

Inorganic Phosphate (Pi) is a vital molecule in cellular metabolism, that plays a crucial role in various biochemical processes. It comprises one phosphorus atom bonded to four oxygen atoms in a tetrahedral arrangement. [1]. They are an “essential nutrient to living organisms.” [2]. Before moving on to the role of Pi in cellular metabolism, it is best to define what cellular metabolism is.

To understand cellular metabolism, we must first know what metabolism means in general. Metabolism, in simple terms, is the acquired energy for all cellular functions. With that said, cellular metabolism is the referral to the set of biochemical reactions and processes that occur within a cell to maintain life. The processes involve the conversion of molecules into energy, the synthesis and breakdown of biomolecules, and the elimination of waste products. [3].

Furthermore, the two main roles of inorganic phosphate in cellular metabolism are its involvement in ATP (adenosine triphosphate) synthesis and hydrolysis. [4]. As known, ATP is the primary energy currency of cells, which provide energy to various cellular processes. Inorganic phosphate is also utilized during the phosphorylation of ADP (adenosine diphosphate) which forms ATP through processes like oxidative phosphorylation and substrate-level phosphorylation. In addition, the inorganic phosphate's role in cellular signaling and regulation is crucial as it acts as a phosphate donor that regulates the reactions of enzyme activity, protein function, and gene expression. [5].

Moving on, the relation of Inorganic phosphate to phospholipid structure and metabolism is that phosphorus plays a critical role in various aspects of biological functions such as skeletal development, mineral metabolism, and diverse cellular signaling pathways. It is an essential component of phospholipids found in plasma and organelle membranes, as well as nucleotides that are crucial for cellular energy production and serve as building blocks of DNA and RNA. Phosphorus is also involved in phosphorylated intermediates within intracellular signaling pathways. [6]. Phosphorus is necessary for enzymatic processes like glycolysis, renal ammoniogenesis, and mitochondrial oxidative phosphorylation, which are essential for generating ATP, the primary energy source for cells. [7].

Moreover, phosphorus is crucial for a wide range of biological functions, including intracellular signaling, maintaining membrane integrity, and facilitating skeletal biomineralization. As a result, maintaining a balanced phosphorus level is vital for the overall well-being of an organism. Cells and organisms can detect changes in inorganic phosphorus (Pi) concentrations in their surroundings and respond by adjusting Pi uptake and modifying biochemical processes within cells (local effects) as well as in distant organs (endocrine effects). [8].

With that being, multilamellar bodies (MLBs) are organelles enclosed by membranes, ranging in size from 100 to 2400 nm. They consist of concentric layers of membranes and often have a dense core when viewed under an electron microscope. MLBs are present in various cell types and play roles in storing and releasing lipids. [9]. The connections between inorganic phosphate, cellular metabolism, and multilamellar organelles all lie in their roles with the cellular structure, energy, metabolism, signaling pathways, and many other

functions. The multilamellar organelle connects with inorganic phosphate through several biological processes, such as energy metabolism, wherein the inorganic phosphate is involved through the synthesis and utilization of ATP (adenosine triphosphate). Perhaps even in calcium phosphate deposition, where multilamellar organelles like lamellar bodies in lung cells play roles in calcium homeostasis and phosphate metabolism. [[10](#)].

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