

Establishment of developmental gene silencing by ordered polycomb complex recruitment in early zebrafish embryos

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Abstract

Vertebrate embryos achieve developmental competency during zygotic genome activation (ZGA) by establishing chromatin states that silence yet poise developmental genes for subsequent lineage-specific activation. Here, we reveal the order of chromatin states in establishing developmental gene poising in preZGA zebrafish embryos. Poising is established at promoters and enhancers that initially contain open/permissive chromatin with 'Placeholder' nucleosomes (bearing H2A.Z, H3K4me1, and H3K27ac), and DNA hypomethylation. Silencing is initiated by the recruitment of polycomb repressive complex 1 (PRC1), and H2Aub1 deposition by catalytic Rnf2 during preZGA and ZGA stages. During postZGA, H2Aub1 enables Aebp2-containing PRC2 recruitment and H3K27me3 deposition. Notably, preventing H2Aub1 (via Rnf2 inhibition) eliminates recruitment of Aebp2-PRC2 and H3K27me3, and elicits transcriptional upregulation of certain developmental genes during ZGA. However, upregulation is independent of H3K27me3 – establishing H2Aub1 as the critical silencing modification at ZGA. Taken together, we reveal the logic and mechanism for establishing poised/silent developmental genes in early vertebrate embryos.

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