Integrins play essential roles in insect cellular immunity

Integrins are phylogenetically conserved transmembrane receptors consisting of heterodimers of two subunits called α and β. Eighteen α subunits and 8 β subunits exist in mammals and form heterodimers giving rise to 24 different integrins. Integrins play important roles in a variety of biological phenomena by mediating cell-cell adhesion. In addition, integrins connect the extracellular matrix with the cytoskeleton and activate intracellular signaling pathways. In Drosophila melanogaster, it is reported that integrins involve in embryonic development, epithelial remodeling, muscle attachment, tracheal terminal branching, luminal organization of tracheae. Additionally, several studies reported that integrin play important role in insect immunity. Therefore, in this review, the involvement of integrins in insect cellular immunity was introduced and showed how integrin regulate cellular immunity.

The importance of integrins was implicated by RNA interference (RNAi) specific to integrin subunit gene and genetical modification of integrin subunit gene. In Spodoptera exigua, the suppression of β Se1 gave significant mortality to larvae in a dose-dependent manner (Surakasi et al. 2011). Moreover, Drosophila melanogaster depleted integrin subunit was susceptible to bacterial infection and showed high mortality (Shiratsuchi et al. 2012). These reports indicated that integrins are integral in insect physiology. In addition, gene expression of integrin subunit in hemocytes was induced when hemocyte-spreading occurred or artificial beads were encapsulated in Pseudoplusia includens (Lavine and Strand 2003). Similary, the expression of β integrin gene in hemocytes from S. exigua larvae injected with bacteria was also upregulated (Surakasi et al. 2011). These reports suggest that integrins may play an important role in immune response.

Several studies reported the involvement of integrins in insect cellular immunity. Phagocytic activity of Escherichia coli decreased when BINT2, a β subunit of integrins of Anopheles gambiae, was knockdowned (Moita et al. 2006). When the expression of integrin β 1 of Manduca sexta was suppressed, the percentage of beads fully encapsulated by hemocytes extremely decreased (Levin et al. 2005). And encapsulation of artificial beads was incompletely accomplished when expression of Ofint β 1, integrin β subunit of Ostrinia furnacalis was suppressed (Xu et al. 2012). By RNAi of β 1 integrin of S. exigua, numbers of nudules per larva also reduced (Surakasi et al. 2011). These results firmly support the hypothesis that integrins play an critical role in cellular immunity.

Additional reports indicated how integrins activate cellular immune response. it is suggested that integrins mediate hemocyte-spreading reaction. Hemocyte spreading was impaired by RNAi specific to β 1 integrin of S. exigua and O. furnacalis (Surakasi et al. 2011)(Xu et al. 2012). Moreover, it is
reported that F-actin growth, which is integral to hemocyte spreading, was regulated by integrin $\beta 1$ expression in *O. furnacalis* (Xu et al. 2012). These results indicated that the polymerization of F-actin may control the spreading of hemocytes, and integrins play key role in actin polymerization.

Taken together, integrins regulate hemocyte spreading that is essential to cellular immune responses via polymerization of F-actin, which causes resistance to bacterial infection and keep homeostasis. However, the activation mechanisms of cellular immune responses are unclear. Therefore, further study is required.

### Reference


### Key words

Integrin, Cellular immunity, phagocytosis, encapsulation, nodule formation, hemocyte spreading, F-actin growth, RNAi