

## Disruptive genomics: Is China's BGI the epicenter of the world's biotech revolution?

What is the world's largest genomics organization? According to [its own proud web site, it's BGI](#), the Chinese sequencing giant formerly known as the Beijing Genomics Institute.

BGI seems to come by that expansive claim honestly. It possesses 178 sequencing machines (purchased at half a million dollars each), and they churn out at least 25 percent of the world's genomic data. That's more sequence production than any other single institution. BGI has sequenced the genomes of many thousands of people, plus a great motley of other genomes: plant, animal, and microbial.

Those data come from [Michael Specter's piece on BGI in the January 6 New Yorker](#). Given the *New Yorker's* famed fact-checking system, there seems no reason to doubt them. For GLP readers, the article is a must-read.

However, "The Gene Factory" is paywalled. If that means it's inaccessible for you, much of the same information can be had in two earlier open-access articles by other writers: "Inside China's Genome Factory," Christina Larson's *Tech Review* piece from last winter and John Bohannon's ["Why Are Some People So Smart? The Answer Could Spawn a Generation of Superbabies"](#) in *Wired* last summer.

### Technical challenges and hot-button issues

Specter's piece has an added dimension, though: It's a case study in how to place an enormous amount of scientific information before a largely non-technical audience with no pedagogical seams showing. While telling the BGI story, Specter has achieved a compact and uncomplicated primer on genetic basics, genes and their molecules. He even explains, very simply to be sure, how a sequencing machine works.

*Tech Review* put BGI on its list of 50 Disruptive Companies for 2013. It's an uncommon mix of commercial biomedical services and basic genomic research funded by those services. Larson quotes BGI's president Wang Jian thus: "I use my left hand to make money and my right hand to do basic research." According to Specter, BGI has 4,000 employees at its main facility, an 8-story former shoe factory in Shenzhen with an associated dorm where many of them sleep. It also has outposts around the world, from just-announced Chile to Abu Dhabi.

The *New Yorker* piece manages to touch on nearly all the technical challenges and hot-button issues surrounding genomics—namely the potential impact of cheap sequencing, future prospects for agricultural genomics, the frustrating quest for disease genes, the genetics of obesity, infectious disease organism genomics, reducing birth defects, the possibility of predictive genomics, finding genes for intelligence, studies of human evolution and issues of scientific infrastructure such as sharing of data and other genomic information and even the loss of US pre-eminence in genomic research.

### Intelligence genes and embryo selection

One topic missing from this comprehensive catalog is direct-to-consumer genetic testing—although it might be argued that the piece does consider DTC services tangentially. That's because it takes up a

development Specter and others see as inevitable: embryo screening and selection, especially embryo screening and selection for intelligence genes.

I guess I agree that embryo selection, a procreative technology already here in, well, embryonic form, will before long be an everyday occurrence, at least in wealthier parts of the world. Selecting a single embryo from a bunch of them on account of its genes will be just one more baby-making methodology. It will join IVF and other forms of ART—the non-ironic acronym for assisted reproductive technology—that are now all but routine.

The well-off will certainly be inclined to pay extra for a child that is potentially new and improved over any old offspring achieved by the usual coital lottery. And note that BGI already offers preimplantation genomics testing services. So when its research teams do identify intelligence genes, BGI will be well placed to purvey ways of making sure your kid has them.

### **Searching for intelligence and genetic commerce**

But first things first, and the first thing is that genes influencing intelligence are still to be discovered. BGI is trying to find them via its [Cognitive Genomics project](#). (The Cognitive Genomics Lab is also studying a particular brain defect called prosopagnosia, the inability to recognize familiar faces. It's not clear why this study is part of its portfolio. Prosopagnosia seems mostly to result from damage to a particular brain area during adult life; it appears to have little or nothing to do with general intelligence or with genes, although perhaps there are some exceptions.)

The general intelligence project has plans to sequence the genomes of thousands of super-smart people. You could be one of them; BGI is calling for volunteers. You'll need near-perfect SAT or GRE scores or a Ph.D. in physics or some other math-related field (and from a top program at that). [Get details here.](#)

BGI officials cheerfully acknowledge that IQ enhancement, especially enhancement that involves discarding embryos deemed inadequate, is a thorny issue. But they brush aside the ethical complexities. And yet, Specter says, BGI declares that its agricultural work does not involve GMOs because it does not want to get entangled in GMO politics. BGI's distinction between the two seems oddly contradictory. I can't help wondering if these conflicting assessments are based on BGI conjectures about potential consumer demand—strong in the case of embryo selection, far more unpredictable with GMOs.

### **Genes and their environments**

Specter emphasizes the role of genes as determinants of a creature's traits, including intelligence. Perhaps that's unavoidable in a piece about the world's largest producer of genomes, but it would have been nice—and instructive for the no doubt large number of *New Yorker* readers who don't know much about genetics—to see some acknowledgment that genes do nothing except in context.

In his *Wired* piece, Bohannon notes that BGI discussions of intelligence genes neglect to mention epistasis, the interaction of genes with one another. I would add that it is even more important to point out that [epigenetic events are central to what genes do](#), a fact becoming increasingly obvious the more scientists learn about them.

An organism's functioning, especially its brain functioning, is affected dramatically by epigenetics, a catchall term for the many molecular activities that turn genes off and/or on in particular cells at particular times in life. There's evidence that some especially critical epigenetic events happen very early in development, even before implantation. It is not enough to identify genes that influence intelligence or any other trait; scientists will also need to learn what factors shape gene activity.

### **Hoping for open access**

What will BGI do with the terabytes of data that pour out of its sequencers? Specter reports that BGI says all its data will be freely available to anyone. "BGI intends to transform DNA into a common resource, a kind of universal reference library—freely accessible, wary scientists hope, to anyone who wants to use it."

BGI made a lot of friends when its researchers swung into action on the deadly *E. coli* strain O104:H4 that surfaced in Germany in 2011. They sequenced it in 3 days. They tweeted details. They made the data freely available. This openness was a huge contrast to the Chinese government's previous secretive response to the SARS virus.

Such generous BGI behavior is an encouraging sign that its gigantic databases really will be open to all. But what the government will have to say about such openness is a cause for uncertainty. Specter notes, "BGI has often said that all such data will be shared. There is no reason to believe that anyone there has any other goal. It is possible, though, that the government won't leave the choice in the company's hands."

**GLP columnist Tabitha M. Powledge is a long-time science journalist. She writes On Science Blogs for the PLOS Blogs Network, and has new posts on Fridays.**