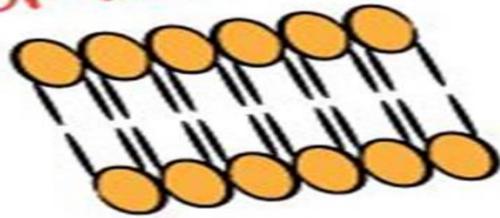
Over 99% of the body's calcium is stored in the bones and teeth in the form of **hydroxyapatite crystals** $(Ca_{10}(PO_4)_6(OH)_2)$.

The remaining 1% circulates in the blood and soft tissues, which is vital for **muscle contraction**, **nerve transmission**, and **blood clotting**.

Calcium

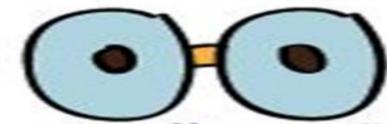


membrane integrity



Calmodulin mediated action of Ca

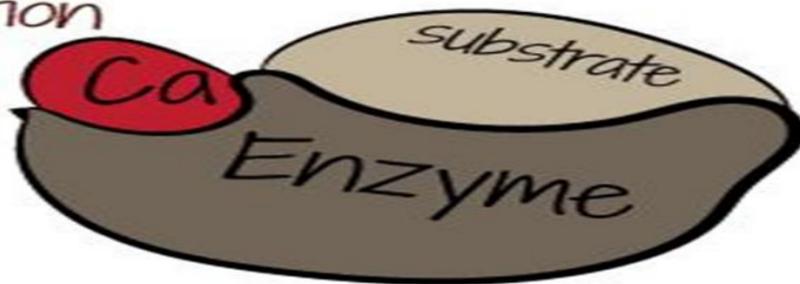
cell-to-cell adhesion



Blood coagulation



enzyme activation



as intra-cellular messenger Ca^{+2}

There is the biological buzzle between BONE and Ca blood level

- Calcium is the most abundant mineral in the body many important functions in the body and its levels must be tightly regulated to stay around 10 mg/dL.
- Bone acts as a "bank" for calcium. When blood calcium levels drop (hypocalcemia), the body withdraws calcium from the bones. When levels are high, calcium is deposited into bone tissue

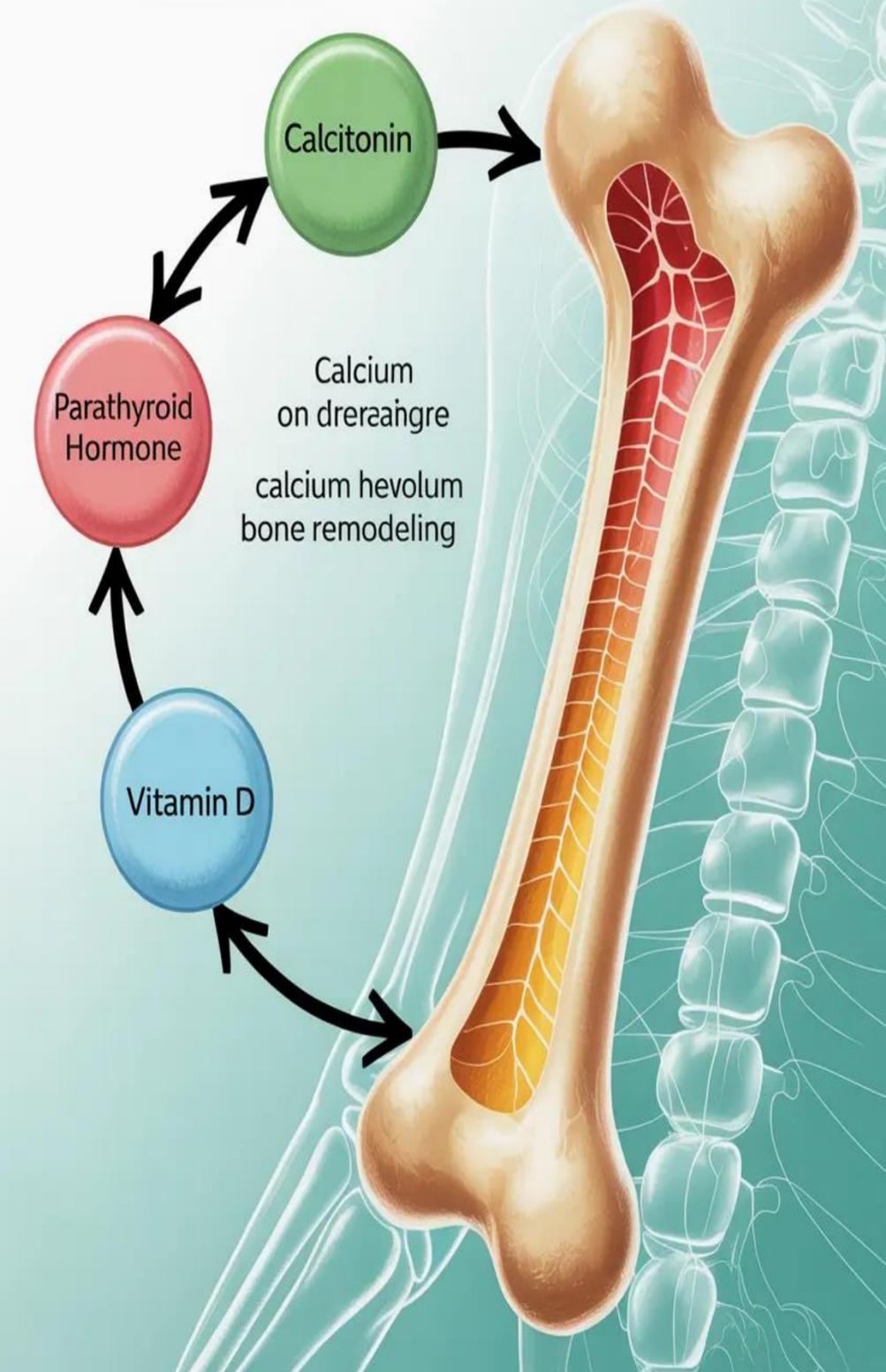
The Remodeling Cycle

Bone is a dynamic tissue that undergoes constant remodeling—**balance between breaking down old bone and building new bone.**

This process is directly tied to calcium metabolism:

- **Resorption (Releasing Calcium):** Specialized cells called **osteoclasts** break down bone tissue, releasing calcium and phosphate into the bloodstream.
- **Formation (Storing Calcium):** Specialized Cells called **osteoblasts** build new bone matrix and mineralize it by depositing calcium and phosphate from the blood.

Endocrine Feedback Loop Calcium Metabolism

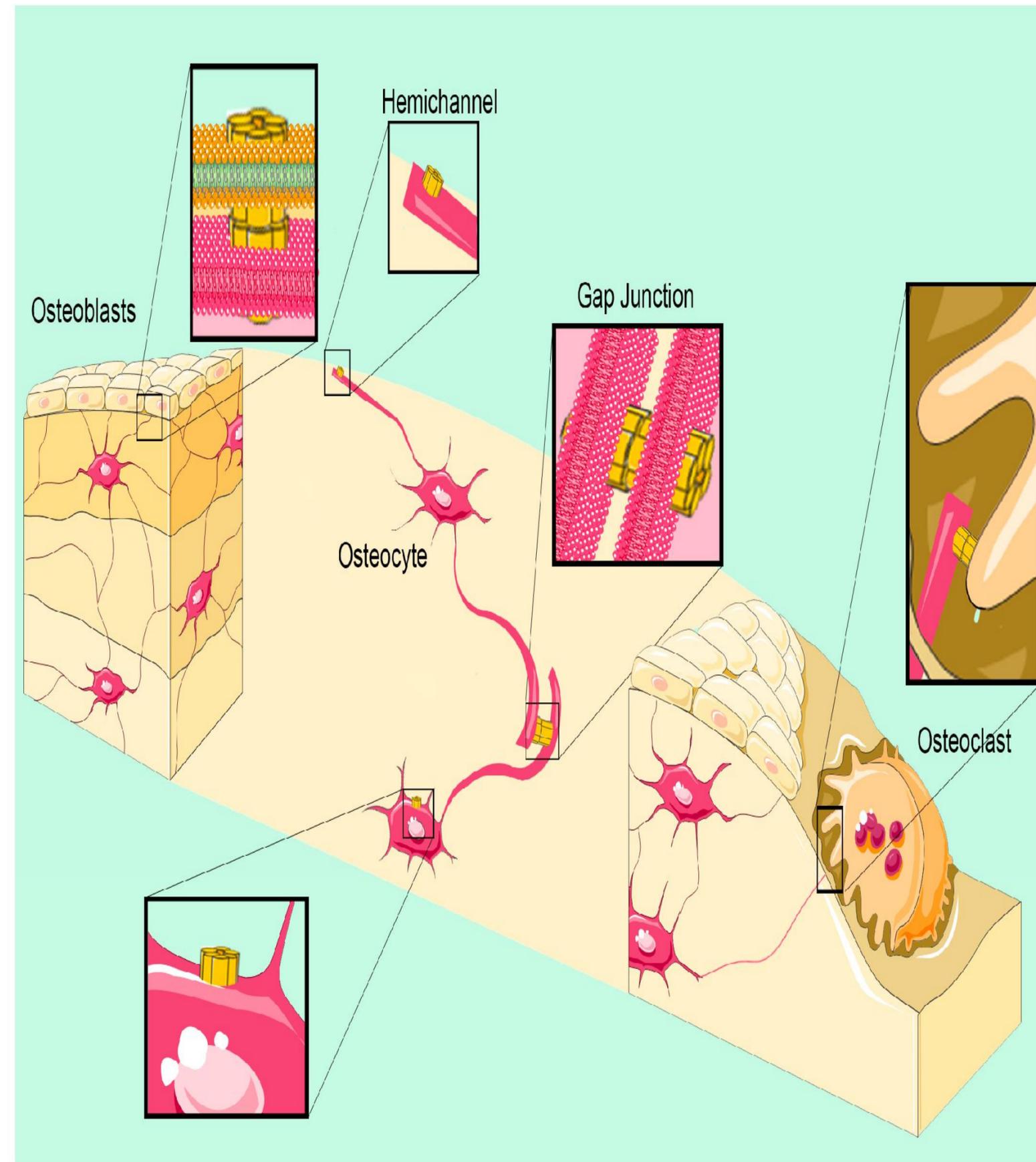


Osteocyte cells

They are osteoblast entrapped cell within the bone matrix.

Function: -

- maintenance of bone matrix, and prevent hypermineralization.
(formation of functional syncytium (osteocyte – osteoblast complex) to prevent (sclerosis) •
- Help in Ca release from bone to blood.
- controlling bone remodeling.
- Contain alkaline phosphatase to prevent dissolution of bone salts



Hypocalcaemia causes hyper-excitability of the neuromuscular junction.

Symptoms include pins and needles, tetany, paralysis, and convulsions.

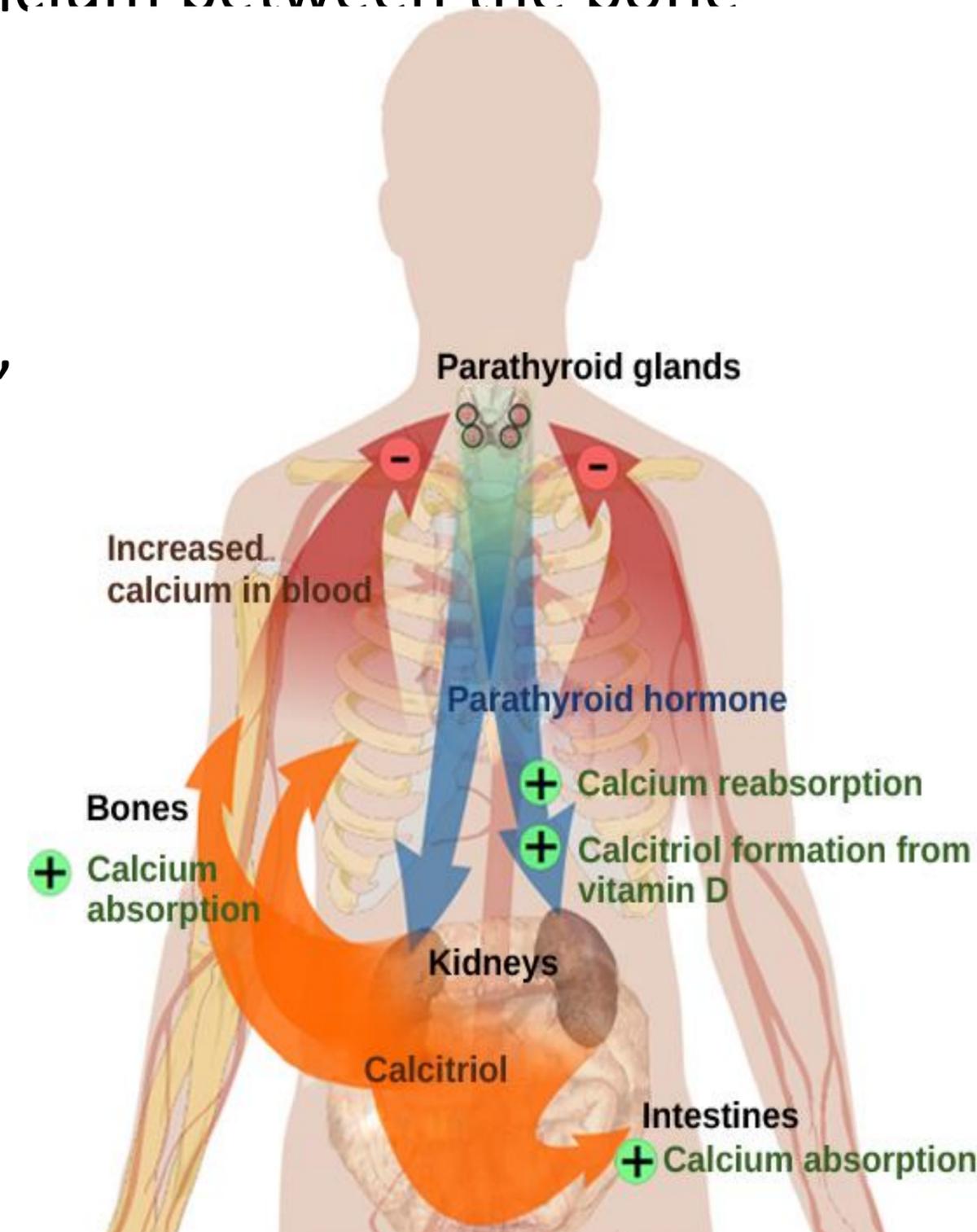
Hypercalcaemia can lead to renal calculi, kidney damage, constipation, dehydration, tiredness, and depression, remembered by the phrase "stones, moans, and groans",

- Stones – renal calculi (kidney stones)
- Moans – depression and tiredness
- Groans – constipation

Hormonal Regulation

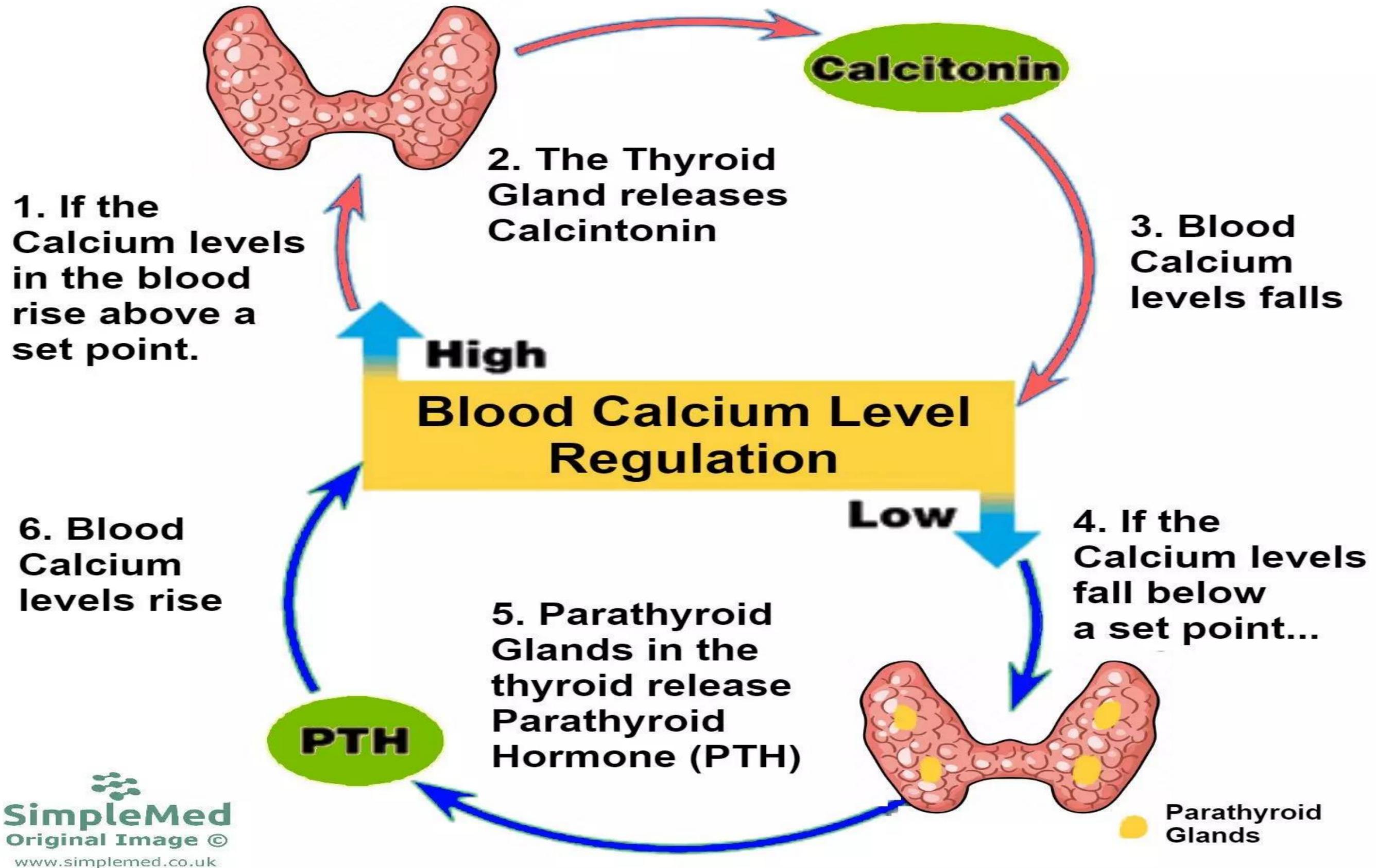
- Three primary hormones regulate the exchange of calcium between the bone and the blood: PTH, Calcitonin, vitamin D (calcitriol)
- Organs regulate calcium metabolism: bone, PT gland, kidney and intestine

Parathyroid hormone (PTH) is released in response to low blood calcium levels. It increases blood calcium levels by targeting the skeleton, the kidneys, and the intestine



- ❖ The parathyroid glands **release** parathyroid hormone (PTH) in response to a decrease in serum calcium.
- ❖ **PTH** acts on the **kidneys** to increase calcium reabsorption in the distal convoluted tubule, and the collecting duct.
- ❖ **The kidney** also responds to PTH by increasing secretion of Vitamin D3, which in turn stimulates calcium absorption through the gut.
- ❖ **PTH** acts on the bones to stimulate osteoclasts involved in bone reabsorption and the release of free calcium.

All of these processes contribute to the rise in serum calcium



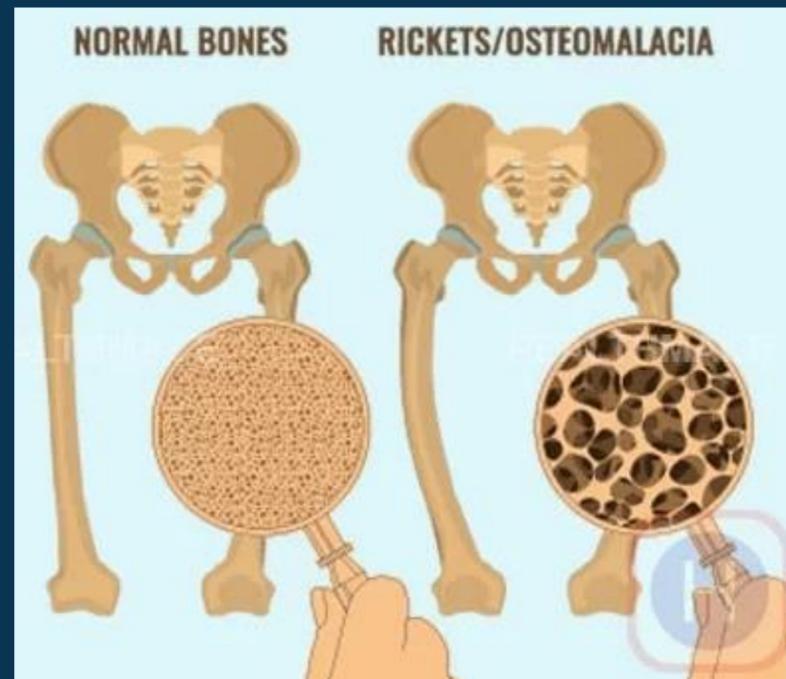
calcitonin hormone

- produced by the parafollicular (C cells) of the thyroid gland
- Calcitonin decreases blood calcium levels by inhibiting osteoclasts, stimulating osteoblasts, and stimulating calcium excretion by the kidneys
- also inhibits calcium absorption in the intestine (inhibits renal reabsorption of calcium).
- This results in calcium being added to the bones to promote structural integrity and decrease in serum calcium.
- Calcitonin is most important in children (when it stimulates bone growth), during pregnancy (when it reduces maternal bone loss), and during prolonged starvation (because it reduces bone mass loss).

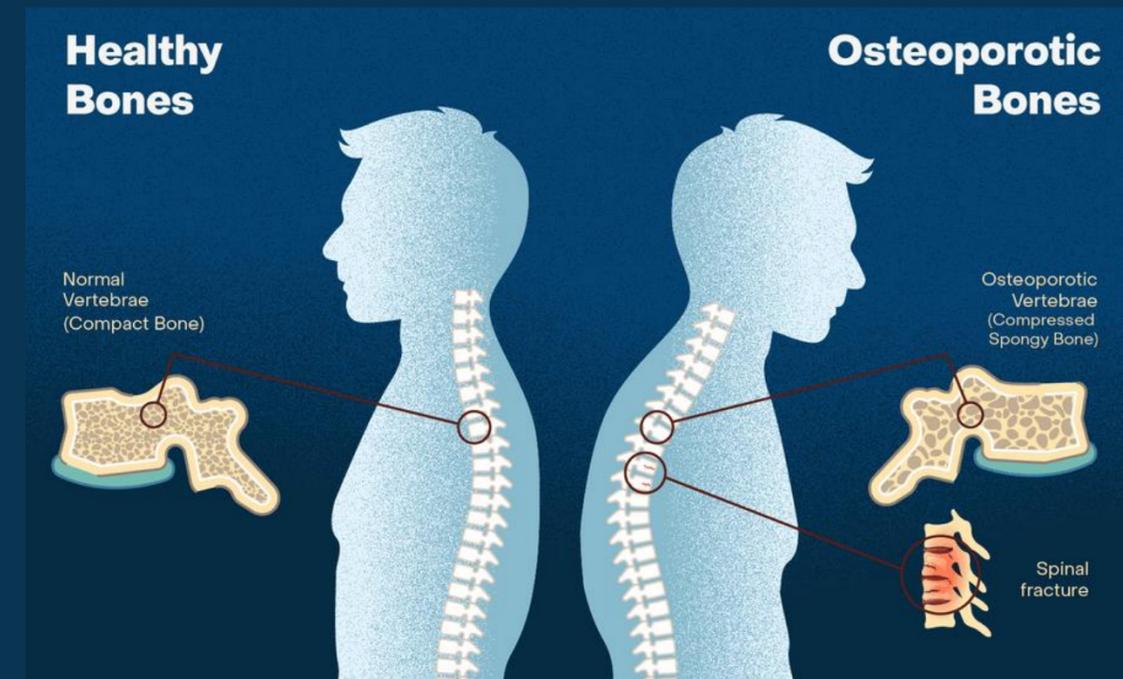
CLINICAL RELEVANCE:



Osteogenesis imperfecta:
defect in collagen →
brittle bones



Rickets/Osteomalacia:
poor mineralization →
soft bones



Osteoporosis:
imbalance in matrix
breakdown and
formation



Ass.Prof. Noura Bakr

THE ANIK

YOUNG

