

Lipid metabolism is a cornerstone of plant biology, influencing a wide array of processes. While lipids primarily serve as structural components of cellular membranes and energy reserves, their roles extend far beyond these basic functions. They are pivotal in signal transduction, stress responses, and adaptation to environmental challenges. Understanding the biosynthetic pathways and regulatory mechanisms that govern lipid metabolism in plants is crucial for gaining comprehensive insights into these essential biological events.

Plant and algal lipids can be broadly categorized into two main groups: storage lipids and membrane lipids. Storage lipids, predominantly triacylglycerols (TAGs), function as energy and carbon reserves. In contrast, membrane lipids are essential components of both photosynthetic and non-photosynthetic membranes. The lipid composition of membranes is intricate and varies across different cellular compartments, cell types, and species. For example, galactolipids are abundant in plastid membranes, while phospholipids are predominant in membranes outside the plastids. Additionally, terrestrial plants form a protective lipidic layer composed of waxes and cutin on their surfaces, which helps prevent water loss, protect against microbial infections, and act as a defense mechanism.

The most essential form of lipid storage are triacylglycerols (TAG). TAGs formed in the endoplasmic reticulum (ER) membrane are deposited between the leaflets of the membrane bilayer, eventually forming spherical organelles known as lipid droplets (LDs). These LDs then separate from the ER membrane and localize to the cytosol. Recent models in yeast and fungi have proposed a potential linkage between TAG synthesis and the cell cycle. For instance, in yeast *Saccharomyces cerevisiae*, the NEM1/SPO7 complex activates PAH1 (phosphatidate phosphatase), a key player in regulating TAG synthesis and membrane biogenesis. The function of PAH1 channels the flow of phosphatidic acid (PA) away from phospholipid (PL) production and toward TAG synthesis, leading to LD accumulation. The activity of phosphatidate phosphatase (PAH1) in yeast is closely linked to its phosphorylation status, influenced by a diverse array of protein kinases. Despite the extensive knowledge gained from yeast models, the regulation of lipid balance by the NEM1/SPO7-like complex in higher plants remains relatively unexplored. This presents an opportunity to explore the conservation and potential roles of homologous NEM1-like proteins in plant metabolism.

The proposed research aims to investigate the functional characteristics of SSP5 and HAD4 from *Arabidopsis thaliana* as potential homologs of yeast NEM1. By addressing research questions through a combination of experimental approaches, this study has the potential to elucidate the mechanism and roles of plant NEM1-like proteins in cellular processes, with a special emphasis on lipid metabolic pathways. Understanding these mechanisms could open new avenues for improving crop resilience and productivity, contributing to advancements in agriculture and biotechnology.