LABORATORY OF

TRANSCRIPTIONAL REGULATION

Development, evolution, gene regulation, transcription factors, eye

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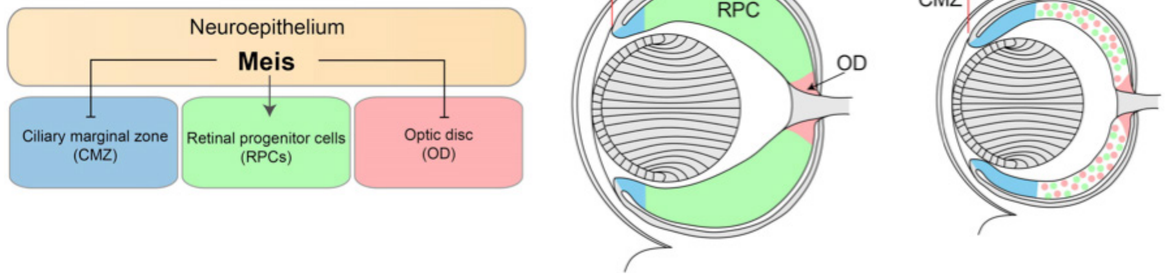
We investigate embryonic development using an integrative approach combining molecular biology, cell biology, developmental biology, genetics, biochemistry, and bioinformatics in order to get insight into the molecular mechanisms underlying the process of animal development and its tinkering during the course of evolution. We are especially interested in the role of transcription factors and signalling cascades integrated into complex gene regulatory networks. Several vertebrate and invertebrate model systems including mice, fish, amphioxus, annelids, and cnidaria are being used in the laboratory to study various aspects of animal development and evolution. The long-term interest of the group lies in the studies of vertebrate eye development, eye evolution, and body plan evolution.

The vertebrate eye development has been studied for a long time, but only in the last two decades the function of individual transcription factors began to be elucidated. Genetic manipulation in mice combined with interrogation of whole-genome occupancy of key transcription factors allows addressing the role which individual transcription factors play during embryonic development and how they interact with each other. Dissection of the regulatory networks will enhance our understanding of specific aspects of mammalian eye development and will lead to a more profound understanding of congenital eye defects in humans. We currently investigate the gene regulatory networks associated with transcription factors Pax6 and Meis during the retina, lens, and cornea development.

One of the most intriguing queries in developmental biology is how the specialized cell types, tissues, organs and the body plan evolved throughout the animal kingdom. We use invertebrate chordate amphioxus that has widely been used as a reference outgroup to infer ancestral versus novel features during vertebrate evolution. We identified Wnt/β-catenin signalling as an evolutionarily conserved determinant of chordate dorsal organizer, and provided insight into cell-type evolution in the chordate retina.



Meis homeobox genes control progenitor competence in the retina

Selected publications:

1. Sunny SS, Lachova J, Dupacova N, Kozmik Z*. Multiple roles of Pax6 in postnatal cornea development. Dev Biol 2022 491:1-12.
2. Dupacova N, Antosova B, Paces J, Kozmik Z*. Meis homeobox genes control progenitor competence in the retina. Proc Natl Acad Sci U S A. 2021 118(12):e2013136118.
3. Pergner J, Vavrova A, Kozmikova I, Kozmik Z*. Molecular Fingerprint of Amphioxus Frontal Eye Illuminates the Evolution of Homologous Cell Types in the Chordate Retina. Front Cell Dev Biol 2020 Aug 4;8:705.
4. Kozmikova I*, Kozmik Z. Wnt/β-catenin signaling is an evolutionarily conserved determinant of chordate dorsal organizer. Elife. 2020 May 26;9:e56817.