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Mapping T-cell Development in the Human Thymus,  
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Today, I want to tell you about my favorite type of cell: The T-cell.

If you think about your immune system like an army, the T-cell is the head general. They are the ones who decide who's an invader, like a bacteria or a virus, and who's sick, like a cancer cell. And when they figure out that something is wrong, they are the ones who initiate your lifesaving immune response.

What I'm really interested in is how T-cells learn who's a good cell and who's a bad cell. This is a really important question to understand because if a T-cell can't detect a bad cell, that's when we get infection and if the T-cell mistakes a good cell for a bad cell, that's how autoimmunity arises and we end up with diseases like diabetes or arthritis. Diseases which affect millions of people worldwide. So how do we study how T-cells learn during their development?

T-cells develop in an organ called your thymus. It's about the size of your fist and it sits on top of your heart. We know from mouse models that T-cells enter into the center of your thymus and they spend about three weeks migrating from the center out to the edge and back again. We know that this migration is necessary for T-cells to develop effectively but we don't actually know why T-cells migrate. What cells they're talking to along the way, which are teaching them, or how well that mouse model reflects what is happening in our own human thymus.

Over the past few years, researchers have developed new technologies that allow us to measure all of the signals a cell is producing at a given time. Basically, you take your tissue, you break it up and then you profile the cells to see what messages they're producing. There's a key limitation though, you have to break the tissue up and when you do that, you lose the spatial, or positional information. Cell signaling is context dependent. You have to know where cells are in relation to each other to understand how they're communicating.

In my research, I use a new technology called Codex that allows us to see all of those signals within the tissue so that we can keep the spatial, or positional information. In my thesis, I aim to create a detailed map of T-cell development in the human thymus so we can understand what signals are necessary to produce effective T-cells. We can use this information to study how signaling goes wrong in patients with autoimmune diseases and we can try to recreate this process in the lab so that we can make T-cells that can be used as a therapeutic to either fight cancer or supplement immunity. Thank you.