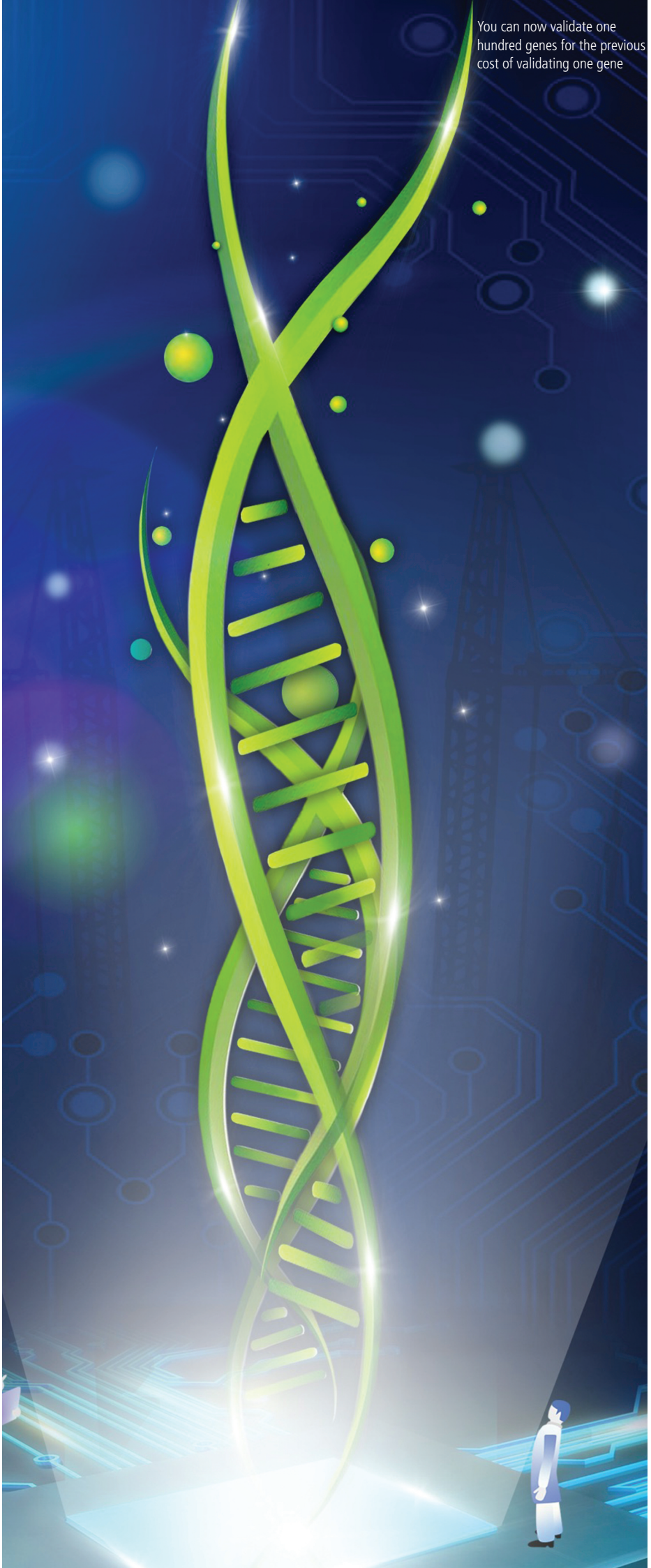

approach, what we call "enzyme cascade synthesis," is one that Codexis has refined as a core strength during our 16-plus year history.

There is a healthy competition between these two approaches. Generally speaking, when there are many chemical transformation steps required to produce a given target compound, an in vivo approach might be preferred. However, when there are fewer steps required, enzyme cascades deliver many benefits, including much shorter proof of concept and development timeframes, higher development predictability and significantly lower capital investment.

HA: Are there challenges or bottlenecks within the synthetic biology stack?

Emily Leproust: Reading and writing DNA used to be rate limiting. When the first human genome was sequenced in the early 2000s, it cost $3 billion, took 13 years and required the participation of scientists all around the world. It now costs about $1000 to sequence a human genome in a commercial lab. With our silicon-based DNA-synthesis platform, Twist Bioscience has created cost reductions and efficiency improvements for DNA writing. With access to highly affordable and fast DNA production, developers can explore a lot more avenues and, ultimately, make more discoveries.

Cumbers: With the DNA-reading-and-writing bottlenecks removed, the challenge now is high throughput analysis so that developers can characterise and test the variants they've created. New hardware tools continue to come online that allow materials, large numbers of single cells for instance, to be very efficiently managed for high throughput testing.

Mark Fischer-Colbrie: Increasing the speed and efficiency of the design-build-test-learn pipeline is an ongoing challenge within the synthetic biology community. The reduction in DNA synthesis costs has had a dramatic impact, but using our acoustic liquid handlers has demonstrated further step-change improvements in multiple areas. DNA assembly reaction volumes can be reduced by up to 100-fold and can be assembled in 3 hours compared with the 18 hours of conventional methods that use pipette-based liquid handling. This not only results in significant cost and time savings but enables projects that were previously considered to be impractical.

After a gene sequence has been assembled, the sequence must then be validated or verified using a sequencing device. Conventional pipette-based liquid handling processes are very slow, cumbersome, prone to cross-contamination and extremely expensive. Our systems can impact this test phase in much the same way as the build phase — delivering dramatic cost savings through miniaturisation and accelerating workflows via rapid any well to any well transfers.

Acoustic liquid handling uses sound waves to eject precisely sized droplets from the source plate onto the destination plate suspended above it. It can transfer liquids with extreme precision, down