Analysis of Membrane Lipid Differences Between Basal and Differentiated Osteoblastic Cells Using Lipidomics

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The intricate process of bone formation, remodeling, and healing involves the orchestrated activities of various cell types. In vitro culture models have significantly contributed to uncovering the biology of osteoblastic cells. MC3T3, an osteoblast cell line, serves as a valuable model for studying pre-osteoblast phenotypes, exhibiting temporal transitions from proliferation to nodule formation and mineralization, mimicking aspects of intramembranous osteogenesis. These transitions are crucial for understanding the mechanisms underlying bone development and the molecular signals that regulate osteoblast differentiation and function, which are essential for developing therapeutic strategies for bone-related diseases.This study aims to elucidate the differences in membrane lipid composition between basal pre-osteoblast MC3T3 cells and their differentiated counterparts. MC3T3 cells were cultured in α-Minimum Essential Medium (α-MEM) supplemented with 10% fetal bovine serum (FBS). Differentiation was induced using ascorbic acid and β-glycerophosphate. Lipids were extracted using the Matyashi method and injected into an untargeted LC-MS/MS system. Lipid annotations were performed using the MS-DIAL software and the MetaboAnalyst website for bioinformatics analysis. Our findings reveal distinct differences in the total lipid profiles between differentiated and basal MC3T3 cells. Specifically, changes were observed in the relative abundances of glycerophospholipid derivatives, along with alterations in the free fatty acid profile. These disparities in lipid composition suggest dynamic lipid remodeling associated with osteoblastic differentiation. These findings offer new insights into the underlying mechanisms of bone mineralization and bone-related diseases. Additionally, they may inform the development of potential therapeutic interventions targeting lipid metabolism pathways in bone-related diseases.

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