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Boston bio innovation ecosystem: known secrets and hidden secrets

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Boston Bio Innovation Ecosystem
"Known Secrets and Hidden Secrets"

보스턴 바이오혁신 생태계: 알려진 비밀과 숨겨진 비밀

Questrom OTM Seminar
September 22, 2022

김종성 Jay S. Kim, Ph.D.
Boston University
Questrom School of Business
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QUESTROM MEANS BUSINESS.

Welcome to the Questrom OTM Seminar

"Boston Bio Innovation Ecosystem – Known Secrets and Hidden Secrets"

Why are you here?

Scientists | MD/Ph.D. | Business | Government | **Entrepreneurs**

Disclaimer

1. *This seminar will probably NOT give you an immediate idea for an A-journal publication.*
2. *It might, however, change your life ….. Just imagine what would have happened to you if you had participated in a similar seminar held in Silicon Valley in the 1990s.*

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BOSTON UNIVERSITY

Cambridge Massachusetts
June 2017

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Welcome to Boston!
Agenda

1. The News - "Global #1 Bio Cluster"
2. Questions from around the world
3. Elementary Studies
4. Best Practice Studies
5. Theories of Bio Innovation – Entrepreneurs & Ecosystem
6. What will I do differently?

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The News

Boston is now Global #1 Biopharma Cluster

GEN Genetic Engineering & Biotechnology News

		NIH Funding	VC Funding	Patents	Lab Space (mil sq ft)	No. Bio Jobs
1	Boston/ Cambridge	$519 million	$2.0 billion	5,634	16.77	82,075
2	San Francisco Bay Area	$230 million	$2.7 billion	9,559	16.36	63,158
3	New York / New Jersey	$366 million	$0.3 billion	3,522	14.19	127,651
4	Maryland / DC Metro	$221 million	$0.3 billion	3,959	9.5	38,189

*Source: http://www.genengnews.com/the-lists/top-10-us-biopharma-clusters/77900646 (May 2016)

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Continuing News
Global #1 Biopharma Cluster Is Accelerating

		NIH Funding	VC Funding	Patents	Lab Space (mil sq ft)	No. Bio Jobs
2016	Boston/ Cambridge	$519 million	$2.0 billion	5,634	16.8	82,075
2017	Boston/ Cambridge	$1.06 billion	$3.1 billion	6,496	19.9	86,235
2018	Boston/ Cambridge	$2.46 billion	$6.2 billion	7,565	26.8	90,566
…						
2022	Boston/ Cambridge	$3.2 billion	$13.6 billion	10,119	49.1	104,000

*Source:
http://www.genengnews.com/the-lists/top-10-us-biopharma-clusters/77900646 (May 2016)
https://www.genengnews.com/lists/top-10-u-s-biopharma-clusters-5/ (June 2017)
https://www.genengnews.com/lists/top-10-u-s-biopharma-clusters-6/ (September 2018)
https://www.genengnews.com/topics/drug-discovery/top-10-u-s-biopharma-clusters-9/ (June 2022)

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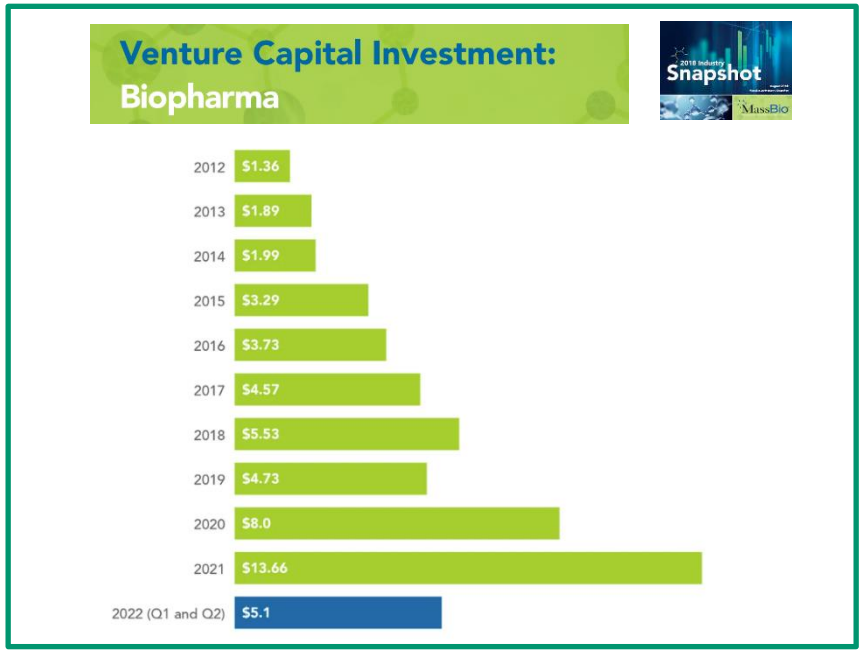
The Boston Phenomenon

"Attracted by burgeoning biotech startups around Kendall Square, global pharmaceuticals move into the crowded space."



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Questions from around the world

How did Boston build such a flourishing bio innovation ecosystem?

How can we build one in our country? In our city?

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Known Secret #1

Mass Governor Deval Patrick (2007-15)

May 8, 2007, BIO International Convention

"There is no place in the world with as much talent in life sciences and biotech as here in Massachusetts.

Now is the time for us to invest in that talent and bring together the resources of our unparalleled research universities, teaching hospitals, and industry to work toward a common goal, to grow ideas into products, to create cures and jobs."

10 years

$1 billion

MASSACHUSETTS LIFE SCIENCES CENTER

MassBio
MASSACHUSETTS BIOTECHNOLOGY COUNCIL

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Known Secret #2

HARVARD MEDICAL SCHOOL

Since 1782

MASSACHUSETTS GENERAL HOSPITAL

BRIGHAM AND WOMEN'S HOSPITAL

Boston Children's Hospital
Until every child is well™

DANA-FARBER CANCER INSTITUTE

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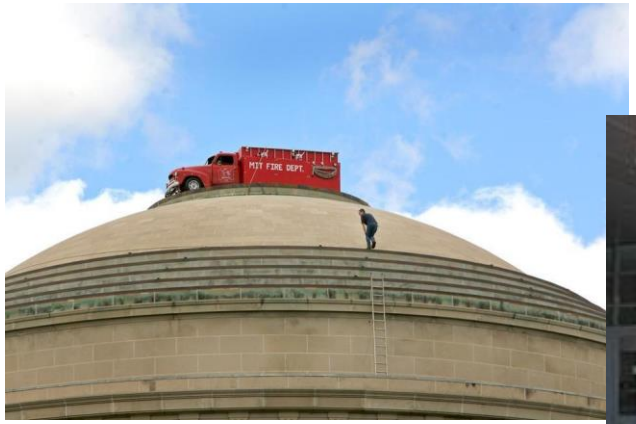
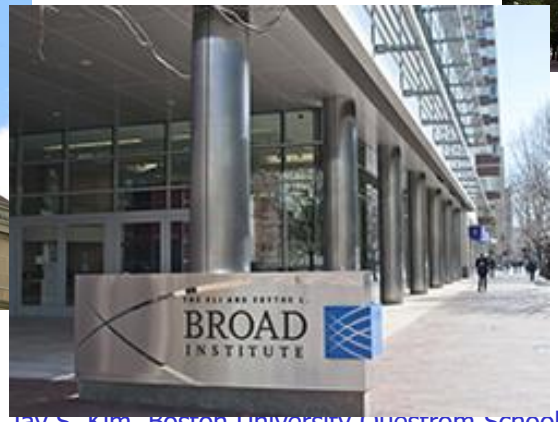
Known Secret #3

MIT

Massachusetts Institute of Technology

President Susan Hockfield
(2004-12)





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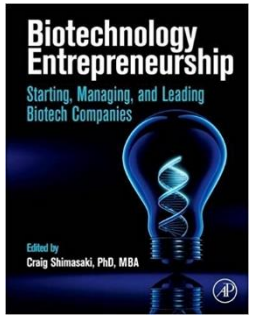
The Elements

"Five Essential Elements for Growing Biotechnology Cluster"



2014

1. Abundance of high quality, adequately funded academic research
2. Ready resource of seasoned and experienced biotechnology entrepreneurs
3. Ready access to high-risk, early development-stage capital willing to fund startup concepts
4. Adequate supply of technically skilled workforce experienced in biotechnology industry
5. Availability of dedicated wet-laboratory and specialized facilities at affordable rates

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Elementary Studies

	Scientific Research	Seasoned Entrepreneurs	Early-stage Funds	Skilled Workforce	Wet-lab Facilities
Boston					
San Francisco					
New York					
Singapore					
Shanghai					
Seoul, Korea					

$$\textit{Bio Innovation Ecosystem} = \boldsymbol{f}(E_1, E_2, E_3, E_4, E_5)$$

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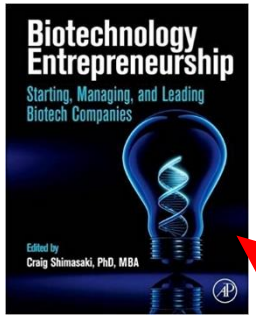
Elementary Studies
"Many interesting research questions"



1	2	3	4	5
Abundance of high quality, adequately funded	Ready resource of seasoned and experienced biotechnology entrepreneurs	Ready access to sources of high-risk, early and development-stage capital willing to fund startup concepts	Adequate supply of technically skilled workforce experienced in biotechnology	Availability of dedicated wet-laboratory and specialized facilities at affordable rates

"An abundance of one element does not compensate for the lack of another. All five of these essential elements must be present in sufficient quantities in order for a biotechnology cluster to take root and flourish."

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We have had similar research experiences before – with Silicon Valley

How did Silicon Valley build such a flourishing startup ecosystem?

How can we build one in our country? In our city?

- A Japanese research team conducted a very extensive and systemic research to find out the secrets of Silicon Valley success
- Determined the "six" essential elements of flourishing tech startup ecosystem
- Discovered that the Japanese government has been working on those elements for decades, but without any substantial progress in startups
- Concluded "since it appears to be impossible to transfer the Silicon Valley ecosystem to Japan, the government may be better off by supporting the move of Japanese tech startups to Silicon Valley so that they can benefit from the rich environment."

Source: Dasher et al (2015) "Institutional Foundation for Innovation-Based Economic Growth," prepared for National Institute for Research Advancement, Japan

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To answer questions from around the world

How did Boston build such a flourishing bio innovation ecosystem?

We need more than a snapshot!

We need to understand the trajectory!

How can we build one in our country? In our city?

We need to understand the mechanism that pushes and pulls those elements toward the development of a dynamic ecosystem!

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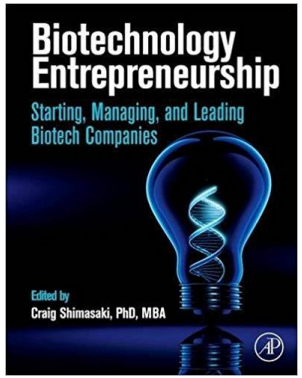
Hidden Secret #1

"The mechanism that pushes and pulls those elements toward the development of a dynamic ecosystem"

Best Practice Study to discover Hidden Secrets



1	2	3	4	5
Abundance of high quality, adequately funded academic research	Ready resource of seasoned and experienced biotechnology entrepreneurs	Ready access to sources of high-risk, early and development-stage capital willing to fund startup concepts	Adequate supply of technically skilled workforce experienced in biotechnology industry	Availability of dedicated wet-laboratory and specialized facilities at affordable rates

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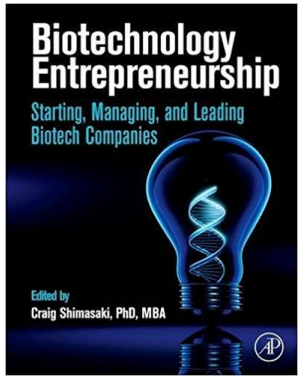
Hidden Secret #1

"The mechanism that pushes and pulls those elements toward the development of a dynamic ecosystem"

Best Practice Study to discover Hidden Secrets

1



Abundance of high quality, adequately funded academic research

2

Reac
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biote
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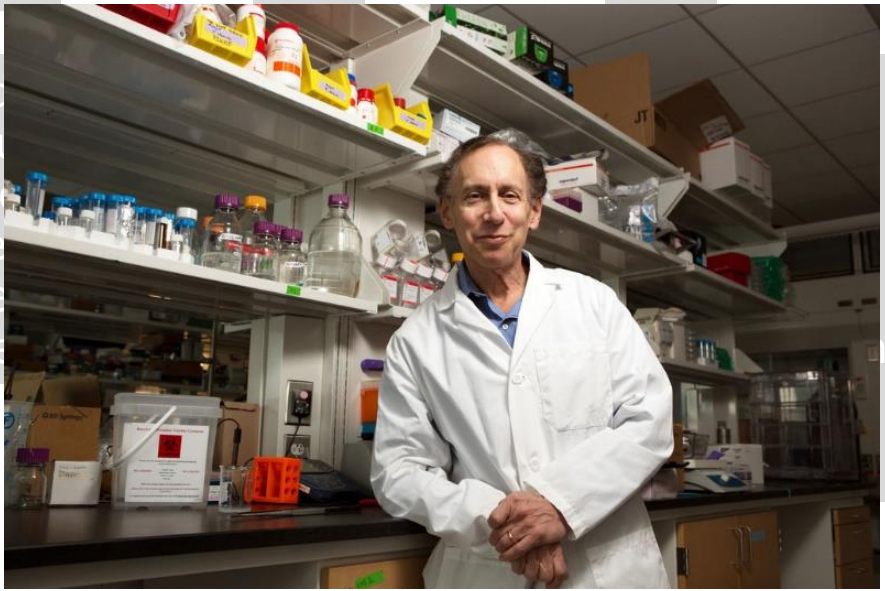
3



4

5

Availability of dedicated wet-laboratory and specialized facilities at affordable rates

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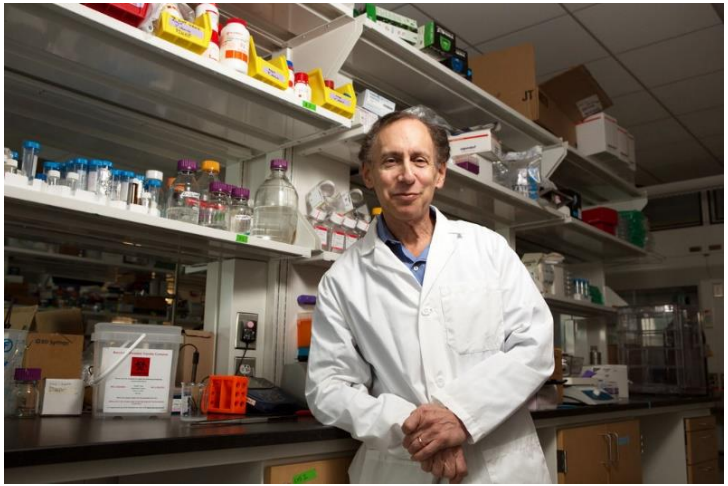
Dr. Robert Langer
MIT



Robert S. Langer is the David H. Koch Institute Professor (there are 11 Institute Professors at MIT; being an Institute Professor is the highest honor that can be awarded to a faculty member). Dr. Langer has written over 1,250 articles. He also has nearly 1,050 patents worldwide. Dr. Langer's patents have been **licensed to over 250 pharmaceutical, chemical, biotechnology and medical device companies**. He is the most cited engineer in history.

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Bob Langer Companies

"40 companies since 1987"

1987

Advanced Inhalation Research

1997

• • • •

2001

2011

"estimated market value of $23 billion"

(Source, HBR 2017)

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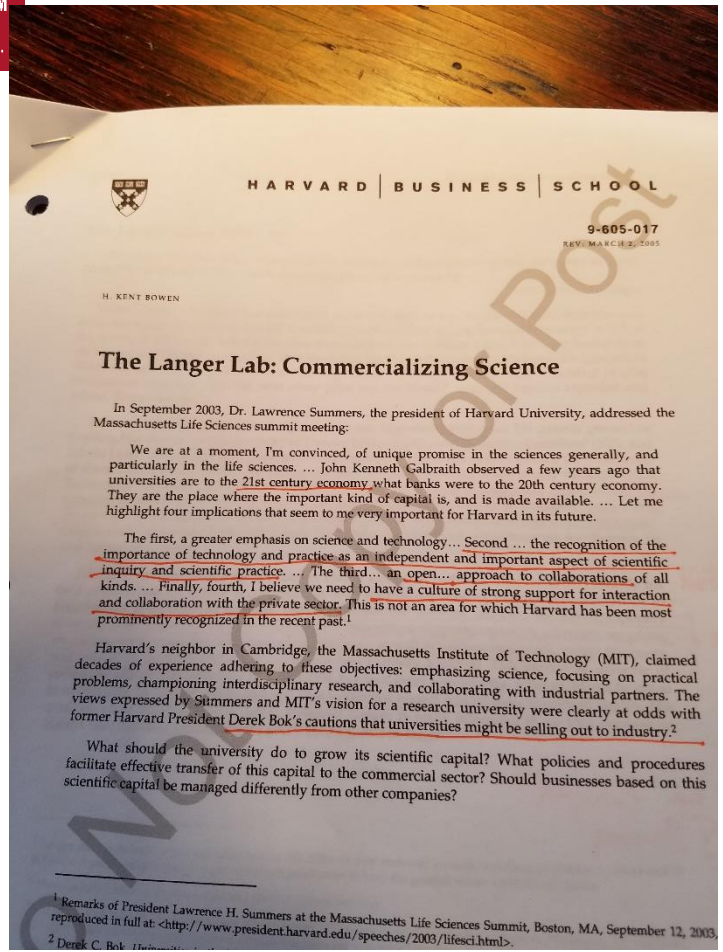

HARVARD | BUSINESS | SCHOOL

9-605-017

REV: MARCH 2, 2005

H. KENT BOWEN

The Langer Lab: Commercializing Science

In September 2003, Dr. Lawrence Summers, the president of Harvard University, addressed the Massachusetts Life Sciences summit meeting:

> We are at a moment, I'm convinced, of unique promise in the sciences generally, and particularly in the life sciences. … John Kenneth Galbraith observed a few years ago that universities are to the 21st century economy what banks were to the 20th century economy. They are the place where the important kind of capital is, and is made available. … Let me highlight four implications that seem to me very important for Harvard in its future.
>
> The first, a greater emphasis on science and technology… Second … the recognition of the importance of technology and practice as an independent and important aspect of scientific inquiry and scientific practice. … The third… an open… approach to collaborations of all kinds. … Finally, fourth, I believe we need to have a culture of strong support for interaction and collaboration with the private sector. This is not an area for which Harvard has been most prominently recognized in the recent past.[1]

Harvard's neighbor in Cambridge, the Massachusetts Institute of Technology (MIT), claimed decades of experience adhering to these objectives: emphasizing science, focusing on practical problems, championing interdisciplinary research, and collaborating with industrial partners. The views expressed by Summers and MIT's vision for a research university were clearly at odds with former Harvard President Derek Bok's cautions that universities might be selling out to industry.[2]

What should the university do to grow its scientific capital? What policies and procedures facilitate effective transfer of this capital to the commercial sector? Should businesses based on this scientific capital be managed differently from other companies?

[1] Remarks of President Lawrence H. Summers at the Massachusetts Life Sciences Summit, Boston, MA, September 12, 2003, reproduced in full at: <http://www.president.harvard.edu/speeches/2003/lifesci.html>.

[2] Derek C. Bok, *Universities*

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Bob Langer – How does he do it?

Questions

- How does Langer Lab successfully commercialize science?
- What should the university do to grow the scientific capital?
- What should the government do to facilitate the transfer science to industry?
- How should the businesses based on the scientific capital be managed?

Harvard Business School Case Study

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Bob Langer – How does he do it?
Langer's Own Words

Ideal Research Project
(for the symbiotic relationship between science and science-based business)

1. A huge idea
2. A seminal paper
3. A blocking patent
4. Preliminary *in vivo* studies in animals

"There is very little that is really impossible."

"My goal has always been not just to write the scientific paper or file a patent, but to really push some of these ideas to the point where they will affect people's lives in a positive way."

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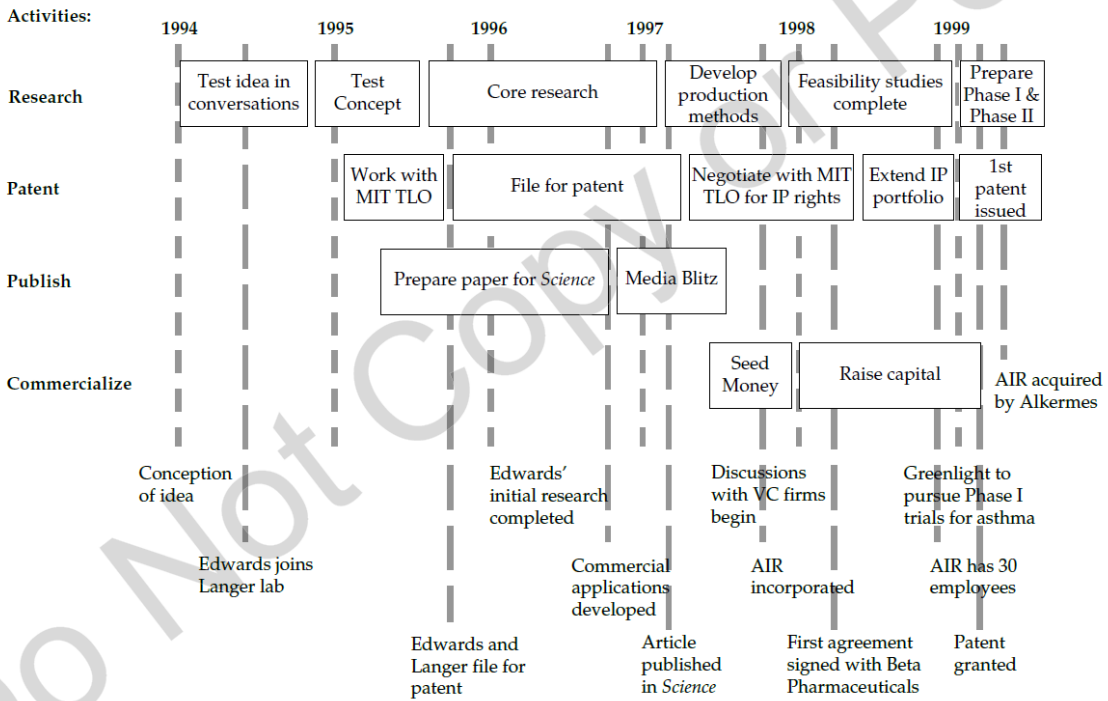
Bob Langer - How does he commercialize research outcome?

Exhibit 6 Timeline for Creating the Company, Advanced Inhalation Research (AIR)



Source: Michael J. Roberts and Diana Gardner, "Advanced Inhalation Research, Inc.," HBS Case No. 899-292 (Boston: Harvard Business School Publishing, 1999).

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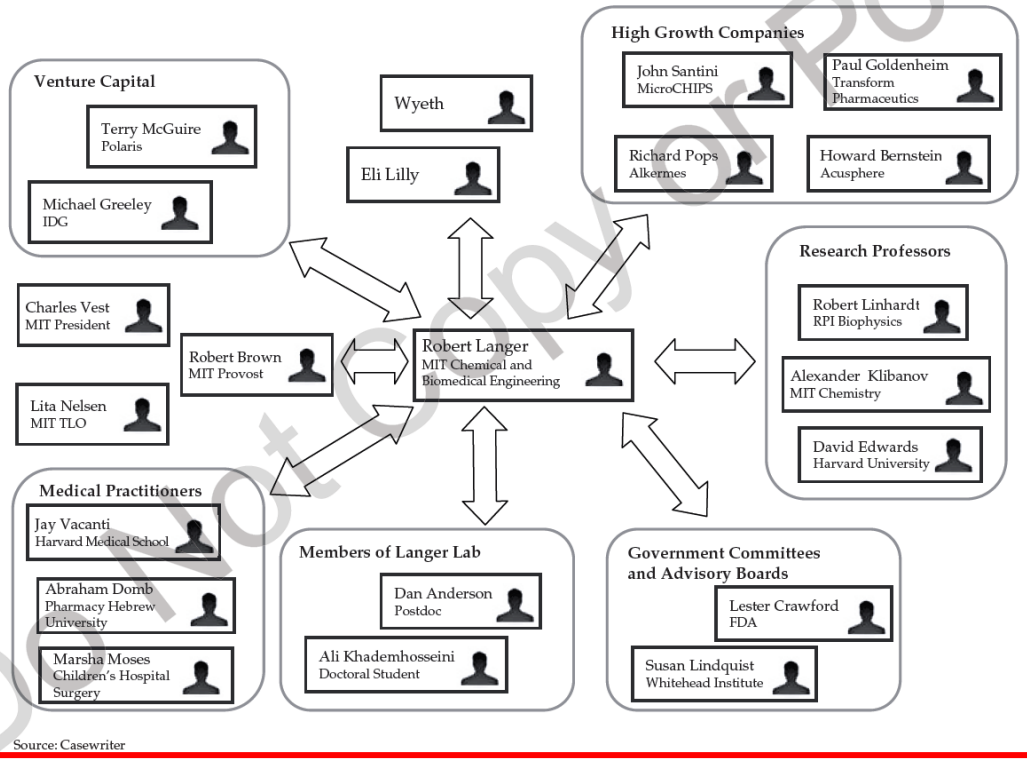
Bob Langer – How does he do it?

Langer's Network

Exhibit 3 Representative Sketch of Professor Langer's Professional Network



Source: Casewriter

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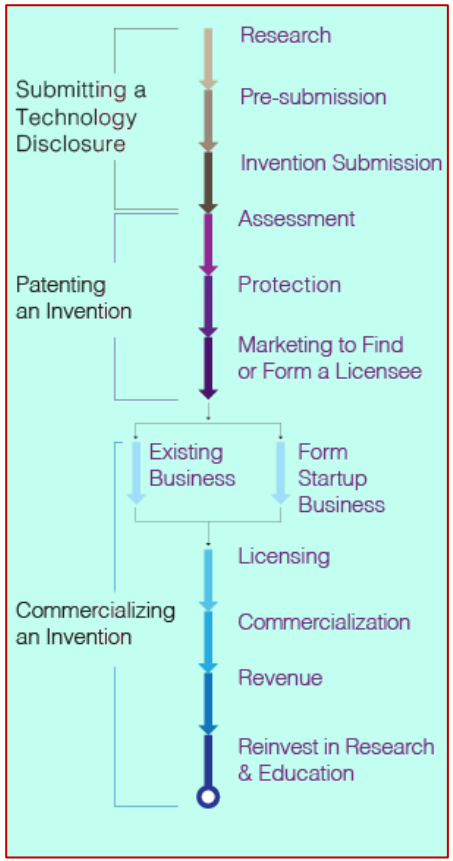
MIT TLO



MIT Technology Licensing Office Organizational Chart

OFFICE OPERATIONS
Assistant Director, Operations
Marlene Mack

Sr. Human Resources/Archiving Admin. Assistant
Cathy Jin

Front Desk Admin. Assistant
Alexandra Ramos

Compliance Administrator
Tenzom Shongnak

Sr. Federal Compliance Assistant
Luna Latif

Federal Compliance Assistant
Helene Rivera

MIT USE OF NAME AND TRADEMARK
Technology Licensing Officer
Peter Bebergal

Sr. Trademark & Use of Name Admin. Assistant
Cory Tasley

COMMUNICATIONS
Communications Officer
Karen Baird

Marketing Consultant

Marketing Interns

INFORMATION TECHNOLOGY
Senior Analyst Programmer
Jeff Lura

Systems Administrator
Thomas Brand

ASSOCIATE PROVOST
Krystyn Van Vliet

DIRECTOR
Lesley Millar-Nicholson

Executive Assistant
Andrea Barry

LICENSING TEAM

PHYSICAL SCIENCES
Associate Director
James Freedman

Licensing Officers
Linda Chao
Dan Dardani
Myron Kassaraba
Kevin Lefebvre
Deirdre Zammit

LIFE SCIENCES
Associate Director
Lauren Foster

Licensing Officers
Donald Corcoran
Christina Hedberg
Jim Roberts
Ben Rockney

Associate Licensing Officer
Andrew Moomey

Sr. Technology Licensing Associate
Emalee Couture

Technology Licensing Associates
Kate Beriont
Caitlyn Ward
Tyler Guitroz

Administrative Assistants
Chanel Palmer
Stephanie Starbard

MATERIAL TRANSFER AGREEMENTS
Associate Officer
Charlie Miller

FINANCIAL OPERATI
Assistant Director, Fina
Zineta Borogovac

Royalty Distribution & Equity Coordinator
Sanjay Ray

Financial Coordinator
Nick Northrup

Financial Assistant
Gloria Garrison

Accounts Receivable Specialist
Jonathon Glidden

Finance/Intellectual Property Admin. Assistant
Joseph Lee

Broad Financial Assistant
Andrew Donaghey

PATENT ADMINISTRATION
Assistant Director, Intellectual Property
Jonathan Hromi

Sr. Intellectual Property Paralegal (Physical Science)
Susan Ouijli

Sr. Intellectual Property Paralegal (Life Science)
Laura Lapsley

Intellectual Property Assistant
Emma Blades

IPIA Assistant
Allison Madden

June 2020

MIT | TLO Technology Licensing Office

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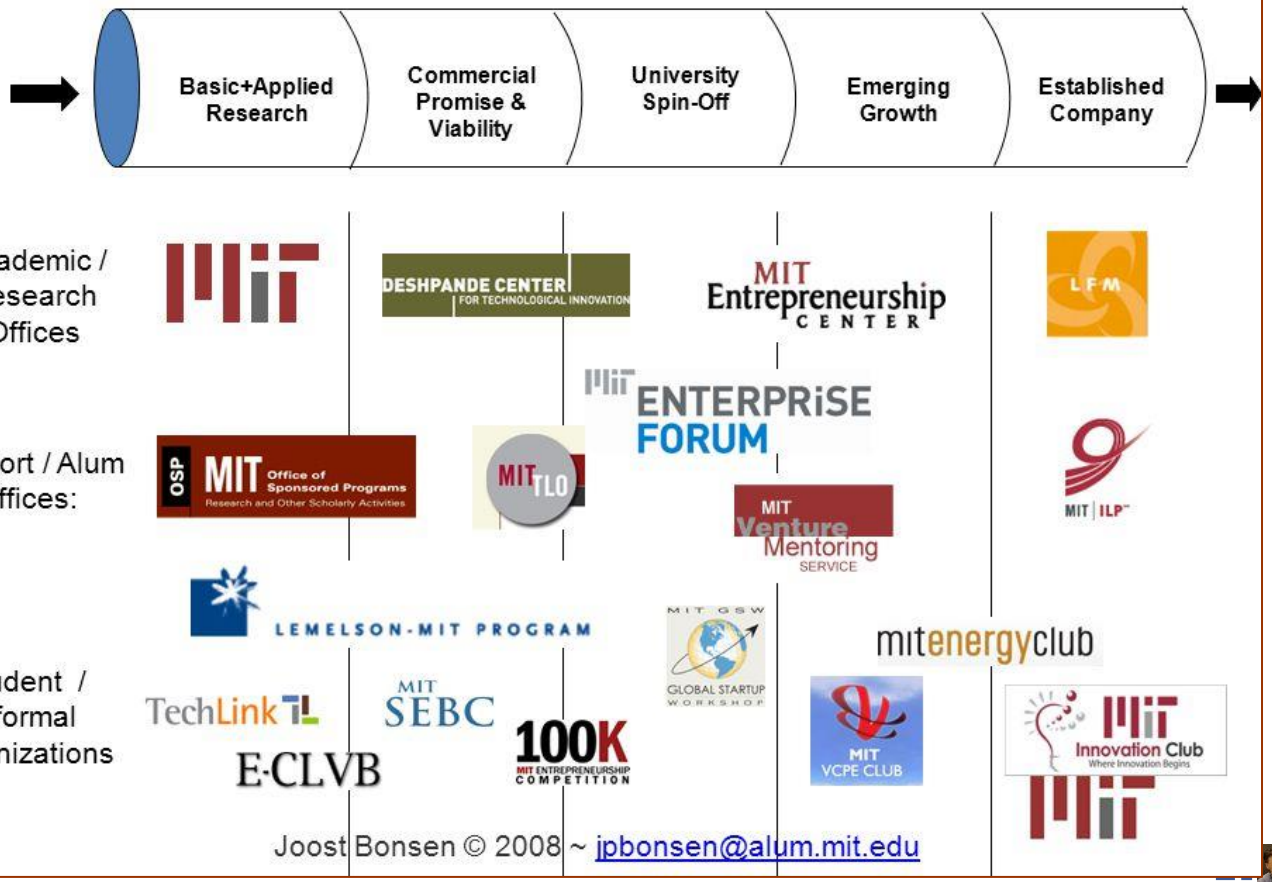
MIT Innovation Ecosystem & Pipeline



Joost Bonsen © 2008 ~ jpbonsen@alum.mit.edu

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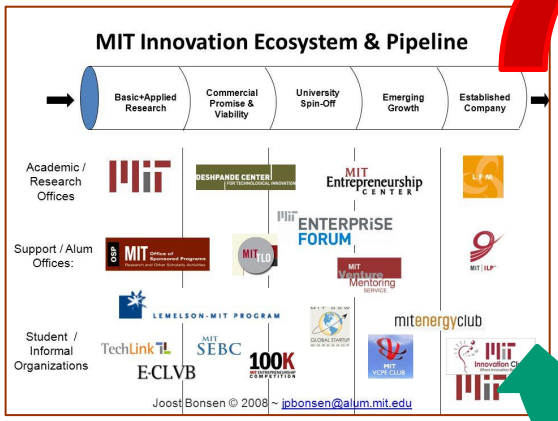
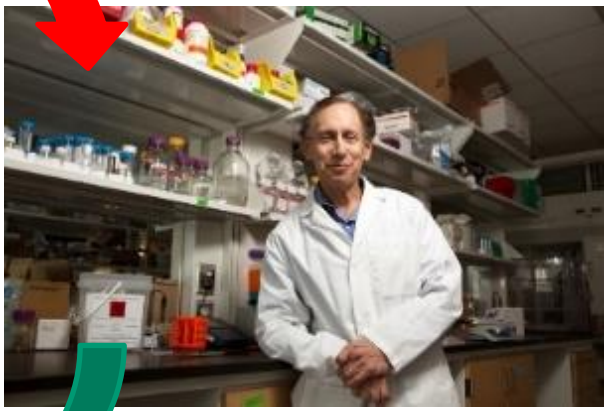
Cause & Effect?





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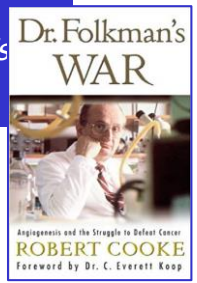
Bob Langer – How does he do it?
Not everyone can do this!

"This style of research should be encouraged and enabled, but not expected."

Charles Vest,
President of MIT

"There are all kinds of geniuses in the Harvard area, so we classify them. There are standard geniuses, and you can follow how they got from here to there, once they show it to you. But with a magician genius, you have no idea how he did it. Langer is that kind of genius – like an Einstein or a Feynman."

Dr. Judah Folkman, in Robert Cooke, *Dr. Folkman's War: Angiogenesis and the struggle to defeat cancer*, 2001



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Can we train scientists to be like Bob Langer?
A hint for a dynamic ecosystem

IBE
Institute for Biomedical Entrepreneurship

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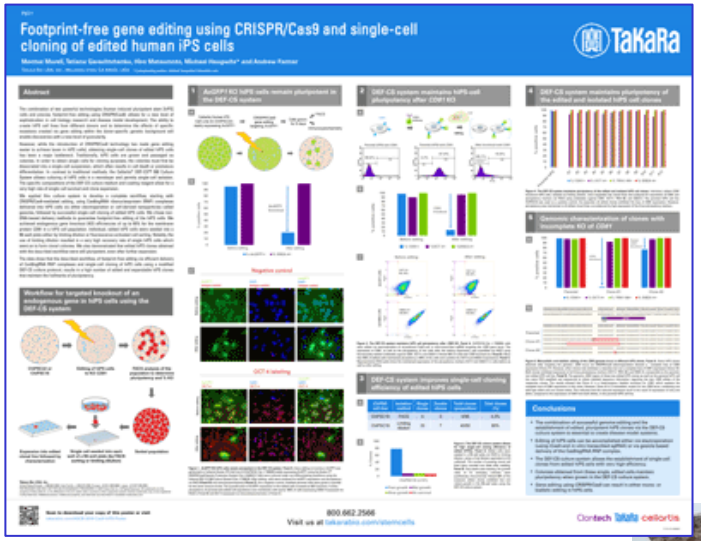
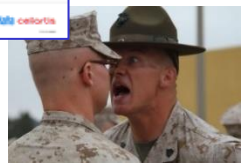
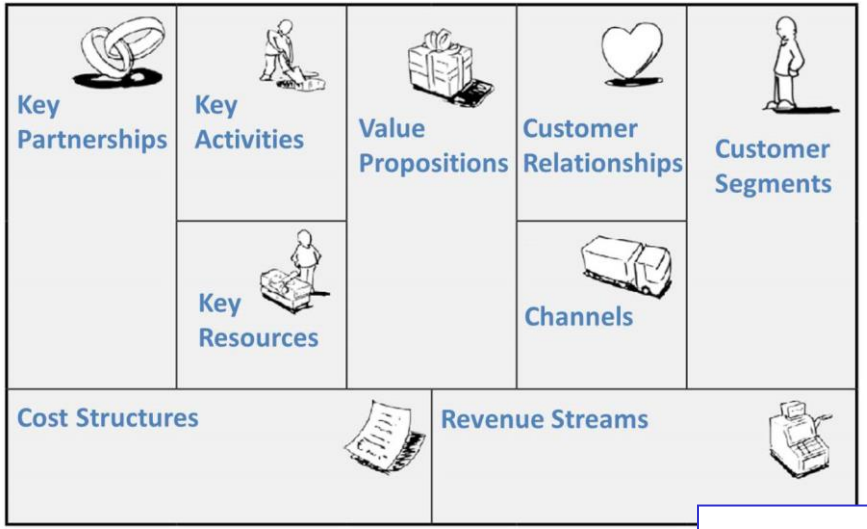
Can we train scientists to be like Bob Langer?

A hint for an effective training/development program







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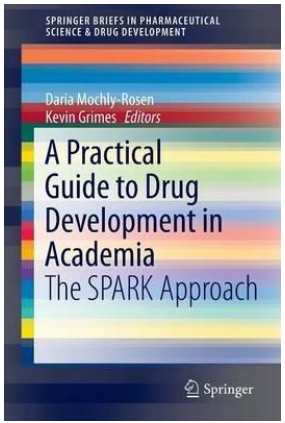
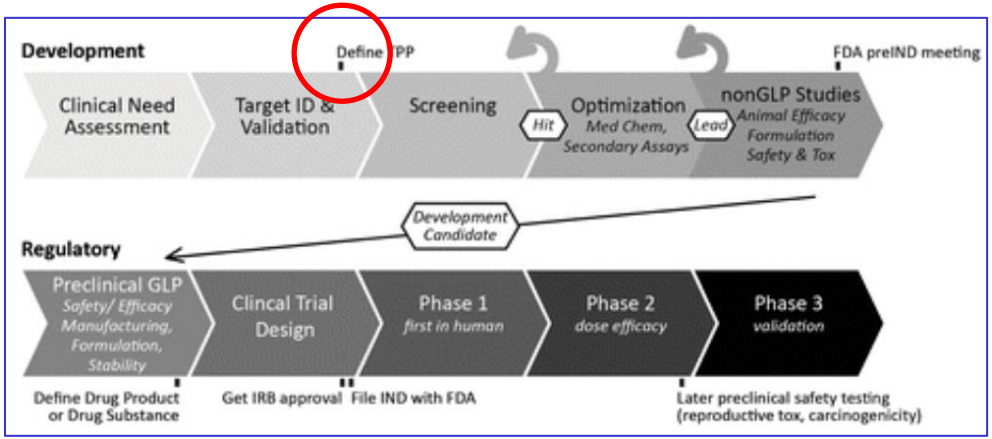
Can we train scientists to become like Bob Langer?

A hint for an effective training/development program





TPP (Target Product Profile)

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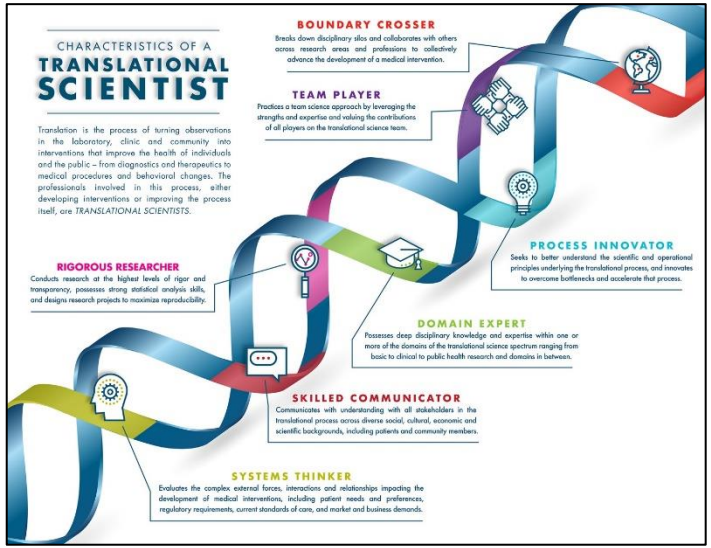
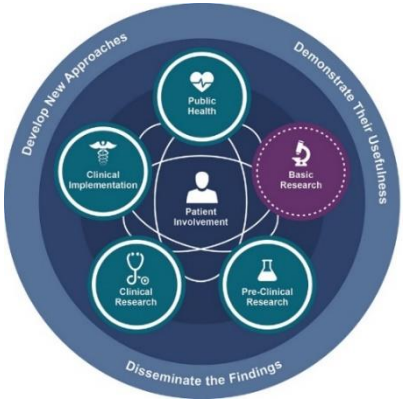
Can we train "translational scientists" like Bob Langer?
Now a US National Agenda



NIH National Center for Advancing Translational Sciences



Dr. Christopher Austin

I-CORPS@NCATS

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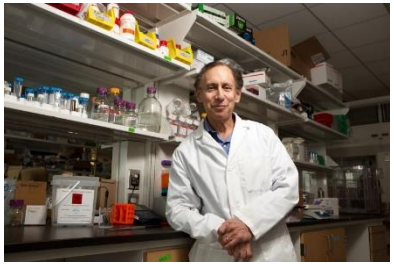
Hidden Secret #1

OTM lessons (or just insights) from the story of Bob Langer



1

When (and what kinds of) does science provide opportunities for innovative business?

2

What provides fertile grounds for scientific advancement?

What provides fertile grounds for scientific entrepreneurship?

3

What are the essential personal traits of science-driven entrepreneurs?

How do they learn and develop those capabilities?

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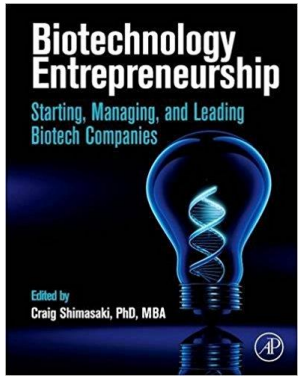
Hidden Secret #2

"The mechanism that pushes and pulls those elements toward the development of a dynamic ecosystem"

Best Practice Study of Hidden Secrets



1	2	3	4	5
Abundance of high quality, adequately funded academic research	Ready resource of seasoned and experienced biotechnology entrepreneurs	Ready access to sources of high-risk, early and development-stage capital willing to fund startup concepts	Adequate supply of technically skilled workforce experienced in biotechnology industry	Availability of dedicated wet-laboratory and specialized facilities at affordable rates

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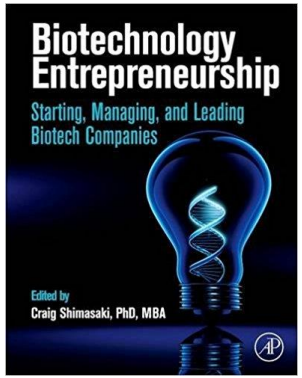
Hidden Secret #2

"The mechanism that pushes and pulls those elements toward the development of a dynamic ecosystem"

Best Practice Study of Hidden Secrets

1



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Availability of dedicated wet-laboratory and specialized facilities at affordable rates

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LabCentral

You cannot start a biotech startup from garage – it started from a simple business idea!

Dr. Johannes Fruehauf, Founder, Executive Director

"When a group of scientists decide to start a company to translate their innovative research findings into a commercial product, the last thing they want to worry about is how to find a lab space and fill it with all the necessary equipment.

Rather than spending the first six months and the first million dollars to set up the physical facility, they would rather want to spend their time to advance their theories and identify collaboration partners.

That is how we founded the concept of a common lab space, completely prepared with all the necessary equipment and regulatory requirements, readily available for an affordable rent."

Circa 2014

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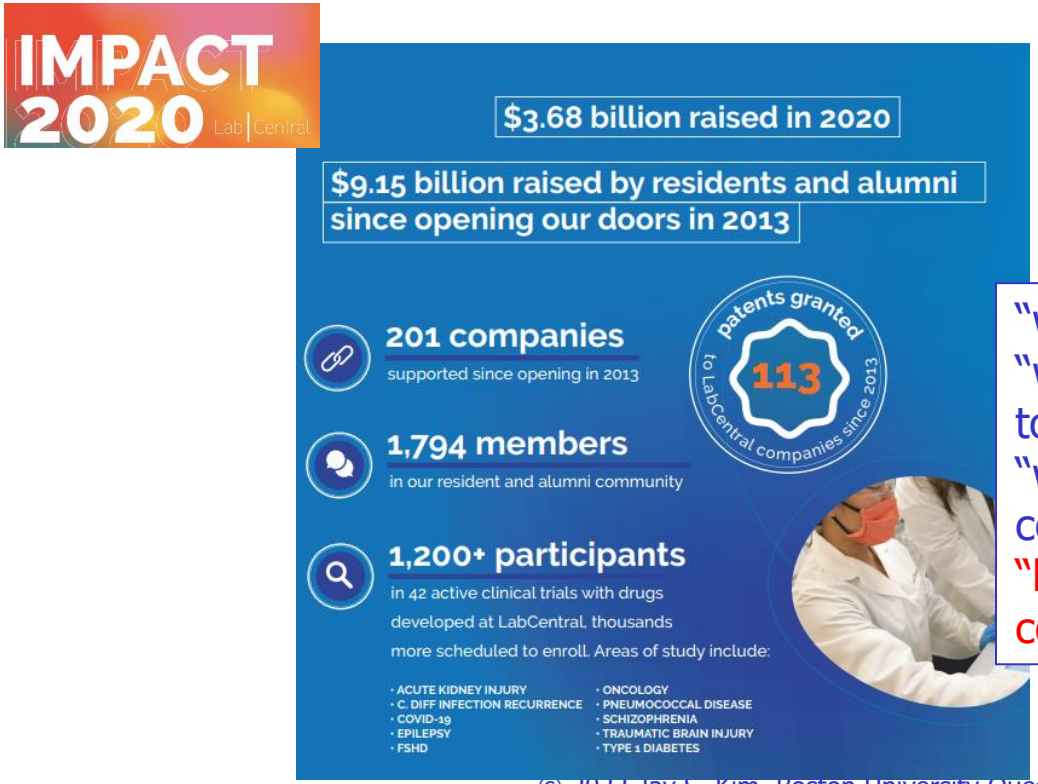
"Beyond the wildest dream" Impact

A signature institution in the Boston Bio Innovation Ecosystem



"we help them move faster"
"we help them improve the probability to succeed"
"we help them discover better commercial opportunities"
"by building a dynamic innovative community"

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What caused LabCentral's growth as a signature institution?

By Creating Values to Resident Startups, Sponsors, & Public Sector

Resident Startups – Customers

Sponsors – Investors

Government – Stakeholders

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LabCentral's Value Propositions

Creating Values to Resident Startups, Sponsors, & Public Sector

Resident Startups –
The Customers

1. Capital Efficiency

- Instead of $1-2 million CAPEX
- $4,000 per month per bench

2. Operating Efficiency

- Co-purchase of devices and materials
- Professional LC staff with technical & business expertise

3. Network Effect

- Collaboration among residents
- Big Pharma want to meet new startups
- Law firms and VC investors as well

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LabCentral's Value Propositions

Creating Values to Resident Startups, Sponsors, & Public Sector

Sponsors –
Buyers & Providers

1. Big Pharma

- Can visit 70+ promising startups regularly
- "Golden Ticket" to nominate particular startups
- Yes, Open Innovation

2. Equipment & Materials Co

- Future "big" customers
- Lead Users for new technology innovation

3. Capital Investors

- Due diligence as it is happening

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LabCentral's Value Propositions

Creating Values to Resident Startups, Sponsors, & Public Sector

Government – Stakeholders

1. State & Local governments

- Invite startups to your hub
- High-quality jobs
- And spill-over effects (best restaurants, international visitors,….)

2. Universities & hospitals

- Where is my science going?
- Recruiting best talents to your departments

3. Real estate & construction

- The district is rapidly being redeveloped

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Design of LabCentral

Operating Systems – Hardware & Software

Internal Design:
Open & Shared

External Design:
Located for Easy Access

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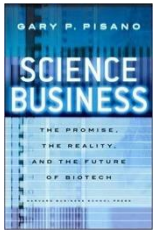
How does LabCentral do it?
"pushes and pulls innovation elements"

- "Our residents benefits the most from the opportunities to collaborate with co-residents, sponsors, and the local community in general.
- After graduating, most alumni move to another location near LabCentral with similar culture and infrastructure for collaboration.
- Indeed, when we evaluate future residents, we closely examine the team's ability and willingness to collaborate with others."



"Participants in the new bio innovation ecosystem need to establish a more intense long-term partnership, that goes beyond the current rush to open innovation or licensing model and enables them to assess confusing results from every discovery endeavor."

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Key "software" words from Johannes

Capital Efficiency

Operational Efficiency

Transparency

Proximity

Lab Central

Variety

Adaptability

Intentionality In Design

Minimize Frictions, Maximize Collisions

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QUESTROM MEANS BUSINESS.

Hidden Secret #2

OTM lessons (or just insights) from the story of LabCentral

1

Operational (and financial) focus of science startup – science, science, science.

Focus!

2

Commercialization of science requires close and honest collaboration with adjacent sciences and technologies.

Collaborate!

3

The efficiency and effectiveness of collaboration are accelerated by maximizing collision.

Experiment!

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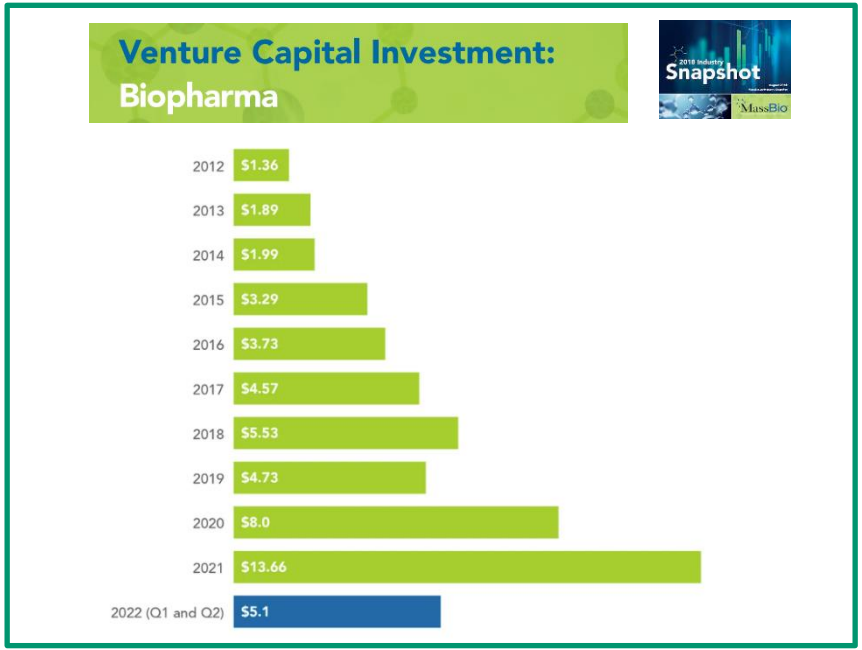
Hidden Secret #3

"Global pharmaceuticals move into the crowded space in Kendall Square, primarily attracted by burgeoning biotech startups."

Why?



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Merck's R&D Strategy 2006

"The basic science for drug discovery would require more collaboration with outside research partners to keep pace with changing technology"

Open Innovation

1. Aggressively recruit top scientific talent
2. Decentralize research facilities
3. Leverage in-house capabilities through external alliances

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GARY PISANO

Discovering the Future: R&D Strategy at Merck

As the year 2001 dawned, Dr. Edward Scolnick, president of Merck Research Laboratories (MRL), could not help but be optimistic about Merck's future. Revenues in 2000 had increased 23% while the industry's revenues as a whole were relatively flat.[1] Key growth products, particularly Vioxx®, Zocor®, Singulair®, Fosamax®, and Cozaar®/Hyzaar®, had established strong positions in their respective marketplaces. As a result, the company's revenue and earnings growth (18%) had surged, topping the industry, and the company's stock price had increased by 26% to $90.99. Even more exciting, Scolnick felt, was Merck's pipeline of new drug candidates. The company had five new drugs in advanced clinical trials, two vaccines with large sales potential in early trials, and several entirely new candidates in the early stages of development. Merck's CEO, Ray Gilmartin, noted to a group of the company's senior management in July 2000: "We have more chemical entities moving through early development than ever before in our history. This is the most productive time ever for Merck research." With the company on solid footing, Gilmartin believed that the time was ripe to, as he put it, "break away" from the rest of the pharmaceutical industry. One of the breakaway strategies that Gilmartin and Scolnick had outlined was to expand Merck's lead in cutting-edge science. While Merck had always had a reputation for outstanding scientific capabilities, Scolnick was well aware that the pharmaceutical industry was experiencing a scientific revolution unparalleled in the industry's history. From genomics and proteomics to genetically engineered therapeutic proteins and gene therapy, the basic science of drug discovery was changing. Scolnick commented:

> There's a veritable explosion in the growth of scientific knowledge in drug discovery. In the area of genomics, there are now a whole new set of technologies that can impinge on what we do in research. Target identification, screening, and even clinical trials will be altered by these. Exploiting these new technologies will require *really* different ways of thinking than we're used to.

The explosion of new knowledge that Scolnick referred to encompassed a vast constellation of technologies and was being spawned by hundreds, if not thousands, of academic research laboratories, government research institutions, and entrepreneurial ventures around the globe. Hardly a day passed without announcements of some major new scientific breakthrough.

[1] Major drug manufacturers' revenue growth was 0.3% for 2000, Media General Financial Services.

Professor Gary Pisano prepared this case in collaboration with Research Associate Ann Learned, and with assistance from Research Associates Kim Slack and Rodrigo Martinez. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

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Pfizer's Center for Therapeutic Innovation (CTI 2010)

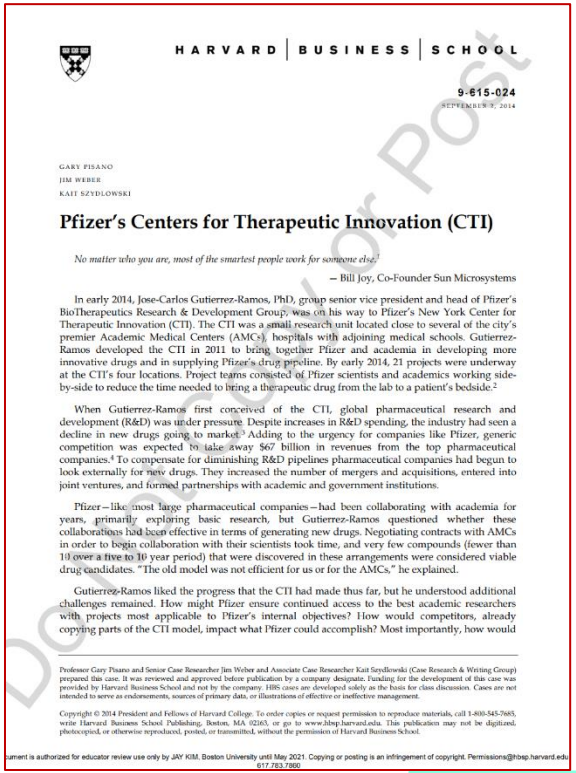
Small research labs where Pfizer researchers can collaborate with academics

Located in the biotech hotspots of Boston, New York, San Diego, and San Francisco

Built in close proximity to Academic Medical Centers

Staffed with Pfizer scientists including engineers, chemists, and project managers to bring CTI projects closer to their end goal of developing a new drug

Open Innovation



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SEPTEMBER 9, 2014

GARY PISANO
JIM WEBER
KAIT SZYDLOWSKI

Pfizer's Centers for Therapeutic Innovation (CTI)

No matter who you are, most of the smartest people work for someone else.[1]

– Bill Joy, Co-Founder Sun Microsystems

In early 2014, Jose-Carlos Gutierrez-Ramos, PhD, group senior vice president and head of Pfizer's BioTherapeutics Research & Development Group, was on his way to Pfizer's New York Center for Therapeutic Innovation (CTI). The CTI was a small research unit located close to several of the city's premier Academic Medical Centers (AMCs), hospitals with adjoining medical schools. Gutierrez-Ramos developed the CTI in 2011 to bring together Pfizer and academia in developing more innovative drugs and in supplying Pfizer's drug pipeline. By early 2014, 21 projects were underway at the CTI's four locations. Project teams consisted of Pfizer scientists and academics working side-by-side to reduce the time needed to bring a therapeutic drug from the lab to a patient's bedside.[2]

When Gutierrez-Ramos first conceived of the CTI, global pharmaceutical research and development (R&D) was under pressure. Despite increases in R&D spending, the industry had seen a decline in new drugs going to market.[3] Adding to the urgency for companies like Pfizer, generic competition was expected to take away $67 billion in revenues from the top pharmaceutical companies.[4] To compensate for diminishing R&D pipelines pharmaceutical companies had begun to look externally for new drugs. They increased the number of mergers and acquisitions, entered into joint ventures, and formed partnerships with academic and government institutions.

Pfizer—like most large pharmaceutical companies—had been collaborating with academia for years, primarily exploring basic research, but Gutierrez-Ramos questioned whether these collaborations had been effective in terms of generating new drugs. Negotiating contracts with AMCs in order to begin collaboration with their scientists took time, and very few compounds (fewer than 10 over a five to 10 year period) that were discovered in these arrangements were considered viable drug candidates. "The old model was not efficient for us or for the AMCs," he explained.

Gutierrez-Ramos liked the progress that the CTI had made thus far, but he understood additional challenges remained. How might Pfizer ensure continued access to the best academic researchers with projects most applicable to Pfizer's internal objectives? How would competitors, already copying parts of the CTI model, impact what Pfizer could accomplish? Most importantly, how would

Professor Gary Pisano and Senior Case Researcher Jim Weber and Associate Case Researcher Kait Szydlowski (Case Research & Writing Group) prepared this case. It was reviewed and approved before publication by a company designate. Funding for the development of this case was provided by Harvard Business School and not by the company. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

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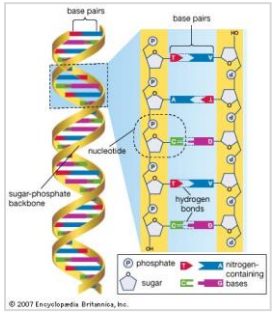
Sudden rush toward open innovation was planted by "The Biotechnology Revolution"

"In the mid-1970s, stunning biological breakthroughs set the stage for the modern biotechnology industry."

Genentech
A Member of the Roche Group



1976

Scientists could now cut and paste snippets of deoxyribonucleic acid (DNA), the blueprint of life and the longest known molecule in the universe.

By gaining the power to revise DNA and create new protein products, biologists in the laboratory could more precisely manipulate the primary biological molecules of life.

Part of the excitement stemmed from the fact that the traditional way of finding cures for diseases was extremely effort-intensive and expensive.

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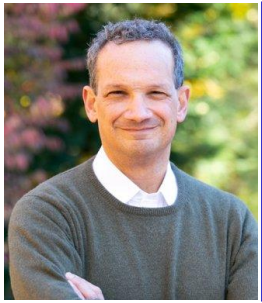
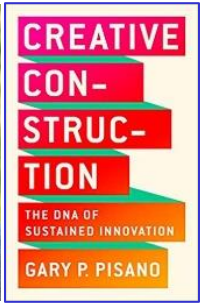
QUESTROM MEANS BUSINESS.

"Deep Dive into the Molecular Biology Revolution"

Technological innovations are happening in three interrelated processes of drug discovery





1. Search for therapeutic targets
2. Synthesis of potentially therapeutic compounds
3. Screening of compounds for the desired therapeutic activity

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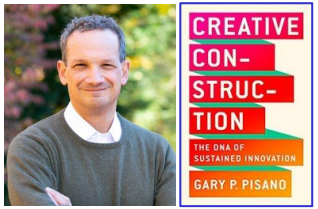

Search for therapeutic targets

- Historically, drug compounds had been found, not designed. Now the search begins with an attempt to understand the underlying biology of the disease.
- Currently 500 molecular targets. Potentially 5,000-10,000 targets.
- Genomics; functional genomics; systems biology
- "The problem is that nobody is trained in this stuff."

Synthesis of therapeutic substances

- Historically, isolated from natural sources or chemically synthesized. Now, vastly expanded techniques.
- Recombinant DNA (rDNA) – "large molecules" like recombinant insulin; Genentech and Amgen
- Monoclonal antibody (MAb) – "magic bullets" targeting specific "marker"
- Gene therapy – correct the basic problem by altering the genetic information of patient's cells
- Structure-based design
- Combinatorial chemistry

Screening compounds on targets

- Slow & labor-intensive; Bottleneck in the discovery process
- High Throughput Screening (HTS) – automated, robotic-based technology for testing vast number of new compounds against a large number of assays
- "Synergistic Effect" = HTS + Structure-based design + Combinatorial chemistry

QUESTROM MEANS BUSINESS.

"Deep Dive into the Molecular Biology Revolution"

Technological innovations are happening in three interrelated processes of drug discovery

Search for therapeutic targets	Synthesis of therapeutic substances	Screening compounds on targets
Historically, drug compounds had been found, not designed.	Historically, isolated from natural sources or chemically synthesized.	Slow & labor-intensive; Bottleneck in the discovery process
Currently 500 molecular targets. Potentially 5,000-10,000 targets.	Gene therapy – correct the basic problem by altering the genetic information of patient's cells	compounds against a large number of assays
Genomics; functional genomics; systems biology	Structure-based design	"Synergistic Effect" = HTS + Structure-based design + Combinatorial chemistry
"The problem is that nobody is trained in this stuff."	Combinatorial chemistry	

It is not a story of one major new technology.

Rather, a vast number of technologies were fundamentally altering the ways in which new drugs were discovered.

We have not seen all possibilities, yet!

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Molecular Biology Revolution & Challenges to the Big Pharma

"Scientific Revolution"

It is not a story of one major new technology.

Rather, a vast number of technologies were fundamentally altering the ways in which new drugs were discovered.

"Business Challenges"

"The problem is that nobody is trained in this stuff."

A massive scale of R&D would be necessary to exploit the vast opportunities offered by the molecular biology revolution

"Entrepreneurship Opportunities"

Different companies are making different technological "bets" on the future.

Organizations can follow many different strategies in drug discovery.

Successful drugs come from collaborations among many innovative research and development institutions.

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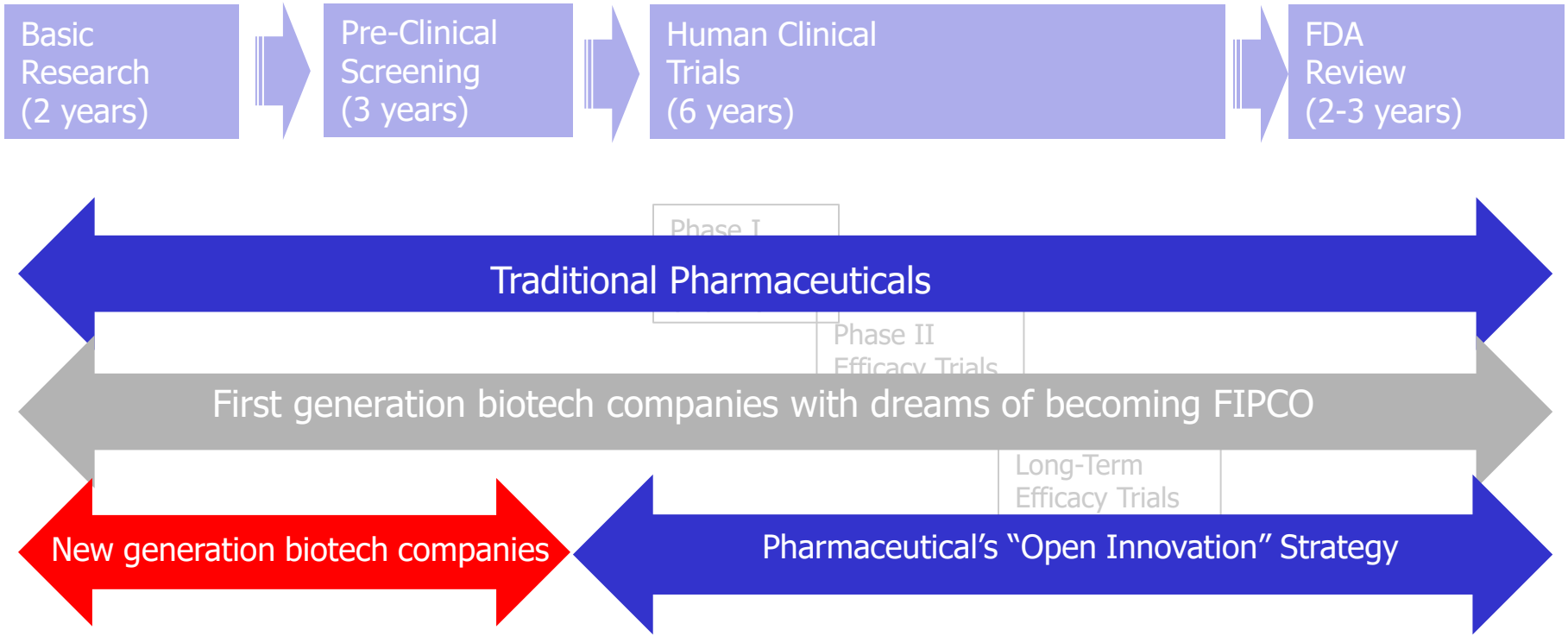
Dividing Roles between Pharmaceutical Companies and Biotech
"Value Chain Disintegration" Through Open Innovation



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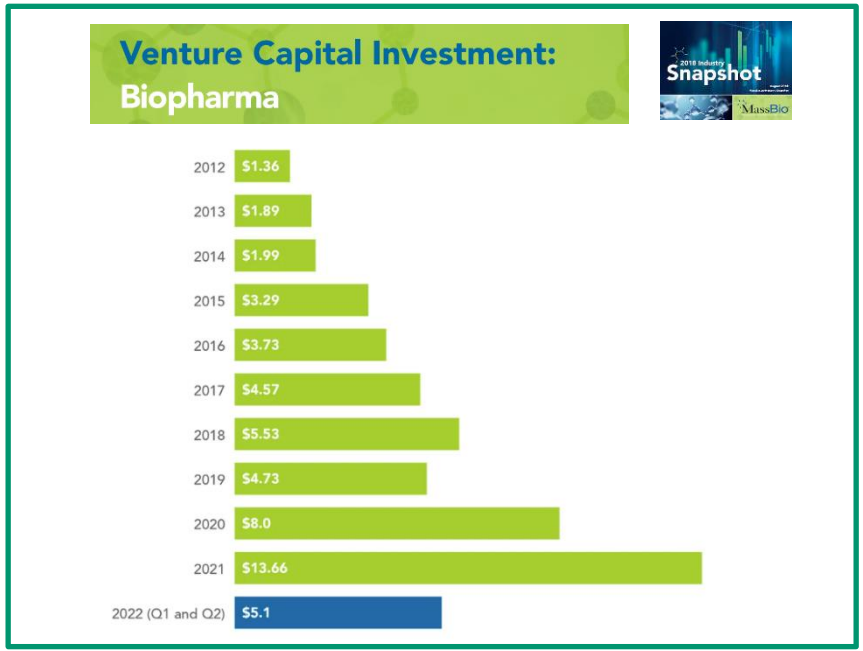
Hidden Secret #3

"Global pharmaceuticals move into the crowded space in Kendall Square, primarily attracted by burgeoning biotech startups."



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QUESTROM MEANS BUSINESS.

Hidden Secret #3

OTM Lessons (or Insights) from the story of Open Innovation

1

Big pharma as anchor stores for biotech hub

2

Big pharma wants "de-risked" breakthrough technologies.

Big pharma lacks systems and culture to engage in the early-stage de-risk process

3

Big pharma depends on size of the business initiatives

Startups need to figure out how their breakthrough technology can create a new platform

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Summary
Boston Bio Innovation Ecosystem is Still Evolving

Known Secret #1

Known Secret #2

Known Secret #3

Hidden Secret #1

Hidden Secret #2

Hidden Secret #3

Ecosystem Opportunity

Entrepreneurship Opportunity

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Lessons from Boston Bio Innovation Ecosystem: Suggestions for **OTM**

It is BIG!

It is somewhat different from our traditional fields of manufacturing and/or services

The field can definitely benefit from the existing operations theories and tools

It is currently managed (with mighty difficulties) by biologists and chemists (and medical doctors).

We need to upgrade our own understanding of molecular biology. Not too much, just a little.

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Lessons from Boston Bio Innovation Ecosystem: Invitations for **Interested OTM Researchers**

Study a company

– Pfizer, Moderna, Ginkgo Bioworks

Define a research agenda

– capacity strategy, project management, digital supply chain

Build a multidisciplinary team

– biologists, chemists, medical doctors

Teach with my case

"Global Rush to Produce Covid-19 Vaccine"

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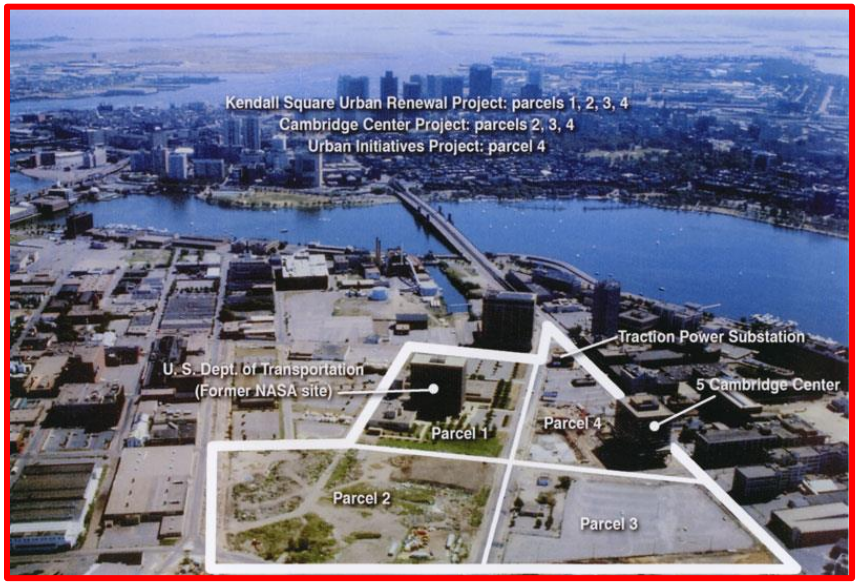
Boston Bio Innovation Ecosystem

It takes time! Yes, we do have time!



1980s

2022

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Thank You!

See You In Boston!

For more information,
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