© 2022. Published by The Company of Biologists Ltd | Journal of Experimental Biology (2022) 225, jeb245364. doi:10.1242/jeb.245364

INSIDE JEB

Killifish neuroepithelial gill cells sense the lactate burn

Killifish gill filaments.

Every sprinting kid knows that feeling as they push through the pain barrier: their lungs are bursting and their muscles sting with pain. That's the sure-fire sign they've run out of oxygen in their muscles and switched to anaerobic respiration; lactic acid is building up in their muscles. However, lactic acid is more than just an uncomfortable metabolic by-product. Some tissues, such as the heart, can use the molecule as an energy source, while lactic acid is also used to produce glucose in the liver and it has a role in regulating breath rate in mammals. However, Erin Leonard from Wilfred Laurier University, Canada, explains that although the fish gill was known to sense lactate levels in the blood to increase breathing rate, no one knew precisely which cells were involved. Suspecting that the fish equivalent of the blood-monitoring carotid body in mammals – neuroepithelial cells in the gills – could be responsible for detecting lactate levels in their blood, she and her colleagues Fiona Weaver and Colin Nurse from McMaster University, Canada, tested whether killifish (*Fundulus heteroclitus*) neuroepithelial cells are capable of reacting to rising levels of lactate in the blood.

Collecting cells from killifish gills, Leonard first identified the neuroepithelial cells from the general mixture by searching for cells that changed their internal calcium levels when treated with potassium ions, CO_2 and low oxygen concentrations – key characteristics of neuroepithelial cells. Once Leonard was sure that she had identified the correct cells, she pulsed them with a low dose of lactic acid (5 or 10 mmol l^{-1}) – concentrations found routinely in blood – and checked how their calcium levels changed. Sure enough, the cells accumulated calcium when bathed in lactate, as you would expect of a lactate sensor. And, when Leonard applied a drug that prevented calcium from entering the neuroepithelial cells, their calcium levels no longer rose when they were exposed to lactic acid.

As lactate has to be transported into carotid body glomus cells by transporter proteins to trigger a signal when the tissue senses the metabolic byproduct, Leonard checked whether blocking the same transporter proteins in the neuroepithelial cells could also prevent them from accumulating calcium: sure enough, it did. So, fish gill neuroepithelial cells are able to take in lactate in much the same way as glomus cells that trigger a signal when lactic acid is sensed by the carotid body.

'These data present the first direct evidence that gill neuroepithelial cells act as lactate sensors', says Leonard, who is keen to identify the next stages of the fish's lactate sensing signalling process.

10.1242/jeb.245364

Leonard, E. M., Weaver, F. E. and Nurse, C. A. (2022). Lactate sensing by neuroepithelial cells isolated from the gills of killifish (*Fundulus heteroclitus*). *J. Exp. Biol.* **225**, jeb245088. doi:10.1242/jeb.245088

Kathryn Knight
kathryn.knight@biologists.com