

Amgen Foundation's move to scale up science education: Virtual laboratory experiences for students

In a lab, you can hypothesize. In a lab, you can run experiments. In a lab, you can learn to think—and operate—like a scientist. If you are a high school or college student and do not have access to a lab then you could be missing out on valuable experience—but not for long.

Thanks to a free virtual lab experience that will be made possible by the Amgen Foundation, headquartered in California, United States (US), and Harvard University, Massachusetts, US, students across the world will soon have the opportunity to tap into this important facet of science education online.

INTRODUCING LABXCHANGE —THE GAME-CHANGING NEXT STEP IN SCIENCE EDUCATION

On May 30 2018, the Amgen Foundation announced that it would contribute US\$6.5 million to Harvard University to create a free virtual lab experience and online community called LabXchange. The LabXchange platform, which will launch next year with a focus on biology, will also offer digital instruction and collaboration capabilities to high school and college students and instructors, enabling students to gain meaningful exposure to the scientific process.

Through LabXchange's virtual lab experience, students will be able to manipulate genes using plasmids. They will be able to



Students perform a science experiment in a classroom laboratory, which will soon be possible as a virtual experience.

The philanthropic arm of Amgen, the largest independent biotechnology company, is building a sophisticated portfolio of programmes that blend meaningful hands-on learning and the best of education technology to deliver on its commitment to reach more students with high-quality, curated and free science education programmes.

practice working with volumes of liquid smaller than one millionth of a litre. They will be taught how to produce thousands of copies of a specific sequence of deoxyribonucleic acid (DNA). There will be simulations ranging from engineering chimeric antigen receptor (CAR) T cells to attack and kill cancer cells to making macrophages resistant to human immunodeficiency virus (HIV) infection. There will also be a unit that demonstrates protein folding using simple experimental simulations, not to mention virtual experiments that mimic the differentiation from stem cells to beating heart cells in a tissue culture.

Soon it won't matter if students are living in Michigan or Malaysia. They will be able

to access an unparalleled lab learning experience—and do it for free.

"Advances in technology are not only having an incredible

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impact on how we develop and deliver innovative medicines to patients, but also in how we educate and inspire the next

generation of scientists," says Robert A. Bradway, chairman and chief executive officer at Amgen. "By joining forces with Harvard, LabXchange's interactive educational platform will give students studying biology around the world access to a unique virtual lab experience for free, dramatically expanding the Amgen Foundation's reach in science education."

Giving students exposure to deeply immersive scientific learning experiences is not a new concept to the Amgen Foundation. In fact, LabXchange is just the latest addition to the Foundation's expansive portfolio of science education programmes that has steadily grown over nearly three decades. However, this

investment is significant in that it reflects a meaningful step towards scalable programmes that leverage the power of technology to open the world of science to young people everywhere.

“This unique virtual lab experience is designed to level the playing field for aspiring scientists globally while directly supporting and complementing our global science education portfolio,” says David Reese, executive vice president of research and development and member of the Amgen Foundation board of directors. “As a career scientist, I have a deep appreciation for what this programme can accomplish by getting students to learn science by doing it.”

For high school and college students, the acquisition of basic lab skills and early engagement in the scientific process can pave the way to more advanced scientific learning—and perhaps even a career in science—but sparking the curiosity of students today is not a given.

THE STORY OF STEM

There is no shortage of research on the skills and education gap that exists when it comes to so-called STEM (science, technology, engineering and maths) fields. One study, conducted by the United States-based Business-Higher Education Forum, shows that 80% of high school students are either not interested or not proficient in STEM subjects (www.bhef.com). Other findings suggest that the number of American students pursuing STEM careers is growing at less than 1% each year despite high demand for STEM jobs (www.act.org). Meanwhile, according to a study by The National Bureau of Economic Research, headquartered in

Massachusetts, US, children from high income families are ten times more likely to be inventors—a conclusion drawn by comparing the household income tax brackets to patent filers (www.equality-of-opportunity.org).

Needless to say, the challenges of science literacy and advancing a technically skilled workforce have broad implications across a host of industries, including healthcare and biotechnology and society as a whole. That is why the Amgen Foundation has made science education an area of focus for nearly three decades.

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-BUSINESS-HIGHER EDUCATION FORUM

THE AMGEN FOUNDATION'S COMMITMENT TO SCIENCE EDUCATION

The Amgen Foundation's first science education programme, developed through a collaboration between Amgen scientists and educators, is called the Amgen Biotech Experience. Over the course of approximately three weeks and under the guidance of their science teachers, student participants produce a recombinant DNA molecule and use it to transform the bacterium *Escherichia coli*. Breaking from the traditional textbook-driven classroom format, students better understand how science is used to develop medicines and are able to imagine themselves as scientists. What started as a single class in 1991 has developed into an innovative programme with more than 700,000 student participants from schools across the US, Canada, Europe, Asia and

HOW DO YOU MEASURE THE IMPACT OF A PHILANTHROPIC INVESTMENT? RUN THE EXPERIMENT.

As the philanthropic arm of a company that relies on data to make some of its biggest decisions, the Amgen Foundation recently decided to conduct an evaluation to test the effectiveness of one of its flagship programmes. The Amgen Biotech Experience puts 80,000 students per year in the shoes of a real-life biotechnology company scientist. But the Foundation wanted to verify with data that this programme does in fact help them to deliver on their commitment to science education.

“We had anecdotal data showing the impact of the programme for many years, with high school science teachers and students raving about the ability to transform a living cell into a protein factory,” says Eduardo Cetlin, president of the Amgen Foundation. “However, with the programme coming into a new funding cycle in 2017, which would include an expansion to nine new international locations, we felt it was critical to ask: Is the programme actually making a difference when it comes to inspiring and educating students in science and biotechnology?”

To find the answer, the Foundation called upon WestEd, a notable independent education research organization headquartered in San Francisco, California, US, to conduct a comprehensive evaluation of the programme. By asking 3,500 high school students a series of questions before and after they went through the Amgen Biotech Experience, WestEd found that students had: (i) significant and substantial learning of biotechnology and (ii) increased interest and confidence in doing science and biotechnology. Students showed a statistically significant increase ($p < 0.001$) and with large effect size ($d = 1.03$) on a 25-question validated assessment, with an average increase of 20 percentage points between the pre- and post-tests.

“It was incredibly rewarding to see the data validating what we knew in our hearts,” notes Cetlin. “Now with LabXchange, we hope to augment the programme offerings to incorporate cutting-edge science experiments that will further enhance the student learning experience and allow them to see the promise of biotechnology firsthand.”

Australia. Students in the Amgen Biotech Experience get hands-on experience with cutting-edge biotechnology tools and perform wet-lab procedures.

The next programme the Foundation established is the Amgen Scholars Program. Launched in 2006 and sustained by a 12-year, \$50 million commitment from the Amgen Foundation, the Amgen Scholars Program invites qualified undergraduate students from hundreds of

colleges and universities to conduct groundbreaking research at the world's leading institutions under the mentorship of world-renowned scientists. The programme is designed to allow exemplary students from all economic backgrounds to participate. More than 3,900 students from 700 colleges and universities have completed the programme, with the vast majority now pursuing advanced degrees and careers in scientific fields. In 2017, Amgen Scholars



**Inside
the Labs
of Amgen**

Some of Amgen's most important innovations have taken place inside its very own labs. Here are 5 legendary Amgen scientists who helped change the practice of medicine.

Amgen scientists pictured clockwise, from top left: Fu-Kuen Lin cloned the erythropoetin gene leading to Amgen's first medicine; Larry Souza cloned the G-CSF gene leading to Amgen's first major oncology medicine; Simon Jackson helped to elucidate the biology of the PCSK9 protein leading to Amgen's first cardiovascular therapy; Cen Xu advanced an antibody approach against the CGRP receptor that led to Amgen's first migraine medicine; David Lacey helped discover the osteoprotegerin (OPG) protein leading to Amgen's first osteoporosis medicine.

alumni published 712 works and received 810 awards, including one named to Forbes's '30 Under 30' in healthcare.

EMBRACING ONLINE SCIENCE EDUCATION TO EXPAND REACH

More recently, the Amgen Foundation has been focused on expanding the reach of its science education portfolio using technology, recognizing that the educational landscape is becoming increasingly technology-enabled. For example, according to one survey of teachers whose pupils range from pre-school to 18 years old, one in three teachers are using technology to encourage working in teams and collaboration, 58% are using tech tools for project-based learning and 55% of teachers are using technology to encourage creative thinking (www.kahoot.com).

The first move in this direction is collaboration with the Khan Academy. The Khan Academy is a free online learning platform, making high-quality, video-based educational content accessible to everyone. In 2017, the Amgen Foundation became the exclusive

sponsor of the Khan Academy's biology content, supporting the programme with a three-year, US\$3 million grant.

Soon after, came discussions that led to the investment in LabXchange. The Amgen Foundation explored for some time how best to connect and virtually scale its high school lab and undergraduate research initiatives. This exploration ultimately led to Robert Lue, a Harvard University professor of molecular and cellular biology, who brings deep expertise in online learning, science education, and the engagement of students in lab and research experiences.

Following the US\$6.5 million contribution from the Amgen Foundation, the team at Harvard University is building prototypes and testing them with potential users in 2018, with plans to launch globally in 2019 with a focus on biology.

"There are many millions of students who, as a result of economic or geographic limitations, simply do not have access to one of the most central aspects of being a scientist, which is working in a laboratory," says

Professor Lue. "LabXchange addresses this issue with a platform that integrates dynamic experimental simulations with background curriculum and social networking—all created to more effectively expose students of varying backgrounds to the authentic and engaging experience of scientific discovery."

Students want to learn wherever and whenever it is convenient for them and platforms like LabXchange have the potential to deliver the goods to students of all incomes and backgrounds.

INSIDE AMGEN'S LABS

When you think about what sort of programmes the Amgen Foundation might support, it's no great leap to imagine they might be related to science or, for that matter, experiences that might immerse you in a lab. After all, over the course of more than three and a half decades, Amgen

went from a small, venture-backed start-up with a handful of scientists operating out of a small building in an unassuming strip mall in southern California to a company that employs many thousands of scientists around the world.

How did that happen? One could argue that it was largely because of what scientists were accomplishing in Amgen's own labs. After all, scientists working in labs at Amgen have made discoveries that led to innovative and meaningful medicines for kidney disease, cancer, osteoporosis, cardiovascular disease and migraine.

As a result, the enthusiasm at Amgen from staff, senior scientists and senior leadership to support the advancement of aspiring scientists through the use of a lab experience should come as no surprise. And this enthusiasm can be seen through the Foundation's long-standing commitment to science education.

"We think the school science lab is a magical place—a place where, as a young student, you get to do what you read about in a science book," says Cetlin. "As students move through their educational journey, the lab is the perfect setting for them to start thinking like scientists: asking questions, crafting hypotheses, designing and running experiments, failing and starting the cycle again. That's why we have invested tens of millions of dollars to give students the chance to experience lab learning firsthand."

For more information about the Amgen Foundation, visit www.AmgenInspires.com and follow us on Twitter @AmgenFoundation. For more information about LabXchange, visit www.LabXchange.org and follow @LabXchange on Twitter.