DECODING BIOTECH SUCCESS

Rapid developments in bioimaging and sequencing technologies have revolutionized biological science. Since Peking University's (PKU) Biomedical Pioneering Innovation Centre (BIOPIC) was founded in 2010, an interdisciplinary group of researchers has been dedicated to developing these cutting-edge techniques, and harnessing them to address fundamental biological issues and compelling medical problems. Their results have improved understanding of biological systems, as well as infectious and non-communicable diseases. On the 10th anniversary of BIOPIC, its founding director, Xiaoliang Sunney Xie, a pioneer in single molecule biology, reflects on its growth, and shares his vision for the development of single-cell technologies.

XIAOLIANG SUNNEY XIE
BIOPIC's Founding Director

What led you to establish BIOPIC?

I started my academic career as a biophysical chemist, as I enjoy playing with instruments. Physical chemistry has offered tools for better understanding biomolecular processes, fuelling many advances. I originally focused on bioimaging, using single-molecule fluorescence microscopy and other tools, which allow monitoring, analysing and manipulating activities of single molecules in live cells. It changed the way biological problems are addressed.

As next-generation sequencing takes off, genomic analysis can be done much faster and more cheaply. This technological revolution in biological sciences is bringing a new era of precision medicine. Seeing the application potential of new sequencing technologies, I began to shift to single-cell genomics, and developed our own sequencer. Meanwhile, the idea of building a centre dedicated to developing and harnessing cutting-edge technologies for fundamental science and medicine emerged. Myself, along with two other PKU alumni, proposed the idea to our alma mater, and in 2010, BIOPIC was officially established.

What makes BIOPIC unique?

BIOPIC is a technology-driven biomedical research centre, fusing basic research, biotechnology development, and medical applications. I believe breakthroughs in research tools are essential for driving life science research. Cross-disciplinary integration is also vital. To this end, we've brought in multidisciplinary researchers, including physical chemists or biophysicists, such as myself, structural biologists, molecular biologists, as well as those working on biotechnology or engineering, mathematics, and computational science. Many of our new biotechnologies are results of collaboration. I'd say the level of interdisciplinarity at BIOPIC is unparalleled.

We are also unique in our emphasis on clinical translation. We have works published in leading journals, but that is not our ultimate goal. We encourage our researchers to commercialize their technologies, and to collaborate with clinicians for applications in medicine. As scientists, we are interested in advancing fundamental science, but are also keen to benefit society with our technologies.

What are the cutting-edge technologies that BIOPIC focuses on?

BIOPIC was initially named Biodynamic Optical Imaging Centre, based on my earlier work at Harvard on single-molecule imaging. Now we've broadened our scope. We focus on single-cell genomics technologies, including high-throughput sequencing, genetic editing, and microfluidic control. These, along with single-molecular imaging, super-resolution and label-free imaging technologies, enhanced by big data analytics can be used to advance our basic science research, ranging from genomics, genetics and molecular biology, to developmental biology, tumour immunology and bioinformatics. We also emphasize clinical translation of our technologies. A whole-genome amplification technique that we developed enables high-coverage sequencing, and has been used in pre-implantation genetic screening. Our error-correction code sequencing, CRISPR-based sequencing, along with a safe and more efficient gene-editing tool have been used in analysing human embryonic development, stem cells, and tumour microenvironment, informing reproductive medicine, and the diagnosis and treatment of cancer and infectious diseases.

Why are you focusing on single-cell genomics?

Single-molecule technologies have enabled us to explain life processes at the molecular level, an important development in the 20th century. Single-cell genomics is a next-generation sequencing technology with potential to bring in an even bigger revolution, I believe, with greater impact than that of the Human Genome Project. It allows us to probe the full complement of DNA, as well as RNA existing within a cell, mapping genome structure and function. It helps us to answer questions like how genetic information carried by DNA or RNA controls cell functions. This will generate new insights into some fundamental life science issues, and bring new possibilities for clinical application, including prenatal genetic testing and cancer diagnostics.

To find its footing in this rapidly moving field, it is important for China to develop single-cell genomics technologies, including its own sequencers. And we're driving such technological developments at BIOPIC.

How do single-cell technologies pave the way for precision medicine?

Precision medicine must take into account individual variability in genes, and the genetic understanding of diseases enabled by single-cell genomics helps doctors to identify the most appropriate treatment for individuals. In cancer treatment, for example, using next-generation sequencing technologies, we can analyse individual tumour cells and their microenvironment, facilitating identifying new targets for therapy. Recently, one of our PIs revealed the dynamics of single immune cells in liver cancer, using single-cell RNA sequencing, shedding light on potential treatment strategies.

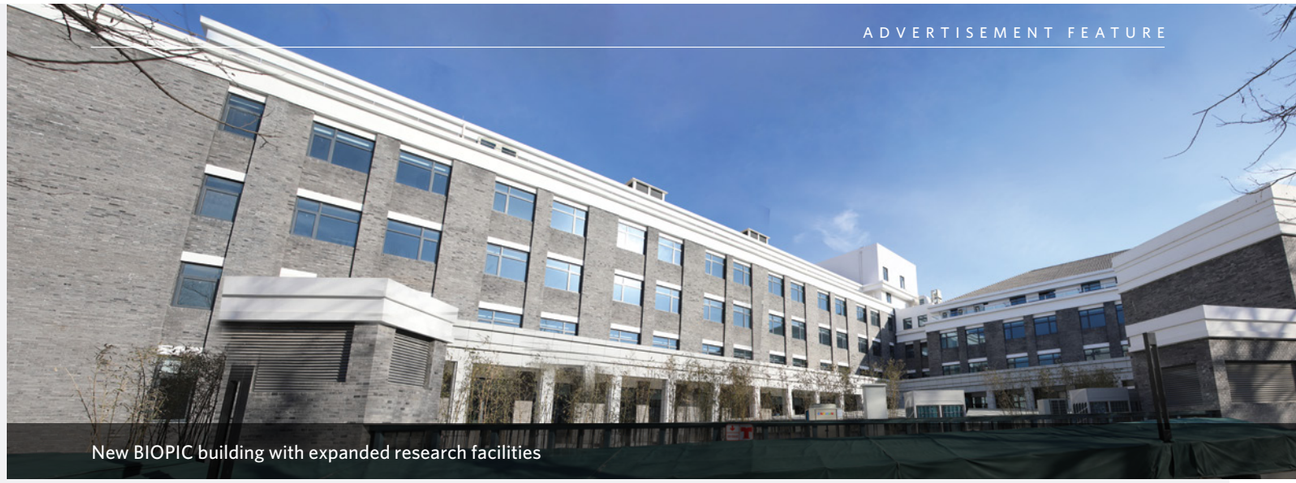
Another example is our collaboration with Jie Qiao, from Peking University Third Hospital, to improve pre-implantation genetic diagnosis and screening. Based on the single-cell whole-genome amplification technology we developed earlier, our new approach has been used to select, with high precision, healthy embryos from couples with known monogenic diseases.

How does BIOPIC promote research translation?

BIOPIC is all about translating technologies into applications — we are only limited by our own imagination. A healthy and fluid ecosystem is needed for translational research, and at PKU, we have abundant resources and strengths in a variety of fundamental fields. On the clinical side, we have many affiliated hospitals. We are also close enough to the bio hub at Zhongguancun Science Park, home to biotech giants (such as BeiGene) and start-ups alike. In fact, five out of the six biotech companies founded by BIOPIC researchers are registered in Beijing. BIOPIC provides our scientists with enough support and freedom, so that they dare to dream big, while nurturing a close-knit intra- and extramural community, so their synergy can spark ideas to translate into clinical contributions.

What is your expectation for BIOPIC?

We aim to make BIOPIC a world-leading research institution in biomedicine, pioneering in cutting-edge biotechnologies and original research. We develop and harness innovative bioimaging and genetic sequencing techniques, which provide tools to investigate basic life science and medical research questions at the molecular and cellular levels. I also expect that our work will be translated into technological and medical breakthroughs, ultimately benefiting society and mankind. ■



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