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**THE ROLE OF CHITOSAN IN CALCIUM, MAGNESIUM AND PHOSPHORUS METABOLISM AND ITS SIGNIFICANCE IN BONE TISSUE METABOLISM****Rakhmonov Farkhod Kholbayevich**Assistant, Zarmed University, Samarkand, Uzbekistan  
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**Abstract.** This article analyzes the influence of chitosan on mineral metabolism in the organism, particularly the biological absorption of calcium, magnesium, and phosphorus, their deposition in bone tissue, and their role in osteogenesis. The significance of chitosan in accelerating bone regeneration, enhancing mineralization, stimulating osteoblast activity, and increasing bone density is highlighted based on scientific sources. The clinical relevance of chitosan-based biomaterials is also examined.

**Keywords:** chitosan, calcium, magnesium, phosphorus, metabolism, osteogenesis, mineralization, regeneration, bone tissue.

**Introduction.** In modern medicine, metabolic disorders of bone tissue — including osteoporosis, delayed fracture healing, and osteomalacia — are widespread globally. Numerous scientific studies indicate that the etiology of these conditions is closely associated with deficiencies in essential minerals. Calcium, magnesium, and phosphorus are the main structural components of bone tissue. Insufficient absorption of these elements leads to reduced bone density, matrix fragility, and functional impairment [11]. In recent years, natural polysaccharides, particularly chitosan, have attracted attention as biologically active compounds capable of regulating mineral metabolism, accelerating bone regeneration, and stimulating osteogenesis [1; 8].

**Main Part.** Chitosan is a high-molecular-weight cationic polysaccharide derived from the deacetylation of chitin and consists of D-glucosamine units. Owing to its positive charge, chitosan readily binds negatively charged ions in the biological environment — including phosphates, carbonates, calcium, and magnesium ions [9; 10]. Therefore, chitosan is considered a natural bioactive compound that supports bone mineralization. Bone tissue mainly consists of hydroxyapatite ( $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ ) crystals, and an optimal calcium-to-phosphorus ratio ensures the mechanical strength and elasticity of bone [12]. Magnesium increases the stability of these crystals and regulates the functional activity of osteoblasts and osteoclasts [11].

**Methodology.** In preparing this scientific article, the authors analyzed recent scientific literature, experimental studies, and publications in international journals on chitosan, mineral metabolism, bone physiology, osteogenesis, and tissue regeneration. Particular attention was given to research examining ion exchange between chitosan and minerals, the influence of chitosan on bone density, osteoblast proliferation, and collagen synthesis [2; 3; 4; 5; 6; 7]. Literature selection was based on major scientific databases, including Scopus, PubMed, and ScienceDirect.

**Analysis.** Chitosan exerts a complex, multi-directional influence on calcium metabolism. Scientific data show that chitosan stimulates active calcium transport mechanisms in the intestinal epithelium, increases its bioavailability, and converts insoluble forms of calcium into biologically active ionic forms [8; 9]. As a result, calcium is more efficiently incorporated into the bone matrix, enhancing osteoblast activity. Increased osteoblast function accelerates the formation of new bone matrix, promotes collagen fiber production, and facilitates the uniform deposition of hydroxyapatite crystals.

Chitosan also has a significant biochemical effect on magnesium metabolism. Due to its ability to bind magnesium ions, chitosan slows their excretion from the body and helps maintain physiological magnesium levels in the blood. Magnesium is essential for ATP synthesis and energy metabolism in bone cells. Thus, stable magnesium levels improve bone elasticity, strength, and regenerative capacity [11; 13].

Chitosan also plays an important role in phosphorus metabolism. Studies indicate that chitosan binds phosphate ions, enhances their absorption, influences enzyme activity related to phosphorylation, and accelerates the formation of hydroxyapatite crystals [10; 14]. Maintaining a physiological calcium-phosphorus balance is essential for the mechanical stability of bone, the strength of the crystalline structure, and optimal bone density. By helping regulate this ratio, chitosan is considered an important modulator of bone tissue metabolism.

In bone regeneration, chitosan is widely used as a biomaterial. It fills bone cavities, stimulates cell migration, serves as a natural scaffold for new tissue formation, improves microcirculation at the injury site, and accelerates collagen synthesis. Numerous bioengineering studies highlight chitosan as one of the most effective polymers enhancing osteointegration [12; 15].

**Results.** Experimental studies unequivocally confirm the positive effects of chitosan on bone metabolism. Research conducted on various animal groups demonstrates that diets or preparations containing chitosan increase bone density by 20–30%, improve the mechanical strength of bones, and normalize physiological levels of calcium, magnesium, and phosphorus. Enhanced osteoblast proliferation and differentiation, increased collagen synthesis, and improved structural organization of the bone matrix have also been observed. Faster fracture healing, shorter regeneration phases, and improved quality of bone scar formation have been reported.

Clinical trials further support the high efficiency of chitosan. Chitosan-based formulations used in osteoporosis treatment increase bone density, reduce bone pain, and improve overall metabolic indicators of bone tissue. In dental implantology, chitosan-enriched biomaterials accelerate bone formation around implants, increase osteointegration, and shorten healing time. In post-traumatic bone cavity reconstruction, chitosan-based polymer blocks create favorable conditions for new bone formation, enhance blood circulation, and reduce the risk of infectious complications.

**Conclusion.** Chitosan is an important biologically active compound supporting the metabolism of essential minerals (calcium, magnesium, phosphorus) and bone tissue. It enhances calcium absorption, stabilizes magnesium and phosphorus metabolism, accelerates the formation of hydroxyapatite crystals, stimulates osteogenesis, and promotes bone regeneration. Therefore, chitosan holds significant scientific and practical value as a promising natural polymer for preventing osteoporosis, accelerating bone repair, and supporting the complex treatment of bone disorders.

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