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Role of G proteins in Plant Pathogen Interaction

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Abstract

The first line of defence is PTI, whereas the second line of defence is ETI against the invading pathogen. Signal transduction plays a key role in plant defence mechanisms. The heterotrimeric G-protein plays an important role in signal transduction. G-proteins are composed of three subunits namely α, β, γ and the α component determine specificity. Activation results in conformational changes in the structure results in the formation of α subunit (Gα) and Gβγ dimer (Gβγ). Stimulatory G (Gs) protein coupled receptors activate appropriate enzyme and stimulates signalling pathways and expression of defence responses. The signalling system regulates infection related phenomenon in fungal pathogenesis.

Keywords: G proteins, Plant immunity, signal transduction, Pathogenicity

Introduction

All plant cells are capable of detecting invading pathogens and producing the necessary signals to defend them at the infection site. Plant immunity can be activated by two types of molecules: PAMP-triggered (PTI) and effector-triggered immunity (ETI). The Pathogen-associated molecular patterns (PAMPs) are considered to be conserved throughout classes of microbes and to contribute to basal immunity, whereas effectors are species, race, or strain specific and contribute to pathogen virulence. The first line of defence is PTI, whereas the second line of defence is ETI. In effector-triggered immunity (ETI), plant resistance (R) proteins detect specific pathogen effectors from a variety of plant pathogens and induce defence responses.

Pathogen gain resistance due to the selection pressure and leads to the breakdown of resistance. The host plants also develop receptors against newly formed effector and the cycle repeats again which is referred as a zig-zag model (Jones and Dangl, 2006). This is known as coevolution process of pathogen and host. Both PTI and ETI induce stomatal closure and a hypersensitive response (HR), a

programmed host cell death, to limit pathogen development. Signal transduction is the transfer of induction in which the extracellular substances perceived by the signal molecules will be transferred through a series of sequential events. It is a downstream cascade of defence reaction which results in the activation of transcription factors. Recent advanced studies found that heterotrimeric G-protein (G-protein) plays an important role in signal transduction. G-proteins are highly conserved in eukaryotes.

G proteins

Extracellular signals from cell surface receptors are transferred into intracellular effectors in the presence of heterotrimeric G-proteins. (Neves, 2002). Extracellular signals are commonly encountered by G-protein-coupled receptors (GPCRs) in fungi and metazoans, and are then transmitted to downstream targets via heterotrimeric G-protein complexes. Plant heterotrimeric G proteins have a role in a variety of biological activities as well. The active or inactive states of G proteins are determined by the binding of GTP or GDP, respectively. The heterotrimeric G proteins and the small G proteins are two major subfamilies of G proteins.

Structure of G proteins

The heterotrimeric G-protein composed of Gα, Gβ, and Gγ subunits. The small G proteins appear to be similar to free a subunit, operating without the Gβ heterodimer. The receptor-binding region, as well as a guanosine nucleotide binding site and GTPase activity, are found in the subunit of the heterotrimeric G protein (Sprang, 2016).

Function of G proteins

- The cell-surface receptors (G-protein-coupled receptors, or GPCRs) activate the G-protein heterotrimer by triggering the G subunit to release GDP, allowing the G subunit to bind GTP.
- It leads to the structural changes and heterodimer dissociation and formation of Gα subunit (Liu *et al*., 2013).
- G-protein signalling is terminated after the Gα subunit hydrolyses GTP to GDP and the heterotrimer reassociates.
- G proteins act as signal controller, increase signal transduction, serve as a point of signal modulation and provide specificity between GPCRs and effectors.
- It has been found that it plays key role in cAMP pathway, MAPK pathway and Calcium ion dependent signalling system.

- The signalling system regulates infection related phenomenon in fungal pathogenesis. In wheat pathogen *Stagonospora nodorum*, inactivation of Gna I, a gene encoding a Gα subunit, resulted failure in direct penetration. (Solomon *et al*., 2004)

Mechanism of Action

Cyclic Adenosine monophosphate (cAMP) is a second messenger of intracellular signal transduction. Adenylyl cyclase, which is found on the inner side of the plasma membrane, produces cAMP from ATP. The binding of elicitor with membrane bound receptor leads to activation of α subunit of G protein. Stimulatory G (Gs) protein coupled receptors activate adenylyl cyclase (AC). AC converts ATP to cAMP. The accumulation of higher cAMP results in the activation of cAMP- dependent protein kinase A (PKA). It leads to the phosphorylation of various proteins.

Conclusion

G protein plays an important role in signal transduction which is triggered by pathogen or its elicitors. It plays a significant role in infection related phenomenon in fungal pathogenesis which is triggered by signal transduction system.

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