Modelling species transport and consumption using COMSOL Multiphysics

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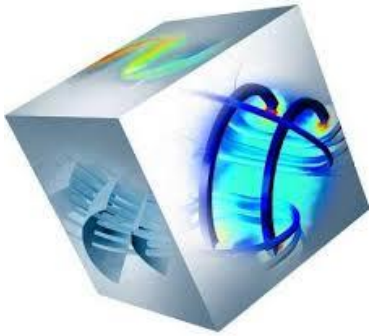

Course: Fenomeni di trasporto biologico

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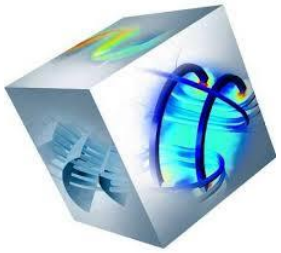


Problem description

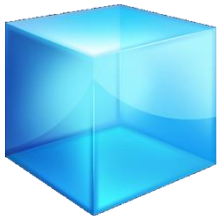
- Model steady-state O_2 diffusion and consumption within a cell laden construct

$$\nabla \cdot \left(-D\nabla c_{O_2}\right) = R - \boldsymbol{u} \cdot \nabla c_{O_2}$$
$$R_{O_2} = V_{O_2} \cdot \delta\left(c_{O_2} > c_{O_2,cr}\right)$$

Generic advection and diffusion equation

- Boundary oxygen concentration: $c_{O_2} = p_{O_2} \cdot K_{H,O_2} = 0.21$ mM
- Oxygen consumption rate: $V_{O_2} = 1 \cdot 10^{-3}$ mol/(m³ · s)
- Oxygen diffusion in the construct: $D_{O_2} = 1 \cdot 10^{-9}$ m²/s
- $\delta\left(c_{O_2} > c_{O_2,cr}\right) = \mathrm{flc1hs}(c_{O_2} - c_{O_2,cr}\,,\ c_{O_2,cr}/2)$ → COMSOL smoothed Heaviside function with continuous first derivative and without overshoot
- Critical oxygen concentration to account for cell necrosis: $c_{O_2,cr} = 2.64$ µM
- Cell construct volume: 27 mm³

Is it better a cube- or a sphere-shaped construct to maximize cell viability?



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