The revolution in molecular biology within the last few decades has led to the identification of multiple, diverse inputs into the mechanisms governing the measurement and regulation of organ size. In general, organ size and homeostasis is controlled by both intrinsic, genetic mechanisms as well as extrinsic, physiological factors. Examples of the former include the spatiotemporal regulation of organ size by morphogen gradients, and instances of the latter include the regulation of organ development by endocrine hormones, oxygen availability, nutritional status and the mechanics of the microenvironment. However, integrated model platforms, either of in vitro experimental systems amenable to high-resolution imaging or in silico computational models that incorporate both extrinsic and intrinsic mechanisms are lacking. Here, I will discuss collaborative efforts to bridge the gap between traditional assays employed in developmental biology and computational models through quantitative approaches. These interdisciplinary efforts are being applied to develop integrated models of epithelial growth and homeostasis in the larval wing imaginal disc of the fruit fly, due to the wealth of previous genetic knowledge for the system. In particular, I will discuss our current understanding of how intrinsic and extrinsic factors impact the spatiotemporal dynamics and possible functional roles of calcium signaling in development and homeostasis using a combination of microfluidics devices, organ culture and computational modeling of signal transduction. Integrated models of intrinsic and extrinsic growth control and regenerated are expected to provide greater insight into how cells communicate to coordinate tissue-level responses.