

New models for pattern formation, mechano-chemical interactions and multiscale analysis

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Hydra has been a fruitful model system in developmental biology for over 100 years. Even before the empirical discovery of morphogens, their existence was hypothesised in 1952 by Alan Turing. He proposed a simple model of reacting and diffusing “morphogens” as a plausible mechanism for spontaneous pattern formation in biological tissue, mentioning Hydra patterning as a prominent example. In this talk, I will show how Turing and other pattern formation concepts stand challenges arising from the current experimental research. In particular, I will introduce new models to investigate interactions between pattern formation subsystems controlling development of different body structures such as head and tentacles. Another aspect these models cover is dynamics of formation of complex and overlapping patterns of different genes (such as multiple Wnts). The Turing-style morphogen-based models will be compared to a mechano-chemical model exhibiting de novo pattern formation. The latter will use geometric singular perturbation allowing separating fast and slow-scale subsystems. Model simulations will be compared to the current experimental results.

The presentation is based on joint works with Moritz Mercker and Frits Veerman (IAM, Heidelberg University), and the experimental group of Thomas Holstein (COS, Heidelberg University).