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Theory and Numerics of Multicomponent Mixture Models for Soft Biological Tissues

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One natural category of porous materials is represented by biological soft tissues, such as cartilage, lung or skin. The challenge of describing these materials lies in their complex inhomogeneous microstructure consisting of mostly ionized water and collagen fibers embedded in an extracellular meshwork of charged protein compounds. In order to describe the physiological behaviour of soft tissues on the macroscale, the electro-chemomechanical couplings between the constituents as well as the viscoelastic and anisotropic properties of the extracellular matrix must be considered. In order to meet these requirements, the well-founded Theory of Porous Media (TPM) is applied, which consistently allows for the description of multiphasic continua with internal interactions. For the efficient numerical treatment within the FEM, the governing set of multi-field equations is rewritten in weak form including physically meaningful boundary terms. The overall applicability of the multicomponent mixture approach is finally shown by representative numerical examples.

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