This Detailed Map of a Human Cell Could Help Us Understand How Cancer Develops

Mapping a human cell gives researchers a view of subcellular architecture and sheds light on how cancer develops.

By Cody Cottier
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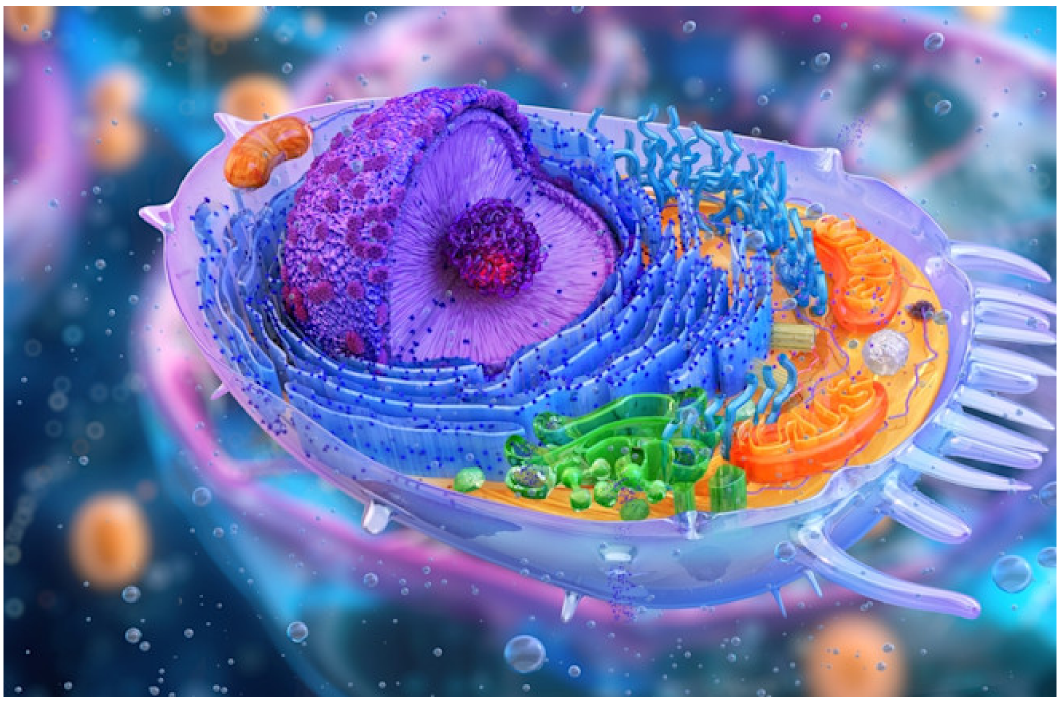

Human cell illustration. (Image Credit: Corona Borealis Studio/Shutterstock)

It's been more than two decades since scientists finished sequencing the human genome, providing a comprehensive map of human biology that has since accelerated progress in disease research and personalized medicine.

Thanks to that endeavor, we know that each of us has about 20,000 protein-coding genes, which serve as blueprints for the diverse protein molecules that give shape to our cells and keep them functioning properly.

Yet, we know relatively little about how those proteins are organized within cells and how they interact with each other, says Trey Ideker, a professor of medicine and bioengineering at University of California San Diego. Without that knowledge, he says, trying to study and treat disease is “like trying to understand how to fix your car without the shop manual.”

Mapping the Human Cell

In **a recent paper in the journal *Nature***, Ideker and his colleagues presented their latest attempt to fill this information gap: a fine-grained map of a human cell, showing the locations of more than 5,000 proteins and how they assemble into larger and larger structures. The researchers also created **an interactive version** of the map.

It goes far beyond the simplified diagrams you may recall from high school biology class. Familiar objects like the nucleus appear at the highest level, but zooming in, you find the nucleoplasm, then the chromatin factors, then the transcription factor IID complex, which is home to five individual proteins better left nameless.

This subcellular metropolis is unintelligible to non-specialists, but it offers a look at the extraordinary complexity within us all.

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Surprising Cell Features

Even for specialists, there are some surprises. The team identified 275 protein assemblies, ranging in scale from large charismatic organelles like mitochondria, to smaller features like microtubules and ribosomes, down to the tiny protein complexes that constitute “the basic machinery” of the cell, as Ideker put it.

“Across all that,” he says, “about half of it was known, and about half of it, believe it or not, wasn't known.” In other words, 50 percent of the structures they found “just simply don't map to anything in the cell biology textbook.”

Multimodal Process for Cell Mapping

They achieved this level of detail by taking a “multimodal” approach. First, to figure out which molecules interact with each other, the researchers would line a tube with a particular protein, called the “bait” protein; then they would pour a blended mixture of other proteins through the tube to see what stuck, revealing which ones were neighbors.

Next, to get precise coordinates for the location of these proteins, they lit up individual molecules within a cell using glowing antibodies, the cellular defenders produced by the immune system to bind to and neutralize specific substances (often foreign invaders like viruses and bacteria, but in this case homegrown proteins).

Once an antibody found its target, the illuminated protein could be visualized under a microscope and placed on the map.

Enhancing Cancer Research

There are many human cell types, and the one Ideker’s team chose for this study is called the U2OS cell. It’s commonly associated with pediatric bone tumors. Indeed, the researchers identified about 100 mutated proteins that are linked to this childhood cancer, enhancing our understanding of how the disease develops.

Better yet, they located the assemblies those proteins belong to. Typically, Ideker says, cancer research is focused on individual mutations, whereas it’s often more useful to think about the larger systems that cancer disrupts.

Returning to the car analogy, he notes that a vehicle's braking system can fail in various ways: You can tamper with the pedal, the calipers, the discs or the brake fluid, and all these mechanisms give the same outcome.

Similarly, cancer can cause a biological system to malfunction in various ways, and Ideker argues that comprehensive cell maps provide an effective way to study those diverse mechanisms of disease.

"We've only understood the tip of the iceberg in terms of what gets mutated in cancer," he says. "The problem is that we're not looking at the machines that actually matter, we're looking at the nuts and bolts."

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Mapping Cells for the Future

Beyond cancer, the researchers hope their map will serve as a model for scientists attempting to chart other kinds of cells.

This map took more than three years to create, but technology and methodological improvements could speed up the process — as they did for genome sequencing throughout the late 20th century — allowing medical treatments to be tailored to a person's unique protein profile.

"We're going to have to turn Moore's law on this," Ideker says, "to really scale it up and understand differences in cell biology […] between individuals."

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Article Sources

Our writers at **Discovermagazine.com** use peer-reviewed studies and high-quality sources for our articles, and our editors review for scientific accuracy and editorial standards. Review the sources used below for this article:

- Nature. **Multimodal cell maps as a foundation for structural and functional genomics**
- **U2OS Cell Map**

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