Evolution of the extracellular matrix for multicellularity

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Abstract:

The evolution of multicellularity is a major transition in the morphological organization of organisms, however, the molecular mechanisms important for this transition in any taxa are currently not well understood. In most taxa, the molecular signature of the transition to multicellularity is obscured by nearly a billion years of divergence. Multicellularity evolved recently in the volvocine algae, thereby preserving the molecular signature of this transition. The volvocine algae include members that span the range of morphological complexity from unicellular (e.g. *Chlamydomonas*) to undifferentiated multicellular (e.g. *Gonium*), to species with differentiated tissues (e.g. *Volvox*). Importantly, the genomes of *Chlamydomonas* and *Volvox* have shown to be remarkably similar, suggesting the transition to multicellularity only requires the evolution of a few genes. To find genes important for multicellularity in undifferentiated multicellular G*onium pectorale,* we performed a genetic screen for unicellular mutants. From this we identified a mutant, *uc-1C7,* that is 99.6% unicellular. Resequencing its genome revealed that the causative mutation is in an ortholog of *GDT1,* which is conserved across all eukaryotes. GDT1 is localized to the trans-Golgi, where it plays a role in the proper glycosylation of proteins destined for the extracellular matrix. We found that the *uc-1C7* mutant is sensitive to detergent lysis consistent with defects in extracellular matrix assembly. When the *GDT1* ortholog from *Gonium* is expressed in unicellular *Chlamydomonas,* it causes a multicellular gain-of-function phenotype. These results suggest that GDT1 is important for multicellularity by regulating the maturation of proteins destined for the extracellular matrix to promote cell-cell adhesion.