THE worldVIEW 100

THE VISIONARIES WHO CONTINUE TO RESHAPE BIOTECHNOLOGY—AND THE WORLD

At just 40 years old, biotechnology is a relatively new industry. Its starting point, arguably, was the 1975 Asilomar Conference on Recombinant DNA, at which the potential benefits and hazards of DNA manipulation and the ways it should be regulated were debated and essentially decided upon. Most of the seminal figures in the development of biotechnology are alive today. Indeed, many of them are still working in the field that they love.

Here, we name 100 of the industry's leading lights in a list we've dubbed "The Worldview 100." The honorees include researchers who provided fundamental insights into biological processes, as well as their colleagues who developed those insights to create the biology-based goods and services that are the essence of biotechnology. We also recognize the business experts who had the foresight to provide financial backing in this high-risk, nascent technology sector, along with the entrepreneurs who constructed and implemented the business principles that made those investments pay off. Dotted throughout are several visionary legislators and administrators who understood the need to create fertile conditions enabling biotechnology to flourish, and a number of key media figures who have helped to convey its potential and successes to the community at large. The realm of biotechnology extends so far that some people on our list might not even consider themselves part of this industry. Nonetheless, these scientists and business builders are as complementary to the emergence of the field as two parents are to a child.

Advances in biotechnology are the results of the efforts of many tens of thousands of people. The Worldview 100 could easily have been developed as The Worldview 500, The Worldview 1,000, or any multiple thereof. In identifying just 100 individuals, our intention is to illustrate the range and quality of its leaders, rather than to offer a definitive register of its "most important" contributors. Nevertheless, the list stands scrutiny as a collection of extraordinarily talented and effective people. To learn more about them, we provided each with an opportunity to respond to a few questions—some serious and others less so—and we share some of their answers.

What traits do these leaders have in common? Creativity and enterprise are givens. Resilience and self-sacrifice are also critical, as the complexity of the science and its regulation demands they constantly strive to maintain momentum, however far away their goal appears. And since risk-taking is practically the norm in biotech, these figures have to possess the confidence to outdare the crowd, to blaze a trail and to maintain their nerve, sometimes against overwhelming odds. Emotional intelligence is another prerequisite for The Worldview 100, who invariably have the ability to get along with others and the forthrightness to be constructively critical when necessary.

One suspects that many of biotech's key players would have stood out in whichever career they chose. So what enticed them into this field? Perhaps its newness, offering the thrill of putting a personal stamp on a fledgling industry, was part of the attraction. But surely the biggest draw was the scope and potential impact of the work: re-envisioning health and wellness, transforming agriculture, retooling traditional industries and providing solutions to the global energy crisis in a climate-friendly manner. What greater challenges does our world face?

We present *The Worldview 100*, who are facing them head-on.

—The *Scientific American Worldview* team with key contributions from Alexandra Hariri and Richard Gallagher.

THE WORLDVIEW 100 SURVEY METHODS

We developed and finalized this list in several steps through a process carried out from December 2014 through March 2015. First, we invited dozens of leaders in biotechnology and biosciences to nominate their choices for the most influential people in the field. We encouraged the nominators to select living experts currently working in the sector from a range of contributing areas, including industry, academia, public policy, finance, law and beyond. That process generated a list of almost 400 nominees. We then recruited more experts—many of them from the original group of nominators—to suggest anyone on the list of nominees worthy of selection to a more refined coterie of the 100 most influential figures in today's world of biotechnology. For the final step, we tallied the votes, and the 100 people most selected formed The Worldview 100. Here, we highlight the 10 individuals who received the highest number of votes. We present the other 90 honorees in alphabetical order.

YOUR TOP 10

GEORGE CHURCH

professor of genetics | Harvard Medical School | Boston, Massachusetts, U.S.

Church started his career with sequencing, especially through the development of advanced devices, and he continues to help scientists collect and analyze data about the most basic life traits. As the director of PersonalGenomes.org, he provides open access to data that explore the foundation of human traits around the world. His work on next-generation sequencing and cellular and tissue engineering spawned a dozen companies based on medical genomics or synthetic biology. *Kirkus Reviews* called his book *Regenesis*, coauthored with science writer Ed Regis, "a valuable glimpse of science at the edge."

FRANCIS COLLINS

director | U.S. National Institutes of Health | Bethesda, Maryland, U.S.

"I think my greatest contribution to biotechnology arose from the charge I was given to lead the international Human Genome Project," Collins told *Scientific American Worldview.* "Through the dedicated work of 2,400 scientists in six countries, we successfully sequenced and made immediately available the 3 billion base pairs in the human genetic blueprint—ahead of schedule and under budget." To make biotechnology even more effective, he said, "It is especially important to support the creative minds who are pursuing high-risk projects that, if successful, may yield high rewards for expanding biological knowledge or fighting human disease."

BILL GATES

co-chair and trustee | Bill & Melinda Gates Foundation | Seattle, Washington, U.S.

Best known as the cofounder of Microsoft, Gates turned his wealth into philanthropic giving through his and his wife's foundation, which, its website states, works to "bring about the kinds of changes that will help people live healthier and more productive lives." Clearly, innovation has always played a fundamental role in his career. He once noted, "I believe in innovation and that the way you get innovation is you fund research and you learn the basic facts." That thinking took him a long way.

MELINDA GATES

co-chair and trustee | Bill & Melinda Gates Foundation | Seattle, Washington, U.S.

In her 1982 high school valedictorian address at Ursuline Academy in Dallas, Texas, Melinda Gates offered the following wisdom: "If you are successful, it is because somewhere, sometime, someone gave you a life or an idea that started you in the right direction. Remember also that you are indebted to life until you help some less fortunate person, just as you were helped." At that time, no one could even imagine the help that she would bring to the world. According to her foundation's website, it has given grants totaling US$32.9 billion.

PEGGY HAMBURG

former commissioner | U.S. Food & Drug Administration | Silver Spring, Maryland, U.S.

Born to a two-physician family, Hamburg joined the family business—but in a managerial capacity. Before working for the FDA, she served as commissioner of the New York City Department of Health and Mental Hygiene, where she significantly slowed the spread of tuberculosis. When President Obama named Hamburg the FDA commissioner in 2009, Georges Benjamin, then executive director of the American Public Health Association, said, "She's all about integrity and science…. She can be tough when she needs to be, and she's going to need to be real tough in that job." How right he was.

LEE HOOD

president & cofounder | Institute for Systems Biology | Seattle, Washington, US

Hood played a role in the development of five instruments that drive today's biological sciences: automated DNA sequencers, DNA synthesizers, protein sequencers, peptide synthesizers and an ink-jet printer for constructing DNA arrays. Today, he works on integrating biology, computation and technology to build so-called P4 medicine, which is predictive, personalized, preventative and participatory. In the 2012 *Scientific American Worldview*, Hood posited that the traits of a successful entrepreneur are "having a clear picture of the future that is very different from what other people have, and an ability to drive towards that future."

ERIC LANDER

professor of biology | MIT | Cambridge, Massachusetts, U.S.

After publishing a 2005 article in *Nature* on the chimpanzee genome, Lander said, "The goal is not just butterfly collecting or mammal collecting to simply describe mammals. All of that comparative work across mammals is about informing the human genome for medicine. Until we actually understand all the working parts within our genome, we won't really be able to practice the most informed medicine." As a core member of the Broad Institute, Lander continues to explore what genomics can tell us about human physiology and diseases—especially how to treat them.

BOB LANGER

David H. Koch Institute Professor | MIT | Cambridge, Massachusetts, U.S.

Langer described his greatest contribution to biotechnology as "discovering how to create materials that enable the controlled release of macromolecules." Such devices can deliver drugs—even genetically engineered proteins—for long periods, and Langer is even working on versions that can be controlled through magnetic, ultrasonic and enzymatic methods. The best way to increase the effectiveness of biotech today, he said, is to provide "more funding for basic research." Langer's output—including more than 1,000 patents, which have been licensed to over 300 companies—attests to his indefatigable drive.

CRAIG VENTER

founder | J. Craig Venter Institute | La Jolla, California, U.S.

In 2013, Venter told Bloomberg, "Genome design is going to be a key part of the future. That's why we need fast, cheap, accurate DNA synthesis so you can make a lot of iterations of something and test them." By then, he and his colleagues had already created a bacterial genome from scratch. Now, as the CEO and cofounder of Human Longevity, Inc., Venter hopes to combine information about various biological features—including the genome, proteome, biome and more—with advanced algorithms and computing to create new therapies to extend our years of high-quality life.

JANET WOODCOCK

director | Center for Drug Evaluation & Research | U.S. Food & Drug Administration Silver Spring, Maryland, U.S.

Woodcock helped to develop a regulatory framework to accommodate future advances in biotechnology. Nonetheless, the discipline's effectiveness could be enhanced even more, she said, through "greater attention to translational science." So far, the biggest impact biotech has had on our daily lives is "the food revolution," she said, adding that "forms of gene therapy may be 'coming of age.'" And the most embarrassing moments of her career? "Too numerous to count!" she answered.

NAGLAA ABDALLAH
head | Agricultural Genetic Engineering Research Institute
Cairo University | Giza, Egypt

Abdallah participates in the science and use of genetically modified crops in a variety of ways. She is editor-in-chief of *GM Crops and Food* and the acting director of the Egypt Biotechnology Information Center.

JULIAN ADAMS
president | research & development
Infinity Pharmaceuticals
Cambridge, Massachusetts, U.S.

With more than 30 years of experience as a chemist and executive in the pharmaceutical industry, Adams played a part in delivering many life-saving treatments. Among them was his role in the discovery and development of Velcade, a blockbuster cancer drug.

RICH ALDRICH
cofounder | Longwood Fund
Boston, Massachusetts, U.S.

A serial founder and builder of biotechnology companies, including Concert Pharmaceuticals and Vertex Pharmaceuticals, Aldrich repeatedly delivers capital to promising projects. His work, though, goes beyond biotechnology. For instance, he serves on the board of the Greater Boston YMCA.

MAHALETCHUMY ARUJANAN
executive director | Malaysian Biotechnology Information Centre (MABIC) | Selangor Darul Ehsan, Malaysia

When asked to identify a career-changing moment, Arujanan replied, "I was fired by one of my previous employers because I refused to play politics and apple polish the boss. I am who I am today because I left that employer. And the two most important traits I keep out of my organization are politics and the need to be 'nice' to the boss."

ANTHONY ATALA
director | Wake Forest Institute for Regenerative Medicine
Winston-Salem, North Carolina, U.S.

"Currently, there are not enough organs to go around," Atala declared at TED2011. He aims to solve that healthcare crisis by making new organs with 3D printing, which could produce an unlimited supply for the patients who need them.

DAVID BALTIMORE
Robert Andrews Millikan Professor of Biology | California Institute of Biology
Pasadena, California, U.S.

In his Nobel Lecture, Baltimore said, "The study of biology is partly an exercise in natural esthetics. We derive much of our pleasure as biologists from the continuing realization of how economical, elegant and intelligent are the accidents of evolution that have been maintained by selection."

STÉPHANE BANCEL
president & CEO | Moderna Therapeutics
Cambridge, Massachusetts, U.S.

After raising US$450 million for Moderna in 2015, Bancel told *The New York Times*: "We do not want to do what most biotechs do, which is one drug at a time. We want to go in parallel."

SOL BARER
managing partner | SJ Barer Consulting
Summit, New Jersey, U.S.

"We are optimistic now that many fatal diseases can indeed not only be treated but potentially cured," said Barer, former CEO and chairman at Celgene. Biotechnology "has impacted entrepreneurial behavior motivating students to go into this field, motivating entrepreneurs to create companies, encouraging investment in the field," he added, "and all of this leading to better therapies for patients."

ROGER BEACHY
director | World Food Center | University of California, Davis | Davis, California, U.S.

This plant biologist visionary and founding president of the Danforth Center knows how to keep things in perspective. "After a series of laboratory successes that followed the discovery of disease-resistant technologies, I self-assuredly referenced 'being on a roll,'" he told *Worldview*. "Soon thereafter I took a fall and a long roll down a run at the Purgatory ski resort at a Keystone Conference. To my chagrin and embarrassment, a friend, Jonathan Jones, from the John Innes Center, UK, shouted, 'Are you still on a roll, Beachy?'—not just one time, but repeatedly in following years."

SETH BERKLEY
CEO | Gavi, the Vaccine Alliance
Geneva, Switzerland

On extending the global reach of today's cutting-edge medicines, Berkley opined, "Even stronger public-private partnerships will ensure that the products of this revolution are made available to those living in the poorest parts of the world. In my current job at Gavi, the Vaccine Alliance, we have used this kind of model to help developing countries deliver vaccines to more than a half billion additional children and prevented more than 7 million future deaths in the 73 poorest countries in the world."

KAREN BERNSTEIN
cofounder, chairman & editor-in-chief
***BioCentury* | Redwood City, California, U.S.**

"Newspapers, movies and our culture in general are filled with uninformed views about science, business and economics that harm our society's ability to make informed decisions about everything from food to medicine," Bernstein asserts. "There is no simple fix for this, but I think we must try."

SANGEETA BHATIA
director | Laboratory for Multiscale Regenerative Technologies | MIT
Cambridge, Massachusetts, U.S.

"We're engineers working in a science environment, thinking about human health," Bhatia told NBC News. "What engineers like to do is tinker, so we encourage that spirit of tinkering in the lab."

JACK BOBO
senior advisor for biotechnology
United States Department of State
Washington, DC, U.S.

"People love innovation almost as much as they despise change," Bobo said. "This aversion to change has delayed the adoption of agricultural biotechnology in some parts of the world. To increase the effectiveness of biotechnology, we need to build public support and trust. In order to do this, scientists need to stop telling people what they do and start telling them why they do it. It's only after you build trust that science matters."

MARY BOOTE
CEO | Truth About Trade and Technology
Des Moines, Iowa, U.S.

"Speaking specifically about agriculture," Boote said, "the ability of a farmer to add a much-needed room to his home or pay a child's school fees because of an increased yield due to biotech-crop access is a quality-of-life success story."

DAVID BOTSTEIN
CSO | Calico | South San Francisco, California, U.S.

With genomes available for a growing list of organisms, Botstein takes the next step—using them to explore complete biological systems. This includes learning to analyze and display biology's genomic big data.

BOB BRADWAY
chairman and CEO | Amgen
Thousand Oaks, California, U.S.

Regarding a new manufacturing plant in Singapore, Bradway recently told the *Pacific Coast Business Times*, "This is an approach to manufacturing that we think will enable us to reduce our cost per gram of proteins by an order of magnitude of about 60%."

> "This aversion to change has delayed the adoption of agricultural biotechnology in some parts of the world." —JACK BOBO

STEVEN BURRILL
CEO | Burrill LLC | San Francisco Bay Area, California, U.S.

Looking back on biotech's history, Burrill opined, "On balance, the science has moved far faster than anyone could have assumed, and the business a little slower. 1,000 years from now when they write the then 3,000 years of recorded history of mankind, this will go down in history as mankind's greatest moment—when we truly, for the first time, understood the basis of life and our ability to improve it, transforming healthcare, agriculture, energy and industrial production."

ATUL BUTTE
director | Institute of Computational Health Sciences | University of California, San Francisco | San Francisco, California, U.S.

Discussing the new institute, Butte notes, "We hope that we will be successful in making discoveries and developing diagnostics and therapeutics. If we want to change the world of medicine, we have to bring those discoveries into the marketplace and closer to patients."

BROOK BYERS
founding member | Kleiner Perkins Caufield & Byers | Menlo Park, California, U.S.

Byers and his family support innovation so extensively at the University of California, San Francisco, that the school established the Byers Family Distinguished Professorship. Moreover, Byers is especially known for developing large venture capital funds devoted to biotechnology.

ART CAPLAN
Drs. William F. and Virginia Connolly Mitty Professor of Bioethics | New York University | New York, New York, U.S.

As his biggest contribution to biotechnology, Caplan cited: "Helping to lay out the ethical case for moving advances forward while protecting human subjects." His most embarrassing moment? "Applying for a grant with Dan Callahan while at the Hastings Center in 1985 to study the ethics of human and animal cloning and getting rejected by the NSF and NIH on the grounds that we did not understand the science and mammalian cloning was impossible."

ISAAC CIECHANOVER
president & CEO | Atara Biotherapeutics South San Francisco, California, U.S.

Over his 20-year career, Ciechanover has spurred numerous medical advances and driven mergers and licensing worth US$6.7 billion. He also cycles, scuba dives and loves Pink Floyd's *The Dark Side of the Moon*.

RON COHEN
founder, president & CEO | Acorda Therapeutics | Ardsley, New York, U.S.

To make biotechnology more effective, Cohen says, "I would start a $30 billion initiative to emphasize and improve STEM education in U.S. K–12 schools…. We need to ensure that the next generation will produce enough high-quality scientists and industry leaders to maintain our leadership, which creates not only life-saving medicines, but also high-value, high-wage jobs." If not for his current career in the industry, he would have been an actor in the New York theater. "That's what I did in between my careers in medicine and biotechnology," he said.

STANLEY CROOKE
CEO | Isis Pharmaceuticals Carlsbad, California, U.S.

A pioneer who helped lead the creation of RNA-targeted drug discovery, Crooke told *Worldview* that the "one and only time I guaranteed a new drug would work in the next clinical trial was to the SmithKline Beckman board when I was president of R&D there. We had a vasopressin antagonist and it worked beautifully to increase free water clearance in all animal models. In man, it was a partial agonist and actually caused water retention."

SUSAN DESMOND-HELLMAN
CEO | Bill & Melinda Gates Foundation Seattle, Washington, U.S.

Desmond-Hellman told *Worldview* that she wants to "accelerate a process" already underway at the Gates Foundation, which is "forging public-private partnerships to develop products specifically for the lowest-income countries." She added, "In recent years, we've seen some very promising signs of what can happen when a nonprofit or a government agency works with a business to reduce market risks, such as through volume guarantees…. If I could bring about any single change in the biotech field today, it would be to encourage all players in this sector to be more imaginative and aggressive about seeking such partnerships."

PETER DIAMANDIS
founder & chairman | XPRIZE Foundation cofounder, Human Longevity, Inc. Culver City, California, U.S.

In a 2012 interview with *Wired*, Diamandis declared, "If someone is always to blame, if every time something goes wrong someone has to be punished, people quickly stop taking risks. Without risks, there can't be breakthroughs." No wonder he created the XPRIZE, with its mission of "designing and launching large incentive prizes to drive radical breakthroughs for the benefit of humanity." Diamandis is also cofounder of Human Longevity, Inc., along with Craig Venter and Robert Hariri.

JENNIFER DOUDNA
Li Ka Shing Chancellor's Professor in Biomedical & Health Sciences | University of California | Berkeley, California, U.S.

One of the leading researchers who created the CRISPR-Cas9 technology for genome engineering, Doudna believes that we must "increase connections and communications between academic labs and companies" to help biotechnology move ahead even faster.

NINA DUDNIK
founder & CEO | Seeding Labs | Boston, Massachusetts, U.S.

"My goal, through Seeding Labs, is to ensure that as many scientists as possible have the right tools, training and professional networks to make impactful contributions to biotechnology," says Dudnik. "There is remarkable talent around the world, and developing capacity and infrastructure for these individuals is a smart, measurable investment in global science." She added, "Our responsibility does not end in the lab, especially in the digital age. We need to be ambassadors and translators for science."

DREW ENDY
associate professor Bioengineering | Stanford University Stanford, California, U.S.

Endy, a synthetic biologist, told *The Guardian*, "I want to be able to design and build biological systems to perform particular applications. The scope of material I can work with is not limited to the set of things that we inherit from nature."

OMID FAROKHZAD
associate professor | Harvard Medical School | Boston, Massachusetts, U.S.

An expert in developing nanoparticle-based systems of drug delivery, Farokhzad said of one of his recent studies: "This is the first example of a targeted nanoparticle technology that reduces atherosclerosis in an animal model." His work also explores nanomedicine's potential to treat many other diseases.

NINA FEDOROFF
Evan Pugh Professor of Biology The Huck Institutes of the Life Sciences Pennsylvania State University State College, Pennsylvania, U.S.

Fedoroff pioneered the development of molecular cloning and analysis techniques for plants starting in the late 1970s, and today she would like to see governments "simplify their regulation and make the regulations product- and not process-based."

JAY FLATLEY
CEO | Illumina | San Diego, California, U.S.

Flatley told *Worldview* that we are "moving into an era of greater diagnostic precision and personalization of patient care," such as non-invasive prenatal testing for chromosomal abnormalities and liquid biopsies to detect DNA circulating in the blood from cancer cells. He added, "I think one of the most meaningful impacts will be allowing us to live healthier lives longer."

MICHAEL J. FOX
founder | The Michael J. Fox Foundation for Parkinson's Research | New York, New York, U.S.

Since 2000, Fox's foundation has contributed over US$450 million for research on Parkinson's disease, more than half of which went toward developing treatments. "We are outcomes-focused, incorporating milestones into every award and tying grant payments to achievements of those milestones," the foundation website states.

ROBB FRALEY
executive vice president and CTO Monsanto | St. Louis, Missouri, U.S.

"The ability to identify and map every single gene in a plant, as well as create, screen and identify genetic combinations," he said, "has literally changed how we breed crops. Today, we are seeing record rates of gains and yields in crops where these advanced breeding techniques have been applied and as technology costs have rapidly declined, their impact is now reaching native and orphan smallholder crops."

YALI FRIEDMAN
Head, Data Analytics, Scientific American Custom Media | Washington, DC, U.S.

"Fresh out of graduate school I published *Building Biotechnology*, which quickly became the leading textbook on the business of biotechnology," said Friedman. "Lately I have been developing a novel methodology to rank patent attorneys at PatentStat.com, building a tech transfer search engine at TechTransferWatch.com, and leading data analytics for Scientific American Custom Media."

ANITA GOEL
chairman & scientific director | Nanobiosym Cambridge, Massachusetts, U.S.

Goel received the 2013 XPRIZE in recognition of her pioneering contributions to the new field of nanobiophysics and her Gene-RADAR technology, which she described in the 2014 edition of *Worldview* as "a mobile diagnostic platform for providing anyone, anytime, anywhere with instant access to personalized information about their health."

HUGH GRANT
CEO | Monsanto | St. Louis, Missouri, U.S.

In discussing exciting advances in biotechnology, Grant said, "From new areas of research in agricultural biologicals to the intersection of data science and precision agriculture, the seamless use of a variety of technologies—including biotechnology—will transform the future of agriculture."

JIM GREENWOOD
president & CEO | The Biotechnology Industry Organization (BIO) Washington, DC, U.S.

"When I was in college I made a commitment that I wanted to devote my life to service," Greenwood recalls. "When I graduated, I worked as a house parent with special needs children, then as a caseworker with abused and neglected children." Later, he was elected to the Pennsylvania State House, the Pennsylvania State Senate and the U.S. Congress. "When I was offered my position at BIO, I saw it as an opportunity to continue that focus on service," he explained.

ROBERT HARIRI
chairman & founder | Celgene Cellular Therapeutics; cofounder, Human Longevity, Inc. | Warren, New Jersey/ La Jolla, California, U.S.

According to Hariri, "Biotech has been the source of virtually every major new platform of technology which creates new therapeutics, such as biologics, immunotherapy and cellular medicine. I believe cellular immunotherapy will have a quantum effect on the treatment of cancer in the next 3 to 5 years."

DEBBIE HART
president & CEO | BioNJ Trenton, New Jersey, U.S.

"My greatest contribution has been my greatest blessing—my absolute passion for my life's work," says Hart, who leads a biotechnology advocacy group in the biopharma legacy state of New Jersey. "Out of that has flowed an undying optimism for the future, an unrelenting commitment to work hard for our members in their support of patients and an unquestionable belief that what we do matters."

WILLIAM HASELTINE
chairman & president | ACCESS Health International | New York, New York, U.S.

If Haseltine could make one change in the world of biotech, he would "create virtual biotechnology companies that outsource almost all aspects of clinical development, manufacturing and marketing of compounds sourced from academia. I would work with a small staff with little to no infrastructure."

LUIS HERRERA-ESTRELLA
chief | National Laboratory of Genomics for Biodiversity | National Polytechnic Institute | Irapuato, Mexico

If he hadn't gone into biotechnology, Herrera-Estrella told us, he might have been a professional dancer. Instead, he works on genetically modified (GM) crops, of which he said, "due to lack of information and the opposition of anti-technology groups, their full potential still has not been achieved. GM crops reduce the cost of production and the negative environmental impact of agriculture by reducing the use of agrochemicals."

JAMIE HEYWOOD
chairman & cofounder | PatientsLikeMe Cambridge, Massachusetts, U.S.

When asked about the biggest impact of biotech on our lives, Heywood said, "What we have seen so far is like looking at the first computers and anticipating the iPhone and the Internet. Biotechnology is an information frontier that is just beginning to open and it will transform everything about how well and how long we live."

BOB HUGIN
chairman & CEO | Celgene Summit, New Jersey, U.S.

"In the last 50 years, 50% of the economic growth in America is due to medical innovation…and 73% of life expectancy gain in the first decade of this century is due to medical innovation," Hugin recently told CNBC. "Intellectual property is the lifeblood of innovation, and we have to make sure as a company, as an industry, we protect it."

CLIVE JAMES
founder & emeritus chair | International Service for the Acquisition of Agri-Biotech Applications (ISAAA) | Cayman Islands

"The contribution of biotech/GM crops to the alleviation of poverty and hunger," said James, is the most impactful effect biotechnology has had on our lives to date. "The commercialization by Bangladesh, one of the poorest countries in the world, of Bt brinjal (eggplant) can benefit up to 150,000 small resource-poor farmers."

CALESTOUS JUMA
director | Science, Technology, Globalization Project | Belfar Center for Science and International Affairs | Harvard Kennedy School | Cambridge, Massachusetts, U.S.

Although Juma has more than 68,000 followers on Twitter, you don't need to follow his tweets long to understand his perspective. On March 21, for example, he tweeted a photo of a lion and zebra drinking side by side with the hashtag #peace.

CARL JUNE
Richard W. Vague Professor in Immunotherapy | Perelman School of Medicine | University of Pennsylvania Philadelphia, Pennsylvania, U.S.

When we asked June what could drive innovative science that will benefit the healthcare system, he replied, "I think now we're at this real tipping point where we can harvest many of the basic advances, and things previously thought impossible will be happening. I think one thing is we need to educate the public about what can happen because the public will be more involved" with the new therapies.

MARY-CLAIRE KING
American Cancer Society Research Professor departments of medicine & genome sciences | University of Washington Seattle, Washington, U.S.

King applies next-generation sequencing to a wide range of crucial areas, including breast and ovarian cancer, as well as the genetics of schizophrenia. In addition, she even uses sequencing to identify victims of human rights abuse.

RACHEL KING
president & CEO | GlycoMimetics Gaithersburg, Maryland, U.S.

In her testimony to the U.S. Senate Committee on Small Business and Entrepreneurship on March 19, 2015, King eloquently distilled the relationship between science and business: "Patents allow biotech inventions of great societal value to be passed or shared among parties best suited to unlock their potential at any given stage of development and commercialization—each contributing its part, each sharing the risk of failure, each increasing the odds that a product eventually reaches patients."

GANESH KISHORE
CEO | Malaysian Life Sciences Capital Fund | St. Louis, Missouri, U.S.

"The greatest concern I have," Kishore told *Worldview*, "is that the emotional and geographic barriers for the adoption of products of biotechnology have become globally rampant. In fact, it is troubling that our society fails to recognize that all food in our plant and even animal food chain today is 'genetically modified'—and even evolution is about genetic modification leading to adaptation."

"I would improve the communication of biotechnology's enormous value proposition to society." —JOHN MARAGANORE

RAJU KUCHERLAPATI
Paul C. Cabot Professor | department of genetics | Harvard Medical School Boston, Massachusetts, U.S.

Kucherlapati told PhRMAdigital, "Personalized medicine has the potential to significantly alter the health and well-being of all of the American population. And if our population begins to recognize what personalized medicine is, how the principles of personalized medicine would apply to their health and well-being, it would have a very significant impact."

ANNA LAVELLE
CEO | AusBiotech | South Yarra, Australia

In *BioSpectrum*, Lavelle recently wrote: "High-tech innovative industries generate globally competitive economies and sustainable, high-skilled jobs and Australian biotechnology is poised to make its contribution to Australia's growth. Australia has a strong comparative advantage in medical research and the calibre of its researchers, and in its ability to specialize in niche manufacturing."

MARK LEVIN
partner | Third Rock Ventures Boston, Massachusetts, U.S.

Upon receiving the 2014 Leadership in Personalized Medicine Award, Levin remarked, "The best part of the last 40 years has been working with incredible people…to make a difference for patients. It cannot get any better than that!"

ART LEVINSON
founder & CEO | Calico South San Francisco, California, U.S.

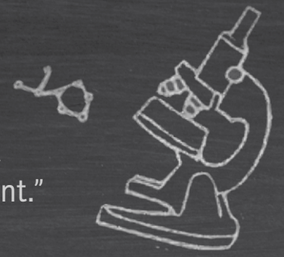
"As a little kid," Levinson once said, "I was always afraid of getting old. On my 7th birthday, I was actually sad, because it just seemed like—wow, 7 is not 6 anymore." No wonder he recently founded Calico, which plans to "devise interventions that enable people to lead longer and healthier lives."

JOHN MARAGANORE
CEO | Alnylam Pharmaceuticals Cambridge, Massachusetts, U.S.

"While there's still more to do," Maraganore said, his chief contribution to biotechnology is "delivering on the promise of RNAi as a new class of innovative medicines." Regarding ways to make biotech more effective, he said, "I would improve the communication of biotechnology's enormous value proposition to society."

ANDY MARSHALL
chief editor | *Nature Biotechnology* New York, New York, U.S.

Marshall described his greatest contribution to his field as "finding the best and brightest to work with me. And helping the best and the brightest junior faculty meet the best and the brightest in the business world. Not enough is being done to give gifted researchers the funding and opportunities they need. A lot of good science is falling between the cracks."



"My philosophy has been one of differentiation. Look at what's there and keep challenging yourself to be different."
—KIRAN MAZUMDAR

KIRAN MAZUMDAR
chairman & managing director
Biocon | Bangalore, India

In the 2011 edition of *Scientific American Worldview*, Mazumdar told us: "My philosophy has been one of differentiation. Look at what's there and keep challenging yourself to be different: If everyone is after generic products, how can you get into novel programs? If you can do that, then you stand apart and you can do things more effectively."

TERRY MCGUIRE
cofounder & general partner | Polaris Partners | Boston, Massachusetts, U.S.

"It's not good enough to be intellectually smart," McGuire once said, "you need to be clever, clever enough to figure out new ways to make things happen. Plus, you need ambition that is beyond monetary, a desire to see a better world."

HENRY MILLER
Robert Wesson Fellow in Scientific Philosophy & Public Policy
Hoover Institution | Stanford University
Stanford, California, U.S.

Miller considers his most significant contribution to biotechnology to be "the record-setting FDA approval of human insulin, when I headed the team that reviewed it in 1982." He'd like to see more FDA advances today, including "more scientific, risk-based regulation."

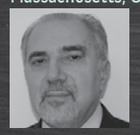
DAVID MOTT
general partner | New Enterprise Associates
Timonium, Maryland, U.S.

After executive roles in pharma, Mott moved to healthcare venture investing in 2008, where he quickly made a name for himself. In fact, *FierceBiotech* called him the "leading life sciences venture maven," given the billions that he has raised.

KAREN NELSON
president | J. Craig Venter Institute
Rockville, Maryland, U.S.

Nelson's group published the first paper on the human microbiome in 2006, which she said, "launched and invigorated an unbelievable awareness of the microbes in and on us." For the most exciting application of biotechnology in the past year, Nelson pointed to "Human Longevity, Inc.—bringing the genome, microbiome, metabolome and phenotypes of individuals into a single vision with really major implications for how we approach healthcare."

STELIOS PAPADOPOULOS
chairman | Biogen Idec | Cambridge, Massachusetts, U.S.



In 1979, Papadopoulos started collecting biotech IPO data, and he recently showed that 2014 brought the industry 22% more IPOs than in 2000, the so-called bubble year. In the age of computation and big data, he still gets results the old-fashion way—he collects it by hand.

ROGER PERLMUTTER
president | Merck Research Laboratories
Boston, Massachusetts, U.S.

"I fairly early on established a pretty simple set of guiding principles," Perlmutter told the American Association of Immunologists in 2013, "focus on grievous illness… focus on the task, not the tool…[and] do the experiment in people."

KIM POPOVITS
chairman, CEO & president | Genomic Health | Redwood City, California, U.S.

"The core values of our company and the core focus of our company [are] centered around patients," Popovits explained in a company video. "Each one of us who came here in the early days, I can say, was personally motivated—through professional or their own personal experience with cancer—to really transform cancer care."

RICHARD POPS
chairman & CEO | Alkermes | Dublin, Ireland

In 2012, Pops told *Scientific American Worldview* that even while jogging or playing tennis he lets "work run in the background. Sometimes the solution to some problem will arise after days and days. My philosophy of life is determined optimism. I am always able to turn adversity into opportunity."

GEORGE POSTE
Del E. Webb Chair in Health Innovation
biomedicine & biotechnology | Arizona State University | Tempe, Arizona, U.S.

Poste told us that he'd like to see "radical reform of NIH funding policies for academia," adding, "Current NIH funding policies are anachronistic and propagate individual investigator-centric silos of reductionist biology, which lack critical mass and are ill-suited to address the complexity of unresolved disease challenges that require large scale, multi-disciplinary, team-based approaches, often involving multiple institutions."

He also won the prize for the best embarrassing moment: "During my surgery training rotation at the University of Bristol Veterinary School in the UK, I quickly realized that I was ill-suited for a full-time career as a clinical veterinarian. Apart from angry patients who bit, kicked and scratched and were thoroughly resentful, the nadir was reached in my attempt to anesthetize a large tree porcupine from the local zoo by applying the anesthetic mask to the wrong end of what was a large, wriggling ball of spines, which prevented any easy effort to distinguish anterior and posterior axes."

PAM RONALD
director | Laboratory for Crop Genetics Innovation & Scientific Literacy | University of California, Davis | Davis, California, U.S.

When *Worldview* asked Ronald to tell us her greatest contribution to biotechnology, she pointed out her work with rice, in particular, "isolation of the *Xa21* resistance gene and the *Sub1* submergence tolerance gene in collaboration with my colleagues." Her pick for the most exciting application of biotech in the past year: the HIV and Ebola vaccines.

RAM SASISEKHARAN
Alfred H. Caspary Professor of Biological Engineering and Health Sciences & Technology | department of biological engineering
MIT | Cambridge, Massachusetts, U.S.

Sasisekharan told us that his biggest contribution to biotechnology was "developing a technology platform for glycobiology that has impacted both regulatory as well as drug development in various fields." To enhance the effectiveness of biotech today, Sasisekharan would like find ways to "speed the process of bringing much-needed medicines to patients."

GEORGE SCANGOS
CEO | Biogen Idec
Cambridge, Massachusetts, U.S.

"We're in a very exciting time in the biotechnology industry," Scangos said in the PwC 2015 US CEO Survey. "The stock prices of all biotechnology companies have increased dramatically in the past few years, so you hear talk about whether we're in a bubble or not. I don't think this is a bubble. These price increases reflect actual increased value and productivity in the higher number of drugs coming forward."

LEONARD SCHLEIFER
founder, president & CEO | Regeneron
Tarrytown, New York, U.S.

Of his early days as a bioentrepreneur, Schleifer recently told CNN, "We had this belief that the world needs innovative products." But his career as a dealmaker began years before in the snow-shoveling business: "When you have to do a whole block's worth of shoveling, you get a lot of experience" negotiating.

AMY SCHULMAN
venture partner | Polaris Partners
Boston, Massachusetts, U.S.

Not afraid to laugh at herself, Schulman told *The New York Times* in a 2011 interview about the first time she took a deposition: "I got there early, and I thought that the most important thing was to control the witness. I didn't realize…the way you control somebody is not by intimidating them. But I adjusted the chair…so that I'd be really tall, and could look down imposingly on the witness. But I raised it so high that as soon as I sat down, I toppled over and fell backward."

RAJIV SHAH
distinguished fellow | School of Foreign Service | Georgetown University
Washington, DC, U.S.

With nearly 60,000 Twitter followers, Shah tweets on a range of topics, from coffee to Ebola. On February 18th he wrote: "We have to find new ways of bringing huge pools of capital to #globaldev, especially in infrastructure. Be bold & creative going forward."

PHILLIP SHARP
institute professor | David H. Koch Institute for Integrative Cancer Research at MIT
MIT | Cambridge, Massachusetts, U.S.

"My greatest contribution to biotechnology is novel science and translation of this science to helping people through cofounding and participating on the boards of Biogen Idec (1978) and Alnylam (2002)," Sharp said. "This has benefited millions of people around the world as patients and as well in the creation of new jobs."

PATRICK SOON-SHIONG

chairman | Chan Soon-Shiong Family Foundation | Culver City, California, U.S.

"Soon-Shiong is rolling out a series of companies that represent a $1 billion-plus effort to fight cancer in new ways," *Forbes* recently reported. "This includes buying DNA sequencers to unravel the DNA of cancer patients, not in a clinical trial but as standard practice, at an unprecedented scale."

PAUL STOFFELS

CSO | Johnson & Johnson
New Brunswick, New Jersey, U.S.

"The mission of our innovation centers is to find the best science available in an early stage, and then to accelerate it in order to stimulate the development of new healthcare solutions," Stoffels explains on a Janssen website. "By doing so, we have tracked down more than 2,700 valuable opportunities in 18 months and concluded some 80 collaboration agreements."

JACK SZOSTAK

Alex A. Rich Distinguished Investigator department of molecular biology
Massachusetts General Hospital
Boston, Massachusetts, U.S.

"Is it easy or hard for life to emerge from the chemistry of early planets?" Szostak asked in an iBiology lecture. "Unfortunately, it's going to be a long time before we can answer that question in the most satisfying way, by direct observation." In his lab, though, Szostak seeks to reconstruct the process by which primitive cells—that is, life—emerged from a swirl of chemicals some 4 billion years ago.

HENRI TERMEER

cofounder | Lysosomal Therapeutics
Cambridge, Massachusetts, U.S.

In a 2013 article, *The Boston Globe* called Termeer "a life sciences legend." Termeer served as chairman, president and CEO of Genzyme, a company that he ran for nearly 30 years. He sits on more than a dozen biotech boards and continues to mentor people entering the field.

SHIRLEY TILGHMAN

professor | molecular biology | Princeton University | Princeton, New Jersey, U.S.

"I have been worried for some time that the improvements in the status of women in our society have slowed in recent decades, after remarkable gains in the wake of the feminist movement," Tilghman recently told *The Daily Princetonian*. "It is very clear that until we find better solutions for working parents—including paid maternity leave and proper child care options—the progress is going to be slow."

LUKE TIMMERMAN

founder & editor | *Timmerman Report*
Seattle, Washington, U.S.

"Many biotech companies have overreached on drug pricing," Timmerman asserted. "The industry could go a long way toward restoring public trust by lowering prices, or at least backing off on the relentless increases. Public reputation matters for a number of reasons. Public funding is essential for the basic research that helps advance industry. Biotech also needs a large pool of people willing to participate in clinical trials, and share their health data. People are reluctant to do those things for people they don't trust."

ERIC TOPOL

director | Scripps Translational Science Institute | La Jolla, California, U.S.

Topol said his chief contributions to biotech have been the new drugs he has helped develop, such as tPA and abciximab (ReoPro). These medicines, he noted, are "now expanding across all medical disciplines and diseases" and have "completely changed the landscape of effective treatments."

ROBERT URBAN

head | Johnson & Johnson Innovation
Boston, Massachusetts, U.S.

"This moment in medicine is really a very exciting demonstration of how converging talents can be leveraged," Urban said in a video produced by the Science & Technology Innovation Program at the Woodrow Wilson International Center for Scholars. "The biologists who understand the molecular basis of disease in unprecedented ways are beginning to work more closely with technologists and engineers to [turn] that knowledge into a form of know-how that can [lead] to new types of products that can be used by physicians."

MARC VAN MONTAGU

founder & chairman
Institute of Plant Biotechnology Outreach
Ghent University | Ghent, Belgium

"I want to stress that this GM technology we developed in Ghent, that it's really technology that we needed," Van Montagu told the audience at TEDx in 2014. "So it's a myth that is propagated that we can do without."

FLORENCE WAMBUGU

CEO | Africa Harvest Biotech Foundation International | Johannesburg, South Africa

"Our mission is to improve food security and the welfare of African populations by using the tools of agronomy and agricultural biotechnology," Wambugu recently told the Life Sciences Foundation's *LSF Magazine*. "We are working to build healthy communities and help smallholder farmers produce plentiful, nutritious food supplies…. We are working to create sustainable agricultural systems."

JUDY WANG

senior manager | biotech affairs & regulatory
DuPont Pioneer China | Beijing, China

"I personally have been engaged in biotech R&D and management since 1996," Wang wrote in a response on GMO Answers. "I have seen [the China Ministry of Agriculture] grant Safety Certificates for importing food and feed processing material from biotech crops….In 2012 alone, China imported 58 million tons of biotech soybean and became the world's biggest country for biotech soybean importation and consumption."

JAMES WATSON

chancellor emeritus
Cold Spring Harbor Laboratory
Cold Spring Harbor, New York, U.S.

While heading the Cold Spring Harbor Laboratory, Watson commissioned the DNA Learning Center (DNALC) in 1987 to deepen the public's understanding of DNA, the genome and related technologies. Since that time, the DNALC has provided hands-on training for introducing students from middle school through high school to molecular genetics. The program has reached half a million kids on Long Island and in New York City, along with tens of thousands of teachers, who received instruction on teaching biotechnology-based lab units and even entire courses.

MARY WOOLLEY

president | Research!America
Alexandria, Virginia, U.S.

Discussing the 21st Century Cures legislation in one of her weekly advocacy messages, Woolley wrote: "Among our priorities will be to ensure that basic discovery is not neglected….We will continue to push for final bipartisan language that effectively boosts the return on medical progress by accelerating discovery, development and delivery."

TADATAKA "TACHI" YAMADA

executive vice president, chief medical & scientific officer | Takeda Pharmaceuticals
Osaka, Japan

If he hadn't entered the field of biotechnology, Yamada said, "I think I would still have focused on patient benefit by pursuing my career as an academic physician or as someone committed to global health." Of the past year's biotech advances, he found "the maturation of gene therapy and microbiomics as real market opportunities" the most intriguing.

SHINYA YAMANAKA

director & professor
Center for iPS Cell Research & Application
Kyoto University | Kyoto, Japan

Yamanaka received the 2012 Nobel Prize for his invention of induced pluripotent stem cells (iPSCs). Writing on the Knoepfler Lab Stem Cell Blog about the rapid pace from discovery to use of iPSCs in a clinical trial, he said: "The rapid transition is because many bright and passionate people are in the iPSC field. The funding and infrastructure provided by the Japanese government is also a major factor, as these have encouraged excellent scientists to enter the field."

GEORGE YANCOPOULOS

president | Regeneron Laboratories
Tarrytown, New York, U.S.

"Innovation in science and technology is at the heart of Regeneron's mission to discover and develop new treatments for serious diseases," Yancopoulos said while discussing the 2014 Regeneron Prize for Creative Innovation. "Investing in science education and the identification and development of talented new researchers is critical to foster tomorrow's medical breakthroughs."

ELIAS ZERHOUNI

president, global R&D
Sanofi | Paris, France

At a conference in London, Zerhouni pointed out the urgent need for regulatory harmonization, saying, "In my short experience of five years [at Sanofi], I have not seen a single regulatory decision that was fully consistent across regulatory agencies."

DAPHNE ZOHAR

founder & CEO | PureTech Ventures
Boston, Massachusetts, U.S.

"Our industry is very good at pattern recognition," Zohar told *Worldview*. "However, creativity often involves breaking those patterns, doing things differently." She continued, "The ability to measure millions of physiological and other health-related data points over time is one of the most intriguing areas in terms of its impact on drug discovery, clinical trials and new medical modalities."