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Role of Membrane Lipid Derivatives in Plant Pathogenesis

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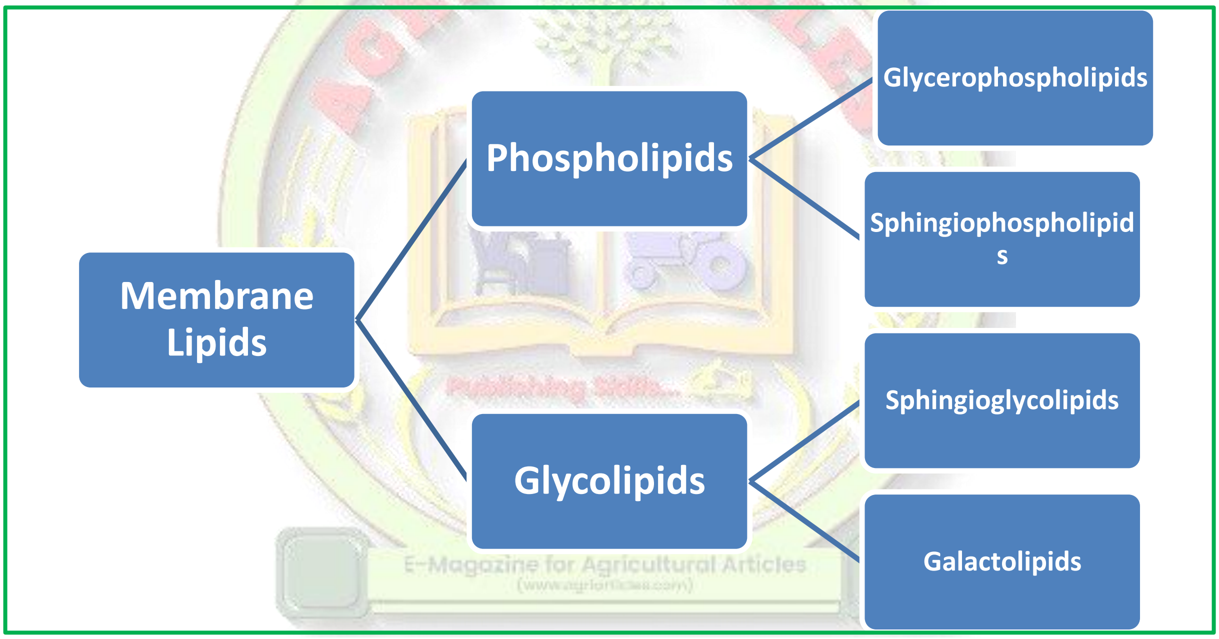
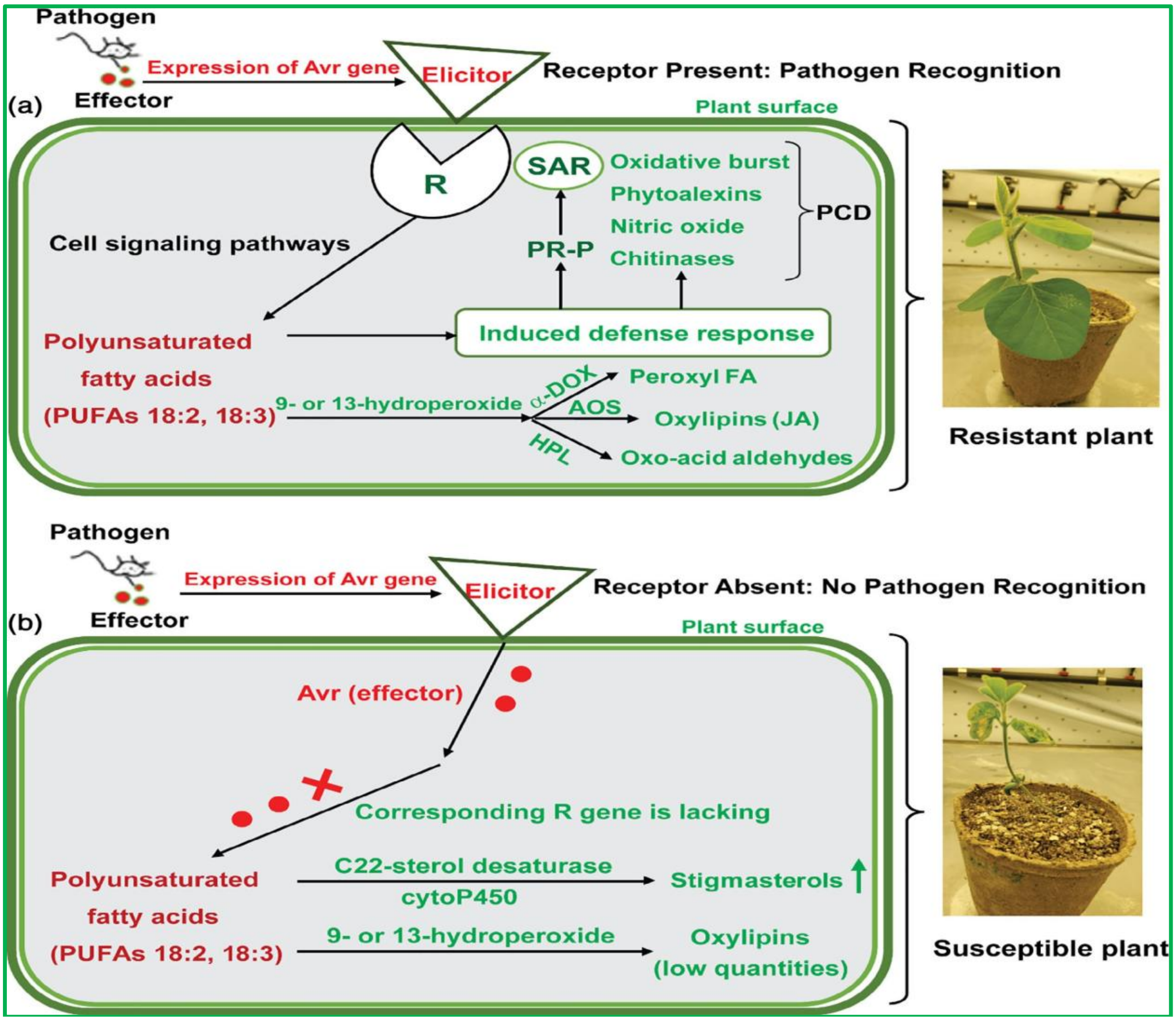
Lipids are important components of plant cell membranes because they provide energy for metabolic processes. They also play a role in photosynthesis, serve as a physical barrier on the surface of epidermal cells to protect the plant from environmental threats, and act as second messengers in signal transduction systems that affect plant growth, development, and stress response. Plants have two key sites for lipid biosynthesis: the endoplasmic reticulum and the plastid. Our efforts to understand the role of lipids in plant-microbe interactions have been hampered by the hydrophobic structure of lipids and the relative volatility of key lipid metabolic products.

Classification of Membrane Lipids



Hypersensitive Defense Reaction

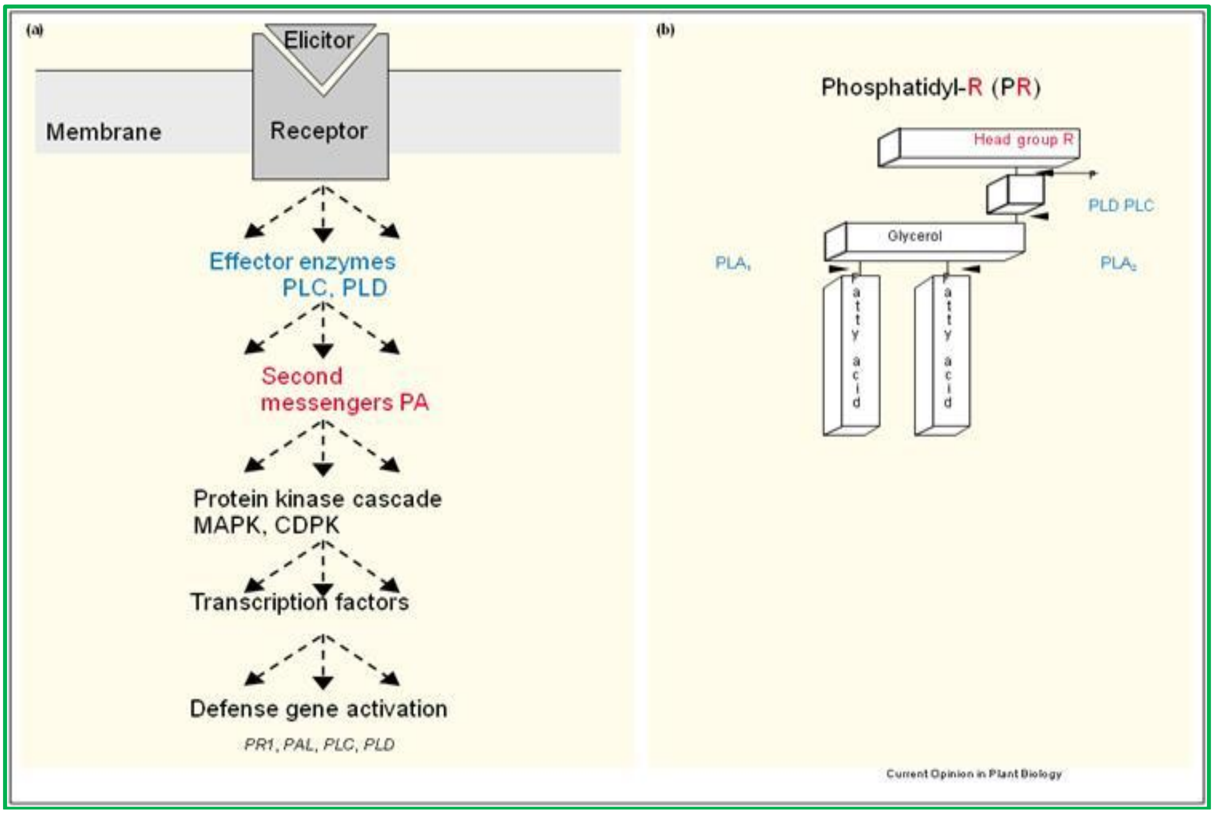
The plant's hypersensitive defensive response is mostly initiated when it detects a pathogen or other biotic stressor. This happens when viruses produce avirulence (Avr) gene products that bind to or interact with R-gene products in the host plant. This is referred to as qualitative or gene-for-gene resistance. When the R-gene from the plant and the Avr gene from the pathogen are both present, recognition takes place, resulting in disease resistance for the host and pathogen avirulence. However, if either the pathogen's Avr gene or the plant's R-gene is missing, there is no recognition, resulting in a compatible reaction and disease infection. The activation of plant defensive responses occurs when R and Avr proteins interact directly (Adigun *et al.*, 2021).



In resistant (a) and susceptible (b) plants, the interaction between plant resistance (R) gene(s) and pathogen avirulence (avr) gene(s). The expression of the avr gene is triggered when pathogens attach to the plant cell. These effectors enter host cells through specific receptors or mechanisms. (a) The plant cell expresses R-gene product(s) that are capable of identifying specific pathogen avr gene products. Biochemical changes such as the creation of an oxidative burst, phytoalexins, hydrolytic enzymes, salicylate, and the expression of pathogenesis-related proteins cause localised cell death in the hypersensitive response (HR) (PR-P). Following HR, systemic-acquired resistance (SAR) is a comprehensive plant resistance response. The enzymes lipoxygenase (LOX), -dioxygenase (-DOX), allene oxide synthase (AOS), and hydroperoxide lyase (HPL) operate as substrates for the polyunsaturated fatty acids (PUFAs) 18:2 (linoleic acid) and/or 18:3 (linoleic acid) and create chemicals that may further increase plant defences. (b) The host cell lacks an R-gene and is incapable of recognising avr gene products. The enzyme cytochrome P450 raises the ratio of stigmasterol to -sitosterol by causing sterol C22 desaturation. Inducible lipoxygenase produces small amounts of oxylipin(s) in the cell membrane, resulting in plant vulnerability.

Phospholipid Signaling in Plant Defense

For plant–microbe interactions, several defence signalling routes and locations of cross-talk have been characterised, although many of the early signal transduction processes remain unclear. We introduce some new participants in this review, including phospholipase C (PLC), phospholipase D (PLD), and phospholipase A2 (PLA2), as well as the second messengers they produce.



Phospholipids can operate as co-factors for membrane enzymes, signal precursors, or signalling molecules, in addition to being structural components of membranes. A lipid produced in a specific membrane domain can act as a cytosolic protein docking site. Once the protein binds, it can be activated directly by a conformational change or indirectly by being placed in close proximity to another protein, such as a protein kinase. Furthermore, some lipids can alter the physical features of the membrane, such as its curvature, affecting its ability to form vesicles. This characteristic may help in vesicle trafficking, membrane recycling, and secretion (Laxalt and Munnik, 2002).

Conclusion

Membrane lipids' molecular function in plant pathology is critical for the plant's survival during pathogen invasion. Phospholipids, glycolipids, sterol lipids, and sphingolipids make up plant membrane lipids. Membrane lipids and derivatives, according to Christensen and Kolomiets (2011) and Siebers *et al.* (2016), play an important role in the infection process. They play a key role in the establishment of a membrane contact between the host and the microbe (Christensen & Kolomiets, 2011; Siebers *et al.*, 2016). From a structural and functional standpoint, membrane lipids are a diverse group of molecules. They have a wide range of functions depending on their molecular weight and lipid species. Because to differences in chain length, functional group composition, and unsaturation, membrane lipids have a wide range of structure. Changes in chemical reactivity, the ease with which molecular species are reformed in response to pathogen infection, and differences in biosynthetic or metabolic processes that are stimulated are all possible (Fahy *et al.*, 2011).

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