Envisioning a better future with organoids

Innovation at the speed of life™

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Introduction

Accelerating organoid modeling for improved human health

"Lost in translation" is too often the story of promising therapies designed in the lab. During preclinical trials, drugs are rigorously screened for efficacy and safety, and only the most promising candidates are advanced. Despite this, nine out of every ten drug candidates will fail during clinical trials.[1] These failures not only represent a significant loss of time and money for drug developers, but they can also have serious health consequences for patients.[2]

Why are preclinical results such poor indicators of clinical success? A major contributor to these failures is the gap between preclinical models and human biology—what works *in vitro* or in animal models often fails to translate into meaningful preclinical benefit. The human immortalized cell monolayers frequently employed to screen new compounds lack the complexity necessary to predict how organs and systems will react to a given treatment. And while animal models are complex, they differ significantly from human biology.

To improve the accuracy and predictive capabilities of preclinical models, researchers are racing to unlock the power of spatial biology, which allows us to examine biomolecules and cells in their native, three-dimensional context. For example, organoids can be used as a spatial biology tool where stem cells are guided into self-assembling miniature replicas of organs or tissues. These three-dimensional organoids are much better than cellular monolayers and animal models at mimicking human physiology in a lab, allowing us to test new treatments under more realistic conditions.

Despite the potential, organoids bring their own challenges. Growing these small imitations of human organs is a time-intensive process, and there can be significant variability between organoid batches. In order to utilize organoids for drug development, we must find ways to grow them in a consistent and scalable manner. Furthermore, collecting and analyzing the wealth of data that organoids can provide will require more sophisticated technology capable of rapidly detecting and analyzing this information.

Overcoming these obstacles is paramount if we are to improve the efficacy, safety and success rate of the treatments we advance into clinical trials. Together, we must craft powerful instruments capable of capitalizing on sophisticated organoid models, giving patients and companies a safer and more effective drug development process. Danaher is lending our expertise and resources to meeting this need, accelerating innovations driven by three primary questions:

1. How can we make organoid models a reliable and scalable resource for drug development?
2. How can we analyze these 3D organoids and live cell systems so that we can gain the necessary depth of information needed to advance scientific understanding?
3. How can we use artificial intelligence (AI) to enhance the predictive power of these organoids, and thus improve the success rate of clinical trials?

1. Sun D, Gao W, Hu H, Zhou S. Why 90% of clinical drug development fails and how to improve it? Acta Pharmaceutica Sinica B. 2022;12(7):3049-3062. doi:10.1016/j.apsb.2022.02.002
2. Organoids Are Small. Their Future is Big. | Danaher. Accessed September 24, 2025. https://www.danaher.com/organoids-are-small-their-future-big

Quantifying drug development costs

A clear opportunity for improvement

10-15

years to get a new drug through clinical trials.[3]

$1-2B

Billion (USD) to approve a drug for clinical use.[3]

90%

of drug candidates fail during clinical trials.[3]

3. Sun D, Gao W, Hu H, Zhou S. Why 90% of clinical drug development fails and how to improve it? Acta Pharmaceutica Sinica B. 2022;12(7):3049-3062. doi:10.1016/j.apsb.2022.02.002

Better models

Capturing human complexity with organoids

How can we study a liver, a heart, and the large intestine within the confines of a petri dish? Questions like this are the central pillar of most biomedical research, where scientists work to piece together the intricacies of human physiology. For much of the last century, cell cultures and animal models have been the tools used to approximate human biology in the lab. Immortalized human cells grown in a flat monolayer can tell us much about how our cells respond in isolation, but completely remove the three-dimensional context that defines real tissues. Animal models present the inverse problem, providing insights at a systemic level, but for an entirely different species.

Enter organoids: a significant step forward for biomedical research that provides us with an opportunity to study our cells within a three-dimensional context. The potential applications of this are widespread, but early efforts have demonstrated the utility of organoids for studying solid tumors.[4] Organoids present a powerful opportunity for us to replicate the complex array of cells that create the tumor and, when combined with immune cells and stromal cells, the tumor microenvironment. This provides labs an opportunity to test anti-cancer compounds within the unique context that makes cancer treatment so difficult.

But applying this approach to larger drug development efforts will require thousands of organoids to generate meaningful, reproducible insights. Many labs currently create organoids manually, in a labor-intensive process that introduces significant variability from one experiment to the next. Without consistency between samples, scientists struggle to parse out which molecules are most effective. And without the capacity to produce large volumes of consistent organoids, the statistical power of these studies remains limited.

Automated organoid production could remedy many of these concerns. Automation simplifies organoid production in a scalable manner, removing much of the variability and human bias from the equation. With instruments like Molecular Devices' CellXpress.ai, organoids can be generated at scale with the consistency and reproducibility that drug developers need to screen potential therapies effectively. This improved uniformity will allow drug developers to rely on organoids as a predictable resource for testing new therapeutic molecules with accuracy.

As scientists ourselves, Danaher understands the importance of readily available and reproducible models. Organoids are a feat of modern biology, and investing the resources to properly engineer these organs-in-a-dish is a worthwhile effort. With better models of human complexity in the lab, we can work together to make more informed choices in the clinic.

4. Streamline 3D Cancer Assays with Automated Innovations | Danaher Life Sciences. Accessed September 25, 2025. https://lifesciences.danaher.com/us/en/blog/streamlining-3d-cancer-assays.html

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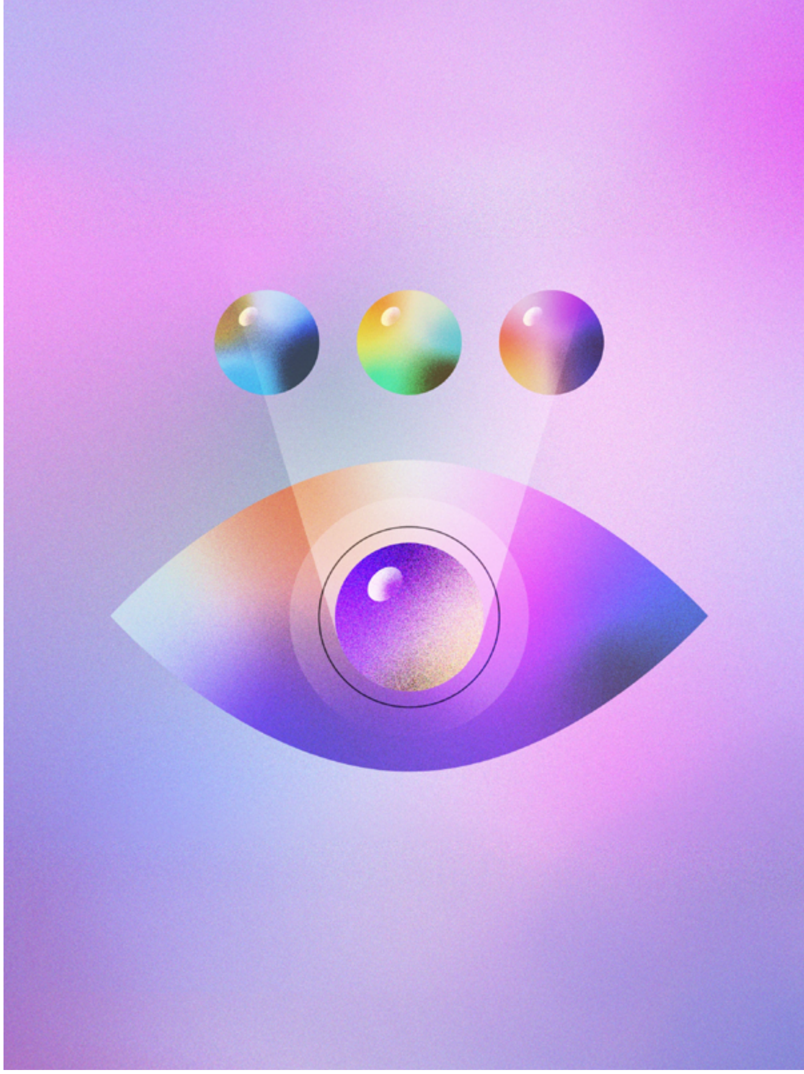
Researchers, doctors, and patients all share an interest in safer and more effective drugs. With organoids, we can do a much better job of mimicking human biology, thereby enhancing the drug development process. We believe it's worth investing the resources to make organoid technology as powerful and accessible as possible."

Lars Kristiansen, Vice President
Product Innovation & Strategy, Molecular Devices

A deeper understanding

Looking inside: Generating high-quality organoid images



Modern microscopy has long solved the question of how to image a flat, monolayer of cells. Studying living, multi-dimensional organoids is significantly more challenging, and solutions must be found to improve our understanding of how to treat disease. In-depth microscopy analyses help drug developers characterize novel molecules early, thus giving them higher confidence when moving from preclinical to clinical trials.

Organoids are remarkably delicate structures. Even routine light exposure during microscopy can be damaging to their integrity and viability, in a phenomenon known as phototoxicity. To conduct their experiments, scientists need to manipulate and image entire organoids; this includes tagging key proteins, recording time-lapse videos and tracking cellular responses. The challenge is to do this without disrupting the normal activity of the organoid, so that researchers can accurately observe how the model responds to the drugs being tested.

To achieve this, Danaher is bringing together experts in protein labeling with innovators in automated microscopy. For instance, Abcam continues to expand its extensive antibody library, equipping drug developers with sensitive labels that detect key biomarkers. When paired with advanced imaging systems, these antibodies can identify multiple biomarkers within a single image capture, significantly reducing light exposure without compromising data quality. Bringing this together with advanced algorithms, such as the Viventis systems offered by Leica Microsystems, we can visualize deep into the organoid structure—preserving cellular integrity while gaining high-resolution insights.

Drug developers rely on clear, high-resolution images of cellular interactions and organoid responses to guide the development of effective treatments. By uniting experts in antibody development, automated imaging and computational analysis, Danaher is unravelling the inner workings of organoid models. Together, we're enhancing our understanding of complex biology and accelerating the path to better treatments for the benefit of patients everywhere.

More predictive power

Visualizing success with smart microscopy and AI

Microscopy images of organoids contain an extraordinary depth of information. From cell morphology and intercellular connections to the spatial distribution of labeled proteins, each image holds a complex biological narrative. The sheer volume and richness of this data can be overwhelming—often exceeding what the human eye and mind can fully interpret. AI offers a powerful solution, enabling researchers to extract meaningful insights from these intricate visual datasets with speed, precision and consistency.

As part of the Danaher Beacons program, and in collaboration with Stanford's Department of Bioengineering, we are creating the next generation of AI-powered "smart microscopy" technologies.[5] One of the primary goals of this project is to use AI to increase the number of protein biomarkers that can be studied in a single organoid. Fluorescent labeling is time-intensive and limits the number of proteins that can be studied within a single experiment. To overcome this, the Beacon team has developed an AI-driven technique for virtually labeling up to 50 protein biomarkers without a physical tag. This dramatically accelerates the pace of discovery but also significantly reduces costs and minimizes sample disruption—making organoid analysis faster, more scalable and more informative.

The innovation doesn't stop there. The team is now using organoid imaging data to train a predictive AI engine on known anti-cancer drugs. Organoids are treated with compounds that have either succeeded or failed in clinical trials, creating a rich dataset of biological responses. The AI interprets this high dimensional data set and will detect subtle patterns and phenotypic changes that are invisible to the human eye.

This approach not only enhances our understanding of drug efficacy but also holds promise for predicting clinical outcomes earlier in the development process. AI allows us to enhance the already significant modeling power of organoids, offering us better choices in the drugs we advance to clinical trials.

Conclusion

Enhanced modeling power for better treatment

All too often, clinical trials fail to translate preclinical research into effective treatments. The predictions made in animal models and 2D cell cultures fall short, making drug development a risky process for both companies and patients. At Danaher, we believe there is a better way. We can do better by improving the models we use to screen new compounds before they enter the clinic. **With scalable organoid technology, insightful image analysis, and predictive AI models, Danaher is building a future where drug discovery is better than ever before.**

5. Danaher Launches Beacon Research Collaboration with Stanford University Aiming to Build Next Generation of Smart Microscopes for Cancer Drug Screening - Jul 11, 2024. Accessed September 23, 2025. https://investors.danaher.com/2024-07-11-Danaher-Launches-Beacon-Research-Collaboration-with-Stanford-University-Aiming-to-Build-Next-Generation-of-Smart-Microscopes-for-Cancer-Drug-Screening

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