Importance of variation in cytoplasm viscoelasticity throughout embryonic cell division

The first few cell divisions are crucial for successful embryonic development of multicellular organisms. In order to divide properly, a myriad of biochemical and mechanical events need to be precisely coordinated. Mechanical events, such as positioning of the mitotic spindle, segregation of chromosomes, and cytokinesis, depend on the material properties of the cytoplasm. For more than a century, studies have consistently shown that the cytoplasm behaves as a viscoelastic material, with properties changing throughout the cell cycle stages. Nonetheless, variation of viscoelasticity throughout the cell cycle and its importance for correct embryonic cell division remains poorly understood.

We aim to understand how different cytoplasmic components contribute to the viscoelastic properties through different stages of the cell cycle, focusing on the centrosome positioning mechanisms. We approach this question by using *Xenopus Laevis* cytoplasmic extract, which recapitulates several mechanical and biochemical processes of embryonic cell divisions. Cytoplasmic extracts are valuable model systems because they combine the complexity of *in vivo* systems with a wide possibility to be biochemically and mechanically modified. Using magnetic tweezers and introducing magnetic particles into the cytoplasmic extract, we probe the mechanical properties of the bulk cytoplasm. This reveals drastic increases in the fluidity of the cytoplasm during mitosis.

To examine the mechanics of centrosome positioning, we encapsulate cytoplasmic extract with artificial centrosomes in oil. Interestingly, the dynamics of microtubules cause centrosomes to oscillate around the geometric center of the droplet, reaching the center of the droplet consistently at a very precise cell cycle stage of the extract. Linking centrosome positioning and variability of viscoelastic properties of the cytoplasm might offer insight into the mechanics of cell division in large embryonic cells, a subject that continues to be debated. In the future, understanding the mechanical properties of cytoplasm in early embryonic cells could reveal a better understanding of human embryonic development, potentially addressing the challenge of *in vitro* fertilization failure.