Three Elements in Human Body

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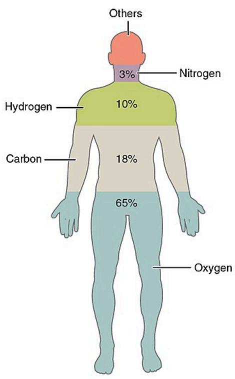
1 The chosen three elements

The three elements I selected for analysis are calcium (Ca), phosphorus (P), and iodine (I), which are among the most abundant and essential minerals in the human body.



Element	Symbol	Percentage in Body
Oxygen	O	65.0
Carbon	C	18.5
Hydrogen	H	9.5
Nitrogen	N	3.2
Calcium	Ca	1.5
Phosphorus	P	1.0
Potassium	K	0.4
Sulfur	S	0.3
Sodium	Na	0.2
Chlorine	Cl	0.2
Magnesium	Mg	0.1
Trace elements include boron (B), chromium (Cr), cobalt (Co), copper (Cu), fluorine (F), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), selenium (Se), silicon (Si), tin (Sn), vanadium (V), and zinc (Zn).		less than 1.0

Fig.1 Elemental Composition of the Human Body[1]

2 Why the elements are important in our body

2.1 Calcium

Calcium is a critical element in the human body, essential for numerous physiological processes[2]. It plays a vital role in muscle contraction, nerve impulse transmission, blood clotting, heart rhythm regulation, and maintaining fluid balance within cells. Moreover, calcium is indispensable for building and maintaining strong bones and teeth. The body's requirement for calcium is particularly high during growth phases like childhood, pregnancy, and lactation, as these are critical periods for skeletal development and calcium reserves[3][4]. Long-term calcium deficiency significantly increases the risk of osteoporosis, characterized by weakened bones prone to fractures[5].

2.2 Phosphorus

Phosphorus is a crucial element for human health, comprising approximately 0.6% of the body's total weight. About 85% of the body's phosphorus is found in bones and teeth as calcium phosphate crystals, which provide structural integrity and hardness[6]. The remaining phosphorus is distributed in soft tissues and extracellular fluids. Phosphorus is vital for several key physiological processes, including energy metabolism, genetic information storage and transmission (DNA and RNA), intracellular signaling, and maintaining cell membrane integrity through glycerophospholipids[6]. Moreover, phosphorus plays an essential role in acid-base balance and is a critical buffer in extracellular fluids[7].

2.3 Iodine

Iodine is an essential micronutrient primarily crucial for the synthesis of thyroid hormones, which regulate various physiological processes including metabolism, growth, development, and cellular differentiation. It is particularly critical for neurodevelopment, cognitive function, and brain maturation, especially during pregnancy and early childhood. Severe iodine deficiency during pregnancy can lead to severe neurodevelopmental disorders in offspring, such as cretinism, which includes profound mental impairment, hearing loss, and motor dysfunction[8][9][10].

3 How the elements work in our body?

3.1 Calcium

Calcium works through a highly regulated metabolic pathway involving multiple hormones and organ systems. The main hormones regulating calcium homeostasis are parathyroid hormone (PTH), vitamin D, and calcitonin. Calcium is absorbed in the gastrointestinal tract, particularly in the ileum, through passive and active transport mechanisms regulated by vitamin D[2][3]. The kidneys, intestines, and bones are critical in maintaining calcium levels. The kidneys adjust calcium excretion based on hormonal signals; bones store and release calcium to maintain serum calcium levels[7]. Serum calcium is tightly regulated and does not fluctuate significantly with dietary changes due to this rapid homeostatic response involving bone resorption or deposition, intestinal absorption, and renal reabsorption. Any disruptions in these mechanisms can result in clinical conditions such as hypercalcemia or hypocalcemia[2][3][4].

3.2 Phosphorus

Phosphorus metabolism in the human body involves a sophisticated interplay between dietary intake, absorption, transport, storage, and excretion, mediated by hormones like parathyroid hormone (PTH) and vitamin D. Dietary phosphorus, mainly inorganic phosphate (Pi), is absorbed in the gastrointestinal tract through both transcellular active transport mechanisms and passive paracellular diffusion[6]. The kidneys regulate extracellular phosphorus levels by reabsorbing filtered phosphorus through transporters in proximal tubules. Bones serve as a reservoir for phosphorus, continuously exchanging phosphorus with extracellular fluid through bone formation and resorption processes regulated by osteoblasts and osteoclasts. Disruptions can lead to clinical conditions such as hypophosphatemia (bone disorders like osteomalacia) or hyperphosphatemia[7].

3.3 Iodine

Iodine functions predominantly by its incorporation into thyroid hormones. Dietary iodine is absorbed from the gastrointestinal tract into the bloodstream and then actively transported into thyroid follicular cells through the sodium-iodide symporter[9]. Inside these cells, iodide is oxidized by the enzyme and integrated into tyrosine residues of thyroglobulin, forming thyroid hormones. These hormones are crucial for numerous physiological processes including energy metabolism, protein synthesis, and neurodevelopment[8][9]. The secretion of thyroid hormones is tightly regulated by the hypothalamic-pituitary-thyroid axis via thyroid-stimulating hormone. Both iodine deficiency and excess disrupt this finely tuned system, potentially leading to goiter, hypothyroidism, hyperthyroidism, or autoimmune thyroid disease[10].

4 Conclusions and future perspective

Calcium is crucial for maintaining bone density, muscle function, nerve transmission, and blood clotting. Adequate intake during critical periods—childhood, adolescence, and menopause—significantly lowers the risk of osteoporosis and fractures[2][7]. Future studies should refine global calcium intake guidelines based on demographic needs and dietary patterns, and also investigate the potential cardiovascular risks associated with excessive supplementation to ensure safe practices[11].

Phosphorus plays an equally vital role, supporting skeletal strength, energy production, and genetic stability[6][7]. However, the rising intake of phosphorus through processed foods often exceeds recommended levels, potentially disturbing the calcium-phosphorus balance and negatively impacting bone and cardiovascular health[11][6]. Future research must define safe phosphorus intake thresholds, evaluate the health impacts of phosphorus additives, and establish preventive strategies, especially for elderly populations and patients with chronic kidney disease.

Iodine, although needed in trace amounts, is indispensable for thyroid hormone production, regulating metabolism, growth, and neurodevelopment[10]. Despite the success of salt iodization programs, iodine deficiency remains a global health concern, particularly among pregnant women and children. Ongoing surveillance, improved supplementation strategies, and further studies on iodine's role in autoimmune diseases and cancer are essential to safeguard public health[8][9].

In conclusion, ensuring optimal intake of calcium, phosphorus, and iodine is critical for preventing deficiency-related diseases and enhancing long-term health. Future efforts should prioritize tailored nutritional strategies, continuous public health monitoring, and adaptation to evolving dietary trends.

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