Research Vision

My research focuses on unraveling the cellular and molecular mechanisms underlying tissue-specific cancer risk, with a particular emphasis on colorectal cancer (CRC) and the developmental origins of the gut epithelium. By integrating lineage tracing, single-cell genomics, and multi-omics approaches, I aim to uncover fundamental principles of tumor evolution, tissue regeneration, and immune interactions that drive disease progression.

1. Clonal Dynamics & Tumor Progression

I have developed a molecular clock approach using CRISPR-based lineage tracing to record the timing of cellular events in vivo. This approach revealed clonal selection as a hallmark of precancer-to-cancer transition, showing how early-stage polyclonal tumors evolve into monoclonal malignancies. By dissecting these evolutionary dynamics, my research sheds light on how clonal selection shapes tumor progression and therapeutic resistance.

2. Regeneration & Developmental Origins of Cancer Susceptibility

My work uncovered a unique regenerative cell population in the mouse intestinal epithelium, providing critical insights into injury-induced regeneration and tissue homeostasis. Looking ahead, I aim to explore how developmental origins contribute to cancer susceptibility by comparing the functional and molecular differences between the colon and small intestine.

3. Bridging Tumor Genomics & Immune Microenvironment

To understand how tumor-immune interactions shape cancer evolution, my research will integrate immune profiling with tumor cell lineage trees at single-cell resolution. By identifying clonal bottlenecks in CRC progression, I aim to uncover new therapeutic vulnerabilities and mechanisms of immune evasion.

4. Future Directions & Impact

- Develop a mouse model for in vivo inflammation recording to study how chronic inflammation influences tumor initiation and tissue regeneration.
- Bridge the gap between genomic variations and phenotypic consequences by mapping genotype-phenotype relationships in CRC.
- Leverage multi-omics technologies to develop early intervention strategies and precision medicine approaches for cancer and epithelial regenerative disorders like IBD.

By combining developmental biology, cancer genomics, and single-cell technologies, my research aims to uncover fundamental principles of tumor evolution and translate these insights into targeted therapeutic strategies that can improve patient outcomes.