SUPPLEMENTAL METHODS

Device Fabrication:

Our devices consist of three PDMS layers, each fabricated from a separate master mold. To fabricate the 'flow' layer, we used a master mold with two photoresist layers. We first spin coated and patterned a 15 μm-thick layer of SU8-2025 negative photoresist (Microchem) to define the aspiration channels. We next spin coated and patterned a 100 μm-thick layer of SIPR-7123 positive photoresist (Micro-Si) to create the remaining parts of the flow layer mold. The 'press-down' and 'control' layer molds were created from 65 μm- and 75 μm-thick layers of SU8-2050 (Microchem), respectively. From these molds we cast RTV-615 PDMS (GE Silicones), deposited either by pouring (for the 'immobilization' layer) or spinning (for the 'control' and 'flow' layers). Following this we cured the layers for 1 hour at 80 °C, then bonded the layers together thermally for 36 hours.

Cell-Body Tracking:

To track the movement of all cell bodies, we captured movies at 50x magnification of pmec4::gfp animals immobilized either by the anesthetic NaN_3 at concentrations 10 μM or by our microfluidic device. 10 μM NaN_3 was the highest anesthetic concentration that allowed us to recover the animals. At 50x magnification, 1-3 cell bodies were randomly selected and were visible in the movies. The fluorescence intensity in the movies was first thresholded to identify locations of high GFP expression, corresponding to the cell bodies. An algorithm next identified all connected regions and removed those too small to be cell bodies, then calculated the centroids of the remaining objects. The centroids were overlaid onto the original movies to ensure the cell bodies were properly identified.

Lifespan Synchronization, Animal Preparation, and Lifespan Analysis:

The development cycles of both populations were synchronized by dissolving gravid adults in a mixture of bleach, NaOH, and M9 buffer. Their embryos were washed by repeated centrifugation and aspiration and allowed to hatch overnight in the absence of food. The following day the synchronized L1 larvae were transferred to NGM plates containing *E. coli.* (day 0), and allowed to develop into L4-stage larvae at 20 °C. On day 2 the animals were delivered to the microfluidic chip. To remove any debris before loading the animals into our devices, we first suspended the animals in M9 buffer, centrifuged at 400 rpm for 1 minute, and aspirated the supernatant. This process was repeated two more times before introducing the worms into the device. The control population was also treated the same way. Following the experiment, both populations were examined once per day for dead animals that did not respond to prodding with a platinum worm pick. The surviving animals were transferred to a fresh plate to be scored the following day. All experiments were performed in compliance with the guidelines seth forth by MIT Commitee on Animal Care (CAC).