A Novel Amphitropic Motif in the N-terminal Helix of Heterotrimeric G-proteins

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Heterotrimeric G-proteins relay signals between membrane-bound receptors and downstream effectors. The α subunits of this super-family are anchored to the membrane by one or more lipid modification at their N-termini. These modification can be palmitoylation (also known as S-acylation), myristoylation or both. While the consensus sequence for myristoylation has been well characterized, no sequence determinant for palmitoylation is apparent. We therefore used systematic homology modeling of all different human G_α proteins to look for a three-dimensional structural determinant of palmitoylation rather then a linear sequence motif.

Comparison of the N-termini of this super-family revealed that all α subunits modified only by palmitoylation contain a similar structural motif at their N-terminal helix. This motif is characterized by a prominent positive patch that extends a positive potential well beyond the molecular surface of the protein. Furthermore, this patch is on the opposite side of the N-terminal helix, relative to the face that interacts with the $\beta\gamma$ subunits. Hence, these positive patches are free to interact with the negatively charged inner surface of the plasma membrane. On the other hand, the magnitude of this positive patch is much reduced in α subunits that also undergo myristoylation.

Based on previous results, we suggest that that palmitoylation of G_α proteins requires prior targeting to the plasma membrane. The signal for this membrane localization is therefore either myristoylation or the novel motif that we identified. This signal is further enhanced by interaction of the α subunit with the $\beta\gamma$ complex. The N-terminus of a G_α protein can therefore be described as amphitropic, containing dual signals attracting it to the membrane and enabling it to undergo palmitoylation. As palmitoylation has been shown to modify a plethora of proteins extending beyond G-proteins, this motif could be more widely applicable.