

From the Editorial Board

Introduction, Rationale and Commentary on Recognizing and Celebrating Innovation in Our Industry

ABSTRACT

This article summarizes our intent and basis for recognition of innovators in our industry, including the criterion that we are using for those organizations selected. Our focus for this year is largely on the Biopharma segment, because of Covid-19 and the positive and significant impact that our industry has made in that regard. We focus on companies across the life cycle from startups ranging to the large multi-national pharma companies.

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INTRODUCTION

OUR INDUSTRY, ALONG with US NIH, BARDA, FDA and CDC all deserve credit for their respective contributions over that last year. That has resulted in US and global market introductions of several vaccines along with diagnostics, and therapeutics. Now, almost two-thirds of Americans view the pharma industry positively according to recent Harris Poll surveys. It's a stunning reversal from just one year ago, when only about one-third (32%) rated the industry positively. We also signal our intent for subsequent issues later in 2021 to include recognition for innovation in the areas of Digital Health and in Digital Therapeutics/Diagnostics, to be developed in alliances with universities who are leaders in these fields.

We announced our intent to publish an annual tribute to the innovators in our community in a recent introductory “From the Boardroom” article in J. Commercial Biotechnology titled “What’s Coming Next in Transformative Innovation”, c. f. Boni et al, J. Commercial Biotechnology, Vol. 25, No. 4, pp 1-3, (2020). In short, our premise is that in our diverse, healthcare-centric industry it is appropriate for us to recognize annually, companies and their leaders who have developed and validated creative business models to facilitate transformative innovation and evolution in our industry. Inspirational, team-based leadership, leading to developing a culture of innovation is a critical part of the success of companies that pursue transformative technologies.

Innovation occurs by the creation and implementation of novel platforms and partnerships/alliances to develop, commercialize and bring to market, multiple emerging and promising innovations driven by “cutting edge” science and technology that enable products and services that serve real and compelling needs. To achieve commercialization of transformative innovations, we most often start with the creation of early-stage organizations, e. g. startups and emerging companies and business models appropriate for these products and services. And, to achieve full commercial potential they leverage alliances and partnerships across the value chain by leveraging open innovation. Over decades that defined the evolution of biotechnology, we have witnessed the emergence of many startup organizations, funded by grants, followed by angel investments, and multiple venture capital rounds. They have also partnered with larger organizations via partnerships to provide funding and access to other parts of the value chain. These larger partners (most often pharma) control more resources, and are “owners” of a larger share of the value chain – on both the customer facing and company facing side of the business model “canvas”. See for example our recent article (The “Art of Collaborations”: Understanding the Anatomy of Transformative Transactions in Biopharma; JCB Vol. 25, No. 4 (2020), pp. 50–56. These alliances have often, but not always, led to mergers and acquisitions that fill the product pipeline. Subsequent to de-risking and value-added provided by early-stage VC funding, many of these corporate alliances are funded directly by the pharma partner. However, many more are funded by a

corporate sponsored VC fund. For example, in the last few years, the following firms have been most active in this regard: J&J, Pfizer, SR One, Roche, Sanofi, Amgen, AbbVie, Illumina, and GV (Google Ventures).

As a result, we have observed over the last several decades an effective convergence of Pharma and Biotech to create what is now recognized as the Biopharma industry – big pharma, big biotech, and emerging biotech. This trend has also been mirrored in the MedTech industry, and is in a stage of early evolution in Digital Health, Medicine and Therapeutics.

Within the last year, and driven by the Covid-19 pandemic, we have observed unprecedented success in following this model precipitated by extreme and urgent customer need. We have seen efficient and powerful partnerships that have facilitated the development of effective vaccines, therapeutics and diagnostics on a remarkably short time scale. Our industry pursued a path of collaboration between large and smaller entities, both national and international to develop several COVID-19 vaccines and rolled them out to millions in a matter of months! We also saw both diagnostic and therapeutic products developed and brought to market. This is an obvious credit to the many universities, emerging companies and their industry partners across the value chain. And, with a credit to years of prior investment to advance these transformative technologies. Manufacturers also are rightly receiving a lot of credit, and deserve a ‘shout out’. Also notable is the role of government funding via NIH and BARDA. But, regulators have also played a key role to provide safe and effective solutions that are currently being rolled out to the world. We have also seen promising technologies such as robotics and artificial intelligence/machine learning (AI/ML) begin to emerge as early stage offerings, albeit at a still early adoption stage. These technologies and business models are expected to evolve and drive innovation in MedTech and digital health, medicine and therapeutics. Many of these are recognized in this volume, but we intend to cover these transformative innovations and innovators in more depth in subsequent issues editions in 2021 and 2022.

In our previous work, we have noted the following simplified business model evolution to capture the transformation in the pharmaceutical industry over the decades. And, we now add Pharma 5.0 to our evolution (stay tuned).

- **Pharma 1.0** (1980's and 1990's) – *Focus on Blockbuster Drugs*
 - The Billion Dollar Molecule in Big Pharma
 - Biotechnology industry born with Genentech, Amgen, and a number of others

- **Pharma 2.0** (1990's–2000) – *Focus on Portfolio Development*
 - Pharma beginning to partner with and acquire emerging biotech to fill their product portfolios
- **Pharma 3.0** (2000–2010) – *Focus on Patient and Payer Centricity. Emergence of the genomic era, and the promise of personalized medicine.*
 - Maturing of strategic alliances as a strategy
 - Enhancement and formalization of outsourcing as CROs moved from “just find me patients” to the entire gamut of resources representing the validation of the concept of the virtual pharma company.
- **Pharma 4.0** (current) – *Convergence of 5Ps*
 - 5 P's aligning (patients, physicians, providers, payers, partners)
 - Biopharma partnerships accelerated across the board, and more formal, open innovation executed
- **Pharma 5.0 (emerging)** – *Exploitation and Integration*
 - Commercialization, adoption and development of business models to achieve the promise of personalized medicine and appropriate business models for digital health, therapeutics, and diagnostics

In this regard, we focus on innovative companies ranging from promising startups as they progressed through their emerging and clinical development stages, to the larger pharma companies who often are in need of products to fill their pipelines to fill patient need. As noted above, none of this occurs without leadership (in both the larger pharma companies and in the emerging companies that provide the promising products for the pipeline. Therefore, we also recognize the historic contributions of a small cohort of historical innovation leaders that have stood out to us during the last 30 or 40 years as the industry evolved. Their pioneering leadership drove transformative change and exploited opportunities that set the stage for where we are today. Without them, the industry would not exist and be as productive as has been recently demonstrated with the development and commercialization of vaccines, antibodies, and diagnostic testing to fight the current Covid-19 pandemic. Below we include a brief paragraph for those leaders who have demonstrated exceptional contributions to our industry and recognized by our Editorial Board.

SELECTION CRITERIA

Companies from across the life cycle were selected based on the criteria listed below. And, in our editorial opinion, it is essential for these organizations to possess the leadership to have developed and sustained the resources, processes and values (RPV) that they creatively acquire and deploy to support innovation as defined below, at least through the initial stages of capitalization and team formation. The entrepreneurial process model starts with an opportunity, identifies and acquires the required resources, and assembles the team/leadership necessary to pursue and exploit the opportunity. We cite specifically the **following essential elements for companies selected:**

- The organization is built on a business model, that is either disruptive or radical/transformational, and the opportunity being pursued is sufficient to create new markets and value networks capable of eventually disrupting an existing market and value network, and displacing established market-leading firms, products, and alliances.
- Critical elements of the business model have been validated with resources and processes. Especially the value propositions associated with the patient, physician, provider, and partner components.
- Critical elements of the technology-enabled platform have been validated beyond the laboratory stage, and the company has developed intellectual property that is strongly protected with patents (worldwide) and/or trade secrets
- The organization has been well funded and validated by credible investment sources and/or partners.
- A credible management/leadership team, CEO, and open innovation partnerships are in place to reduce the risk of moving the organization successfully thru the next several value inflection points including clinical validation and payer validation. And, the leadership team has enabled development of a culture of values that encourage innovation.

OUR HISTORIC, LEADERSHIP ROSTER OF INDUSTRY FOUNDERS AND LEADERS

For this, our first year to recognize innovators, we are focusing on our largest industry sector, Biopharma, which is now matured. We do include some emerging innovators in the digital segment, but plan a more in-depth focus on this sector later in 2021 to provide additional coverage of some exciting digital innovations. These issues will focus more exclusively on: 1) digital health/medicine; and, 2) Robotics as an emerging digital solution/ therapeutic.

As noted, the importance of dedicated and inspiring leadership is needed. We have developed the following list of pivotal, industry thought-leaders and pioneers along with highly annotated bio-sketches of each - summarizing their noteworthy achievements and contributions to the industry. For our first year, we have developed this list from our Editorial team and Editorial Advisory Board members. In future years we plan to broaden via a survey of an extended network of industry experts.

However, leadership and team building deserves a short perspective on those topics, especially related to transformative innovation. Therefore, we focus briefly on the skill sets and practices of disruptive or transformative innovators. Boni, with Cunningham and Sloat published a recent article in JCB titled “Bridging Theory and Practice for Commercialization and Innovation: A Market-Centered Perspective for Cross-Industry Applications”, c. f. JCB Vol. 24, No. 1 (2018), pp 7–36. In that work, we highlighted data that described innovative organizations by aggregating them into three categories: Needs seekers (market pull), market readers (fast followers), and technology drivers (technology push). In our opinion, most frequently it is the needs seekers who build organizations that are successful with transformative innovation. However, most of these leaders are also well trained in and conversant with the enabling technologies, i.e. they are scientifically trained. We also incorporated in that article some key principles that comprise the “innovators DNA”, as reported by Dyer, Gregerson and Christensen in their recent classic book titled “The Innovators DNA: Mastering the Five Skills of Disruptive Innovators”, c. f. Harvard Business Review press (2011). These authors identify five capabilities (traits or behaviors) demonstrated by the best innovators: (1) **Associating, or associative thinking:** drawing connections between questions, problems, or ideas from other disciplines or unrelated fields; (2) **Questioning:** posing queries that challenge common, or current ways of thinking; (3) **Observing:** “or watching” the behavior of users, customers, suppliers, and competitors to identify new ways of doing things; (4) **Experimenting:**

constructing interactive experiences and provoking unorthodox responses to see what insights emerge (we view this as basically an extension of “the scientific method, i. e. hypothesizing and testing”); and, (5) **Networking**: engaging people with different ideas and perspectives. The authors explain how to generate and pursue ideas (or potential opportunities) with these skill sets, collaborate with “delivery-driven” colleagues to implement ideas, and build, collaborative innovation skills throughout the organization that is focused (like a laser) on commercializing, or bringing to market, new and unique products and services.

In selecting our list of individuals for our initial “**JCB Innovators Hall of Fame**”, each of the individuals name therein have followed the principles underlying the Innovators DNA. And as a result, they have launched and/or built multiple organizations that brought to market many transformative innovations. Since this is our first year, we are naming the following individuals, some of whom have died, but others are still with us and contributing to innovation in our industry today. While some have been pioneers in the formation of our industry, some have emerged as leaders of new industry segments as the pharma industry has grown and diversified into many new segments.

THE JCB INNOVATORS HALL OF FAME - 2021

DAVID U'PRICHARD

David was a leader of R&D and well versed in drug discovery in pharma (Beecham Pharmaceuticals, a predecessor of Glaxo Smithkline Beecham – GSK). He also served on many boards and participated as an early stage investor thru Druid Bioscience. This background led to his pioneering leadership to create a very unique organization and concept intended to discover, develop and commercialize drugs while navigating multiple “valleys of death” – the BioMotiv/Harrington project. This is a very novel organization focused on accelerating breakthrough medicines (potentially transformative technologies/ academic discoveries). This organization was designed by David and his collaborators to move them from the laboratory into the clinic and thru the commercialization stages in collaborative partnerships with pharma. We included a description in recent article in our recent special edition; c. f. Boni, “An introductory perspective on emerging, transformational technologies in biopharma: promises, challenges, and impediments”; c. f. Boni, JCB Vol. 25, No.4, pp 21–24 (2020). We also refer the interested reader to the BioMotiv/Harrington

website <https://www.biomotiv.com/the-harrington-project>. David died recently and is missed by our community.

HENRI A. TERMEER

Henri was a biotechnology executive and entrepreneur who is considered a pioneer in corporate strategy in the biotechnology industry for his tenure as CEO at Genzyme; https://en.wikipedia.org/wiki/Henri_Termeer. He was named as one of the top fifty leaders of thought in orphan drugs and rare diseases in a list published by Terrapin for the World Orphan Drug Congress which included “eminent personalities that have advanced rare disease research.” Henri was a biotech pioneer long before anyone knew what biotech were. He founded Genzyme which is often said to have kick started today’s orphan drug biotech M&A frenzy. Henri is definitely a mover/shaker in the biotech world and in the orphan drug space. He will always be known as the guy who figured out how to build a great business by making drugs for rare diseases. An inspiration and pioneer, many of his protégés have since moved on to lead other successful companies in the rare disease and biotech space thanks to his influence.” In 1993, Termeer helped bring about the creation of Biotechnology Industry Organization through the merger of two associations created in the 1980s (now Biotechnology Innovation Organization). He later served as BIO’s CEO, and served on the BOD of Moderna.

GEORGE RATHMANN

Rathmann co-founded and served as the first CEO of Amgen, one of the early, pioneering companies in biotechnology. After transitioning the company to leadership by Gordon Binder, he founded and served as CEO of ICOS, a Seattle-based company. ICOS later formed a novel joint venture with Eli Lilly & Co. to commercialize an ICOS discover. This new drug (Cialis) was then taken into clinical studies and commercialized for treating erectile dysfunction and enlarged prostate (benign prostatic hyperplasia) – a competitor to Viagra. While at ICOS, he raised the largest-ever-to-date private offering for a biotechnology company. Rathmann received the first of the Biotechnology Heritage Awards from BIO, in recognition of his career as a scientist and entrepreneur. While leading Amgen, Rathman built and led a team that lasted well beyond his tenure there, and indeed still today is a role model for innovation. For reference, see the book review written by Art Boni and published in JCB in 2009; “**Science lessons: What biotech taught me about management**” written by Gordon Binder and Philip Bashe. Journal of Commercial Biotechnology (2009) 15, 86–91.

ROBERT S. LANGER

Langer is well known in the fields of engineering and science, but is cited here as the founder of “Langer Lab” at MIT. This organization is responsible for over 30 spin off companies; c.f. https://en.wikipedia.org/wiki/Robert_S._Langer. Most of these companies were venture-backed, leveraged MIT inventions for successful commercialization, and incorporated Langer’s post docs. To illustrate, we have invented a phrase that we and others in the technology transfer community describe as “the Langer model” for successful technology transfer, i. e. transfer the technology, and the post-docs into the company for seamless commercialization. It really speaks to building a well-balanced team that brings expertise in technology and business together around breakthrough technologies for success.

“He is the most cited engineer in history and 4th most cited individual in any field having authored over 1,500 scientific papers, and is also a prolific entrepreneur, having participated in the founding of over 40 biotechnology companies including Moderna. Langer’s research laboratory at MIT is the largest biomedical engineering lab in the world; maintaining over \$10 million in annual grants and over 100 researchers. He has been awarded numerous leading prizes in recognition of his work”. And for public acknowledgement, Massachusetts innovators-Transforming the world, Langer is featured as “Revolutionary Biomedical Technology through Development of Controlled Drug Delivery Systems”.

ROBERT (BOB) SWANSON AND HERBERT (HERB) BOYER

We profile these co-founders of Genentech together, appropriately since their names are forever intertwined, and that is an appropriate way to profile the combination of science (Boyer), and finance/VC (Swanson) for founding and growing pivotal, transformative organizations: https://en.wikipedia.org/wiki/Robert_A._Swanson. Genentech was a pioneer in the field, and it remains one of the leading biotechnology companies in the world (now operating as a unit of Roche). **Swanson** served as CEO of Genentech from 1976 to 1990, and as chairman from 1990 to 1996. He graduated from MIT, with an undergraduate degree in chemistry and a master of science degree in management. Thanks to the science based courses, and then graduate business courses he took at MIT, he realized that he was particularly interested in two things: organizational development, and the commercialization of innovative ideas. He was fascinated by the potential of recombinant DNA technology, and decided to cold call scientists working on the technology. This led to the partnership with Boyer, who was

a professor at the University of California, San Francisco (UCSF). Boyer’s scientific expertise and Swanson’s business plan convinced the venture capitalists at Kleiner Perkins Caulfield and Byers who funded Genentech. According to Wikipedia, “Robert Swanson’s legacy can still be found to this day through the company he cofounded and led. Genentech is still producing drugs and treatments to this day, and some of his policies, such as allowing company scientists to publish, are still in place. Genentech scored many firsts under Swanson’s leadership, such as developing the first drug produced via genetic engineering, being the first biotechnology company to go public, and being the first biotechnology company to sell its own drug. All business model innovations. These accomplishments have earned Genentech, Swanson and Boyer, a place in the history of the biotechnology industry. **Herb Boyer**, represented the science: https://en.wikipedia.org/wiki/Herbert_Boyer. Genentech’s approach to the first synthesis of insulin won out over Walter Gilbert’s approach at Biogen which used whole genes from natural sources. Boyer built his gene from its individual nucleotides. He served as Vice President of Genentech from 1976 until his retirement in 1991. This science/business partnership worked well to create and grow a truly world-class organization that brought together transformative science with business/strategy to create an organization that was distinguished as the first biotechnology IPO. And, of course a stream of innovations, partnerships and financings that led to an innovative partner with the part of the Roche family of companies, and a right to buy that was eventually exercised to make Genentech an integral part of that organization.

SUE DESMOND – HELLMAN, MD

Sue is an American oncologist and biotechnology leader who served as the Chief Executive Officer of the Bill & Melinda Gates Foundation from 2014–2020. Wikipedia. She was previously Chancellor of the University of California, San Francisco (UCSF), the first woman to hold the position, and Arthur and Toni Rembe Rock Distinguished Professor. In 1995, she joined Genentech as a clinical scientist; she was named chief medical officer the following year, and in 1999 became executive vice president of development and product operations. From March 2004 through April 2009 she was president of product development, playing a role in the development of two of the first gene-targeted therapies for cancer, Avastin and Herceptin. She left after the company was bought out by Roche Pharmaceuticals.

MARC LEVIN

Xconomy announced Marc Levin, co-founder and partner at Third Rock Ventures, with their 2019 Lifetime Achievement Award in Boston. <https://xconomy.com/national/2019/07/31/mark-levin-named-xconomys-2019-lifetime-achievement-award-winner-in-boston/>

“Levin built Millennium Pharmaceuticals—inspiring a generation of future executives/entrepreneurs along the way—and also helped reinvent the venture capital market for early stage biotechs by founding Third Rock, where his work has helped bring “a slew” of important new companies and new drugs to market. His efforts have played a key role in making Boston biotech what it is today”.

“Levin, who has spent about 40 years in the biotech world—30 of them at venture capital firms—says taking the slow, methodical path is the key to success. Since Third Rock’s founding in 2007, the firm has raised \$2.7 billion and invested in more than 50 companies, including standouts like Agios, Foundation Medicine, and Bluebird Bio”.

Third Rock, Levin says, “spends up to four years finding the right mix of business executives and scientists to tinker with an idea—such as whether a genome scan could identify the best drug for each patient—just to decide if there’s enough there to start a company”. “One academic with one idea will not be successful, mostly,” Levin says in an interview with Xconomy. “We go out and meet all the best people in the world and we [together] develop an R&D plan, a discovery plan, [and reflect on] does this make regulatory and reimbursement sense ... we’ll spend years on that idea.”

“That combination of active networking and recruiting is key to the teams Levin put together both at Third Rock and Millennium Pharmaceuticals, says John Maraganore, currently CEO of biotech Alnylam Pharmaceuticals in Cambridge. “You can have the greatest science and the greatest idea and if you don’t have the right people behind it, the likelihood of success is really low,” he adds”. Note that Millennium and Alnylam are profiled in an mini-case study by S. Rang later in this special edition of JCB.

ALEJANDRO ZAFFARONI

Alejandro Zaffaroni was a serial entrepreneur who was responsible for founding several biotechnology companies in Silicon Valley. Products that he was involved in developing include the birth control pill, the nicotine patch, corticosteroids, and the DNA microarray. Wikipedia. “Dr. Zaffaroni was most closely associated with Alza, which developed new ways to

administer medicines to increase their effectiveness, reduce side effects and allow people to take pills less frequently. These advances include extended-release tablets, implantable devices and skin patches, like the NicoDerm CQ nicotine patch. Founded in 1968, Alza was acquired by Johnson & Johnson for about \$12 billion in 2001. He also co-founded Affymetrix in 1991; the company was a pioneer in developing DNA chips, more formally known as microarrays. Those chips revolutionized genetic studies, allowing many genes to be analyzed at once. They are now widely used in studies aimed at finding genetic variants linked to different diseases”.

c.f. <https://www.nytimes.com/2014/03/07/business/alejandro-zaffaroni-biotechnology-entrepreneur-dies-at-91.html>

The following is included herein for historical reference regarding the origins of Alza, and is abstracted from a 2004 Kansas University News article. It nicely illustrates university ties/technology transfer (well before implementation of the Bayh-Dole Act) to commercial drug development organizations: In 1967, **Takeru Higuchi**, widely recognized as the “Father of Physical Pharmacy” was persuaded to join the KU faculty (he invented the time-release medication capsule, which would release medicine slowly into the bloodstream). New facilities for his research were part of the package. Alejandro Zaffaroni offered Higuchi an enticing prospect - to start a company called Alza in Palo Alto. Higuchi preferred to remain in Lawrence. Therefore, Alza operated out of Lawrence for five years, in the building next door to McCollum laboratories that today bears Higuchi’s name. Dipivefrin or Propine® (dipivaloyl epinephrine) was developed by Takeru Higuchi at Alza/INTERx, with some of the work done at KU. The product was eventually sold through Allergan in Irvine, CA. Higuchi also held the patents through Alza, with much of the work done at KU-on the Alza osmotic drug delivery systems.

WILLIAM J. RUTTER

Bill is an American biochemist who cofounded the early biotechnology company Chiron Corporation together with Edward Penhoet and Pablo DT Valenzuela; Wikipedia. “He is also Founder and Chairman and CEO of Synergenics, LLC, which controls a consortium of companies with different, but complementary approaches to diagnosis, prevention and treatment on a worldwide basis. Previously, Dr. Rutter was co-founder and chairman of Chiron Corporation, a major biotechnology company which is well known for the development of recombinant DNA-based vaccines,

including Hepatitis B, and for the discovery of Hepatitis C, the first sequencing of the HIV-AIDS virus. Chiron pioneered the development of quantitative DNA-based diagnostic tests measuring viral load, which has played a major role in protecting the blood supply, and also in developing drugs for treatment of these diseases. Chiron was acquired in two stages by Novartis and its antecedent company Ciga-Geigy. Dr. Rutter has served on boards of Novartis and several Biotech companies, including Cytokinetics, Sangamo Biosciences, and Synergenics companies. Dr. Rutter is a member of the National Academy of Sciences and the American Academy of Arts and Sciences. Previously, Dr. Rutter served as Chairman of the Department of Biochemistry and Biophysics at UCSF. His lab made key contributions to biotechnology and recombinant DNA technology, including cloning of the human insulin gene and the production in yeast of a virus-like particle for Hepatitis B, which was eventually used in the manufacture of a Hepatitis B vaccine". <https://goldlabfoundation.org/presenters/william-rutter/>

JOSHUA S BOGER

Josh Boger, Ph. D is an organic chemist and is considered a pioneer in the field of structure-based rational drug design. Wikipedia. "In 1989, Boger founded Vertex Pharmaceuticals Incorporated. He has served variously as its President, CEO and Chairman of the board. At Vertex, Boger pioneered an approach to structure-based rational drug design that changed the way that drug development occurred. Employees worked in multi-disciplinary teams, combined technologies from biophysics, chemistry and computer science, and applied them to drug discovery and the development of small molecule drugs. As of 2003, Vertex was listed as one of forty worldwide Technology Pioneers by the World Economic Forum, for advancing drug discovery through this approach". Vertex and Berger were also profiled in two books by Barry Werth. "The Billion Dollar Molecule- the quest for the perfect drug" (1994) deals with the early history of Vertex, and the technology/business intersection. "The Antidote Inside the World of New Pharma" (2014) looks at the evolution of Vertex 20 years later.

FREDERICK FRANK

Frederick Frank is an investment banker, with more than 50 years of experience on Wall Street. He is considered the first investment banker to have specialized in the areas of biotechnology, pharmaceuticals, and health care services. As of 2014, Frank became a founder and chair of EVOLUTION Life Science Partners. Wikipedia. He

is credited as lead underwriter for over 125 IPOs and as a negotiator in over 75 mergers and acquisitions Frank was chosen as one of the top 100 contributors to biotechnology in 2005". "In the late 1970s, Frank began to work with companies such as Cetus, a company developing industrial applications for Recombinant DNA technology, and Genentech. Frank saw rDNA technology as a "game-changing opportunity. Advised by Frank, Cetus went public on March 1, 1981 with the second-largest IPO in U.S. corporate history. Frank was also instrumental in the Bristol-Myers Squibb merger of 1989 and the Hoffmann-La Roche acquisition of Genentech in 1990. At the time, the merger of an established pharmaceutical company with a younger biotechnology company was highly unusual. It has been described by Frank as a "strategy of convergence".

STELIOS PAPADOPOULOS

Stelios has been involved with the biotech and pharma industries for nearly three decades. Papadopoulos retired as Vice Chairman of Cowen & Co., LLC in August 2006 after six years with the firm where, as an investment banker, he focused on the biotech and pharma sectors. Prior to joining Cowen, he spent thirteen years as an investment banker at PaineWebber, Incorporated where he was most recently Chairman of PaineWebber Development Corp., a PaineWebber subsidiary focusing on biotechnology. He joined PaineWebber in April 1987 from Drexel Burnham Lambert where he was a Vice President in the Equity Research Department covering the biotechnology industry. Prior to Drexel, he was a biotechnology analyst at Donaldson, Lufkin & Jenrette. He is a co-founder and chairman of the Board of Directors of both, Exelixis, Inc., and Anadys Pharmaceuticals, Inc.; he is a co-founder and a member of the Board of Directors of Cellzome, Inc. He is Chairman of the Board of Directors of Biogen Idec, Inc., BG Medicine, Inc., Joule Unlimited, Inc. and Regulix Therapeutics, Inc. <https://xconomy.com/author/spapadopoulos/>

J. CRAIG VENTER

Founded **Celera Genomics**, The Institute for Genomic Research (TIGR) and the J. Craig Venter Institute (JCVI), where he currently serves as CEO. He was the co-founder of Human Longevity Inc. and Synthetic Genomics. He is known for leading the first draft sequence of the human genome and assembled the first team to transfect a cell with a synthetic chromosome. While maintaining a strong scientific presence, he has also pursued and enabled others (thru Celera) to pursue the commercial

opportunities enabled by the genomic sequencing, including Illumina, also part of his ecosystem in San Diego.

GEORGE M. CHURCH

Dr. Church is a geneticist who has made significant impacts in academia and in translating science into commercial practice. His Wikipedia profile indicates that Church is known for his professional contributions in the sequencing of genomes and interpreting such data, in synthetic biology and genome engineering, and in an emerging area of neuroscience that proposes to map brain activity and establish a “functional connectome.” Among these, Church is known for pioneering the specialized fields of personal genomics and synthetic biology. He has co-founded commercial concerns spanning these areas, and others from green and natural products chemistry to infectious agent testing and fuel production, including Knome, LS9, and Joule Unlimited (respectively, human genomics, green chemistry, and solar fuel companies).

His technology transfer and translational impact indicate that Church has co-founded 22 companies, including Veritas Genetics (human genomics, 2014, with Mirza Cifric, Preston Estep, Yining Zhao, Joe Thakuria), Warp Drive Bio (natural products, 2011, with Greg Verdine and James Wells), Alacris (cancer systems therapeutics, 2010, with Hans Lehrach, Bernhard Herrmann, and Shahid Imran), Knome (human genomics, 2007, with Jorge Conde and Sundar Subramaniam), Pathogenica (microbe and viral NGS diagnostics, 2009, with Yemi Adesokan), AbVitro (immunomes, 2010, with Francois Vigneault), Gen9 Bio (synthetic biology, 2009, with Joseph Jacobson and Drew Endy), EnEvolv (Genome Engineering), Joule Unlimited (SolarFuels, 2007, with Noubar Afeyan and David Berry), and LS9 (green chemistry, 2005, with Chris Somerville, Jay Keasling, Vinod Khosla, Noubar Afeyan, and David Berry). He has participated in technology development, licensing patents and advising most of the Next-Generation Sequencing companies, including Complete Genomics, Life Technologies, Illumina, Danaher Corporation, Roche Diagnostics, Pacific Biosciences, Genia, and Nabsys.

JENNIFER A. DOUDNA, PH. D.

Jennifer is an American biochemist known for her pioneering work in CRISPR gene editing, for which she was awarded the 2020 Nobel Prize in Chemistry along with Emmanuelle Charpentier – Wikipedia. She is the Li Ka Shing Chancellor’s Chair Professor in the Department

of Chemistry and the Department of Molecular and Cell Biology at the University of California, Berkeley. She has been an investigator with the Howard Hughes Medical Institute since 1997. Outside the scientific community, she has been named one of the *Time* 100 most influential people in 2015 (with Charpentier). She is the founder of multiple companies profiled elsewhere in this volume. She is also profiled in the latest Walter Isaacson book, “The Code Breaker” that is reviewed in an Editorial Commentary later in this volume of JCB.

DIETRICH A. STEPHAN, PhD

Dr. Stephan is an industry veteran who is considered one of the fathers of the field of precision medicine, having trained with the leadership of the Human Genome Project at the NIH and then going on to lead discovery research at the Tran Dietrich A. Stephan, PhD slational Genomics Research Institute and subsequently serve as professor and chairm In parallel, Dr. Stephan has exported an of the Department of Human Genetics at the University of Pittsburgh. Stephan has identified the molecular basis of dozens of genetic diseases and published extensively in top-tier peer-reviewed journals such as Science, the New England Journal of Medicine, Nature Genetics, Proceedings of the National Academy of Sciences and Cell. These fundamental new insights form the basis of new molecular diagnostics and knowledge-based therapies. In parallel, Dr. Stephan has exported his new insights into the market to benefit patients through industry co-development or new company formation. Stephan has founded or co-founded in excess of a dozen biotechnology companies. These companies are usually anchored in first-in-class technologies with transformational potential for impact, and backed by top-tier healthcare investors. For example, Stephan co-founded Navigenics, a personal-genetics testing company, which was among the first direct-to-consumer genomics companies. In 2014, he helped launch Pendulum Therapeutics, a leading gut microbiome-modulation company, and served as its Chairman of the board for many years. Stephan also helped launch Peptilogics, Inc. a deep learning peptide therapeutics development company now funded by Presight Capital and Thiel Capital, and currently serves as its Chairman of the board. Stephan has also advised numerous diagnostics, therapeutics and technology companies such as Genia Technologies, a single-molecule sequencer on a chip which was acquired by Roche and Guardant Health, Inc. a cancer “liquid biopsy” testing company. Stephan has a keen interest in new technologies that arise from the collision of various sectors of innovation and which promise step-function improvements in health for the global population. To this end,

in 2019, he founded NeuBase Therapeutics, Inc., a biotechnology company that can uniquely engage disease-causing genes in the human genome and address all causal mechanisms undergirding rare and common diseases, including cancers. Stephan is currently Chairman and CEO of NeuBase Therapeutics. https://en.wikipedia.org/wiki/Dietrich_Stephan

LAURA E. NIKLASON

Laura E. Niklason is Nicholas Greene Professor of anesthesiology and biomedical engineering at Yale University. She is a member of the National Academy of Engineering and the co-founder of Humacyte and specializes in vascular and lung engineering. Her work on lab-grown lungs was recognized as one of the top 50 most important inventions of 2010 by Time magazine. Wikipedia. The early work was done at Duke and MIT. Durham-based Humacyte, a regenerative medicine company that received start-up support from the North Carolina Biotechnology Center 15 years ago, is going public in a novel deal that will give it a market capitalization of \$1.1 billion. Humacyte and Alpha Healthcare Acquisition Corp., a special purpose acquisition company (SPAC) based in New York, have signed a business-combination agreement to take Humacyte public, along with a \$175M PIPE financing agreement. Niklason will lead the company, to be listed on the Nasdaq Capital Market

ANNE E. WOJCICKI

Anne is an American entrepreneur who co-founded and serves as CEO of the personal genomics company 23andMe. The following information is taken from Wikipedia. "As of 2020, she is listed as #93 in *Forbes* list of the World's 100 Most Powerful Women. After her graduation from Yale, Wojcicki worked as a health care consultant at Passport Capital, a San Francisco-based investment fund^[6] and at Investor AB. She was a health care investment analyst for 4 years, overseeing health care investments, focusing on biotechnology companies. Disillusioned by the culture of Wall Street and its attitude towards health care, she quit in 2000, intending to take the MCAT and enroll in medical school. Instead, she decided to focus on research. Wojcicki is best known as the co-founder and CEO of 23andMe, a privately-owned, direct to consumer DNA testing company, which allows for consumers to test for ancestry and health risks. Anne founded the company in 2006 with Linda Avey and Paul Cusenza, with a goal of solving the pain point that a majority of people do not have access to their genetic information, which could provide information

on cures for diseases or treatments, especially with the help of Glaxo and their \$300 million investment. Anne has expressed interest in "revolutioniz[ing] health care" with DNA testing, as it could provide consumers with sufficient enough information as to predict potential genetic illnesses".

DAPHNE KOLLER, PH. D.

Daphne is an Israeli-American computer scientist. She has been a Professor in the Department of Computer Science at Stanford University and a MacArthur Fellowship recipient. She is one of the founders of Coursera, an online education platform. Her general research area is artificial intelligence and its applications in the biomedical sciences. Koller was featured in a 2004 article by *MIT Technology Review* titled "10 Emerging Technologies That Will Change Your World" concerning the topic of Bayesian machine learning. Daphne is the founder and CEO of Insitro, as described below. Her work in the biomedical sciences is recent but promising. And is featured in our emerging company section.

GLEN DE VRIES

Co-founder and co-CEO of Medidata, the most-used platform for clinical trials around the world. Medidata has powered tens of thousands of clinical trials, with millions of patients and billions of patient records. de Vries has been a driver of Medidata's mission and vision since inception in 1999. Their vision is to "power smarter treatments and healthier people" by transformation with technology, non-traditional thinking, and industry collaboration.

ERIC TOPOL

Eric is a cardiologist, scientist and Founder/Director of the Scripps Research Translational Institute. While serving in largely academic positions he has pioneered and published on his vision to advance the use of digital tools and technologies that have the potential to enable physicians in multiple fields to diagnose, treat and cure. His work and publications have illuminated the potential of digital technologies to be developed by others to pursue them in the private sector. His recent book, "Deep Medicine" is a classic overview of this visionary thinking. <https://www.hachettebookgroup.com/titles/eric-topol/deep-medicine/9781541644632/>

ALISE REISEN, MD

According to John Carroll, “Tectonic Therapeutic isn’t your average biotech startup story. For all sorts of reasons. There’s your billionaire Harvard scientist and philanthropist who’s personally bankrolling much of the operation. The CEO is one of the most prominent women involved in the global drug hunting business”. (The Sana website profiles Alise as follows). “Alise was previously President, Global Clinical Development at Celgene Corporation, where she oversaw the development and approval of drugs across their pipeline in oncology, hematology and autoimmune diseases and fibrosis. She currently serves on the board of directors of Homology Medicines and Sharsheret. Alise has extensive early and late clinical development experience working across a broad range of therapeutic areas, including oncology, hematology, rheumatology, dermatology, gastroenterology, pain, respiratory and allergic diseases. She played a leadership role which led to the initial approval of 10 novel medicines and the approval of more than 10 indications for an additional 5 drugs. Alise previously served as Head of Global Clinical Development at EMD Serono. Prior to this, she served as Vice President, Program and Pipeline Leadership, Oncology at Merck and Co. In this capacity, Alise led Merck’s Keytruda (anti-PD-1)

program and oversaw the initial development and filing activities worldwide for melanoma and non-small cell lung cancer, and the initiation of development plans in 7 additional indications. Prior to Merck, she was a faculty member at Columbia Medical School, and a physician and researcher at Columbia Presbyterian Hospital”.

Arthur A. Boni, Ph. D., Editor in Chief

Dennis M. Gross, Ph.D., Associate Editor

Moira A. Gunn, Ph. D., Associate Editor

**Daniel S. Levine, Editorial Opinion
Contributor**