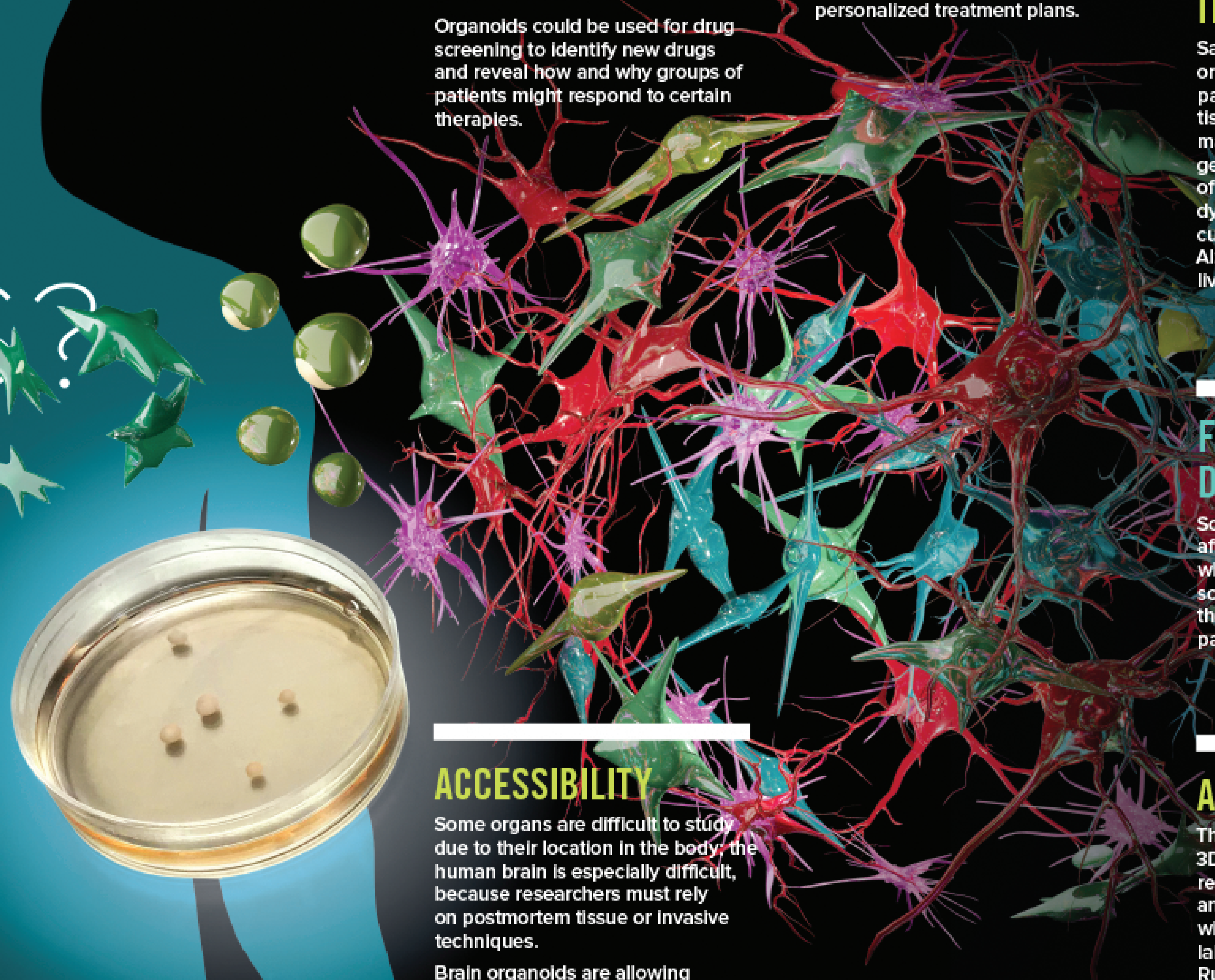
WHAT ARE ORGANOIDS?

Organoids, sometimes referred to as mini-organs, are three-dimensional collections of cells that mimic features of human tissues. These tiny, pale spheres are revolutionizing the way scientists study health and disease.

Many disease models involve growing a single layer of cells adhering to the surface of a flat dish. While helpful, this 2D approach is limited—it does not capture the complexity of a layered, sophisticated system like the brain. Organoids better mimic a diverse group of cells interacting with one another in a three-dimensional space and offer new insights into human biology.

To develop an organoid, scientists typically begin with skin cells from living humans. A mix of proteins then cues the skin cells to revert to pluripotent stem cells, giving them the ability to develop into virtually any type of tissue. A second concoction of proteins signals which type of cell to become—heart cells or pancreas cells, for example. Scientists can also develop organoids directly from tissue, such as a biopsy.

The use of this technology has surged over the last decade, with Salk scientists leading the way in developing larger, more advanced organoid tissues, such as brain organoids. Therapies for neurological disorders, like Alzheimer's, schizophrenia, autism and depression, have lagged behind, in part, because the human brain is a complex organ that is not easily accessed. Even when a drug shows promise in animal models, it often does not work for humans. Although the technology is still a long way from fully representing a human organ, organoids offer an unprecedented model for studying biological processes and unlocking new possibilities for diagnostic and therapeutic research.



TESTING DRUG EFFICACY

Organoids could be used for drug screening to identify new drugs and reveal how and why groups of patients might respond to certain therapies.

ACCESSIBILITY

Some organs are difficult to study due to their location in the body; the human brain is especially difficult, because researchers must rely on postmortem tissue or invasive techniques.

Brain organoids are allowing scientists to observe, as never before, how neurons grow and communicate with one another.

Learn more about how organoids work:

WATCH www.salk.edu/organoids

PERSONALIZED MEDICINE

Because organoids contain the genetic makeup of an individual, this technology could be used to provide personalized treatment plans.

CANCER INSIGHTS

Junko Ogawa, a senior research associate in Tony Hunter's lab, is using brain organoids to reveal insights into glioblastoma. Several labs at Salk are using organoids to explore cancer in other parts of the body as well (see this issue's "Frontiers" article for more).

TISSUE TRANSPLANTS

Salk researchers are developing organoid models of the brain, pancreas, kidney, liver and other tissues. One day, organoids may be used to grow healthy, genetically matched populations of cells to replace diseased or dysfunctional cells to treat—or even cure—diseases such as Parkinson's, Alzheimer's, pancreatic cancer and liver disease.

FASTER DISCOVERIES

Scientists can more quickly and affordably generate organoids, which speeds up the rate of scientific discovery and decreases the reliance on animal models and patient studies.

ACCURACY

The lab of Joseph Ecker found that 3D brain organoids more closely resemble a real brain in structure and function compared with the widespread 2D models used in the lab setting. In addition, the lab of Rusty Gage developed a way to enable organoids to receive blood flow and grow larger, providing a more accurate representation of the microenvironment of a real brain (see "Resolution," next page).