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Date Friday, May 1, 2026

Time 12:00 to 1:00 PM

Location CBB 108

Title: *What Does Human Kidney Atlas Teach Us About Kidney Disease Mechanisms and Clinical Applications*

Abstract: Building upon a foundational Human Kidney resource, we present a comprehensive multi-modal atlas that defines spatially resolved versus unresolved repair states and mechanisms in human kidney disease. Homeostatic interactions between injured kidney epithelium and its surrounding milieu determine successful repair outcomes, while pathogenic signaling promotes unresolved inflammation and fibrosis leading to chronic disease. We integrated multiple single-cell and spatial modalities across 700 samples from >350 patients (250 research biopsies), analyzing 1.7 million cells alongside complementary mouse multi-omic profiles spanning acute-to-chronic injury and aging (>300,000 cells) and spatial transcriptomic analysis of >150 human biopsies. This cross-species atlas delineates functional pathways and druggable targets across the nephron and defines gene regulatory networks and chromatin landscapes governing tubular, fibroblast, and immune cell transitions from injury to either recovery or failed repair states. We identified distinct cellular states associated with specific pathological features that show dynamic distributions between acute kidney injury (AKI) and chronic kidney disease (CKD), organized within unique spatial niches that reveal progression mechanisms from early injury to unresolved disease. Gene regulatory analyses prioritized key transcription factor activities (SOX4, SOX9, NFKB1, REL, KLFs) and their target networks establishing disease states and tissue microenvironments. These regulatory programs were directly linked to clinical outcomes, identifying molecular signatures of recovery and secreted biomarkers predictive of AKI-to-CKD progression, providing a key resource for therapeutic development and precision medicine approaches in kidney disease.

Bio: Dr. Sanjay Jain is a Professor of Medicine, Pediatrics and Pathology & Immunology at the Washington University School of Medicine in St. Louis, Missouri, USA (WUSM). One of the main objectives of his laboratory is to define how the kidneys and the lower urinary tract are organized at a cellular resolution to conduct their normal functions and how this organization at anatomical, structural, cellular, molecular and spatial levels changes in aging and disease. This foundational knowledge is used to decipher the molecular and structural changes that occur in acute and chronic diseases across the life span and establish the blueprint for engineering these organs to supplement kidney function. There is a particular focus on the role of the nervous system in these events and cross-talk with other vital organs that collectively cause significant mortality and morbidity. Dr. Jain's team heavily uses single cell and spatially resolved 2D and 3D multiomics technologies at cellular scale using human tissue to achieve their goals. They also use genetic models to further understand mechanisms of kidney development, regeneration and repair and harmonize model systemssystem and human datasets. The team has made seminal contributions in single cell and spatial mapping and atlas efforts.