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A CutFEM METHOD FOR A MECHANISTIC MODELLING OF ASTROCYTIC METABOLISM IN 3D PHYSIOLOGICAL MORPHOLOGIES

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Investigating neurodegenerative diseases can be done complementary through biological and computational experiments. A good computational approach describing a simplification of the reality and focusing only on some features of the problem can help getting insights on the field. The question addressed in our work is the role of astrocytes in neurodegeneration. These cells have two interesting characteristics that we want to investigate in our model: first, their role as metabolic mediator between neurons and blood vessels and second, their peculiar morphology. In fact, metabolic dysfunctions and morphological changes have been noticed in astrocyte affected by neuropathology. Computationally the main difficulty arising from solving a metabolic model into cellular shape comes from the complexity of the domain. The shape of astrocytes are very ramified, with thin branches and sharp edges. As shown in our previous work [2], a CutFEM [1] approach is a suitable tool to deal with this issue. In our latest work we use real human three-dimensional astrocyte morphologies obtained via microscopy [3] as domain to solve our system. The performed simulations highlight the effect of morphological changes on the system output. Suggesting that our model can be crucial in understanding the morphological-dependency in neuropathologies and that the spatial component cannot be neglected.

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