CALCIUM IN THE ORGANISM  

1000 - 1200g

99% IN BONES and TEETH
Hydroxyapatite
37% Ca\(^{2+}\), 17% P, 5% CO\(_3\)\(^{-}\), Na\(^{+}\), K\(^{+}\), F\(^{-}\), Cl\(^{-}\)

Ensures
- stability
- reserve of Ca in the body

4 - 7 g In body fluids (ionized form)

FUNCTIONS: hemostasis
- excitability of the heart, muscles, nerves
- selective permeability of membranes
- activities of enzymes
- intracellular mediator

Extracellular conc. 10\(^{-3}\) mol.l\(^{-1}\)
Intracellular conc. 10\(^{-7}\) mol.l\(^{-1}\)
CALCEMIA

Kept at physiological levels by help:
PARATHYROID HORMONE, VITAMIN D, CALCITONINE

THREE FRACTIONS OF CALCIUM IN CIRCULATION

1. Ca bound to proteins non-difusible biologically not active

2. Calcium bound in complexes (citrate, lactate)

3. Ionized calcium - free biologically active

\[ \text{Ca [circ]} = \text{ionized Ca} + \text{Ca-proteins} + \text{Ca-complexes} \]

\[ \begin{align*}
2,2 - 2,6 & \quad 1,1 - 1,3 & \quad 0,9 - 1,0 & \quad 0,2 - 0,3 \\
\text{mmol.l}^{-1} & \quad \text{mmol.l}^{-1} & \quad \text{mmol.l}^{-1} & \quad \text{mmol.l}^{-1}
\end{align*} \]
Parathyroid hormone (PTH), calcitonin, vitamin D₃ (D₂)

Ca²⁺ ➣ Calcitonine

PTH

Ca₃(PO₄)₂

Calcitoning

Ca²⁺ ➣ To the blood

Activation of D vitamin

Urine

c↓Ca²⁺, c↑PO₄³⁻
Vitamin D and its activation

Cholesterol
↓ UV light

Vitamin D₃
No effective, just a little

Liver

25-OH D₃
More effective (2.5 times)

Kidneys

If ↑ Ca²⁺
→ ↓ PTH

25-OH D₃

If ↓ Ca²⁺
→ ↑ PTH

If PTH+
24,25 di-OH D₃

Not effective

1,25 di-OH D₃

Effective

Absorption of Ca²⁺ from GIT

Effects of PTH

- Increases calcium absorption from bone
  - Existing osteocytes stimulated (minutes to hours) to transport calcium - calcium pumps
  - Existing osteoclasts activated and new osteoclasts formed (days to weeks) to digest bone and release calcium
    - Stimulated indirectly by osteoblasts

- Decreases excretion of calcium by kidneys
- Increases calcium absorption from GIT
  - Effect manifested via Vitamin D3
    - Produces most active form of D3 in the kidney (1,25-dihydroxy-cholecalciferol)
Effects of Active Form of Vit D3

- Promotes intestinal absorption of calcium
- Causes synthesis of calcium-binding protein and related facilitated transport
- Has slight effect to increase calcium re-absorption in kidneys
- With PTH causes calcium absorption from bone
Effects of Calcitonin

- Calcitonin acts to decrease plasma $\text{Ca}^{2+}$ levels.
- PTH and vitamin D act to increase plasma $\text{Ca}^{2+}$- only calcitonin causes a decrease in plasma $\text{Ca}^{2+}$.
- Calcitonin is synthesized and secreted by the parafollicular cells of the thyroid gland.
- The target cell for calcitonin is the osteoclast.
- Calcitonin acts via increased cAMP concentrations inactivates osteoclasts.
- The major effect of calcitonin administration is a rapid fall in $\text{Ca}^{2+}$ caused by inhibition of bone resorption.

! Removal of the thyroid gland has no effect on plasma $\text{Ca}$ levels!
DEFECTS IN CALCIUM METABOLISM

HYPOCALCEMIA

- absorption from intestine
- secretion of PHT (hypoparathyreosis)
- vitamin D
  - Renal defects - decreased tubular absorption

The main effect of hypocalcemia is increased excitability of nerves and muscles
By decreased threshold of Na⁺ channels
HYPERCALCEMIA

- hyperparathyreosis
- excess of vitamin D
- malignant tumors with metastases into the bones
  \[\uparrow\text{demineralization.}\]
  through \textit{OAF} (osteoclasts activating factor)
- acute immobilization – atrophy of skeleton from inactivity
- increased absorption in \textit{GIT}