

Founders of Maryland Bioscience and Medical Instrument Companies

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Johns Hopkins Institute for Policy Studies
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The “family histories” of Maryland technology companies are intertwined stories of entrepreneurs, technologies, and corporate structure. This project has focused on the pathways taken by the people who founded the technology companies operating in Maryland today. But it has also been necessary to study corporations that have grown and shrunk, restructured or moved away, and merged or spun off; as well as successive generations of technology development in core fields like vaccines, genomics, and optics. The results will help the state refine its marketing to both companies and potential entrepreneurs and better understand and capitalize on its research institutions and other technology generators. The Milken Institute’s 2001 survey ranked Maryland fifth overall in its ratings of states best positioned to take advantage of opportunities for growth in the New Economy, based on high scores in educational attainment, R&D, and capital availability. It is clear from this study that these same strong fundamentals have been providing fertile soil for technology entrepreneurship for 25, 50, and sometimes 100 years.

Six sectors were examined: bioscience and medical instruments, information technology equipment and services, private research and development, energy/chemicals/materials, defense and aerospace, and high technology machinery and instruments. Each sector was characterized by different patterns of entrepreneurship.

Why Maryland?

The researchers sought to answer why entrepreneurs started their companies in Maryland by combing databases, websites, news archives, talking to economic development and technology business association professionals, and, when necessary, telephoning companies to determine what brought the founders to the state. The hypotheses they tested were:

- Entrepreneur was born here and either stayed or returned
- Entrepreneur came to Maryland for a job in another firm and left it to start own company
- Entrepreneur stayed in Maryland to start own company when employer left/closed/ was acquired/laid off employees
- Entrepreneur came to Maryland for job in a federal laboratory
- Entrepreneur came to Maryland for a job in a university
- Entrepreneur came to Maryland to go to school
- “Serial” entrepreneur cashed out of previous start-up and started new company

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Bio-Entrepreneurship in Maryland: Findings

A large percentage of Maryland bioscience/ biomedical companies are home-grown but not by native Marylanders.

Bioscience/medical instruments, the first sector to be analyzed, features the largest percentage of home-grown companies. At least 274 companies in this category were founded in Maryland (or were moved here by their founders) and are still operating in the state, though many of them under different names, management, and corporate structure than when they were founded. With the help of MdBio, Inc. and building on its earlier work, founders have been identified for 178 of the companies, and since many had co-founders, information on 276 founders/co-founders has been analyzed. The vast majority of the bio-founders were not born in Maryland. Because of its research intensity even at later stages of company maturity, this industry reflects the global character of scientific inquiry. Top researchers gravitate to centers of research excellence.

The pace of bioscience/biomedical start-up activity has accelerated over time.

An average of 1.9 companies was founded each year in the 1970s. In 1980, the Bayh-Dole Act gave universities the ability to protect intellectual property developed using federal funding. The results began to become apparent by the mid-1980s – an average of five companies per year were created from 1980-1984, and an average of seven companies from 1985-1991 (12 companies created in 1985 alone). Similarly, amendments to the Stevenson-Wydler Act in 1986 may have stimulated another acceleration in start-up activity growing out of federal labs. In 1992, 12 companies were started and the average from 1992-1996 was 9.2. Maturation of the industry is apparent in the late 1990s, when an average of 13.8 companies were created each year.

Uniquely, the majority of entrepreneurs in this sector come from institutions, not corporations.

Unlike the other five technology sectors examined in this study, fewer than half (122) of the known founders of bioscience and biomedical companies in Maryland launched their start-ups after leaving a position in another company. Moreover, even many of these individuals had spent part of their careers in academia or at federal laboratories before their corporate experience.

Overwhelmingly, bio company founders came from federal laboratories and universities, mostly those located in Maryland.

The National Institutes of Health are the primary generators of bio-entrepreneurs.

As might be expected, the National Institutes of Health (NIH) are the primary sources of entrepreneurs in this sector. The last economic impact study of NIH in 1995 found that the Institutes pumped \$1.7 billion into the Maryland economy, 17 percent of its budget, which at the time was \$11 billion. President Bush has proposed a FY2003 NIH budget of \$27.3 billion; 17 percent would be \$4.6 billion. The economic models used to make such estimates, however, do not look at the contribution made by entrepreneurs trained or employed at NIH in the past. Over 50 of the founders of Maryland bioscience/biomedical companies spent some time at one of the Institutes. **Table BIO-1** on page four lists the former NIH employees who have founded Maryland companies.

Table BIO-1. Maryland Bio Companies Founded by Former NIH Employees

Company Name (when founded)	Founders(s)	Year Founded
Advanced Biotherapy	Simon Skurkovich	1985
Avalon	Thomas Reed*	1999
Biological Mimetics	Robert Garrity George Lin, Peter Nara	1997
BIOQUAL, Inc.	John C. Landon	1981
Bioserve Biotechnologies	Rama Modali	1990
Biotech Research Laboratories	Robert C. Y. Ting	1973
Cabtech, Inc.	Frank Portugal	1985
Celadon	Ronald Peterson	1999
Celera	J. Craig Venter	1998
Claragen	Aprile Pilon	1996
Classen Immunotherapies	John Barthelow Classen	1991
Clinical Cardiovascular Research	Bill White	1997
Cytime	Lawrence Tamarkin	1996
Digene	Floyd Taub	1985
Dovetail Technologies	Floyd Taub	1994
ERNACO	Muriel Lippman	1979
FAST Systems, Inc.	M.J. Waxdal	1986
GeneDX	Sheri J. Bale John Compton	2000
Genome Dynamics	Richard Feldmann	1996
GenoQuest	William Wong*	1999
Genox	Richard Cutler	1995
GenVec	Ronald Crystal	1992
IGEN International	Richard Massey*	1982
Igene Biotechnology	Robert Austin Milch	1981
InforMax	Alex Titomirov	1990
Kemp Biotechnologies	Christopher Kemp	1992
Lifetime Pharmaceuticals	Floyd Taub	1999
Maryland BioTherapeutics	Robert Gallo	2002
Molecular Histology Laboratory	Cecil Fox	1992
NeuralStem Biopharmaceutical	Karl Johe	1996
NeuroTrophic Research Corp.	John Commissiong	1998
North American Vaccine	Ronald Sekura	1988
Panacos Pharmaceuticals	Graham P. Allaway	1999
PEM Technologies	Irving Weinberg	1995
Peptide Technologies	Martha Knight	1984
Protiga	Ewald M. Wondrak	1999
PerImmune	Michael Hanna	1982
Sequella	Leo Einck* Lowell T. Harmison*	1997
The Institute for Genomic Research	J. Craig Venter Claire Fraser	1992
Veritas	Randall Kincaid	1994
Virion Systems	Gregory A. Prince	1987

*Co-founder

Impressive as this list is, it does not capture the additional seven company founders who at some point in their careers spent time as post-doctoral fellows or in any number of other “visiting” capacities at NIH. Many of these individuals were foreign-born and have stayed and enriched Maryland’s bio industry. Several went on to permanent positions at NIH before starting their own companies. It is clear that NIH draws some of the best minds from around the world to the State of Maryland. Very few of them were born here. Without this NIH-imported talent, Maryland would not have one of the top concentrations of bioscience/bio-medical companies in the country.

The NIH influence on bio-entrepreneurship does not end here, however. Its most profound forces are as a buyer of biotechnology/biomedical goods and services, and as a generator of discoveries. From the beginning in the 1980s, when Steve Turner and his colleagues at Bethesda Research Labs (now Invitrogen/Life Technologies) walked the halls of NIH peddling supplies from ice buckets, NIH’s purchasing power has proven to be a powerful stimulus for in-state entrepreneurs and a magnet for those outside Maryland. When asked by project researchers what brought them to Maryland, the founders frequently answered, “well, it was a lot easier to sell to NIH from right around the corner.”

Often, NIH employees have left with their ideas, and licensed the technology on which they had been working. However, others, like Jim Barrett at Genetic Therapy, Inc. (now part of Novartis), saw the potential in collaborating with an NIH scientist who stayed, W. French Anderson, and served as the guinea pig for ironing out the wrinkles in the new Cooperative Research and Development Agreements (CRADAs) authorized by 1986 amendments to the federal Stevenson-Wydler Act of 1980. In more recent years, NeuroLogic (whose co-founder had been an NIH research fellow) is using NIH technology in its Alzheimer’s drug development program and Sequella has used a CRADA with NIH in pursuit of therapies for tuberculosis. In 2000, NIH had 120 active licenses with the following Maryland companies:

- Advanced Biotechnologies
- Antex Biologics
- Baxter International
- BBI-Biotech Research Laboratories
- Beecher Company
- Bio-Brite
- Bio-Molecular Technology
- Bioqual
- BioReliance
- Braton Biotech
- Calypte Biomedical
- Claragen
- CURE, LLC

- EntreMed
- Gene Logic
- GeneDx
- Genetic Therapy (Novartis)
- GenVec
- Guilford Pharmaceuticals
- Henry M. Jackson Foundation
- Igen
- Kemp Biotechnologies
- Life Technologies (Invitrogen)
- MedImmune
- North American Biologicals (Nabi)
- OmniViral Therapeutics
- Osiris Therapeutics
- Otsuka America Pharmaceutical
- PerImmune (Intracel)
- Pharma-Tech Research
- Pro-Virus
- Raf-Tan
- Receptor Biology
- Spectral Dimensions
- Spring Valley Laboratories
- Tibotec Group
- Trevigen
- U.S. Harvest Medical Technologies
- Universal HealthWatch
- Upstate Biotechnology
- Veritas
- VIPS
- VIRxSYS

In addition, NIH had active CRADAs with 20/20 Genomics, BBI-Biotech Research Laboratories, Beecher Company, Claragen, Dovetail Technologies, EntreMed, Genetic Therapy, Guilford Pharmaceuticals, Immunex, Martek Biosciences, MedImmune, Pro-Virus, Sequella, and several e-health companies.

Johns Hopkins connections are shared by many of Maryland’s bio-entrepreneurs.

In FY2001, for the tenth year, Johns Hopkins University’s School of Medicine received more NIH funding than any other research institution in the country, so it is possible to include many of the entrepreneurs listed below in the “NIH sphere of influence” category. Because the University not only conducts research, but also trains physicians, and because of the way physicians are trained (with internships and residencies), many medical doctors, bioscientists, and bioengineers pass through at some point in their careers. To an even greater extent than NIH, Johns Hopkins brings people to Maryland temporarily. **Table BIO-2** on page six shows that they often stay or return.

TABLE BIO-2. Bio Company Founders with Johns Hopkins Ties

Company Name (when founded)	Founder(s)	Undergrad	Master's	PhD	MD	Post-doc	Residency/ Fellow	Faculty/ Staff
AuRx	Laure Aurelian*			X				X
Brassica Protection Products	Paul Talalay							X
Baltimore Rh Typing Laboratories	Group of JHU and UMD physicians							X
BSI Proteomics	Leonard Arnowitz*		MEE					
Cell Works	Paul T'so							X
Chesapeake Biological Laboratories	William Tew					X		X
Clinical Cardiovascular Research	Bill White			X				
EntreMed	John Holaday							X
FASgen	Albert H. Owens, Jr. Craig Townsend James Dick Francis Kuhajda							X
Guilford Pharmaceuticals	Craig Smith							X
Igene Pharmaceuticals	Robert Austin Milch							X
Intralytix	Torrey Brown				X			X
Intralytix	Gary Pasternak			X	X			X
Intralytix	Nina Siegler							X
Keragen	Marc Kahn* Riva Eichner*							X
Loats Associates	Harry Loats		X					
MacroGenics	LeRoy Hood*				X			
Magenta	Jeffrey Ostrove					X		
MetaMorphix	Se-Jin Lee			X	X			X
New Hope Pharmaceuticals	David Hankins							X
Ogden Biosciences (now McKesson HBOC)	Harry Hoppes							X
Oncolmmunin	Akira Komoriya*							X
Oncolmmunin	Beverly Packard*					X		X
Osiris Therapeutics	Arnold I. Caplan*			X				
PEM Technologies	Irving Weinberg						X	
ReProtect	Richard Cone Kevin Whaley							X
ReProtect	Thomas Moench*				X			X
Rubicon Laboratory	Vit Laureman							X
Sensors for Medicine and Science	Arthur E. Colvin, Jr.*			candidate				
Spherix	Gilbert V. Levin			X				
Stimsoft	Richard B. North	X			X			X
Surgi-Vision	Elias Zerhouni						X	X
Virion Systems	Gregory A. Prince							X
Visicu	Brian Rosenfeld Michael Breslow							X

*Co-founder

The University of Maryland, particularly the Schools of Medicine and Pharmacy, is increasingly generating bio-entrepreneurs.

The University of Maryland's connections with bio-entrepreneurs are in general quite direct. Either the entrepreneurs were faculty members at the University's professional schools (and still are, see below) when they founded their companies, or they earned bachelor's and master's degrees here and stayed in Maryland.

TABLE BIO-3. Bio Company Founders with University of Maryland Ties

Company Name (when founded)	Founder(s)	Undergrad	Master's	PhD	MD/ JD	Post-doc	Residency/ Fellow	Faculty/ Staff
A&G Pharmaceutical	Ginette Serrero* Jun Hayashi*							X
Anthrotronix	Jack Maxwell Vice	X						X
Athena Environmental Sciences	William R. Jones			UMBC				UMBI
Athena Environmental Sciences	Sheldon E. Broedel			UMBC				
AuRx	Laure Aurelian*							UMB
Biotech Research Laboratories	Thomas M. Li	UMCP EE						
BioF _x Laboratories	Charles Hewitt*							UMB
Baltimore Rh Typing Laboratory	Group of UMD and JHU physicians							UMB
Calibrant Biosystems	Cheng Lee							X
Celsion Corp.	Augustine Y. Cheung		X	X				UMB
Cera Products	Charlene Dale Riikonen	UMCP						
Chesapeake PERL	William Bentley*							UMCP UMBI
Chesapeake PERL	Minh-Quan K. Pham*			X				
Classen Immunotherapies	John Barthelow Classen				UMB MD			
Cylex	Peter Sottong*		X					
Cyto Pulse Sciences	Richard Walters*		MBA, EE					
GloboMax	David Young* Keith Chan*							UMB
Intralytix	J. Glenn Morris*							UMB
Intralytix	Alexander Sulakvelidze*			X				UMB
Intralytix	John Woloszyn*				UMB Law			
Intronn	Lloyd G. Mitchell*				UMB MD			
LKC Technologies	Frank Chen*	UMCP						
Maryland Biotherapeutics	Robert Gallo							UMB UMBI
Minerva Pharmaceuticals	Linda H. Malkas* Robert J. Hickey*							UMB
Novo Vasc	4 faculty members							UMB
University Pharmaceuticals of Maryland	Larry Augsberger*			X				UMB
University Pharmaceuticals of Maryland	Gary Hollenbeck*							UMB

*Co-founder

Footnote: Business school has become more important for entrepreneurial teams.

Twenty-seven bio companies launched in Maryland had founders who received MBA or other business degrees, six of them from the Wharton School at the University of Pennsylvania. Five were from business schools in Maryland. Most of the management degrees were held by founders of companies started within the last five years. Many of the MBA holders had also earned advanced degrees in science or were part of scientist/business person founder teams.

University-based founders often keep their day jobs.

Thirty-one of the known bio-company founders who were at universities when they founded their companies have kept their faculty positions. This is the result of the growing liberalization of intellectual property and conflict of interest policies at universities as well as a realization that an interest in seeing research results commercialized may not require abandoning an academic career. The entrepreneurs have taken several approaches to juggling their academic and business responsibilities. At founding, one member of the team may take on initial management responsibilities. FASgen, founded by four Johns Hopkins scientists and run by its emeritus member, is an example. At University Pharmaceuticals, three University of Maryland School of Pharmacy founders joined with a co-founder who had extensive industry experience. MacroGenics, which was launched in 2000 by scientists at universities in New York and Washington, hired a seasoned CEO (an ex-MedImmune and NIH employee) a year later. MetaMorphix, a joint venture of the founder's Johns Hopkins lab and a non-profit institute, hired a veteran to manage the company's emergence. The son of Brassica Protection Products' JHU-based founder is CEO of the company.

Maryland's military medicine institutions have contributed entrepreneurs and technology to the state's bio industry.

The authors of a 1988 paper in *Science Magazine* on malaria vaccines included George H. Lowell, W. Ripley Ballou, Jr., and Wayne T. Hockmeyer.³ All three were then at the Walter Reed Army Institute of Research (WRAIR) and went on to start companies that form key links in the history of Maryland's preeminence in vaccine technology: Wayne Hockmeyer's MedImmune (1988); Ripley Ballou's Univax (1988), now Nabi; and George Lowell's Intellivax (1996), now part of ID Biomedical (Canada). After a return to WRAIR, Ballou is now an officer at MedImmune. Eleven of the known founders of Maryland bio companies trace their

roots to WRAIR. In 1999 the hundred-year-old WRAIR built its new main laboratory at the 183-acre Forest Glen annex in Silver Spring, Montgomery County. The Institute conducts research on preventive medicine designed to protect Army personnel from chemical and biological warfare as well as infectious diseases.

The Uniformed Services University of Health Sciences (USUHS) was founded in Bethesda in 1976 to provide training for career military physicians. Nearly 3000 physicians have been trained, and hundreds of others educated in 14 graduate degree programs and a new graduate school of nursing. In Maryland, Dr. William Jones, a co-founder of Athena Environmental, worked there. Dr. Gerald W. Fischer (Biosynexus) came to Maryland to teach at USUHS, and Dr. William Hearl, tapped to head Kirkegaard and Perry's spinoff Capital Genomix, did his post-doctoral studies there. USUHS established an Institute for Vaccine Research in 2000 to involve multiple departments in development of novel vaccine strategies. The new Institute's first two projects were collaborations with Biosynexus and the Henry M. Jackson Foundation for the Advancement of Military Medicine, which is closely allied with USUHS. One of the co-founders of GeneDx, Dr. John Compton, previously worked at the Jackson Foundation, a 1200-employee not-for-profit organization in Rockville that supports military medical research.

Several of the state's biofounders were involved in the early days of the NCI Frederick Cancer Research and Development Center, which was converted from the Army's Ft. Detrick biowarfare center in the 1970s. See **Figure BIO-2** on page 12.

The Naval Medical Research Institute, adjacent to the Army's WRAIR at Forest Glen in Silver Spring, has also produced bio-entrepreneurs. Athena Environmental Sciences co-founder Dr. William Jones and all four co-founders of Tetracore (Drs. William Nelson, Thomas O'Brien, Gary Long, and Beverly Mangold) previously worked at the Navy's preeminent center for basic and applied research and product testing, and evaluation in areas of military importance to the Navy and Marine Corps.

Bio-entrepreneurs have also benefited from partnerships with scientists at the Beltsville Agricultural Research Center.

The Agricultural Research Service's laboratories include gene evaluation and mapping, biology, immunology and disease resistance, instrumentation and sensing, and physiology. Maryland bioscience companies that have had Cooperative Research and Development Agreements (CRADAs) with ARS include Intralytix, Life Technologies, Metamorphix, and IGEN. Thermo Trilogly Corp. and Synbiotics have licensed technology from the Agricultural Research Service.

³Lowell, G.H., W.R. Ballou, L.F. Smith, R.A. Wirtz, W.D. Zollinger, W.T. Hockmeyer, "Proteosome-Lipo-peptide Vaccines: Enhancement of Immunogenicity for Malaria CS Peptides," *Science Magazine*, May 6, 1988, Vol. 240, pp. 800-802.

Foreign scientists have been attracted to Maryland, largely by NIH and universities, and subsequently started bio companies here.

Maryland's bioscience and biomedical industry has been stimulated and enriched by a steady inflow of immigrants who came here to do research at NIH or to study and do research at Johns Hopkins or the University of Maryland. Their home countries span the globe:

TABLE BIO-4. Home Countries of Maryland Bio-Entrepreneurs

Home Country	# of Entrepreneurs
Algeria	1
Canada	1
China	5
France	3
Georgia (formerly Soviet Republic)	1
Germany	2
India	1
Japan	1
Russia	3
South Africa	2
Switzerland	1
United Kingdom	4

A surprising number of Maryland bio companies had family member co-founders.

In traditional industries, companies often pass from generation to generation of owners within the same family, grooming the young to eventually take the helm. Maryland's bio-company founders' family relationships are far richer, revealing spouses who shared scientific training, children who followed parents into science, and siblings whose interests either paralleled or complemented each other.

- Spouses – AuRx, BSI Proteomics, Minerva Pharmaceuticals, Oncolmmunin, Shire (formerly Pharmavene), Technical Resources International, The Institute for Genomic Research
- Brothers – Cary Pharmaceuticals, Digene, Edge Biosystems, Immersion Medical (formerly High Techsplinations)
- Parent/child – Atto Instruments, BBI Biotech Research Laboratories, Large Scale Proteomics, Panacea, STEMRON, SymRx, Taconic Anmed, TherImmune

Maryland bio corporations are beginning to spawn second and third generation entrepreneurs.

TABLE BIO-5. Large Company Origins of Maryland BioFounders

Company Where Founder was Previously Employed	# of Founders
Becton Dickinson	5
Rhone-Poulenc (Rorer)	5
Abbott	4
Merck	3
Smith/Kline Beecham (two at Beecham before merger)	3
Novartis (including one each at CIBA-Geigy and Sandoz, now parts of Novartis)	3
Upjohn (including two at Pharmacia Diagnostics, now part of Upjohn)	3
American Home Products	1
Boehringer Mannheim	1
Dupont	1
Eli Lilly	1
Glaxo Wellcome	1
Hospital Corp. of America	1
Johnson & Johnson	1
Mary Kay Cosmetics (toxicology division)	1
Medicis Pharmaceuticals	1
Miles Laboratories	1
Otsuka	1
Revlon/Rorer (biotechnology research center)	1
Shire Pharmaceuticals	1
W.R. Grace	1

Relatively few Maryland bioscience and biomedical entrepreneurs bring large bio company backgrounds to their start-ups, perhaps because only two of these big firms had a substantial Maryland presence before acquiring smaller homegrown companies. Instead, the growing maturity of the bioscience/biomedical sector in Maryland has allowed it to begin to perpetuate itself through spin-offs of subsidiaries/affiliated companies, spin-outs of employees eager to run their own businesses, and “serial entrepreneurship” by several individuals who have built and sold a series of companies. The following figures provide several illustrative examples of the progeny of seminal Maryland bioscience companies founded in the past six decades. They also illustrate the emergence of a class of seasoned managers within the largest Maryland bioscience companies who have become candidates for CEO positions in new companies.

Figure BIO-1. Microbiological Associates

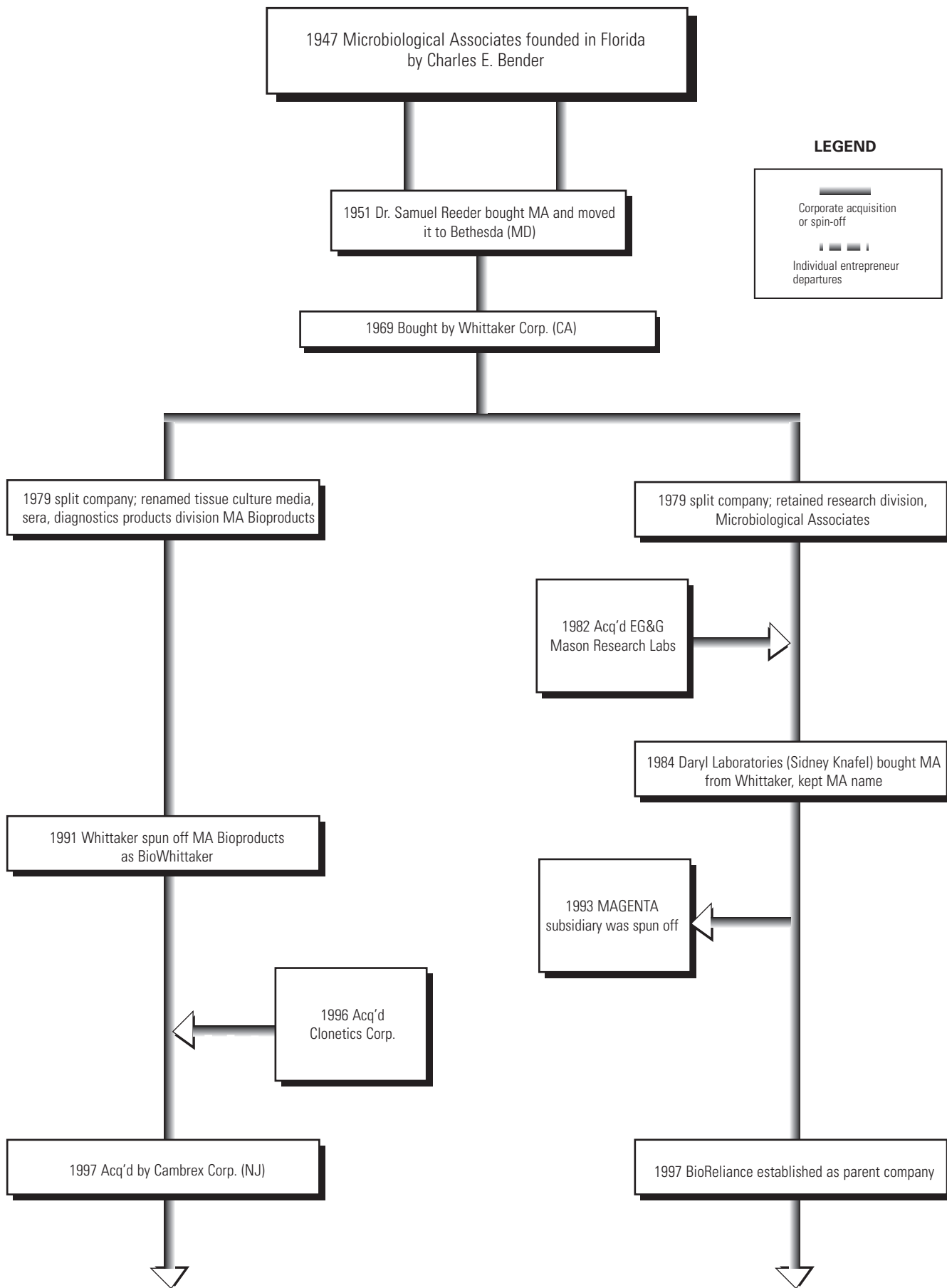


Figure BIO-2. Bionetics Research Laboratories

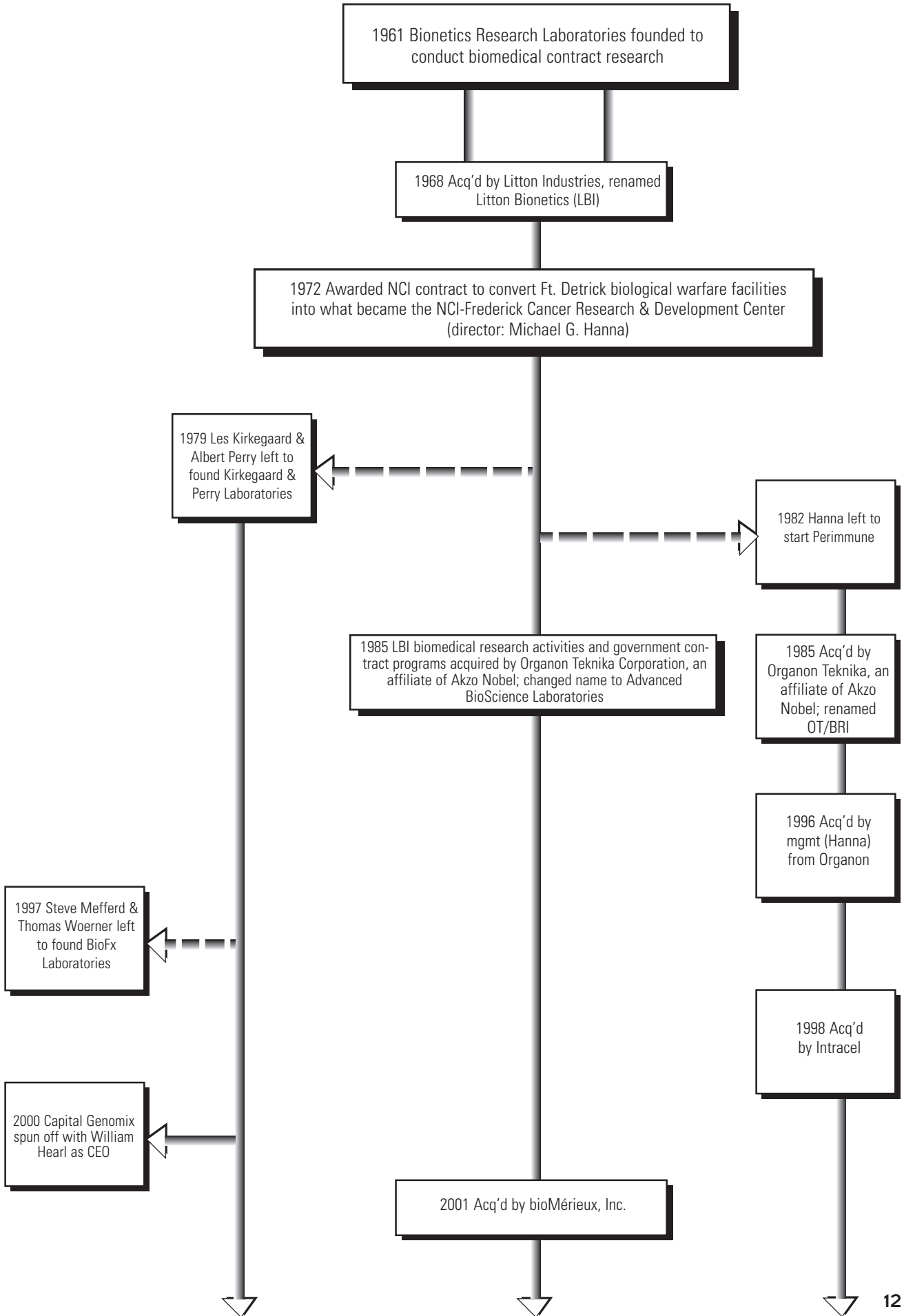


Figure BIO-3. Bionetics Research Laboratories

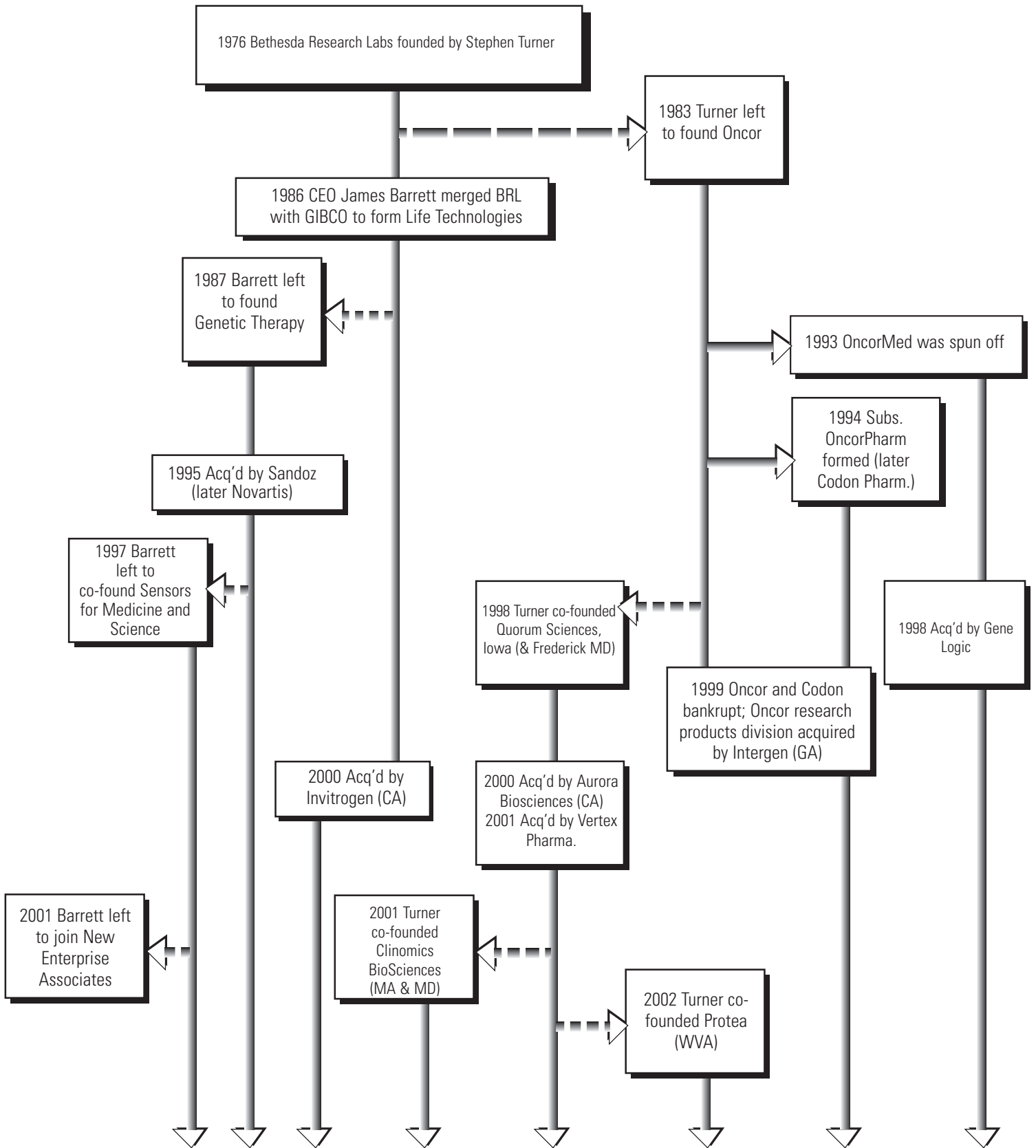
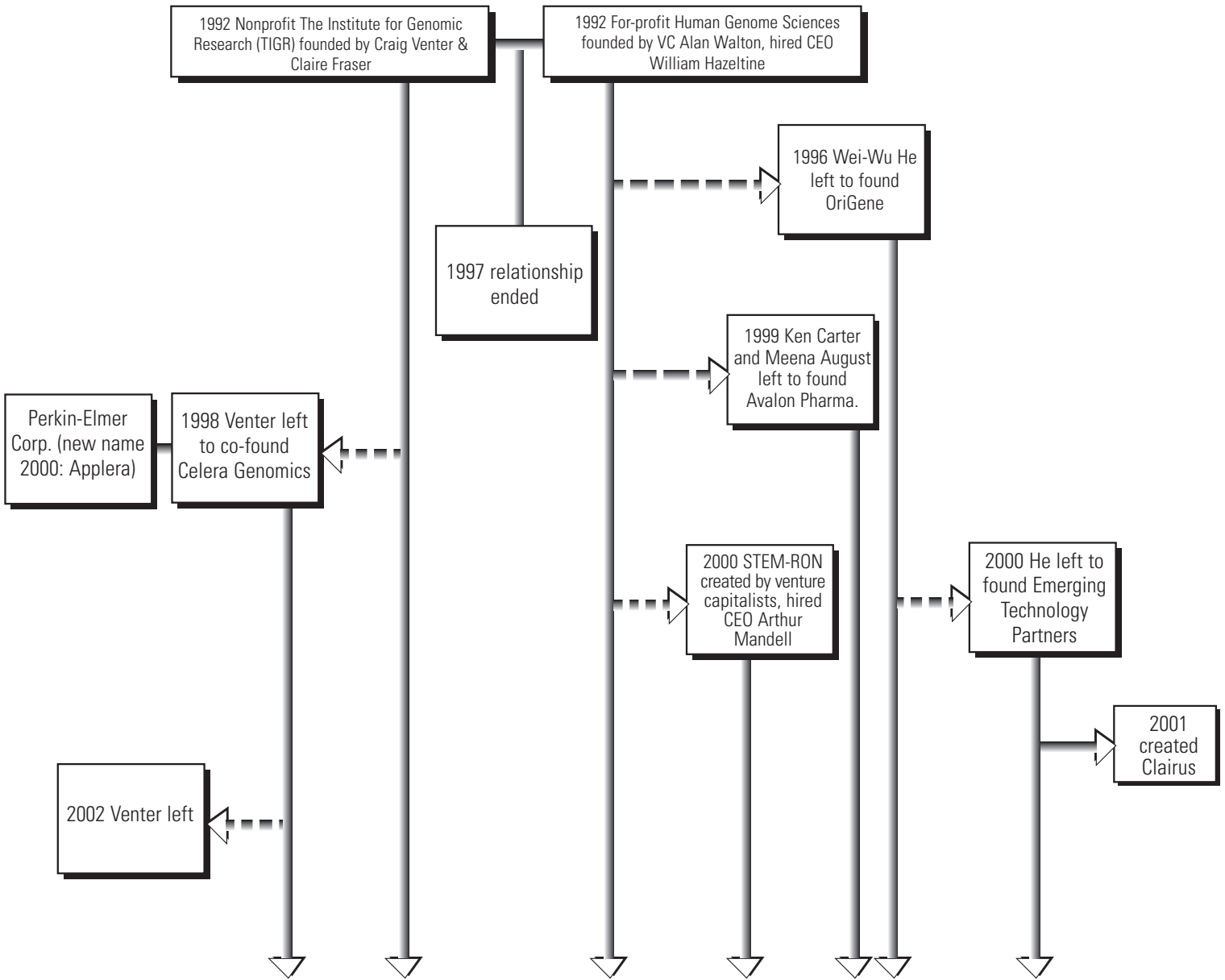


Figure BIO-4. The Institute for Genomic Research and Human Genome Sciences, Inc.



Venture capitalists have been responsible for starting a number of Maryland bioscience and biomedical companies, as well as supplying financing to many others; successful bio-entrepreneurs are now providing venture capital to start-ups.

The role of venture capitalists in Maryland's bioscience company entrepreneurship cannot be overstated. In several cases, venture capitalists have identified groundbreaking science, formed a company to exploit it, and then recruited an experienced entrepreneur to head it. In the words of the late Wallace Steinberg, "we create companies, we don't seed them, which is a big difference."⁴

Steinberg can arguably be called the "father" of biotechnology in Maryland. He and his co-founder Harold R. Werner, who had been executives at Johnson & Johnson, became convinced that

"whereas in the 1970s and 1980s, 80 to 90 percent of all health care-relevant discoveries were made in pharmaceutical companies, in the 1990s and after the year 2000, 75 percent of all relevant scientific discoveries in health care would be made in academic institutions, government institutions and private or biotechnology companies."

--W. Steinberg⁵

Steinberg and Werner created the Princeton, NJ-based HealthCare Investment Corp. in 1985, and invested in Maryland companies at a very early stage, starting with Genetic Therapy in 1987. Steinberg identified the ground-breaking gene therapy work being done by W. French Anderson at NIH, and recruited James Barrett, then president of Life Technologies, to head a new company, Genetic Therapy, Inc. He went on to help found MedImmune in 1988. He is credited with conceiving the 1992 structure for the nonprofit The Institute for Genomic Research (TIGR), where NIH genomics pioneers Craig Venter and Claire Fraser could extend their work, and its sister for-profit Human Genome Sciences, Inc. (HGSI).

Steinberg was alerted to the TIGR opportunity by Alan G. Walton. Walton, the British-born former Harvard professor now chairman of Oxford Bioscience Corp., put together the investors for Human Genome Sciences and asked Dr. William Hazeltine from Harvard to head it. Hazeltine recruited one of his post-docs, Wei-Wu He, to join him in Maryland. In 1999, Walton performed the same role in the founding of Avalon Pharmaceuticals, this time tapping Human Genome Sciences' former head of gene mapping, Kenneth C. Carter, who had left HGSI to form International

Genetics, Inc. In 2000, he brought Michael Palfreyman from his laboratory in Massachusetts to Maryland to head Psychiatric Genomics. Walton says, "Maryland is my prime hunting ground."⁶ More recently, in 2000, a group of investors put together the stem cell company STEMRON Corp. and hired former Human Genome Sciences VP Arthur M. Mandell to be its CEO.

The STEMRON case illustrates another pattern that is beginning to emerge. Successful bio-entrepreneurs have either become full-time venture capitalists or are co-investing with others in new start-ups while continuing to run their own companies. The start-ups they fund have been both spinoffs of their own companies and unrelated enterprises. Wei-Wu He left his start-up OriGene to found the venture capital firm Emerging Technology Partners. James Barrett left his latest start-up Sensors for Medicine and Science to join New Enterprise Associates in Baltimore, one of the county's largest venture capital partnerships. Alex Titimorov, who was until March 2002 the founder, chairman and CEO of InforMax, was one of the investors in STEMRON who hired Arthur Mandell in 2000.

⁴Quoted in Sugawara, Sandra, "A Health Vision: Investment Group Injects Millions into Maryland's Biotech Dream," Washington Post, 1992.

⁵Ibid.

⁶"Barrett, Brendan, "Investors, Where Are You?" Washington Techway, January 7, 2002.

Table BIO-6. Venture Capital for Maryland Bio Companies

Venture Capital Firm	Principal(s)	MD Company Investments
HealthCare Investment Corp. (Now HealthCare Ventures) (Princeton, NJ)	Wallace Steinberg (deceased)	Advancis Pharmaceutical Corporation
	James Cavanaugh (current president)	GeneticTherapy Inc.
		Human Genome Sciences Inc.
		The Institute for Genomic Sciences
		MedImmune Inc.
		Pharmavene (now Shire)
		Sensors for Medicine and Science
Oxford Bioscience Partners (Stamford, CT)	Alan Walton	Artesian Therapeutics
		Avalon Pharmaceuticals
		Exonhit Therapeutics (brought from France)
		Gene:Logic
		Human Genome Sciences
		Martek Biosciences Corp.
		MetriGenix
		Orchid Biosciences (purchaser of Cellmark)
		Psychiatric Genomics
		SymRx
Emerging Technology Partners (Rockville, MD)	Wei-Wu He, William Snider	Aptus Genomics
		Avalon Pharmaceuticals
		Clairus Technologies
		FASgen Inc.
		InforMax
		Intradigm
		Psychiatric Genomics
New Enterprise Associates (Baltimore, MD)		Sensors for Medicine and Science
RHO Ventures (New York, NY)		Advancis Pharmaceutical Corporation
		Genetic Therapy
		Human Genome Sciences
		MedImmune
		Pharmavene (now Shire)
		Sensors for Medicine and Science

While not technically a venture capitalist, Jim Leef's for-profit Association for Entrepreneurial Science (AES) incubator has a 16-year track record of taking on new bioscience companies, nurturing them, and then sending them on their way. Maryland bioscience companies that have graduated from the AES incubator include Fast Systems (1990 graduate), Univax Biologies (now Nabi, 1991), Sitek Research and Development Corp. (1994), and Genvec (2000). Companies currently receiving AES services include Functional Genetics, Intradigm, Novavax, and Transpartum.

Biomedical device entrepreneurs follow different career paths, primarily from industry.

The 30 biomedical device companies that were founded in Maryland are more evenly spread across the bi-metropolitan area, while bioscience companies are heavily concentrated in Montgomery County. Almost all of the firms were founded over ten years ago. This category does not include the many e-health firms that are applying information technology to the management of health care, which are included in a separate chapter of this report.

We know less about the founders of these companies, since their websites are focused on selling their products, which are tangible and photographable. Less emphasis is placed on the qualifications of the founders/management because they are not trying to sell the potential of their companies, but their very real output.

Of the few founders about whom we have information, only four have university ties. The remainder come from industry or health care companies.

While New Enterprise Associates has funded 22 medical device companies around the country, only one Maryland company (Jim Barrett's Sensors for Medicine and Science) has received venture funding from this source. MetaSensors, developer of non-invasive diagnostic monitoring devices to monitor respiratory, ocean, and automotive gas concentrations, received venture funding from Synergy Partners (CA).

Bio Entrepreneurship in Maryland: Implications for Policy and Programs

The majority of Maryland's bioscience entrepreneurs share a link to the National Institutes of Health, Johns Hopkins University, or the University of Maryland. Particularly in the first and second cases, individuals who at one point in their training or careers spent time in the state later returned to start companies. Given the penurious state of most graduate students and young academics, special efforts to reach out to them and create favorable Maryland memories should feature Maryland hospitality along with opportunities for them to see the infrastructure that exists to support entrepreneurs. The Baltimore area in particular should take advantage of this opportunity to make connections with foreign nationals as part of its effort to welcome immigrants.

We need to provide an open-armed experience for graduate students and post-doctoral and visiting fellows while they are in Maryland, exposing them if possible to some of the state's successful bioscience entrepreneurs.

Given the close connections that many bio-entrepreneurs have with Maryland universities, university policies related to intellectual property and conflict of interest can significantly help or hinder the launch of new companies. It is clear that scientific founders do not always need to leave their university posts. It is equally clear that once a bio company moves from discovery to commercial production, the scientific founder/CEO is often replaced with seasoned managers by the venture capitalists who supply the first significant tranches of funding. In order to simultaneously preserve the "seed corn" of academic excellence and foster commercialization of the most promising discoveries,

We need to continue to fine-tune university policies and practice regarding the roles faculty may play in start-up companies, and the flexibility of the terms of their employment (leaves of absence, "start-up sabbaticals" etc.). A parallel look at the legal environment and individual lab policies in federal laboratories needs to be undertaken.

The medical device industry is concentrated in other parts of the country, notably Minnesota, Massachusetts, California, New York, Florida, and Illinois.⁷ However, Maryland has a solid cluster of these types of firms, most of them with years of experience. Because many of them are outside the boundaries of MdBio's

definition of "bioscience" companies, we do not know as much about them as we should, and are therefore lacking the insight we need about how to strengthen and support the growth of this industry. In Massachusetts, where there are over 250 device companies, the Massachusetts Technology Collaborative (MTC) created MassMEDIC (Massachusetts Medical Device Industry Council), which has since spun-off as an independent trade association (www.massmedic.com). The MTC continues to serve as Secretariat and the MTC representative serves as Secretary of the MassMEDIC board. The Medical Device Manufacturers Association was created in 1992 to represent this industry in Washington and has close ties to state organizations like MassMEDIC, Medical Alley (Minnesota), and the Michigan Medical Device Manufacturers and Suppliers Association.

We need to make a concentrated effort to get to know medical device company managers, to knit them into the existing networks of support for entrepreneurs, to celebrate their successes, and to foster the start-up of new medical device companies.

Maryland is fortunate to have the attention of several unusual venture capitalists who prefer to build companies from scratch rather than to invest at a later stage. They have proven by their actions that they believe Maryland to be fertile soil for fledgling bio companies, often moving start-ups (and their scientific founders) here from elsewhere. It is also clear that early endorsement by these pioneers has moved other financiers to join in later rounds of financing. Regular consultation with Alan Walton and James Cavanaugh (and Wei-Wu He as he follows this same path) should be used to determine what supportive roles other Maryland organizations might play in enhancing the chances for success of their new companies. In particular, efforts to ensure the availability of small-scale wet lab space should be intensified. The role of the Association for Entrepreneurial Science's incubator needs to be recognized along with publicly supported incubators as an important element in the Maryland's bioscience company pipeline, and supported in the same way.

We need to find ways to redouble support for the financiers who are matching cutting edge science with seasoned management to launch new bio companies in Maryland and make sure there are places for the start-ups to grow.

⁷Clayton-Matthews, Alan, "The Medical Device Industry in Massachusetts," University of Massachusetts Donahue Institute, 2001. www.donahue.umassp.edu

The world of science is one without national boundaries, and bioscience/biomedical companies are more apt than other industries to have scientific founders and to stay close to sources of scientific discovery throughout their existence. Companies, entrepreneurs, and venture capitalists all have international connections that can be exploited to reach other bio companies and bio-entrepreneurs around the world. Obvious connections include Novartis, Shire, Wei-Wu He, Synergy Partners International (investors in MetaSensors who work through the Nikko Synergy Ventures fund), and Trade Logistics & Strategies, a Bethesda-based international business development company that is developing international (particularly Japanese) sales, distribution, and strategic relationships for 20/20 Gene Systems, BioF_x Laboratories, Cary Pharmaceuticals, Coagulation Diagnostics, and Cylex. Foreign-born entrepreneurs are a second set of potential links to be explored. Third, the extensive international connections of NIH and the universities provide additional pathways to global visibility.

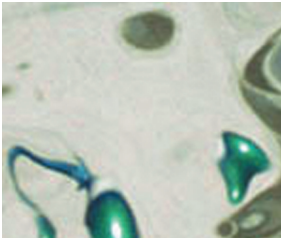
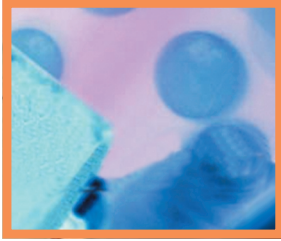
We need to fully exploit Maryland's international bioscience networks to reach bio companies and bio-entrepreneurs around the world.

As Maryland's bio companies have grown and flourished, they are beginning to supply the next generation of managers for new bio firms, sometimes through a "serial entrepreneur" who leaves the helm of a company he or she has started to take on a new challenge, or through the recruitment of second level managers in established firms to head new start-ups. This entrepreneurial talent pool is a corollary benefit of efforts by all in Maryland to help bio companies grow significantly within the state.

We need to continue and intensify efforts to support the growth of our strongest bio companies as they transition from R&D into production.

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