Multiscale Problems for Flow, Transport and Reactions in Tissues

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Abstract: Modelling processes in biological tissue in general leads to the following problems:

- derivation of effective equations from model equations for processes on microscale using homogenization methods,
- multiscale analysis of branching networks (vessels, dendrites, roots, etc.),
- classification and generation of complex geometry,
- analysis of processes in random media,
- derivation of models for flow and particle transport in membranes and tissue, for growing systems, coupling mechanical and chemical processes.

To understand growth and differentiation of tissue or the functioning of organs the information on all scales has to be used, the effect of microscale processes on the macroscale behaviour has to be analysed. Techniques developed mainly for processes in porous media or composite materials can be applied to modelling flow, transport and interactions in biological systems. The derivation of effective differential or boundary conditions is studied. The parameters of the effective equations can be computed from the microscopic cell problems. Reduction of the complexity by averaging and reduction of dimension is basic for the simulation of the processes.

This lecture will give a survey on results obtained by methods of homogenization and multiscale analysis. As an example problems arising in flow and transport through systems of thin channels with solid or flexible walls are discussed. The lecture is mainly based on results obtained in joint work with A. Mikelic and research going on in the modelling group at IWR, Heidelberg.

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