New insights into the role of the developing gill – gas transfer or ionic regulation?

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The gills in fish are important for gas exchange, ion and acid-base regulation, however, the relative role of the gills to each may change during development. In recently hatched larval fish, total body surface area:mass is high and all processes are predominantly initially cutaneous. Simultaneous measurement of unidirectional Na^{22} and O_2 uptake across the gills and skin during development in rainbow trout indicate a shift from skin to gill uptake that occurred 15-16 days post-hatch (dph) for Na^+ uptake and 23-25 dph for O_2 uptake (50-80% longer). Furthermore, this pattern was little affected by water hardness indicating a lack of plasticity in early gill ionoregulatory development. Whether this pattern is observed in other teleost and basal fishes will yield important insight into the role of ionoregulation in vertebrate gill evolution. Dramatic developmental changes in the gills may also be observed later in life in some fishes. In *Arapaima gigas*, the developmental transition from predominantly aquatic to aerial O_2 uptake is associated with a dramatic reduction in gill surface area through filling of gill interlamellar spaces with mitochondrial rich cells. Morphologically, this is consistent with the gills transitioning back to a predominantly ionoregulatory role with the onset of air-breathing.