

Osmoregulation & the Developmental Program

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Fish embryos are able to maintain internal osmolality like adults, although their osmoregulatory organs (the gills, kidney and intestine) are not fully developed. In embryos of many teleost species, numerous mitochondrion-rich cells (MRCs) have been found in the epithelia covering the yolk and/or body, and those extrabranchial MRCs are considered to be the major site of active ion transport.

Since early development varies greatly among teleost species, developmental changes in MRC distribution were compared among several euryhaline or diadromous species, such as Mozambique tilapia, Japanese eel, Japanese flounder and ayu. The spatial shift of cutaneous to branchial MRCs was closely associated with metamorphosis in Japanese flounder.

Morphofunctional studies on cutaneous MRCs in embryos have more technological advantages than on MRCs in adult gills, which exhibit complex three-dimensional structures. Our recent progress in functional classification of MRCs and discovery of 'freshwater-type' Na/Cl cotransporter (NCC) was achieved by using tilapia embryos. The embryonic MRCs were clearly classified into four types (types I-IV), by the simultaneous quintuple-color immunofluorescence staining for NCC, NKCC1a, Na/K-ATPase, CFTR and NHE3.