Carbohydrate-based species recognition in sea urchin fertilization

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Previous researchs have postulated that in sea urchins, gametic mate “choice” during fertilization is controlled primarily, if not exclusively, by interaction of the sperm protein bindin and its egg receptor. We proposed a distinct carbohydrate-mediaded mechanism for cell-cell recognition that coexists with the bindin-protein paradigm. This signaling event precedes the bindin(g) step in the fertilization cascade. When spem approach the sea urchin egg, sulfated polysaccharides in the egg jelly induces the sperm acrosome reaction, which exposes the protein bindin at the tip of the sperm head. Only then can sperm attach to the egg and their plasma membrane fuse. The sulfated polysaccharides responsible for the induction of the acrosome reaction have been isolated from the egg jellies of several sea urchins species, and structurally characterized. These polysaccharides have an unusual structure, composed of linear chains of L-fucose or L-glactose units, with well-defined repetitive units. The specific pattern of sufation and the position of the glycosidic linkages vary among sulfated fucans or sulfated galactans from different species of sea urchins. The polysaccharides show specie specificity in inducing the acrosome reaction, which is in fact regulated by the fine structure of the polysaccharide chain and its sulfation pattern. The system we described not only establishes a new outlook on cell-cell interactions in the widely used, pioneer sea urchin model system; it also shows clear parallels to mammalian fertilization. Given the limitations of studying mammalian fertilization in situ, the sea urchin fertilization system presented here may provide a model for studying the role of egg envelope carbohydrate in triggering the acrosome reaction and lead to new insights in fertility and contraception.