Title: Deeptech Commercialization through Entrepreneurial Capabilities

Speakers: Elicia Maine

Series: Colloquium

Date: May 22, 2024 - 2:00 PM

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Abstract: Presented in collaboration with Navigating Quantum and AI Career Trajectories: A Beginner's Mini-Course on Computational Methods and their Applications

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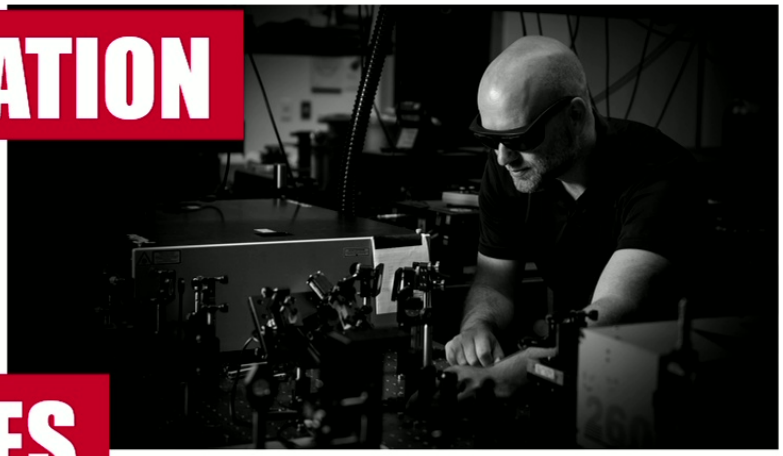
Deeptech or science-based innovations often spend more than a decade percolating within academic and government labs before their value is recognized (Park et al., 2022). This development lag time prior to venture formation is only partly due to technological development hurdles. Because science-based inventions are often generic in nature (Maine & Garnsey, 2006), meaning that they have broad applicability across many different markets, the problem of identifying a first application requires the confluence of deep technical understanding with expert knowledge of the practice of commercialization. This process of technology-market matching is a critical aspect of the translation of science-based research out of the lab (Pokrajak 2021, Gruber and Tal, 2017; Thomas et al, 2020, Maine et al, 2015) and is often delayed by a lack of capacity to identify, prioritize and protect market opportunities. Typically, deeptech innovations can take 10-15 years of development, and tens (or even hundreds) of millions of dollars of investment to de-risk before a first commercial application (Maine & Seegopaul, 2016). Academics seeking to commercialize such inventions face the daunting challenge of competing for investment dollars in markets that are ill suited to the uncertainty and timescales of deep tech development. The time-money uncertainty challenge faced by science-based innovators is compounded by the fact that most of the scientists and engineers with the world-leading technical skills required to develop science-based inventions, lack innovation skills training, and so cannot navigate the complexities of early and pre-commercialization development critical to venture success. Some researchers, having developed a mix of technical and business expertise, have demonstrated a long-term ability to serially spin out successful ventures (Thomas et al., 2020). Entrepreneurial capabilities, which can be learned, enable scientistentrepreneurs to play formative roles in commercialising lab-based scientific inventions through the formation of well-endowed university spin-offs. (Park et al, 2022; 2024). Commercialization postdocs, when supported by well designed training, stipends, and de-risking supports, can lead the mobilization of fundamental research along multiple commercialization pathways. Recommendations are provided for scholars, practitioners, and policymakers to more effectively commercialise deeptech inventions.

Zoom link

DEEPTECH COMMERCIALIZATION THROUGH ENTREPRENEURIAL CAPABILITIES



Dr. Elicia Maine
W.J. VanDusen *Professor of Innovation and Entrepreneurship*
Associate Vice President, Knowledge Mobilization & Innovation
Simon Fraser University

Perimeter Institute Colloquium
Waterloo, May 22, 2024

Prof Jon Thomas, UFV, Canada

Dr Martin Bliemel, UTS, Australia

Dr Cynthia Shippam, NRC-IRAP ITA

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Endowing university spin-offs pre-formation: Entrepreneurial capabilities for scientist-entrepreneurs

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O34
O38
M13
I23

ABSTRACT

University spin-offs are important mechanisms for creating and capturing value from scientific inventions. Academic scientists are uniquely positioned to shape such opportunities long before the university spin-off is founded. To better understand how science-based university spin-offs can be endowed for success, the *pre-formation* stage of 30 ventures co-founded over a 40 year period by a star-scientist-entrepreneur is analysed by matching his 363 co-invented US patents granted to 1476 co-authored publications and these 30 ventures. Employing the extended case method, including the analysis of extensive archival data, iterative interviews, and this unique, longitudinal, multi-level dataset, existing dynamic capabilities theory is confronted and extended with evidence as to how a star-scientist-entrepreneur senses and shapes and seizes opportunities to endow university spin-offs pre-formation. A process model is developed depicting four pre-formation entrepreneurial capabilities with which these science-based university spin-offs are endowed for success. Recommendations are made for scientist-entrepreneurs, investors, university leadership, and for innovation policymakers.

Dr Purnesh Seegopaul,
Pangaea Ventures

Prof Jon Thomas,
UFV, Canada

NATURE MATERIALS | VOL 15 | MAY 2016 | www.nature.com

Accelerating advanced-materials commercialization

Elicia Maine and Purnesh Seegopaul

Long commercialization times, high capital costs and sustained uncertainty deter investment in innovation for advanced materials. With appropriate strategies, technology and market uncertainties can be reduced, and the commercialization of advanced materials accelerated.

NATURE NANOTECHNOLOGY | VOL 12 | FEBRUARY 2017 | www.nature.com/naturenanotechnology

commentary

Raising financing through strategic timing

Elicia Maine and V. J. Thomas

Strategic timing can be key for nano-drug-delivery ventures to get financing. Timely publications engage potential partners; early broad, blocking, relevant patents demonstrate the potential to appropriate value; and venture formation closer to clinical viability better aligns its timeline with that of venture capitalists.

Prof. Andrew Park, UVIC, Canada

Prof. Jon Thomas, UFV, Canada

Dr Azadeh Goudarzi, Integrated Nanotherapeutics

Dr Pegah Yaghmaie, SFU, Canada

NATURE NANOTECHNOLOGY Vol 17 August 2022 802-816

comment

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Rapid response through the entrepreneurial capabilities of academic scientists

Academic scientists who develop entrepreneurial capabilities can make strategic, path dependent decisions that enable university spin-offs to rapidly respond to global crises.

Andrew Park, Azadeh Goudarzi, Pegah Yaghmaie, Varkey Jon Thomas and Elicia Maine

Academic scientists play a central role in the production and translation of breakthrough scientific inventions through the formation of university spin-offs[1–3]. Well-endowed science-based ventures, attracting resources and advancing novel capabilities, can rapidly respond to pressing global health and humanitarian crises such as COVID-19[4]. Policymakers are highly motivated to leverage university science for the dual purpose of solving emerging challenges and increasing economic productivity[4–9]. Yet scholars suggest that, despite increasing investment by the United States government in university research, innovation ecosystem growth is lower today than it has been in the previous four decades[10,11].

Using evidence from the University of British Columbia (UBC) nanomedicine spin-off AbCellera Biologics Inc. (AbCellera), which was the first to co-develop an antibody therapeutic for COVID-19, we examine the capabilities enabling an academic scientist–entrepreneur to respond rapidly to health and humanitarian crises and create economic and social impact. We argue that well-endowed university spin-offs can leverage and extend entrepreneurial

Entrepreneurial capabilities and path-dependent decisions

Recent research[4] suggests that there are four pre-formation entrepreneurial capabilities that lead to well-endowed university spin-offs. This research is rooted in dynamic capabilities theory[13], which posits that some firms exhibit heightened performance due to their ability to leverage unique sensing and shaping and seizing capabilities. Subsequent literature has extended this theory to the level of the individual entrepreneur[14], and more specifically, scientist–entrepreneurs who form university spin-offs[4]. Academic scientists have underappreciated agency to shape commercialization opportunities, particularly in the years prior to venture formation[15,16]. Early path dependent decisions made by scientist–entrepreneurs are critical to post-formation firm success[4], for example, through sensing and shaping capabilities such as technology-market matching[17,18] and seizing capabilities such as claiming and protecting the invention, attracting and mentoring the founding team, and strategic timing of firm-formation[2,19,20]. While empirical research related to dynamic capabilities theory has largely focused on firms post-formation, we demonstrate, through an extended case study, that path-dependent, pre-formation decisions

a highly novel microfluidic technology, which forms the foundation of AbCellera's antibody discovery platform and was their entry point into the antibody therapeutic market. This microfluidic technology, along with antibody-focused research produced by his graduate students in the mid-2000s and later supported by Canadian government science grants related to antibody discovery, indicates that Hansen had already targeted the antibody market for his microfluidic technology long before AbCellera's formation in 2012, demonstrating the first entrepreneurial capability, technology-market matching. Hansen further demonstrated prioritization of the antibody market when he negotiated a "worldwide, exclusive license to the… Technology solely within the Antibody Field of Use"[21] with UBC. This early prioritization of the antibody market by Hansen enabled AbCellera to rapidly develop bamlanivimab. A timeline of the path-dependent decisions described in this section, along with other notable milestones and the demonstration of Hansen's entrepreneurial capabilities, is presented in Fig. 1.

Early patenting and high-quality research publications facilitate science commercialization through university spin-offs[3,4,22]. We find evidence of Hansen

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UVIC, Canada

Prof. Jon Thomas,
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Nanotherapeutics

Dr Pegah Yaghmaie,
SFU, Canada

The role of pre-formation intangible assets in the endowment of science-based university spin-offs

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Abstract: Science-based university spin-offs face considerable technology and market uncertainty over extended periods of time, increasing the challenges of commercialisation. Scientist-entrepreneurs can play formative roles in commercialising lab-based scientific inventions through the formation of well-endowed university spin-offs. Through case study analysis of three science-based university spin-offs within a biotechnology innovation ecosystem, we unpack the impact of *pre-formation* intangible assets of academic scientists (research excellence, patenting, and international networks) and their entrepreneurial capabilities on spin-off performance. We find evidence that the pre-formation entrepreneurial capabilities of academic scientists can endow science-based university spin-offs by leveraging the scientists' pre-formation intangible assets. A theory-driven model depicting the role of pre-formation intangible assets and entrepreneurial capabilities in endowing science-based university spin-offs is developed. Recommendations

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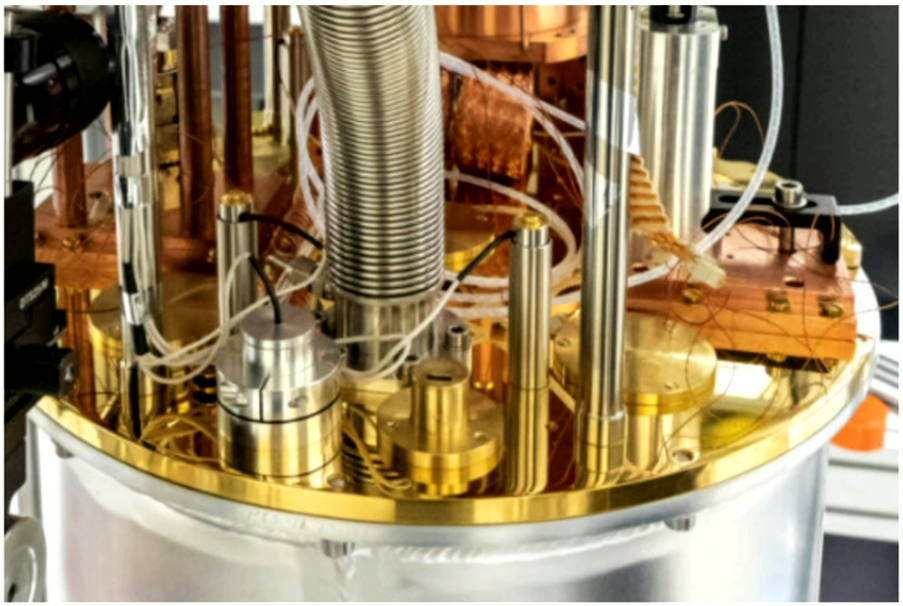

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photonic

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Photonic – Simmons Lab

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Photonic - CEO and i2I Mentor

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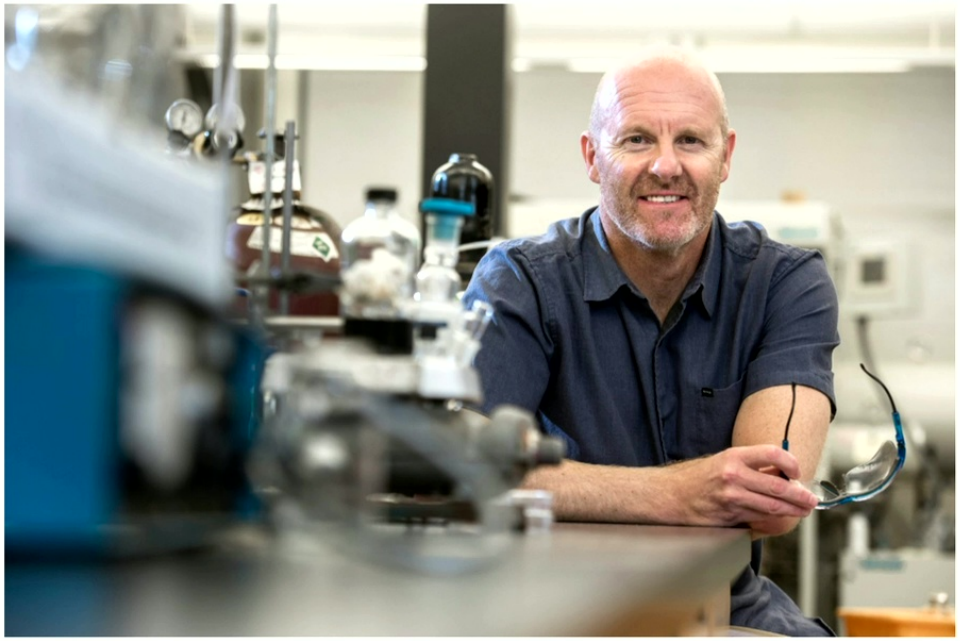
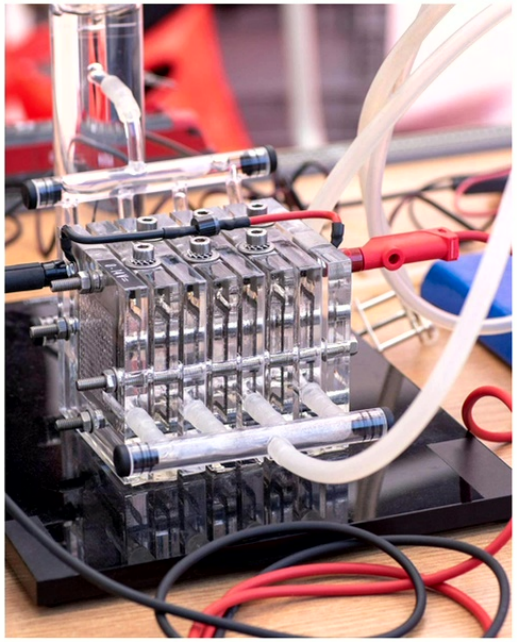
Ionomr - Holdcroft Lab





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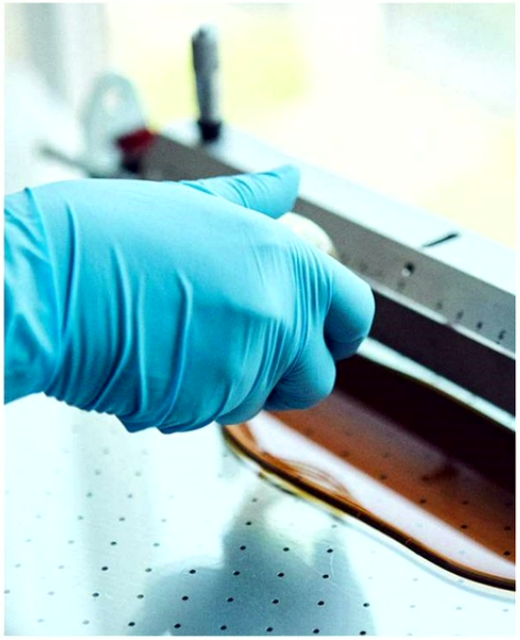
Ionomr - Co-Founding PhD



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Radical Innovation

A technology which enables vast improvements in current performance attributes (i.e. 5-10x), or entirely new attributes, and/or a substantial (30%-50%) reduction in cost per unit.

Utterback 1994; Liefer et al., 2000; Maine, 2008

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Generic Technology

A technology which enables applications across several sectors of the economy.

General Purpose technology
Platform Technology across Industries

Arora et al, 2001; Nerkar and Shane, 2003; Shane, 2004; Maine & Garnsey, 2006

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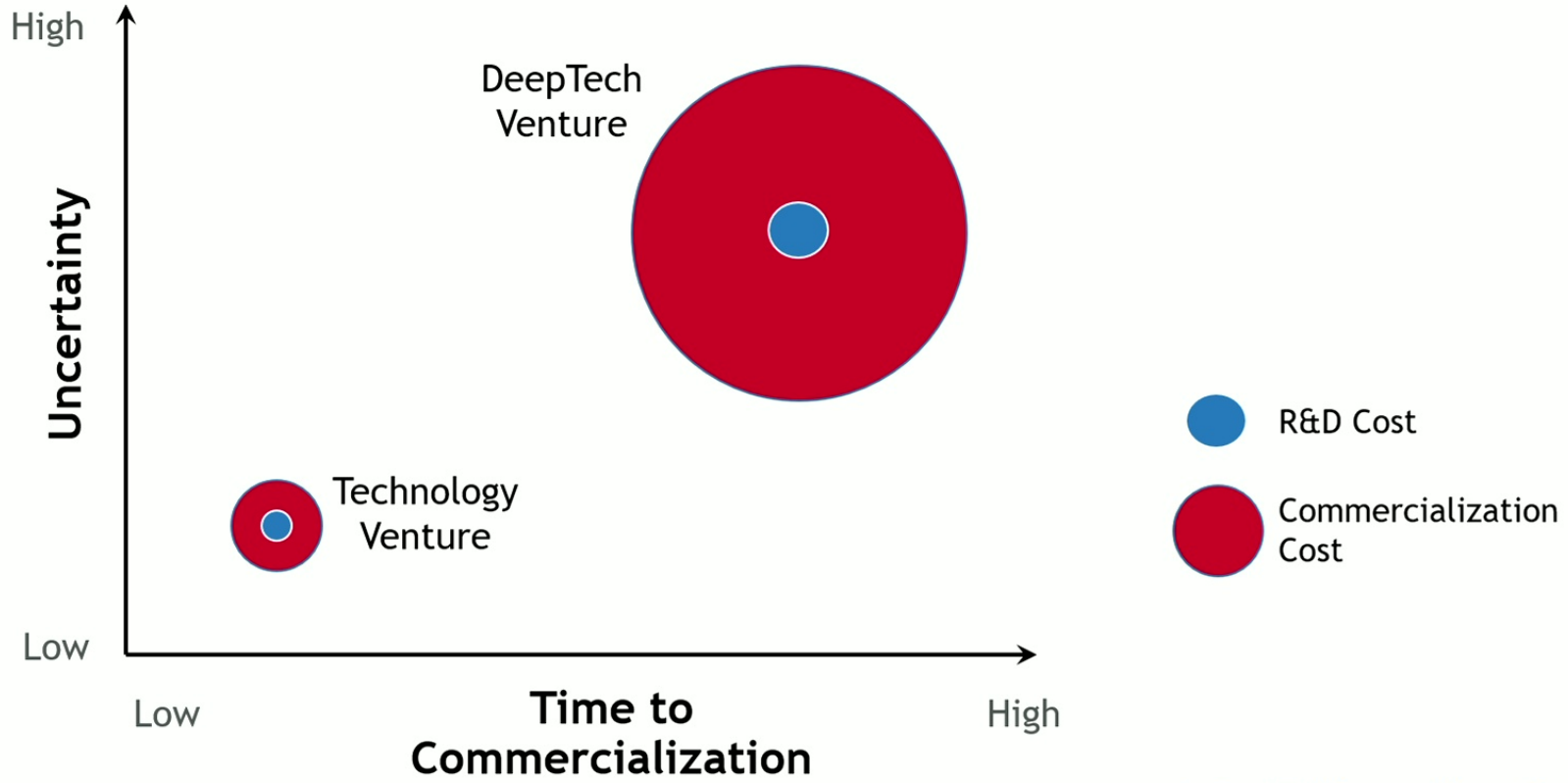
Commercialization Challenges for Science Innovation



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Science Innovation Costs, Timelines and Uncertainty

	Development Time (years)	R&D Costs ($ millions)	Commercialization Costs ($ millions)	Technology Uncertainty	Market Uncertainty
IT	0-2	0-3	1-10	LOW	MEDIUM
Biomed	10-15	5-10	300-900	VERY HIGH	MEDIUM
Advanced Materials	5-15	2-20	50-500	HIGH	HIGH

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Source: Maine and Seegopaul (2016) **Nature Materials**

https://www.nature.com/articles/nmat4625

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Star-Scientist-Entrepreneur: Prof Bob Langer

- > 30 ventures
- > 1400 papers
- > 170,000 citations
- > 360 US patents issued
- Patents licensed to > 300 companies
- helped billions of patients

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Methodology

- Inductive case-based model of the role of Star Scientists in the commercialization processes of university spin-offs

- Mixed Method Longitudinal Analysis
  - Exemplar scientist-entrepreneur
  - 363 issued US patents matched to 1476 papers
  - 363 patents matched to 30 ventures
  - Extensive primary and secondary data analysis

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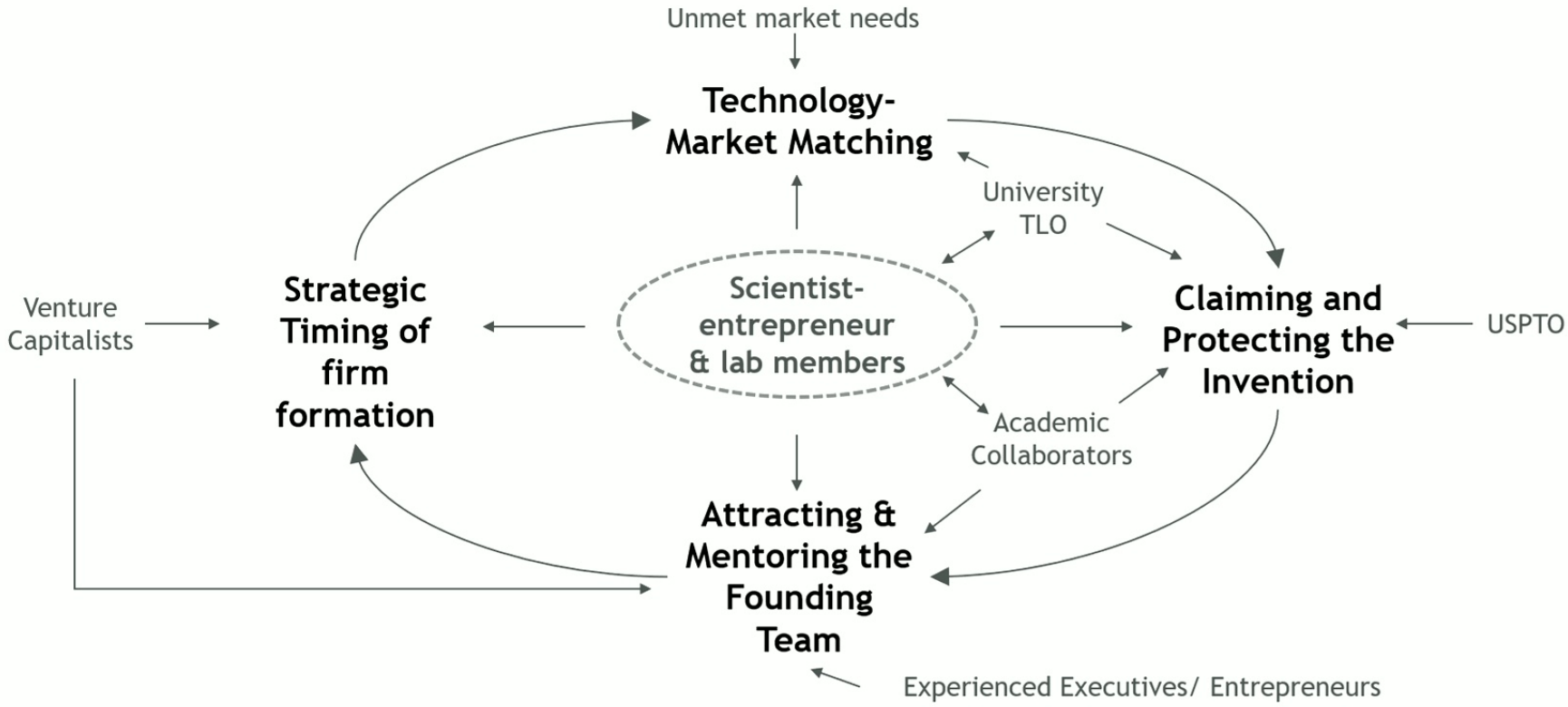
Endowing University Spin-offs Pre-Formation



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Source: Thomas, Bliemel, Shippam-Brett, and Maine, 2020
https://www.sciencedirect.com/science/article/pii/S0166497218307302

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Dr. Carl Hansen, Co-founder & CEO

AbCellera

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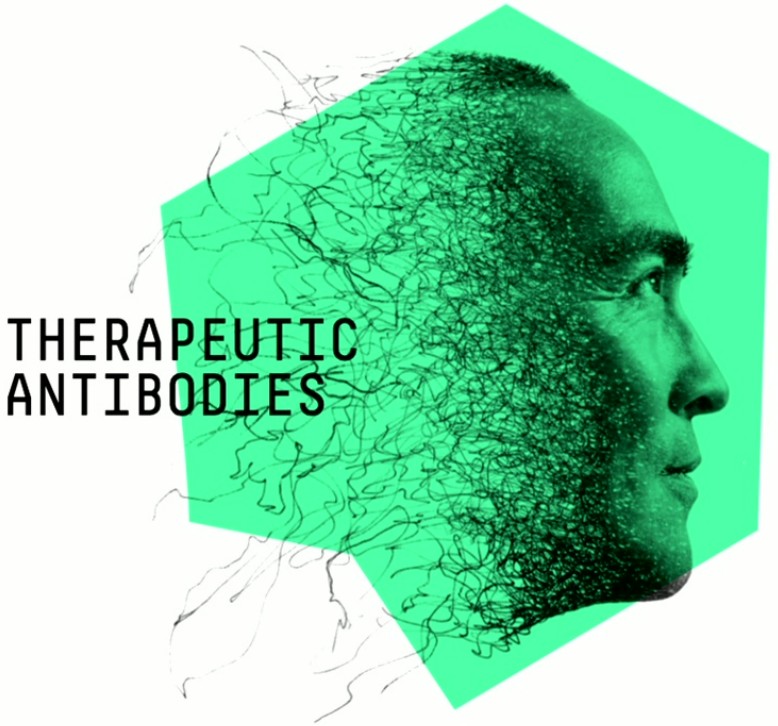

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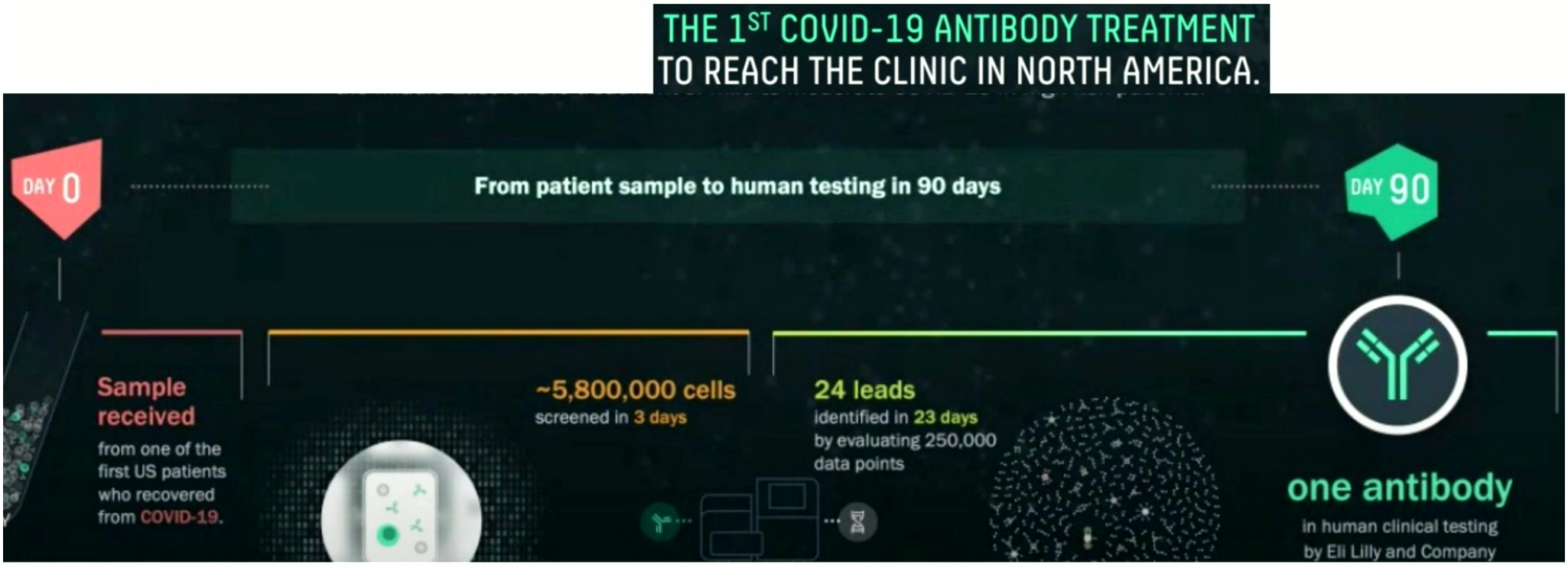
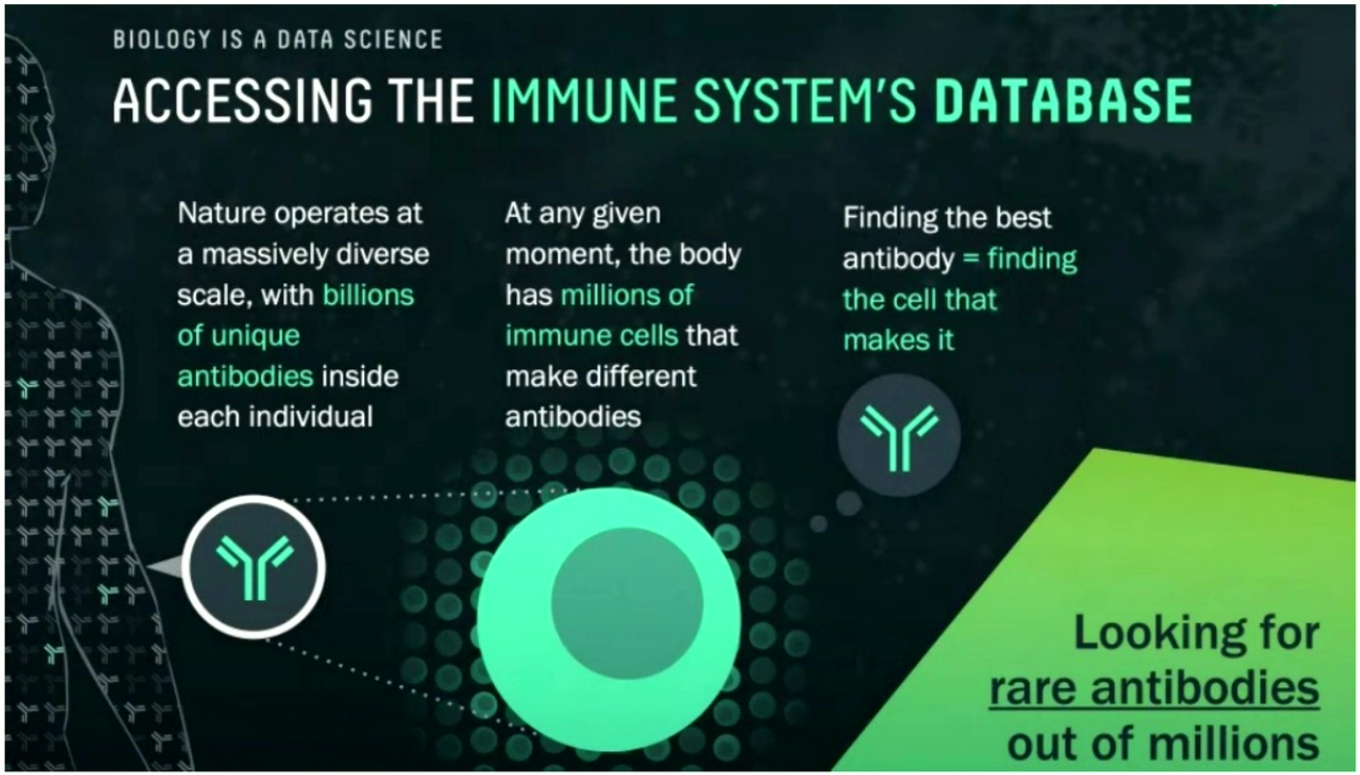
Abcellera's AI enabled antibody discovery



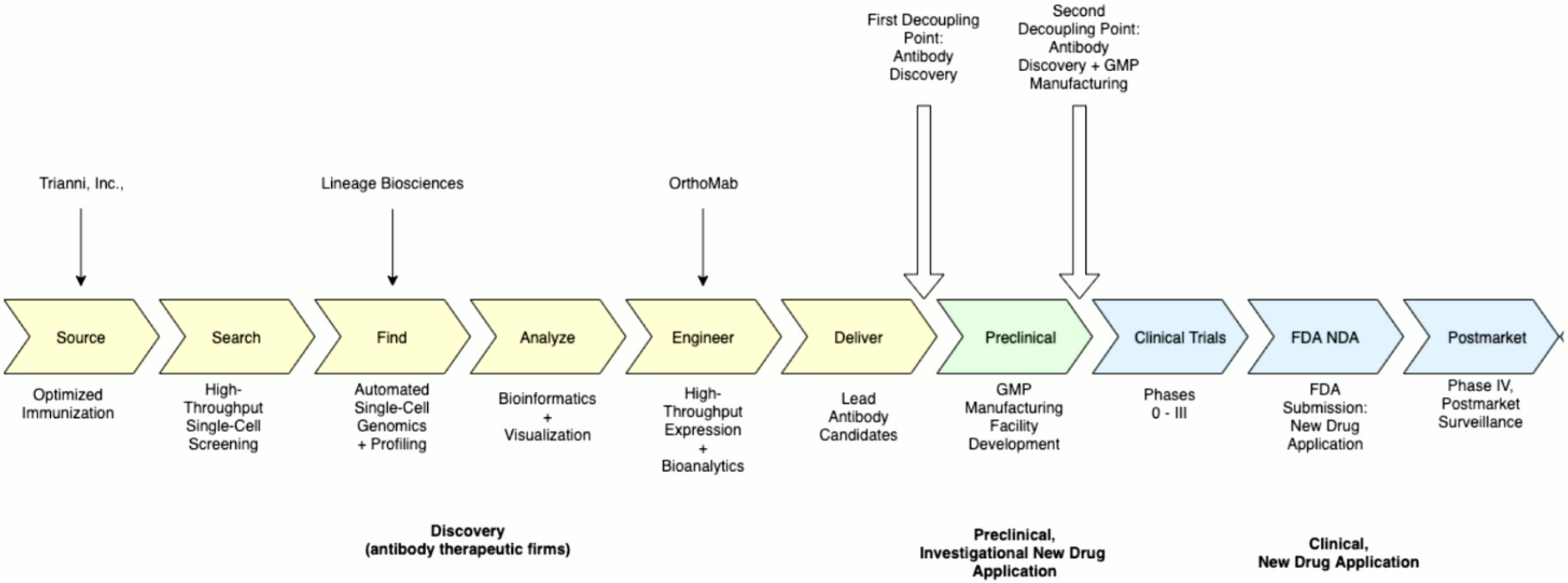
Source: Hughes, 2021 https://www.youtube.com/watch?v=9v38lwvlsgc

Opportunities for AI in Biomed



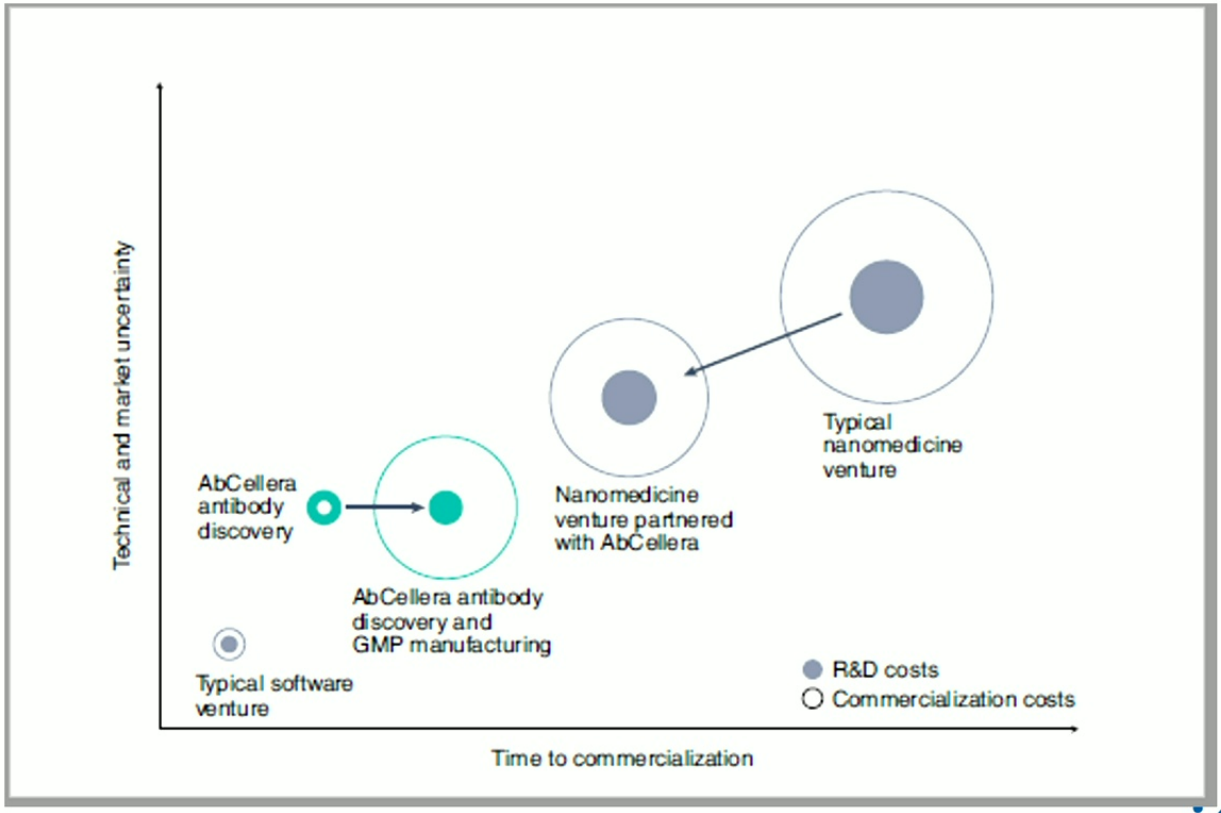
Source: Hughes, 2021

Creating New Value in Therapeutics

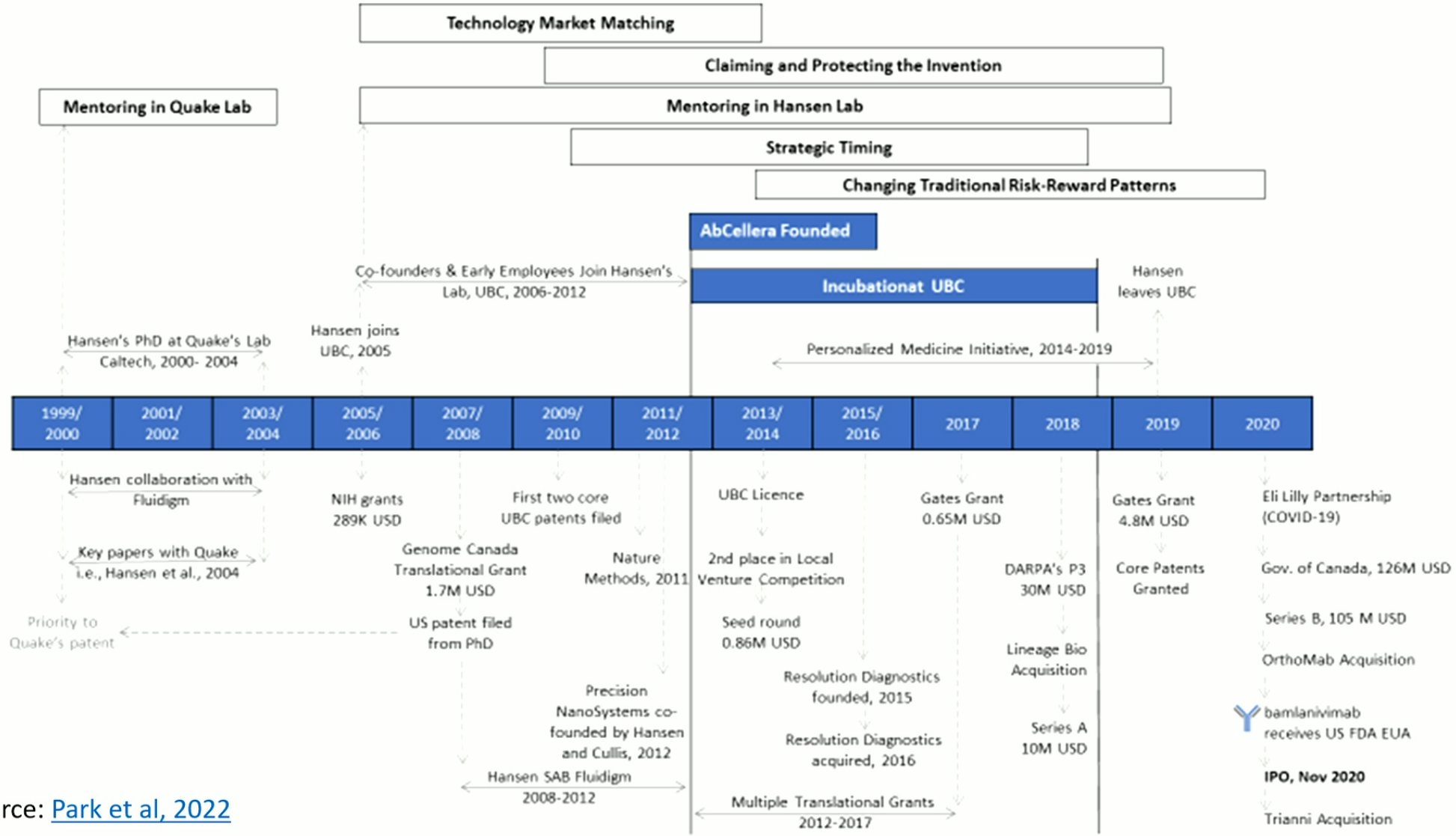


Source: Park et al, 2022

Changing Traditional Risk-Reward



Source: Park et al, 2022



Source: [Park et al, 2022]

Claiming and Protecting the IP

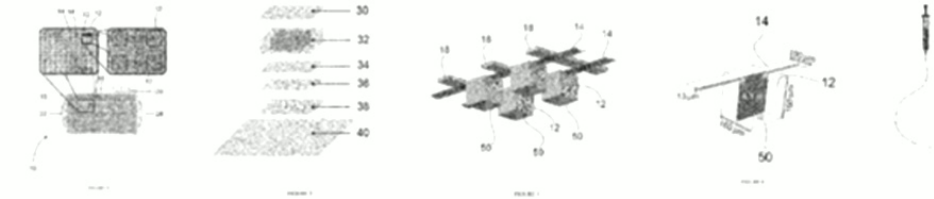
- Key microfluidics paper 7 years before firm formation
- Key patents 2 years before firm formation
- Important for investor signaling, not just IP

System and method for microfluidic cell culture

Abstract

Microfluidic devices and methods for perfusing a cell with perfusion fluid are provided herein, wherein the gravitational forces acting on the cell to keep the cell at or near a retainer or a retaining position exceed the hydrodynamic forces acting on the cell to move it toward an outlet.

Images (21)



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Attracting and Mentoring the Founding Team

Véronique Lecault, PhD
Director & COO

Kathleen Lisaingo, PhD
Director, Discovery Technologies

Kevin Heyries, PhD
Director of Emerging Science & Technologies

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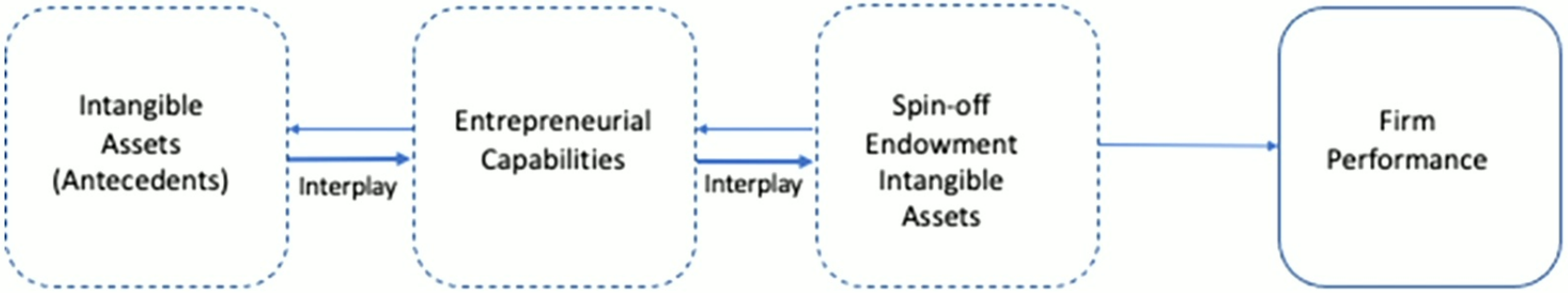
Early Stage IP Strategy Enables Economic and Social Value Creation



- Academic co-founder human capital (Research Excellence)
- Academic co-founder Intellectual Property (Pre-formation Patents)
- Academic co-founder social capital (International Networks)

- Technology Market Matching
- Claiming & Protecting the Invention
- Attracting & Mentoring the Founding Team
- Strategic Timing of Firm Formation

- Market prioritization
- Co-development / beta-testing, and/ or initial customers from scientist' international network
- Pre-formation Spin-off patents
- Pre-formation Spin-off papers
- Mentored scientist employees

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Source: Park et al, 2023
https://www.inderscience.com/info/ingeneral/forthcoming.php?jcode=ijtm

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Entrepreneurial Capabilities Enable Scientists to:

1) Found “well-endowed” science-based university spinoffs
   - **scientist-entrepreneur path**

2) Increase science-based innovation in Industry
   - **champions of innovation path**

3) Increase meaningful translational research in academia
   - **translational scientist path**

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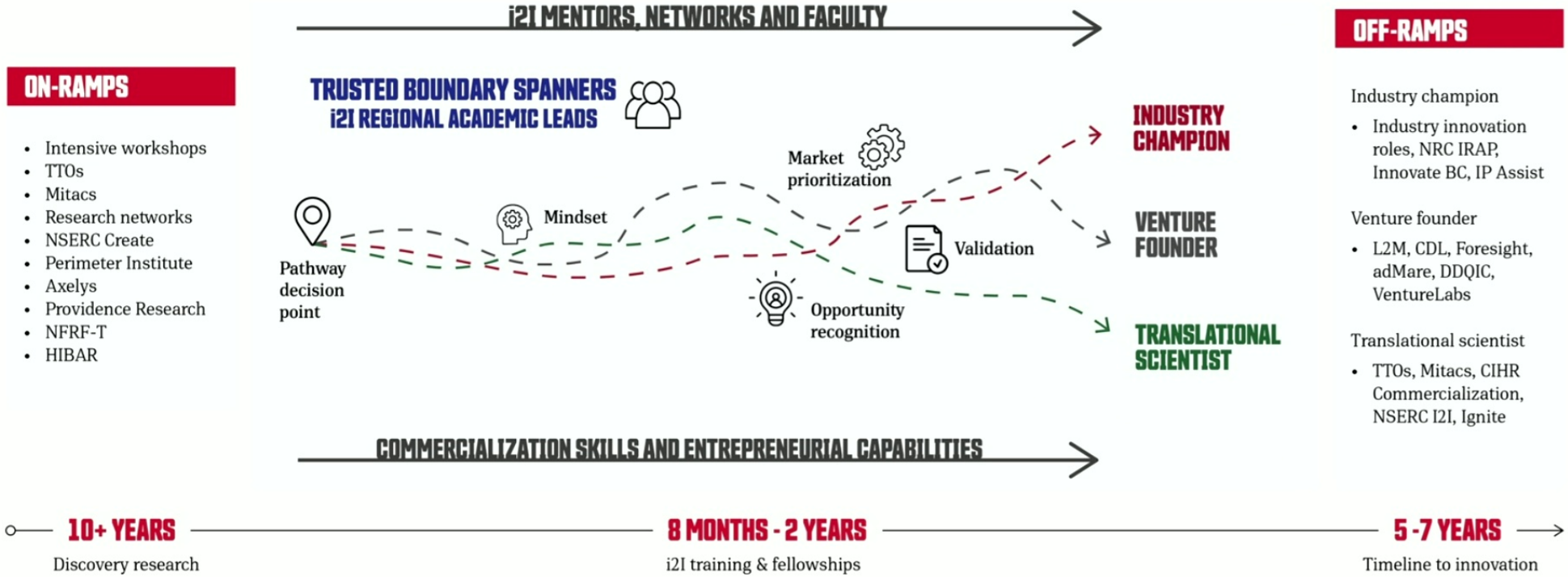

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The 3 Pathways

Scientist Entrepreneur Path

Dr. Benjamin Britton
Chief Strategy Officer, Ionomr Innovations Inc.

Dr. Morgan Lehtinen, *Co-Founder RXN-Hub*

Dr. Meysam Taghinasab
Co-Founder BioSam

Champions Of Industry Innovation Path

Dr. Anat Feldman
Senior Business Development Officer, STEMCELL Technologies

Dr. Rahul Singh
Director, BC Centre for Agricultural Innovation (BCCAI)

Dr. Ryan Jansonius
Battery materials, Telescope Innovations, Corp.

Dr. Sogol Borjian
Vice President, Chemistry & Target Manufacturing at ARTMS Inc.

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The 3 Pathways

Translational Scientist Path

Dr. Finlay MacNab
SFU Clean Hydrogen Hub

Dr. Lupin Battersby,
Knowledge Mobilization Director, SFU

Dr. Sasan Grayli
Research Associate, Institute for Quantum Computing, UWaterloo

Jasneet Kaur
Assistant Professor, Physics & Engineering, Brock University

Dr. Nabil Shalabi
Postdoctoral Researcher Harvard, MIT

Dr. Paul Omelchenko
Postdoctoral Researcher Physics, SFU

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Choosing and Framing your Innovation Idea

- Think of 3 innovation ideas related to your research
- Write down each idea in one sentence and the reason it could create value in a second sentence
- Can you envision how it could enable new and desirable products or services?
- Which innovation idea excites you the most?

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Provincial Collaborators
innovate BC
axelys
Development & Transfer
of Quebec Innovation
Providence Research
We're all in.
fraserhealth
Better health. Best in health care.
Coast Capital innovationCentre
UBC
entrepreneurship@UBC
ySpace
YORK UNIVERSITY
SBME UBC
SCHOOL OF BIOMEDICAL ENGINEERING
CONESTOGA
i2I
invention to innovation
National Collaborators
mitacs
PERIMETER INSTITUTE
NMIN
HRA
HIBAR Research Alliance
FORESIGHT CANADA
STEMCELL TECHNOLOGIES
GreenCentre Canada
changing chemistry, changing the world
PRINCETON UNIVERSITY
adMare
BIOINNOVATIONS
CSPC
UNIVERSITY OF THE FRASER VALLEY
ESPOSITO FAMILY CENTRE FOR INNOVATION & ENTREPRENEURSHIP
INMR INNOVATIONS
BLG
VIRIDIS RESEARCH
National Network
SFU
UNIVERSITY OF ALBERTA
UNIVERSITY OF WATERLOO
Queen's UNIVERSITY
POLYTECHNIQUE MONTRÉAL
UNIVERSITÉ LAVAL
DALHOUSIE UNIVERSITY
MEMORIAL UNIVERSITY