During embryonic development, an unstructured ball of cells is transformed into the diverse structures of tissues and organs in animals. During this process of morphogenesis, tissues comprising tightly packed groups of cells often dramatically deform and flow as the embryo develops and takes on its final shape. The mechanical behaviors of living tissues are crucial for generating organs with the proper shape and function, yet remain poorly understood. Our goal has been to develop experimental approaches to dissect the physical and biological mechanisms that contribute to morphogenesis. We combine novel optogenetic technologies for controlling tissue mechanics with live confocal imaging of tissues to study morphogenesis in the developing fruit fly embryo.

We will discuss examples of how active forces, adhesion between cells, and tissue anisotropy contribute to the remarkable mechanical behaviors of developing two-dimensional epithelial tissue sheets. This work provides a foundation for integrating the physics of living matter into our understanding of embryonic development and may motivate new strategies for building and shaping biological matter in the lab.