Mesendoderm specification in zebrafish gastrulation: the role of extraembryonic tissues

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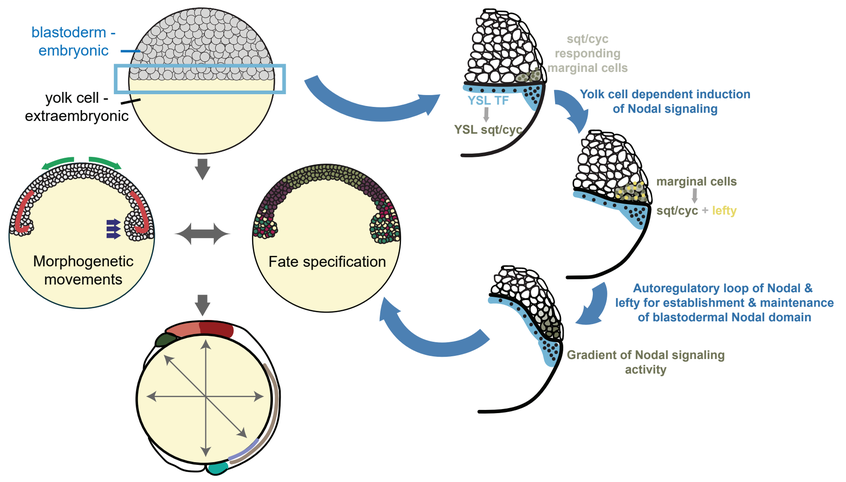
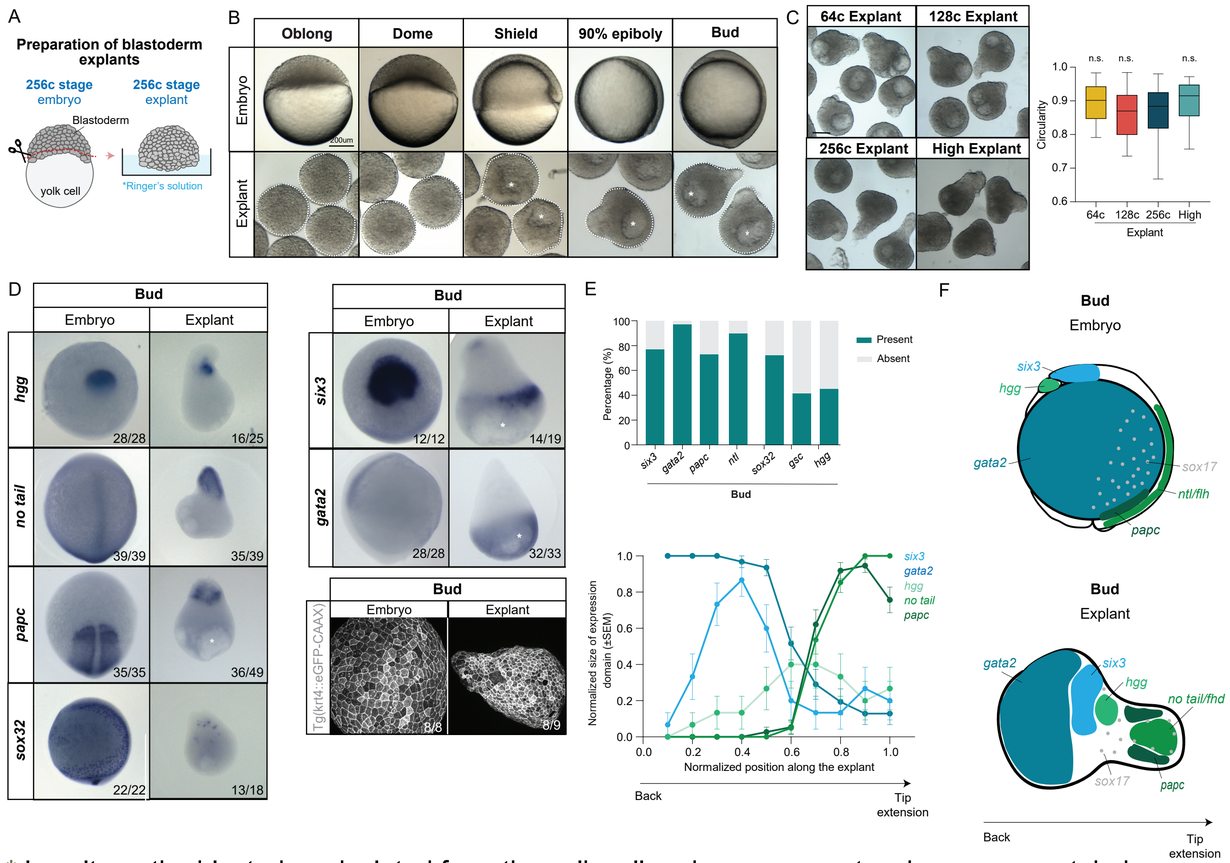
Introduction

During embryonic development, the adult body plan is established through a series of signaling events and morphogenetic changes. In many organisms, extraembryonic structures play important roles in this process. For instance, in the zebrafish embryo, such a structure, the so-called yolk cell with the yolk syncytial layer (YSL), provides crucial signals for germ layer specification and patterning (1,2,3,4) and is involved in gastrulation movements (5,6). To investigate how far the embryo proper can compensate for the loss of the extraembryonic yolk cell and recapitulate developmental processes in its absence, we have established an *ex vivo* system to culture zebrafish embryos in isolation from the yolk cell. Such a system not only allows us to probe the contributions of the yolk cell as a geometric structure and signaling source for embryo development, but further constitutes a system to analyze the specific contributions of different prepatterened cues, extraembryonic signaling sources and self-regulatory interactions of signaling pathways to overall pattern formation and morphogenesis during gastrulation. Our results so far show that mesendoderm induction in the blastoderm is surprisingly robust towards loss of this extraembryonic tissue, however, signaling dynamics of the mesendoderm inducing signaling pathway Nodal are altered. Consequently, the formation of tissues which require high levels of Nodal signaling is variable in blastoderm explants. In line with this, specifically reducing Nodal ligands in the YSL also leads to a reduction of high Nodal signaling dependent mesendodermal domains.



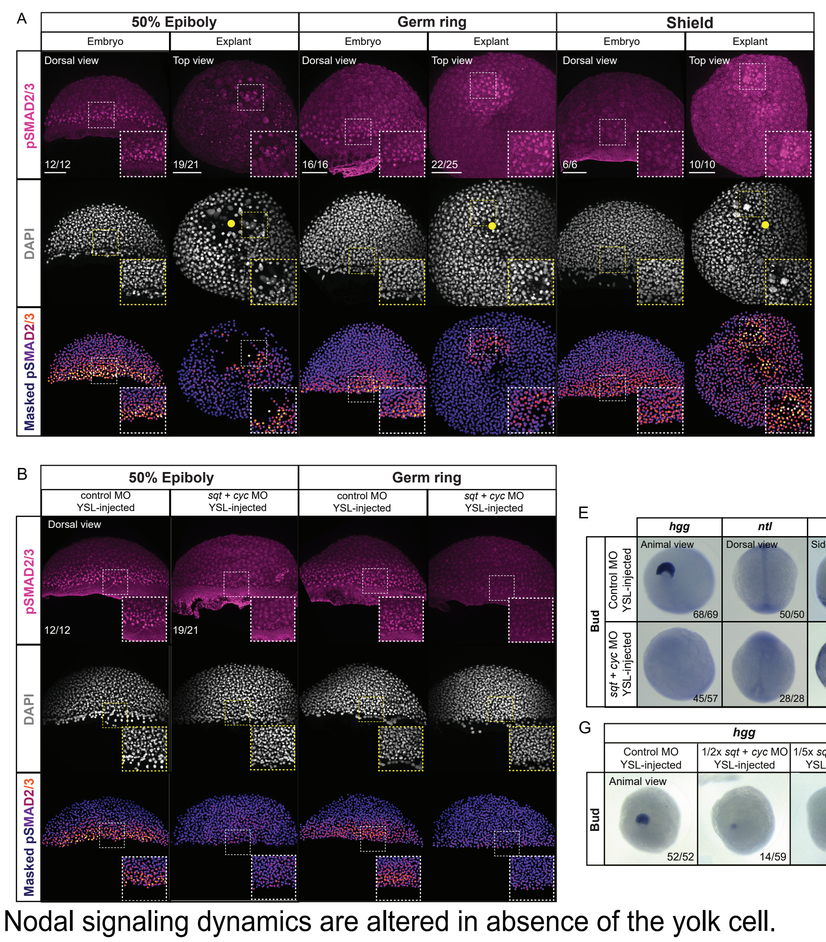
Blastoderm explants undergo a series of stereotypical morphogenetic changes in absence of the yolk cell & specify mesendodermal cell fates



* In culture, the blastoderm isolated from the yolk cell undergoes an extension movement, independently of the stage of isolation from the yolk cell.

* Different mesendodermal cell fates are specified in absence of the yolk cell. Mesendodermal tissues are located predominantly in the extended part of the explant, while ectodermal tissues constitute the main component of the round part.

Changes in Nodal signaling dynamics upon disruption of the YSL source lead to defects in the formation of mesendodermal domains requiring high Nodal doses



* Nodal signaling dynamics are altered in absence of the yolk cell.

* Robust formation of head mesoderm and endoderm requires an intact Nodal signaling source in the extraembryonic YSL.

References

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