Your cells are magnificent little things, every single one is full of complex microsystems all working together to keep you going. They're more intricate and advanced than any machines we can make, but sometimes… they need a little help to get going. Stem cells are like tiny teenagers, they're full of potential but they need a kick in the pants to get going, and that's where I come in. After a stroke, patients are left with chunks of damaged brain tissue. Now, instead of trying to rebuild the incredibly complex human brain from scratch, I'd much give cells the support and encouragement they need to rebuild it themselves. My research goal is to rebuild damaged brain tissue, but in truth, stem cells will be doing all the actual building, I'm just making materials that tell them how to build a brain.

First, we need some structural support, or scaffolding. In healthy tissue, cells exist in a fluid environment called the extra cellular matrix. This matrix is full of useful proteins and also offers structural support in the form of nanofibrous proteins. Different tissues have different needs, so every matrix is unique, and I've been making materials that mimic the nanofibres and proteins specific to healthy brain tissue. To do this, I take small pieces of proteins and attach them to stacking molecules so they form into nanofibres that not only offer structural support, but also trick the cells into thinking they're surrounded by brain proteins. That way, when stem cells are transplanted inside my materials, they look around and think they must be brain cells and act accordingly.

Next, we need to direct the building activities. We have signalling molecules we can use to give cells instructions and tell them what to do, but these are unstable and only last minutes to hours in living tissue. Repeated injections into the brain would be very damaging, so we need a way to safely store these signals and release them gradually over time. My material actually sticks to the signals, holding them safely in place until they detach form the nanofibres over time. I've shown that putting the signals in my material increases their lifespan from hours to weeks.

Finally, we need to make sure that everything happens at the right time. Building a brain is even more complicated than putting together IKEA furniture, so it really is important to start at step one and build everything in the right order. For the stem cells, this means we need to control the timing of when different signals are released. To do this, I've attached long molecular chians to some of the signals to delay their release. The long chains stick to my material as well, holding those signals in place even longer, and when they do detach their extra bulkiness makes them slower to reach the cells. So far, I've achieved a 9-hour delay, and I'm looking at using longer chains to produce a longer delay.

When I'm finished, I'll have a single material that can guide stem cells through the entire process of building new brain tissue, and we can get those damaged brains back up and running.

Kiara Bruggeman, 3MT, 2014.