NIH National Center for Advancing Translational Sciences

3-D Tissue Models

Most drug compounds show promise in the laboratory and animal models, yet they fail when they reach people in clinical trials. In fact, 90% of those compounds turn out to be too toxic or do not work as treatments. 3-D cellular models that mimic the structure and function of human tissues and organs could help researchers reduce that failure rate by better predicting which treatments tested in the lab will be successful in clinical trials in people.

The National Center for Advancing Translational Sciences (NCATS) is a leader in catalyzing the creation of 3-D tissue models. These new models will never fully replicate the complexity of our bodies or replace certain animal models that are critical for research. But they can provide a powerful complement to them. Improving the ability to determine whether a drug will be safe and effective will deliver on NCATS' mission to bring more treatments to all people more quickly.

The Multiple Dimensions of 3-D Tissue Models

3-D tissue models take many forms and range in complexity:

- Organoids are miniature versions of organs grown from human stem cells in a laboratory dish. They mimic key features of a human organ's structure and function.
- **Bioprinted tissues** are produced by printing layers of living human cells and scaffolding materials into complex, functional 3-D tissue that mimics tissue in the human body.
- **Tissue chips** are tiny devices with cellular models that replicate living human tissues and organs, and their environments. Researchers can combine multiple organ tissues on one chip to model how diseases and drugs affect the body across multiple organ systems.

How 3-D Tissue Models Speed Drug Development

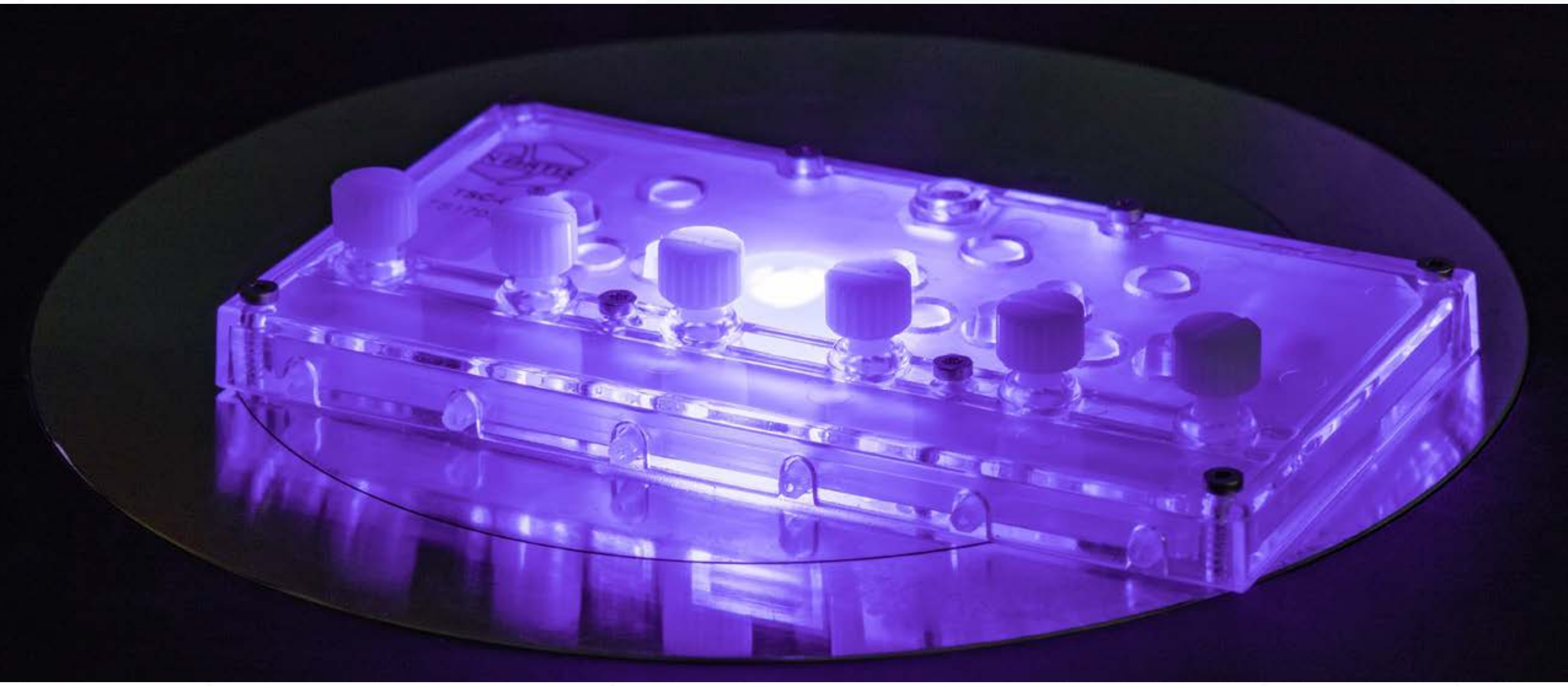
3-D tissue models developed and supported by NCATS are speeding the understanding of and treatments for common and rare diseases:

- NCATS supported the creation of a tissue chip that mimics the biology of two rare neuromuscular conditions that affect the nerves and muscles. Data from that tissue chip model led the U.S. Food and Drug Administration to authorize use of a drug for those two disorders in a clinical trial.
- NCATS-supported researchers used a lung tissue chip to test azeliragon, a possible treatment for inflammatory lung diseases (e.g., COVID-19, chronic obstructive pulmonary disease and steroid-refractory asthma). Azeliragon is now advancing to clinical trials in people.
- An NCATS-supported research team used organoids and tissue chips to reveal the role glucose plays in forming cysts in polycystic kidney disease (PKD), a life-threatening genetic disorder that affects millions of people worldwide. The results could lead to better ways to find and test treatments for PKD.

- NCATS researchers and their academic partners developed a tissue model of cutaneous squamous cell carcinoma (cSCC), a type of skin cancer, on bioprinted skin tissue. They showed that the model can be used to test clinical therapies for cSCC.
- A team that included NCATS researchers used brain organoids to discover how the SARS-CoV-2 virus clusters in certain brain cells. The finding could lead to new insights into the virus' behavior and its possible effects on the brain.
- Nine NCATS-funded tissue chip projects have traveled to the International Space Station. The chips have brought new insights into a host of diseases, including ones that develop faster in low-gravity environments, and possible treatments for them.
- A team including NCATS and National Eye Institute researchers modeled age-related macular degeneration diseases using bioprinted vascularized retina tissue.
- In addition, ten NCATS grants support the use of 3-D tissue models through the Clinical Trials on a Chip initiative, which could redefine clinical trial design and enhance participation in research.

Learn more about how NCATS uses 3-D tissue models and other innovative translational science tools to speed therapies at NCATS' Tissue Chip and 3-D Tissue Bioprinting Program webpages.

Banner image: Cristina Antich Acedo works with bioprinted skeletal muscle tissue for neurodegenerative disease research.



A kidney-on-a-chip. (University of Washington Photo)

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