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Matter of Opinion

Terasaki Institute: Innovating Personalized Health through Convergent Science and Bioengineering

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The Terasaki Institute for Biomedical Innovation is an independent non-profit organization and uses an integrative approach to innovate personalized health. The Institute draws on its scientific, entrepreneurial, and engineering skill set to transform ideas into clinically applicable technologies.

Every person is unique with different challenges to optimal health—from genetic predisposition to disease to socioeconomic barriers. In approaching these challenges, many people look for “omics” as a solution. The term “omics,” used to describe the biological fields of genomics, proteomics, metabolomics, and other “-omic” sciences, aims to understand the cause of disease by analyzing organisms’ genetic or molecular expression. However, using only “omics” information is not a complete solution to health problems as it misses important opportunities provided by other technologies.

Our Institute believes in a more comprehensive approach to solving these problems. This approach integrates the knowledge provided by “omics” with the latest advances in biology, materials science, engineering, clinical science, and entrepreneurship. This integrative approach can be used to develop various medical innovations, including treatments for cancer, cardiovascular diseases, drug addiction, infectious diseases (e.g., COVID-19), and musculoskeletal diseases.

The Terasaki Institute for Biomedical Innovation is a unique non-profit research organization that aims to create solutions that restore or enhance the health of individuals. The Institute develops personalized medical solutions in honor of the late Paul I. Terasaki, Ph.D., a pioneer in the field of transplant science,1,2 who developed one of the first personalized therapies through matching histocompatibility antigens between transplant donor and the patient (Figure 1). In continuing this legacy, the Institute strives to bridge the gap between sickness and wellness by focusing on important health problems, creating “personalized” solutions, and fostering their development into real-world innovations.

Director and CEO Ali Khademhosseini, Ph.D., leads a diverse team of world-renowned, interdisciplinary scientists working in a creative environment that is less restrictive than in research universities, medical centers, or for-profit companies (Figure 1). The processes are designed to expedite addressing the patients’ most pressing needs while nurturing a culture of creativity, teamwork, and “out-of-the-box” thinking. The Institute operates on established principles of collaboration, innovation, and leadership to achieve these goals.

The Institute’s research focus is on enabling personalized health. This begins with the recognition that many innovations to prevent, diagnose, and treat the disease can not be a “one-size-fits-all” solution. Based upon this recognition, we have established the following technology platforms that incorporate emerging interdisciplinary domains with “omics” knowledge to address the needs of individual patients:

- Personalized cells: cells not only carry genetic information but also can be used to treat various diseases. For example, genetically manipulated immune cells can kill cancer cells, and various stem cells can be used in cell replacement/regenerative therapies. The Institute combines tissue engineering and genetic engineering techniques to develop immune or stem cell-based therapies. Through these strategies, the Institute develops a faster, reproducible, and more controllable way to modulate the therapeutic efficacy of cells.
- Personalized micro-physiological models: the absence of precisely defined culture systems hinders the effort to understand cell function and modulate cell behavior for drug discovery and regenerative medicine. Therefore, in order to build a more precise culture system, it is essential to develop technologies that enable tightly controlled, reproducible, and scalable cell microenvironment manipulation. The patients’ cells and tissues can provide direct and accurate information about individual responses to treatment.

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integrating organoids or micro-tissues in microfluidic systems, we will enable unprecedented ability to mimic human tissue behavior for drug discovery and personalized testing.

- **Personalized biomaterials:** the development of novel biomaterials that respond to their surroundings is an emerging area of materials science. At the Institute, our team is developing responsive biomaterials to address various medical needs. Through this approach, biomaterials can be used as scaffolds for artificial tissue growth and for surgical interventions. Furthermore, biomaterial-based drug-delivery systems are being developed to provide closed-loop sensing and on-demand delivery of therapeutics.

- **Personalized implants:** the development of implants that are tailored to the specific architectural or biological properties of defects is of great medical importance. In the Institute, patient-specific shape and size of implants are precisely manufactured using patient-derived anatomical information and clinically relevant biomaterials.

- **Personalized devices:** integration of smart sensors, microfluidics, and flexible electronics can be used to make “point-of-care” diagnostic and therapeutic devices. These so-called theranostic systems can be used to develop wearable or implantable medical devices for rapidly analyzing biomarkers and delivering patient-specific therapies.

To enable these technology platforms, our interdisciplinary teams foster a unique culture of convergence and innovation. All projects are triaged according to their potential to make the greatest impact, and work on each project is organized based on teams of diverse experts. Our scientists and staff work closely with academic and clinical collaborators as well as entrepreneurial partners with long-standing experience in the industry. These partners are fully integrated into the Institute and can evaluate, promote, and de-risk prototypes. This allows us to rapidly translate our innovations.

The Institute blends best practices from academia and the private industry to drive an innovative and influential research culture and uses the latest technology to promote communication. As an independent entity, the Institute can work more efficiently to support such an integrative approach, as it is not hindered by the limitations of excessive bureaucracy. This allows the ideas to be tracked and developed as a finished product without falling into the “Valley of Death,” a common occurrence in other research environments. In addition, this approach allows unrestricted collaborations with both domestic and international researchers, universities, and industry. Furthermore, the Institute recruits top-notch faculty who will work with the Institute collaborators to translate their research into clinically relevant solutions.

The Institute’s overall philosophy is guided by fifteen leadership principles that all employees are expected to follow. These principles have been adopted in the best-in-class corporate cultures of the best performing organizations. In essence, the principles challenge employees to aim high, obsess on patient health, and continuously raise their bar of achievement. Employees are also expected to learn and be curious as well as ensure that all activities are performed with the highest level of integrity. Feedback from employees is taken very seriously by the Institute leaders. On a daily basis, all employees are requested to provide anonymous feedback on various topics. Executive management compiles and responds to the feedback to optimize the working environment. The Institute is designed to encourage the most efficient execution and daily operation. Facilities, human resources, legal, accounting, and other administrative functions are performed through a center of excellence designed to facilitate the faculty’s ability to conduct their research.

Dr. Paul Terasaki’s lifelong goal was to benefit patient health by continuing to promote high-caliber research as he had during his distinguished scientific career. He was an avid philanthropist, and the Terasaki family continued his philanthropic tradition by supporting the Institute. Its board of directors includes multiple generations of the Terasaki family, with Dr. Paul

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**Figure 1. Dr. Paul I. Terasaki and Dr. Ali Khademhosseini**

Dr. Paul I. Terasaki, transplant science pioneer (left), and Dr. Ali Khademhosseini, the Founding Director and CEO of the Terasaki Institute for Biomedical Innovation (right).
Terasaki’s son, Dr. Keith Terasaki, serving as Chairman of the Board (Figure 2). In addition to financial support from the endowment, the Terasaki family has provided three work locations in West Los Angeles, Westwood, and Woodland Hills, CA. All three are located in Los Angeles County, home to approximately 10,000,000 residents, and viewed as the media capital of the world. Because the area lacks significant private research institutes, it could benefit from the thriving ecosystem of technological innovation that the Institute can bring.

The Institute’s educational and training programs have a greater impact through technology that can distribute information to diverse audiences and stakeholders. In addition to creating internet protocol and making most of the social media platforms, various training and information events, such as the Fireside Chats and special seminars, are provided to cover a wide range of topics of interest.

The Terasaki Institute for Biomedical Innovation is a unique organization that combines multiple elements for success. From the spark of an idea to bringing a finished product to fruition, the Institute looks forward to a bright future committed to solving the world’s biggest health problems.

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