

WHAT I LEARNED THIS WEEK

Excerpt from November 30, 2017

5 **China and the U.S. are locked in an “arms race” to dominate genomics, gene editing, stem cells and personalized medicine—with huge implications and new potential winners.**

Historically, the U.S. has been the worldwide champion of genomics and personalized medicine—conducting most of the research on the human genome. However, China is moving to leapfrog America across the precision medicine landscape, investing \$9.2 billion in a 15-year project to leverage the convergence of AI with genomics. In contrast, the Obama administration allocated only \$215 million for a similar initiative.

China’s precision medicine program is already showing results. China’s BGI—the world’s largest DNA sequencer—has developed a technology that can map the human genome for \$600—taking the lead from Illumina. BGI is also launching outsourcing sequencing services for a quantitative “RNA-seq” sample at \$300 or less, close to prices for Illumina or Agilent gene expression arrays. By comparison, Agilent charges between \$700 and \$1,200 for custom gene expression arrays.

Now, both BGI and Illumina are competing to drive down the cost of decoding a human genome to \$100. Consultant Frost & Sullivan calculates that by 2025, between 100 million and 2 billion human genomes could be sequenced. Chinese startup iCarbonX has raised over \$600 million, aiming to sequence 100 million genomes alone, and is developing an AI system to predict a person’s health status in real-time.

China has also launched its second human CRISPR-Cas9 gene editing cancer trial, while the U.S. has yet to begin its first clinical trial. Additionally, China has begun the world's first clinical trials to treat Parkinson's with embryonic stem cells.

What are the implications?

- **China is laying the foundation for entirely new industries by accumulating the largest pools of genomic data.** A Wilson Center study underscores that the U.S./China relationship will increasingly not be a function of the relative share of 20th century manufacturing industries. **Instead, it will be defined by a race in genetic and computing innovation that will drive the economy of the future.**

China is already the world leader in DNA sequencing. By combining access to millions of patients, 30% of global sequencing capacity, and solid government support, the nation aims to extend its leadership.

A genomics investment wave has swept through China during the last six years, notes Yiting Sun in NEO.LIFE. Genomics in China has gone from being dominated by just BGI to at least ten Chinese companies with advanced sequencers that can decode genomes for \$1,000 a piece (see table).

KEY PLAYERS

China's top providers of sequencing services

COMPANY	HEADQUARTERS	FOUNDED	MAIN PRODUCTS
Annoroad Genomics	Beijing	2012	Genome sequencing, liquid biopsy tests, noninvasive prenatal testing, and direct-to-consumer tests that reveal cancer risks
Berry Genomics	Beijing	2010	Noninvasive prenatal testing, exome sequencing, and direct-to-consumer tests that reveal cancer risks
BGI	Shenzhen	1999	Genome sequencing; also manufactures a sequencer
CloudHealth Genomics	Shanghai	2014	Genome sequencing, "liquid biopsy" blood tests for cancer, and direct-to-consumer tests that can reveal a child's ability to absorb certain nutrients
Gene+	Beijing	2015	Direct-to-consumer tests that reveal cancer risks and genomic sequencing of tumors to help cancer doctors develop personalized treatment plans
Haplox	Shenzhen	2014	Liquid biopsy tests and direct-to-consumer tests that reveal cancer risks
Mega Genomics	Beijing	2016	Genome sequencing and direct-to-consumer tests that reveal cancer risks and tolerance of certain medications
Novogene	Beijing	2011	Genome sequencing and liquid biopsy tests
Singlera Genomics China	Shanghai	2015	Genomic sequencing of tumors for personalized treatment plans and "liquid biopsy" blood tests
Veritas China	Hangzhou	2015	Genome and exome sequencing and tests that reveal cancer risks
WuXi NextCode	Cambridge, Massachusetts	2013	Genome sequencing, cloud storage for genomic data, and a genomic database that helps scientists research variation across population groups
Yang Zi Investment Group	Nanjing	2016	State-owned investment group that built a sequencing center

Singlera's China operation is part of California-based Singlera Genomics. Veritas China is part of Massachusetts-based Veritas Genetics. WuXiNextCode was originally a spinoff of Iceland's Decode Genetics, acquired by Shanghai-based WuXi AppTech in 2015.

Source: NEO.LIFE via Medium

- **China's push to merge AI with genomics could provide a competitive advantage.** China's pool of genomic data is poised to grow—requiring AI to interpret and analyze it. Chinese health authorities recently announced the nation's big data platform for healthcare will gather health information from smart tracking devices. This combined with genetic information can help identify new risk markers for a wide range of diseases.

Deep Genomics and WuXi NextCODE are also at the cutting edge of integrating AI and genomics. Deep Genomics uses deep learning to analyze genomic data to not only build a map to decode the functions of genes, but also predict the effect of a genetic mutation. WuXi has one of the largest genomic data platforms using machine-learning to more accurately diagnose rare diseases and design tailored, improved therapeutics.

WuXi is leveraging AI and genomics to fight cancer. A recent partnership with Yale Medical School identified a key new pathway for innovative drugs against heart disease and cancer, as well as genetic signatures to differentiate between 22 different cancers.

- Whoever gains leadership in “deep genomics” could **acquire a military advantage.** Genetic research is inherently a key component of biosecurity. CRISPR could ultimately be used to genetically engineer bioweapons and create “super soldiers,” with increased muscle force and strength.
- A critical issue is who will own the innovations, intellectual property, patents and trade secrets in deep genomics. The Wilson Center asks: “Which company in which country will develop the next tailored cancer therapeutics based on the ability to silence a specific genetic function? **Under which government's regimes will deep genomic ecosystems flourish?**”

U.S.-based Veritas Genetics offers to decode the complete genomes of newborns in China for \$1,500, but does not offer the service in America. The test provides information on 950 serious early- and later-life disease risks, 200 genes connected to drug reactions, and more than 100 physical traits a child is likely to have. In contrast, American medical authorities have historically opposed sequencing healthy babies.

- Key Chinese and U.S. precision medicine leaders are poised to outperform over the long-term. BGI Genomics (300676 CH) has leaped 10-fold since its IPO in July. Other potential beneficiaries include:
 - √ **Berry Genomics/Chengdu Tianxing Instrument and Meter Co.** (000710 CH, 57.50 CNY) – acquired Berry Genomics and has sold off its legacy business. Berry is recognized for its non-invasive prenatal DNA screening test, and has also expanded into genetic testing for disease screening and diagnosis.
 - √ **Illumina** (ILMN, \$226.28) – is a global DNA sequencing leader.
 - √ **Pacific Biosciences** (PACB, \$3.12) - recently established a new DNA sequencing facility in China, and announced a new agreement with Novogene.
 - √ **CRISPR Therapeutics** (CRSP, \$18.66) and **Intellia Therapeutics** (NTLA, \$21.01) – were recently granted patents by China’s State Intellectual Property Office for their respective gene editing technologies.