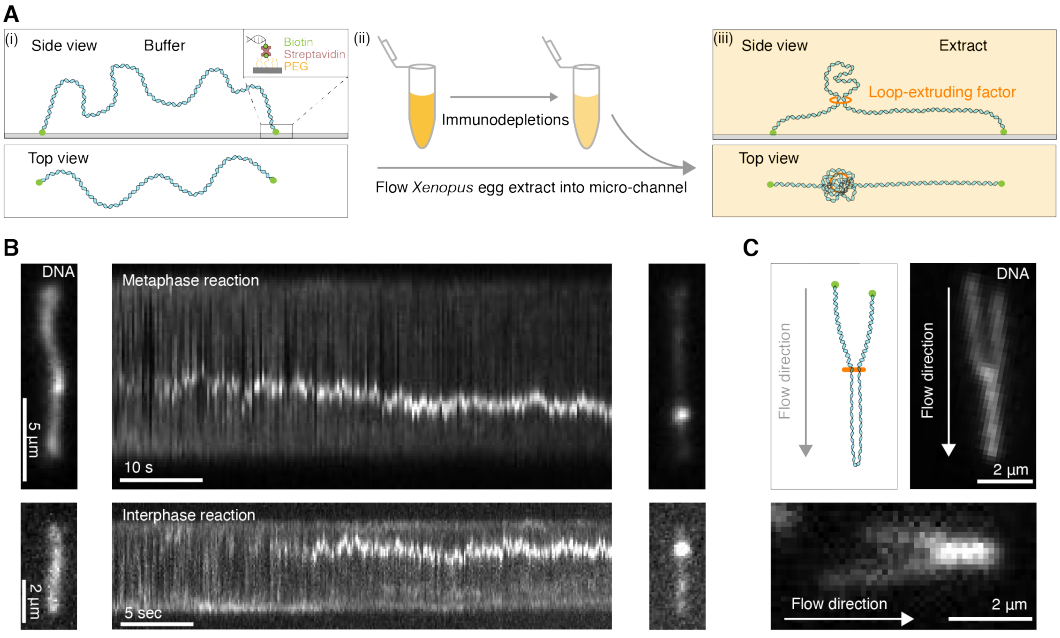
Our lab aims to uncover the principles of how cellular compartments emerge from the collective behavior of individual molecules. To this end, we complement quantitative measurements *in vivo* with reconstitution approaches to rebuild cellular functions using cell extracts and purified components. We combine these approaches with the development of new quantitative biophysical methods and theory.

Current research in the lab is centered around two general questions, both aiming at understanding the emergence of cellular compartmentalization. First, we are studying how the size and shape of spindles arise from the interplay of mechanics, microtubule nucleation, and motor activities, and how these properties are regulated during early development. Second, we want to understand the principles that govern active chromatin organization in the nucleus, a question that has been largely ignored from the physical point of view. We have provided the first direct proof of DNA loop extrusion in a cellular context by reconstituting this process on single DNA molecules in cell extracts. We also have shown that capillary forces driven by transcription factors lead to the emergence of DNA condensates, providing a new physical principle that could explain how distant DNA sequences meet to initiate and regulate transcription in the nucleus. Our assay puts us in a unique position to reconstitute complex processes such as the interplay between transcription and loop extrusion in cellular contexts, and ultimately understand the principles that organize chromatin in space and time. We are currently looking for PhD students to work on this *in vitro* assay in combination with live imaging on embryos to elucidate the mechanisms that drive chromatin organization in the nucleus.

For more information see https://elifesciences.org/articles/53885



Single DNA molecule assay for direct visualization of DNA looping in Xenopus egg extracts. (A) (i) Side and top view schematics of a single strand of DNA attached to a functionalized cover slip via biotin-streptavidin linkers. (ii) Xenopus egg extract is flowed into the microfluidic chamber. (iii) Side and top view schematics visualizing how soluble active loop-extruding factors extrude loops extract. (B) Dynamics of the formation of DNA loops in metaphase (upper) and interphase (lower). Kymograph of DNA signal over time displaying a looping event upon addition of extract (middle). Snapshot of steady-state DNA looping event after ~60 sec (right). (C) Hydrodynamic flows reveal loop topology within DNA cluster. (i) Schematic of the loop topology revealed upon flow. (ii) Topology of extract-induced DNA loops in metaphase (upper) and interphase (lower) visualized using Sytox Orange revealed upon flow.