BIOCONVERGENCE

December 2022

A comprehensive insight into bioconvergence tendencies in the US and Israel

INNOVATION CENTRE DENMARK BOSTON

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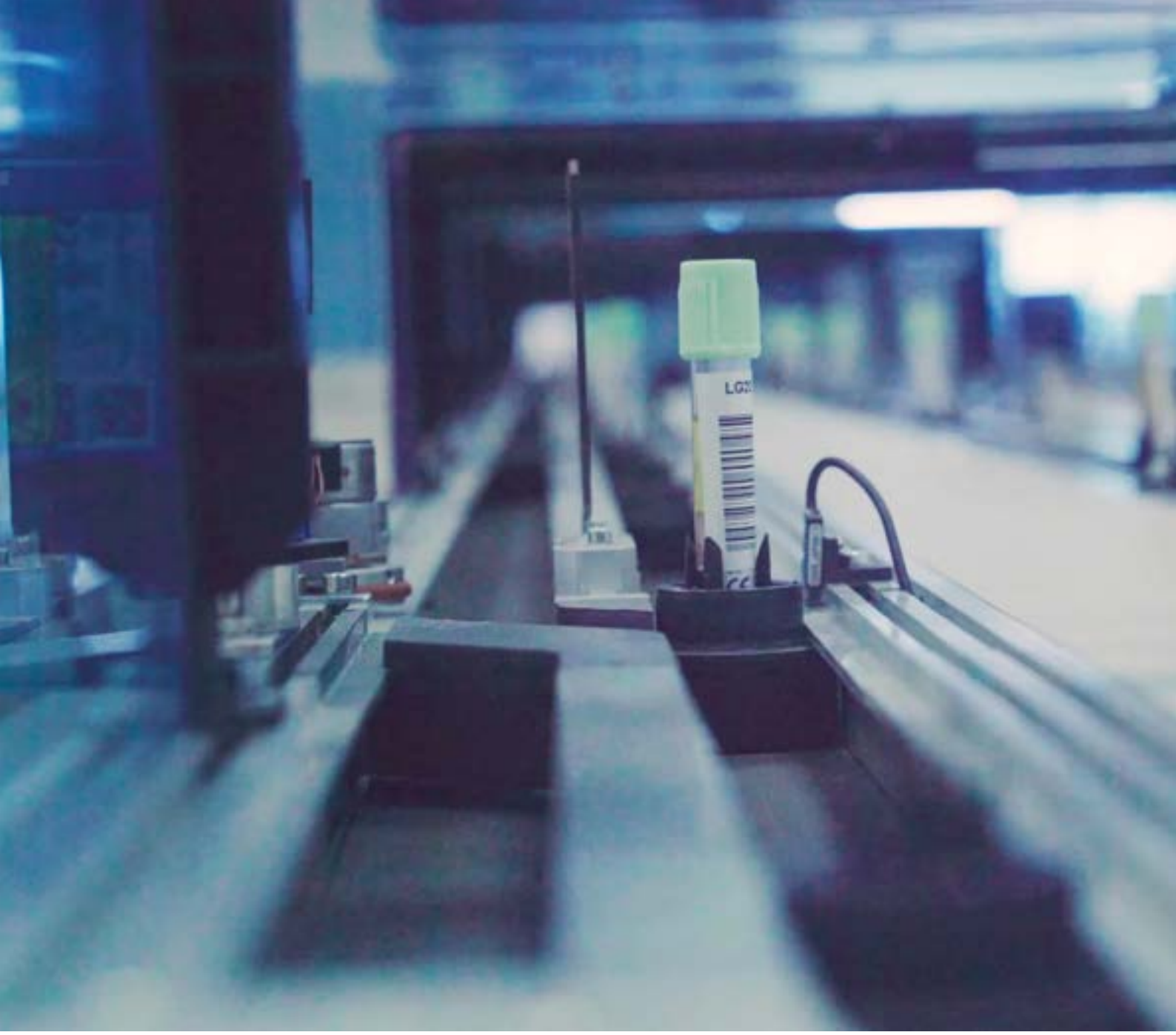

EXECUTIVE SUMMARY

In recent years, global health and life science have been undergoing a revolution driven by three main factors: first, the global health systems and bio-pharm industry crisis caused by the sharp increase in health expenditures and in the development costs and time of new treatments. The second factor relates to recent breakthroughs in the fields of engineering, tech, AI, biology and medicine. The third factor is the COVID19 crisis where global pressure has accentuated cross collaboration between both sectors and countries and opened up for new and faster innovative solutions as well as international collaborations and partnerships. This revolution is fostering a new multidisciplinary approach within life science and health innovation spearheaded globally »

» by the Boston ecosystem in the United States and Israel.

To truly make a difference and forge new paths for solving the most impacting health challenges of today and tomorrow, the life science industry and healthcare systems are facing radical changes both in terms of patients' needs and unmet needs as well as new ways of delivering care. Global health expenditure continues to rise dramatically and is expected to reach ten trillion dollars in 2022 due to, amongst others, increased life expectancy leading to a global ageing population alongside an explosion in chronic diseases such as cancer, heart disease and diabetes.

The world leading ecosystems within life science and health innovation have for a number of years cultivated cross collaboration and multidisciplinary approach responding to unmet medical needs - gene therapy, regenerative medicines, personalised medicines, bio-robotics are emerging new fields, that will shape tomorrow's solutions for patients globally. They are all born/based on the synergies between different technologies from the fields of biology, engineering, computational science, mathematics, nanotechnologies, tissue engineering, known as bioconvergence.

Bioconvergence is about how an entire ecosystem, and its' players systematically collaborate with no boundaries from the very beginning of fundamental research to the commercialising of innovation - involving universities, government, industry, entrepreneurs, hospitals and investors.

This report gathers key learnings from Israel and the US and includes an analysis of the main identified pillars of successful bioconvergence ecosystem – seen from the perspective of Academics, Governments, Industries, Investors, Entrepreneurs, Accelerators.

Denmark is today amongst some of the leading life science countries in the world. In order to maintain a leading position in the coming years and to sustain its life science economy, it is crucial to establish a successful model of bioconvergence in the Danish ecosystem. Denmark is already working with identifying ways of cross-disciplinary research collaboration. A recent report from DFIR - "Interdisciplinarity and Diversity in Research and Innovation"- emphasises the need for interdisciplinarity in research and innovation as a means to meet major societal challenges and achieving detailed, effective and useable knowledge. The DFIR report's examination of some of the elements enhancing the ability of interdisciplinarity to succeed also covers the challenges and barriers involved. Understanding and learning from the Israeli and Boston ecosystems about the components and their stakeholders, dynamics, challenges and opportunities will hopefully accelerate and de-risk this journey for Denmark.

New collaboration models, change of mind-set, breaking down silos and a true partnership culture are keys to successfully implement bioconvergence as an ecosystem.

Denmark has the potential to become an interesting partner for world-leading bioconvergence ecosystems as Boston and Israel and potentially become one of the global frontrunners.

We have gathered key stakeholders from the Danish ecosystem in a sounding board to identify strongholds and weakness in Denmark in relation to implementation of bioconvergence in an open dialogue with global leaders from BARDA, Israeli Innovation Authority, Wyss Institute, Pfizer, Johnson & Johnson, AION Labs, Technion Institute just to mention a few.

The ambition is to continue a strategic collaboration with key stakeholders in Israel and the US to elaborate a roadmap for nurturing a bioconvergence approach in the coming years in Denmark. Based on the key learnings from this report that include an analysis of the main identified pillars of a successful Bioconvergence ecosystem (Academics, Governments, Industries, Investors, Entrepreneurs, Accelerators), we will continue to identify stronghold and ways for international collaboration for the life science ecosystem of Denmark. ⊠

CONTENT

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BIOCONVERGENCE – CROSSDISCIPLINARY RESEARCH IN LIFE SCIENCE

Researchers, governments and insurance payers are looking for safer, more effective and more sustainable healthcare solutions. The need to prevent, diagnose and cure diseases rapidly and at reduced cost has created an aggressive push to rethink the current model. All over the world, the healthcare and life sciences sectors are changing before our very eyes.

An ageing global population and the rise in chronic diseases such as cancer, heart disease and diabetes are putting our healthcare systems under huge pressure. This is tremendously expensive: It is estimated that global healthcare expenditure will surpass $10 trillion in 2022. In the US alone, around 60 percent of the population suffers from at least one chronic condition, accounting for 90 percent of healthcare spending. The Covid-19 pandemic has further exacerbated the challenges of our healthcare systems and magnified the urgent need for better, cheaper, and faster solutions. We must prepare for future crises.

In recent years, bioconvergence has emerged as a concept that recognises that traditional science themes and models can be combined with technology to develop new, cutting-edge life sciences and healthcare solutions. Bioconvergence is expected to revolutionise the future of life sciences.

Israel and the US are among the frontrunners in the application and advancement of bioconvergence in research and development. Together they are establishing a vibrant and strongly competitive new industry, exploring bioconvergence as a national growth engine.

Denmark has long been a leader in life sciences, and the nation has all the ingredients to play an important role in the next era of healthcare. Denmark has built a strong research environment, and is home to innovative start-ups, successful corporates and visionary investment funds. The Danish government invests heavily in research and development, giving the country a good chance of becoming a global leader in bioconvergence.

Denmark can harness the potentials of bioconvergence by learning from the advancements in Tel Aviv and Boston. The nation would benefit from exploring collaboration opportunities with Israeli and US stakeholders, as international collaboration becomes increasingly important in healthcare innovation.

In this report, we explore the potentials of bioconvergence, noting how Tel Aviv and Boston have positioned themselves as leaders in the field. We then discuss how Denmark can be inspired by these two leading ecosystems to set up a strong healthcare innovation model driven by bioconvergence. ⊠

WHAT IS BIOCONVERGENCE

Bioconvergence is an approach to research and technological development that cuts across disciplinary and sectorial boundaries, emphasising the importance of cross-disciplinary research.

Aiming to address scientific challenges, bioconvergence integrates the science, tools, and ways of thinking from the disciplines of biology, chemistry, physics, engineering, medicine, mathematics, and computational sciences. It also borrows ideologies from other life sciences to form a synthetic framework that can be used to tackle scientific and medical burdens lying at the interface of multiple fields.

Bioconvergence has emerged thanks to a culmination of technological advances in the fields of engineering and biotechnology that occurred in the 20th and 21st centuries (see Figure 1).

Integrating ways of thinking from different scientific fields allows researchers and scientists to address specific, unresolved challenges in new ways and to advance discoveries in life sciences. This helps speed up diagnostic processes and drug development. Bioconvergence is revolutionising a wide variety of focus areas, including drug discovery, nanorobotics for drug delivery, regenerative medicine, diagnostics and biological sensors, optogenetics, bioelectronics, and engineered "living" materials. Experts believe it will transform personalised and precision medicine, helping to combat chronic diseases.

Bioconvergence holds particular significance for pharmaceutical companies. In recent years, the cost of producing new drugs has skyrocketed, and the return on investment in drug research has plummeted as a result. The graph in Figure 6.2 depicts how, in 1970, the average cost of creating a new medication was $179 million and that this price has almost doubled every decade. This represents a 15-fold increase, and the average cost of creating a new medication had risen to almost $2.6 billion by the turn of the century. It is interesting to note that, despite rising expenses, there has been no notable increase in the number of pharmaceuticals approved, »

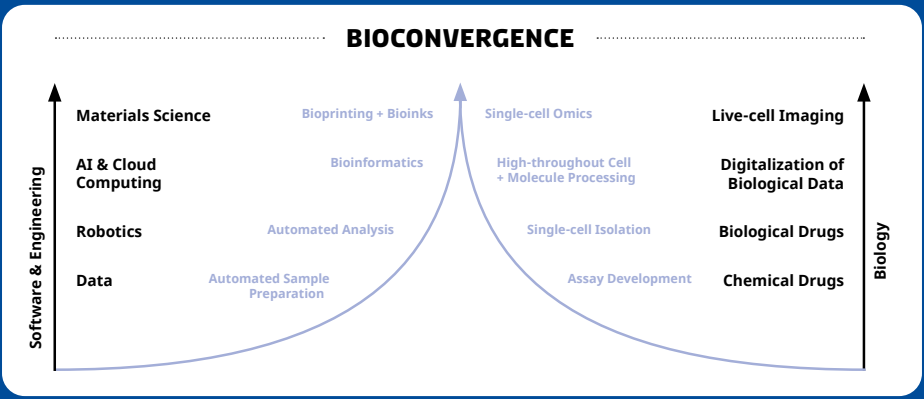

Figure 1

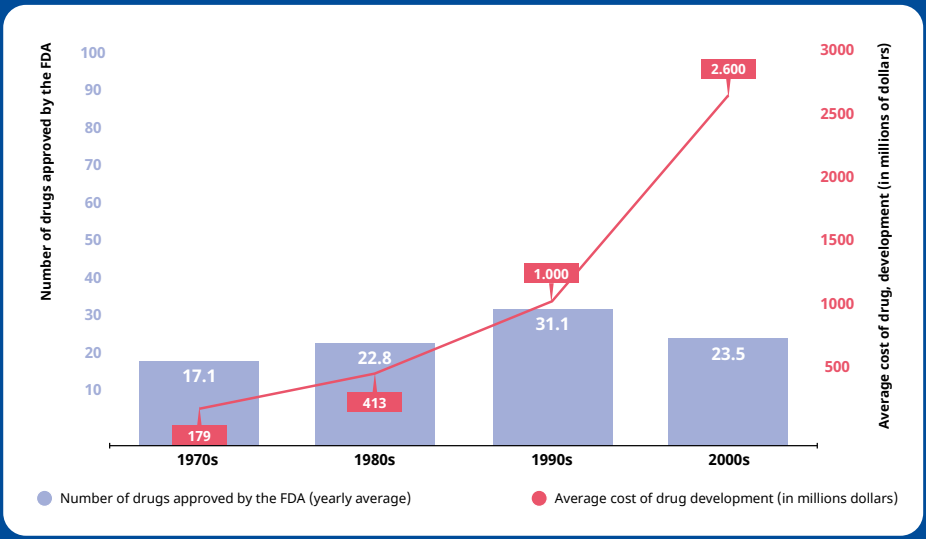

Figure 2: Development Cost of Drugs vis-à-vis Their Authorization in the US

» which has stayed relatively steady at a few dozen per year.

In addition, drug development is a long process that requires testing on humans and risks causing challenging side effects. We also struggle to find effective treatments for chronic diseases such as cancer, heart disease, and diabetes and have come to realise that they require a more personalised approach. As a result, the return on a new drug's development cost has dropped considerably. According to a Deloitte analysis that looked at 12 large public firms, the return on development cost in 2010 was above 10 per cent, but by 2018 it had decreased to around 2 per cent.

These issues have forced health systems and the biopharmaceutical sector to make significant changes in order to identify and produce accurate, tailored, and successful therapeutics. These are challenges that bioconvergence is believed to be able to meet. In this context, the principle of bio-convergence stimulates collaboration and innovation from basic science discovery to translational application.

This model fuels new collaboration building on an entrepreneurial culture that involves not only stakeholders from academia and fundamental research but also from industries, public authorities, and high-risk investors.

What are the benefits of bioconvergence in scientific discovery?

A national focus on bioconvergence will assist us in reaching several goals, such as accelerating new scientific discoveries in life sciences, engaging the vibrant community of researchers to tackle unmet and critical challenges, uplifting the level of science, and increasing societal involvement and interest in science. Coordination is crucial and provides a multi-agency, multi-stakeholder framework of common objectives and goals, leveraging the power of the government stakeholders best positioned to play the role of orchestra masters.

The fields of medicine and human health have seen numerous innovations in recent centuries, but while we previously tried to take a segmented approach to slow disease progression, we now have the potential to consider diseases and pathologies as multifactorial and highly complex disorders impacted by genetic, behavioural, and environmental factors.

A bioconvergence system should change the standards of care and patient management towards a more efficient way of treating patients, ameliorating healthcare systems, lowering costs of innovation, and fighting the inequality of healthcare around the world.

OUR APPROACH TO BIOCONVERGENCE

A fellowship like DARE fosters diversity, which is one of the key ingredients in developing strong researchers and making progress. DARE fellow Sandra Hertz spent 10 months at UCSF and developed a new network and mindset which enabled her to raise 1.2m DKK to return to the Bay Area to pursue a PhD.

Bioconvergence, by its very nature, involves multiple players from different backgrounds. A desk study on the topic guided us to tackle the Bioconvergence Project at an ecosystem level and brought about an Advisory Board to guide us along in this explorative work. The board includes representatives from:

- Academia
- Industry
- Government
- Entrepreneurship
- Ventures Funds
- Accelerators and incubators

The board has individuals from broad-ranging backgrounds. The experts guide the project in the right direction and ensure the successful establishment of an action plan for Denmark to optimize bioconvergence.

In 2021, we hosted three sessions with US and Israeli expert speakers, ranging from academics to industry and government spokespersons. These sessions form the basis of this report.

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Boston – a Leading Ecosystem for Cross-Collaboration in Life Sciences

INTRODUCTION TO THE ECOSYSTEM FOR RESEARCH AND TECHNOLOGY DEVELOPMENT

The concept of convergence has been embraced in the US since the 2000s, and leading ecosystems such as Boston and Silicon Valley have sought out new innovations.

Having enjoyed a global leadership position in the field of biomedical research since the 80s, Boston remains an industry leader and is likely to become a bioconvergence pioneer. The density and diversity of relevant actors in the Boston-Cambridge area has made the capital of Massachusetts a booming hub of innovation activities. A convergence culture persists between universities, industries, investors and governments, attracting players in global life sciences to the state, and sustaining the local innovation economy and network.

"If you draw a circle about two miles around Kendall Square, you probably capture something like 10 or 15 percent of all biomedical research in the United States."

Eric Lander
Founding president of the Broad Institute
11th Director of the Office of Science and Technology, Policy and Science Advisor to the President

Examples of Bioconvergence Projects and Initiatives in Boston

Illumina
Illumina is the company that brought down the price of human genome sequencing to less than $1,000 USD. Illumina, which was founded in 1998 at Tuft University, now develops, manufactures and markets integrated systems for the analysis of genetic variation and biological function. The company's services came about as a result of the parallel developments happening in nucleic acid synthesis, bead-based combinatorial chemistry, and fibre optic sensors developed by telecommunications industries.

Moderna
This MIT spinout was created in 2010 with the ambitions of bringing mRNA drugs to patients and becoming a global leader in this new era. After years of research and development, Moderna's innovative delivery systems and sequencing technology brought a clinically safe and effective vaccine against Sars-Cov2 to the global population—an achievement that took under a year and set a new record.

Boston Scientific
The next generation of medical devices has become more complex and invasive in nature, and addresses chronic diseases such as diabetes, heart failure and pain. Bioconvergence leads the developments in combining drugs with devices. The next step will be the development of bioelectronics and artificial organs. Boston Scientific, a global leader in the medical device industry, is fostering this movement through collaborations and internal innovation in neuro-reparation, urinary care, cardiology and more.

The Harvard Stem Cell Institute
The Harvard Stem Cell Institute (HSCI), founded in 2004, pursues stem cell science and regenerative medicine. The institute works with a network of more than 325 research faculties, and its labs across the university's schools, research centres, teaching hospitals and partner companies, work together to advance stem cell biology and discover new treatments for patients.

The Eric & Wendy Schmidt Center
The Eric and Wendy Schmidt Center was founded in 2020 out of an initiative of the Broad Institute. Working with industrial and governmental partners, the centre brings together a global network of scientists to promote interdisciplinary research between the data and life sciences. Its quest is to transform biology, and ultimately improve human health. Two recent revolutions inspired the creation of the Schmidt Center: the exponential growth and widespread adaptation of data technologies such as machine learning and cloud computing, and the dramatic advances in generating massive amounts of data about living systems through next-generation DNA sequencing, single cell genomics and advanced medical imaging.

The Broad Institute
Founded in 2004, the Broad Institute offers collaborative, cross-disciplinary expertise to support projects in biomedical research and genomics at any scale. The institute is a collaboration created by philanthropists Eli and Edythe Broad in conjunction with several organisations:

- MIT
- The Whitehead Institute,
- Harvard and Harvard-affiliated hospitals
- Beth Israel Deaconess Medical Center
- Brigham and Women's Hospital
- Children's Hospital Boston
- Dana-Farber Cancer Institute
- Massachusetts General Hospital

ACADEMIA: MASSACHUSETTS, THE ATHENS OF THE UNITED STATES

MASSACHUSETTS' POSITION IN ACADEMIC RESEARCH

Academic research is a crucial element of innovative ecosystems. Massachusetts is home to a network of universities and colleges which act like roots for innovative ideas and lay the foundation for the state's dynamic ecosystem. The environment of an academic institution offers research opportunities, solution developments, and collaborative education for future professionals.

Boston is home to two of the world's best universities. Harvard University and MIT are both located in Greater Boston. The area is also home to more than 85 colleges, including Boston University, Tufts University, University of Massachusetts and North-Eastern University. This creates a cultural and academic hub that spans five square miles.

Annually, about 55,000 scientific papers are published in Greater Boston. That's more than double the annual number of publications to come out of Denmark, which sits at around 24,000 each year.

Such a unique landscape attracts talents from all over the world, including post-doctoral students and researchers. Many seek to start their academic careers in this area and hope to have a serious impact on the world. The highly ranked universities attract many students from many backgrounds, and this adds to Boston's unique academic composition.

The co-presence of world-class universities, medical centres and hospitals, and 18 out of 20 of the world's biggest pharmaceutical companies makes Boston an attractive location and explains its retention of talent. The close relationships of so many institutions eases the way for innovative ideas into the market. For students, help and feedback is just around the corner, no matter where they are in Greater Boston.

THE ROLE OF ACADEMIC RESEARCH IN THE INNOVATION ECOSYSTEM OF BOSTON

Boston is home to a thriving entrepreneurial ecosystem as a result of its huge pool of talent. Local innovation hubs introduce the concepts of entrepreneurial thinking and those with big ideas have easy access to the resources needed to bring their concepts to life. This access is crucial for the evolution of ground-breaking science and the implementation of new concepts such as bioconvergence.

Academic institutions in other parts of the US tend to be organized into department silos, as has been traditional in research infrastructure for a very long time. Some silos are scattered in geographically distinct campuses, a method of organising that complicates interdisciplinary research development. This has been one of the challenges to establishing bioconvergence opportunities and bringing the experts of different fields together.

Intentional reorganization of the classic university structure can foster convergence in research, and some universities have even succeeded in breaking down the traditional silos.

In the US, academic institutions are considered the main drivers of bioconvergence since they possess the capacity to connect different research fields. There are many options when it comes to implementing multidisciplinary efforts. Training programmes—such as those offered to students of all levels by the Martin Trust Centre— are an efficient way of introducing the concept of convergence.

At MIT, it is mandatory for all science students to complete a biology course, independent of their study direction. This educates them in the culture of collaboration and lays the foundation for thinking broadly when putting new knowledge into a relevant context. Similar training programmes could easily be offered on data management and interdisciplinary research opportunities.

The development of programmes that involve partners in industry, governmental or non-profit organisations is key for academic researchers wanting to take advantage of external expertise. Such programmes are very implantable in Boston due to the strong ecosystem in which many such players are already in close proximity.

Academic institutions in Boston and the US in general have implemented convergent initiatives in multiple formats. Research institutes employing scientists with joint backgrounds in natural sciences and computer sciences is still a hypothetical occurrence. Yet it is highly plausible. These institutes and departments set out to solve concrete biomedical problems by exploiting the expert skills within their varied resources. Bioconvergence is the way research is conducted at an academic institution or department by combining research fields in a solution with remarkably more promising applicability.

One example of securing cross-functional disciplines at convergence-focused institutes is seen at MIT, where all members are consulted about recruitment, funding and mentoring. In this way, all voices can be heard and potentially satisfied. Another way used in academia to solve specific scientific problems is to establish entire remote campuses for the purpose of transdisciplinary research. The Wyss Institute is an excellent example of this.

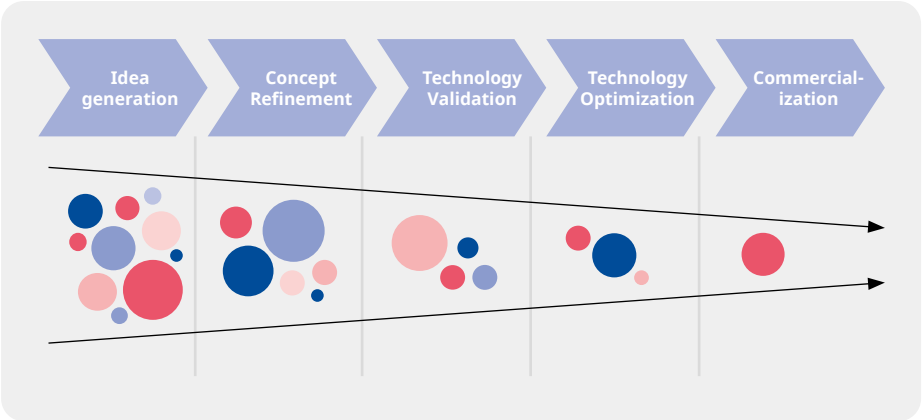
THE HARVARD WYSS INSTITUTE

At the Wyss Institute, bioconvergence is intrinsic to all academic research. Students from schools of medicine, engineering, science and art and design both within Harvard alumni and from 12 collaborating external academic institutions come together.

Here, they perform research in fields such as 3D organ engineering, predictive bio-analytics and living cellular devices. They utilize well-studied biological mechanisms of self-assembly, organization and structure to engineer innovative products and therapies used in healthcare, energy, architecture, robotics and manufacturing.

The Wyss Institute's research projects are developed and commercialized via the strategic creation of start-ups and partnerships in the industry. Successful examples include Editas Medicine, Gen-9Bio Synthetic DNA and Veritas Genetics (full human genome sequencing).

At the Wyss Institute, success is not only measured by the number of articles published, but also by the number of corporate alliances, intellectual property and licensing agreements made. This modern way of working contradicts the idea of a success scale based solely on publicity. Despite its focus, Wyss has still managed to publish 2,600 scientific articles in 12 years, including at least one Science or Nature article each month.



Process Development from Innovation to Commercialization – The Wyss Institute

The Wyss Institute model is referred to as an 'innovation funnel' and it has proven very effective. However, funding remains a major challenge.

Most funding bodies speculate in silos. They typically have a focus area and have not been trained to consider multi-disciplinary fields. Wyss had to convince their supporters that its concept is worth funding, and for the first five years, Harvard University was an important financial supporter. Eventually, the institute managed to create a sustainable model to move it forward.

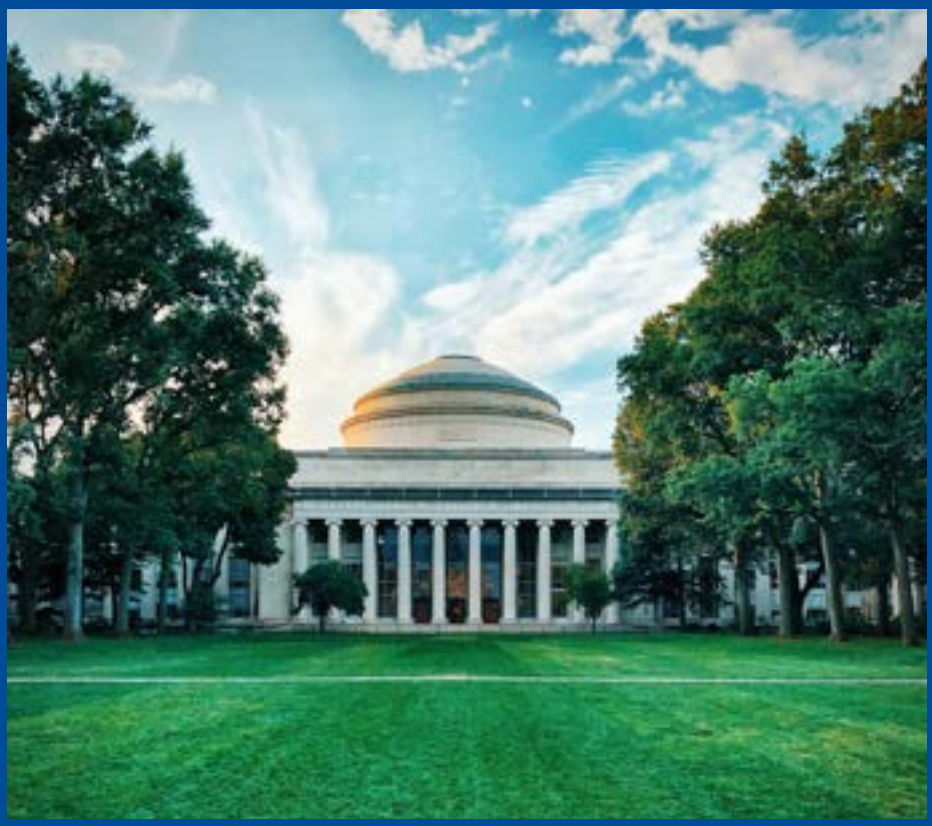
The Harvard Wyss Institute is still heavily dependent on generous donations. The Harvard Wyss Institute operates with a model where a minimum of administrative tasks allows more resources to be allocated to the commercialisation team. The minimal administrative tasks can only be maintained as all scientists working at Harvard Wyss remain affiliated with their home institution which carry out the administrative tasks and leaving their research at Wyss.

STRONG ACADEMIC INSTITUTIONS FOR BIOCONVERGENCE IN THE US

› Koch Institute for Integrative Cancer Research at MIT
At the Koch Institute, transdisciplinary interactions are secured by the physical properties of the premises. Housing faculty members from the biology department as well as several departments at MIT School of Engineering, the Koch Institute allows for crosstalk between biologists, chemists, computer scientists and engineers. This provides optimal conditions for bioconvergent projects aiming to develop new technologies to fight cancer and solve other problems. Robert S. Langer is the iconic institute professor and has an academic background in chemical engineering, as well as tremendous experience in combining expertise from various fields to deliver biological solutions.

› Janelia Farm Research Campus by Howard Hughes Medical Institute
Janelia Farm is an example of an entire campus that was established for the purpose of collaboration across research groups. At Janelia, there are no separate departments to hinder transformative research. Instead, 49 small research groups work on their own projects and share facilities. This enables them to collaborate across disciplines. Backgrounds cover biology, physics, computer science and engineering, which are exactly the competences required to solve complex biological problems. Being independent, Janelia narrows its focus to a few extremely challenging research areas such as neuroscience.

› Broad Institute, MIT and Harvard
The Broad Institute of MIT and Harvard is a research organization that brings together researchers from across many disciplines and partner institutions including MIT, Harvard and Harvard-affiliated hospitals. Based in Cambridge, Massachusetts, the Broad Institute was founded in 2004 to fulfil the promise of genomic medicine. Three years later, the Human Genome Project was created, helped along by Broad Institute scientists. The institute supports collaborative culture, launching innovative, high-risk projects at every scale.



Researchers at the Broad Institute invent new technologies, build and implement computational tools, develop new therapeutics to advance clinics, mentor and train the next generation of scientists and share data and tools openly to enable breakthroughs anywhere. Accelerating biomedical research and improving human health require diversity of all kinds. That means experts in education, training, background, perspectives, interests, and identity must come together to expand creativity when it comes to approaching problems and finding solutions.

The American model of problem solving is the creation of specific research institutes that take charge to attract and converge experts from all fields to work toward specific goals. Over time, this approach to research has led to a number of bioconvergence institutions being set up, and they can be said to be part of the successful US model. This model depends on public grants and fund as well as philanthropic donations.

An important component of these very specialized research institutes is the deep expertise of their collaborators. The culture calls for flexibility and creativity when looking for new solutions or taking and scaling new approaches such as bioconvergence initiatives.

THE BIOPHARMA INDUSTRY AND ITS ROLE IN BIOCONVERGENCE

Industry has often a naturally interdisciplinary outlook to problem solving. It is the structural formation of such organisations that allows for cross-sector and cross-department pollination, and their work culture fosters multi-angle problem solving.

The biopharma industry is a high-tech industry but players have traditionally tended to focus on narrow therapeutic areas. This high level of specialisation induces vertical organization, with different business units targeting different market sectors. Specialised therapeutic areas include consumer health, hospital markets, rare diseases, oncology, gastro-enterology, digital health and gene therapy. Useful as specialisation can be, creating such silos can slow down bioconvergence.

From the development of chemical blockbusters that address chronic diseases to the gold standard of personalized medicine and the development of biologics, the biopharma industry has seen great success. With the birth of bioconvergence, biopharma industries remain important stakeholders that are needed to finance high-risk projects and bring solutions to all steps of development and commercialization.

Technological progress has opened up great potential for life sciences industries to explore new ways in all challenging aspects of their value chain. Potentials include:

- Research and development
- Bio-manufacturing and distribution
- Pharmacovigilance and regulatory affairs
- Clinical development
- Drug delivery systems

Companies therefore play a critical role in adopting bioconvergence principles. Industry works with the scientific community and the various stakeholders of an innovation ecosystem to foster bioconvergence both internally and externally.

Kendall Square: The Global Leader in Biopharma Research

Boston has succeeded in attracting research and development units from most biopharma leaders, and proposes a range of attractive assets that include:

- Pioneering regulation in biomedical research
- A pool of talents from more than 80 universities
- Access to risk capital
- Cutting-edge academic research
- Tax benefits to attract international biotech pharma companies

This has resulted in the development of one of the first innovation ecosystems for biomedical research:

Kendall Square

In 2021, Boston was the first place to innovate life science. The city is home to 18 of the 20 biggest pharmaceutical companies in the world, and these companies are running research and development activities. In 2019, »

» Kendall Square was named the 'most innovative square mile on the planet'. Many players and initiatives have played a role in this success, and two of them could be described as being the most important ecosystem builders. These are the public Massachusetts Life Sciences Center (MLSC) and the private MassBio.

MassBio: The Massachusetts Biopharma cluster

MassBio is a private, not-for-profit organization that was founded in 1985. It provides services and support for the entire community of corporates, small and medium companies, start-ups and service providers in life sciences across Massachusetts.

The organisation represents more than 1,400 members across the state. MassBio plays an important role in animating and promoting life sciences across the scientific community. Networking opportunities are driven by all events that MassBio pilots each year to support and increase collaboration, education, and innovation across sectors. ⊠

BOSTON: AN ACTIVE ECOSYSTEM IN LIFE SCIENCE TRANSFORMATION

Science and technology innovation and progress have opened new fields in healthcare and improved the standards of managing disease in our society. In recent decades, several major revolutions have impacted the life science sector.

1950

The Cell Biology Revolution in 1950: Genzyme
Genzyme has been one of the most successful stories to come out of the Boston ecosystem. Founded by Sheridan Snyder and George M. White-sides in 1981, Genzyme also had a scientific founder, Henry Blair, who had a contract with the National Institutes of Health (NIH) to produce modified enzymes to test in clinical trials. The company was acquired by Sanofi in 2011 for $20+ billion.

1980

The Genomics Revolution in 1980: Illumina
Leading in next-generation sequencing, Illumina is a developer, manufacturer and marketer of life science tools and integrated systems for large-scale analysis of genetic variation and function.

2000

The Microbiome Revolution in 2000: Seres Therapeutics
Seres Therapeutics is a clinical stage biotherapeutic company focused on discovering and developing therapeutic products by targeting the underlying biology of the human microbiome. Founded by Flagship Venturelabs, Seres is pioneering the first therapeutics to catalyse a shift to better public health by augmenting the biology of the microbiome.

2000

The Multiomics Revolution in 2000: System Biology
A focus on system biology and 'omics' is found in the following section.

THE MULTIOMICS TRANSFORMATION

The one-size-fits-all strategy that shapes traditional drug development needs to be replaced by a more individualised healthcare model.

By identifying the factors that predispose an individual to a particular disease and the molecular mechanisms that cause the condition, it could be possible to identify drugs and drug combinations optimised for each individual's unique genetic background. And in the future, it could be possible to model individualised prevention strategies.

Recent technological advances in other high-throughput omics technologies allow for the retrieval of comprehensive and holistic data including genome, transcriptome, proteome, metabolome, microbiome and epigenome. This opens up the opportunity of capturing the whole picture of biological systems and paves the way for the next generation of precision medicine.

However, collecting significant amounts of data and integrating multi omics into patient-centric models remain very challenging. As a consequence, multi-dimensional data integration is currently a very active field of research. Different computational solutions from multi-staged (e.g. associations between the genetic variation and other "omics" markers to meta-dimensional analysis strategies (e.g., using machine learning and dimension reduction methods) are beginning to emerge to run the future generation of drug development.

The development of appropriate and efficient data storage, processing, integration and modelling strategies will continue to be a priority in the fields of clinical informatics, bioinformatics and statistics into the future. The aim is to successfully realize the promise of a multi-omics approach.

Boston and Cambridge ecosystems are leading this new revolution, as technologies and data integration converge toward drug development. Pharmaceutical and biotechnology companies are working with engineering schools to recruit talents they would not have traditionally worked with. Such talents are coming from diverse areas including data science, machine learning and engineering. This shift can also be seen at the company level, where the creation of new bioinformatics and data science teams has increased collaboration between life sciences and tech companies.

Systems biology is an approach used in biomedical research to understand the larger picture—be it at the level of organisms, tissues, or cells—by putting pieces together. It lies in stark contrast to decades of reductionist biology, which focused on taking the pieces apart.

Systems biology represents a novel approach that builds on the genomics revolution and is a good example of how bioconvergence will play out in the future. Large pharmaceutical companies are increasingly applying systems biology approaches and data in drug discovery, drug safety and drug development. They are focusing on identifying higher-risk individuals and carrying out in silico clinical trials.

Although the move towards system-level approaches is progressing as quickly as was anticipated 10 years ago, companies are increasingly recruiting professionals with interdisciplinary backgrounds. Apart from valuing individuals with mixed backgrounds and integrating systems biology approaches, further steps can be taken to »

» advance bioconvergence on a corporate level. One way of utilising the growing biological data that simultaneously leverages cross-sectional opportunities is to create platform-based business models in biology.

Companies have traditionally converged through mergers and acquisitions, and corporations now need to excel in in such strategies. Large corporations could develop the necessary capabilities in-house, working hard to master the right mixture of talents and collaborations. But mergers, acquisitions and partnerships will see positive results more quickly.

One example of this is the gene-editing technology, CRISPR, where there is a tendency for established players to set up research and development collaborations with start-ups working in the space. Some corporates are going a step further by partnering with multiple, and at times competing, start-ups. To capture the cost effectiveness and high precision of this tool, corporates could consider targeting their merger and acquisition capabilities to technologies like CRISPR. With the rapid transformation of technologies converging biotech and AI, corporations and start-ups are facing challenges in both research and design and commercialization. The structures of the future could therefore be barbell-shaped ecosystems characterised by cross-sector networks in which multiple small science-based companies are balanced by a few large corporations.

In Greater Boston, companies achieve the goal of bioconvergence between biologists, mathematicians and engineers in different ways. They benefit from the pool of multidisciplinary skilled talents coming out of local universities and create internal skills such as bioinformatics, machine learning and real-world evidence data. They also take advantage of the local ecosystem of entrepreneurs and focused companies to leverage the power of external innovation and collaboration.

These industries give Boston's ecosystem an impressive potential for problem solving. With their decades of experience in global drug commercialisation and data management, and deep expertise in disease, such industries have many opportunities to apply new sciences to business as well as the economic power to test new technologies and risk investment.

THE US GOVERNMENT: AN ACTIVE PLAYER IN CROSS-COLLABORATION FROM FEDERAL TO STATE LEVEL

The US government has been a proactive leader of innovation in life sciences. Two levels of governance support these efforts. At the federal level, there is a national strategy as well as national priorities and federal sources of funding and leadership. At the state level, strategies vary from state to state and depend on economic and social situation as well as local resources.

Both levels of governance remain key drivers in developing leading innovation ecosystems across the US and promoting bioconvergence. Initiatives from both levels are an integrative part of Massachusetts' success.

This two pronged model has allowed the US to run key scientific projects for the benefit of the global scientific community. The Human Genome Project is one of the biggest research projects ever carried out. Initiated in 1970, it aimed to decode and edit the human genome for a better understanding of disease mechanisms.

Piloted and financed by the federal agency and the NIH, the project involved more than 40 universities across the US. This ability to lead national scale projects on a top-down basis allowed the US to exploit a significant mass of data using state-level expertise and technicity, and encouraged cross-collaboration between the fields of biology, computational sciences, bioinformatics and genetics. Such a colossal logistic effort is a great example of bioconvergence.

Since the initiation of the Human Genome Project, other projects of its kind have been led and supported by the US government. Such projects include the Human Microbiome Project initiated in 2007 and the Cancer Moonshot programme initiated by Joe Biden while he was serving as vice president.

Taking a long-term approach and public funding remain key concerns for both individual researchers and institutional leaders engaged in bioconvergence A sustainable funding resource is crucial for this kind of cutting-edge project, and federal grants are therefore key sources of support for innovative, high-risks projects in bioconvergence. Such projects require many more resources than traditional vertical research projects, and the transdisciplinary review for grants allocation demonstrates the culture shift that needs to occur for further bioconvergence projects to take place.

The government plays an active role in promoting culture for bioconvergence, supporting structures that encourage the sharing of expertise, triggering formal and informal meeting opportunities between experts, and rewarding bioconvergence initiatives all across the US. We will look different examples of these in the following chapter.

How the Federal Government Works Around the Concept of Bioconvergence

Funding for science research and development mainly goes through discretionary funding agencies such as the National Institute of Health (NIH), the Department of Energy (DoE), the Office of Science, the National Aeronautics and Space Administration and the National Science Foundation. In the 2000s the DoE funded projects that were applying supercomputing to genetics research, and this led to a 'genomic revolution'. Thanks to such funding, scientists are now able to study an organism's entire genetic makeup by reading the basic DNA sequences and 'mapping' the human genome.

In time, genome research interests shifted and it is now predominantly funded by the NIH. In 2001 the NIH funded the establishment of the National Institute of Biomedical Imaging and Bioengineering (NIBIB). NIBIB programs accelerate the development and application of biomedical imaging and bioengineering technologies to study, diagnose and treat human disease.

The institute is an engine and testbed for innovative biomedical technologies which it generates at a robust rate. The NIBIB-funded research integrates engineering and the physical sciences with the life sciences, building on opportunities and technical discoveries from biomedicine. The institute spearheads the development of medical technologies that are better, faster, smaller, less costly and more accessible to people across the US and around the world. It is preparing the life sciences workforce for paradigm shifts, catalysing vital biomedical advances that will impact healthcare in the 21st century.

"Convergence science has advanced across many fronts, from nanotechnology to regenerative tissue. Although the promise has been recognized, the funding allocated for convergence research in biomedical science is small and needs to be expanded."

Phillip A. Sharp
Institute Professor at the Koch Institute, Nobel Prize winner, 1993

FEDERAL INITIATIVES & PROGRAMS IN SCIENCE & HEALTH

The National Science Foundation

The National Science Foundation (NFS) is an independent federal agency established by Congress in 1950 to promote the progress of science and technology and to advance the nation's health, prosperity and welfare, as well as to secure national defence. The foundation is the only federal agency whose mission includes support for all fields of fundamental science and engineering except for medical sciences. The NFS aims to keep the US at the leading edge of discovery in areas ranging from astronomy to zoology.

In addition to funding research in the traditional academic areas, the agency also supports 'high-risk, high pay-off' ideas, novel collaborations and numerous projects that may seem like science fiction today, but which, the foundation believes, the public will take for granted tomorrow. The NSF ensures that research is fully integrated with education, so that today's revolutionary workforce will also be training tomorrow's top scientists and engineers.

The concept of convergence in research is multifaceted and this is evident across the NSF's portfolio, which includes the six research-oriented NSF Big Ideas and, most recently, the NSF's Convergence Accelerator: a new mechanism to accelerate use-inspired research and facilitate its transition into practice. Recognizing that convergence is essential to pushing forward the frontiers of research in the US, the NSF has added growing convergence research (GCR) to its portfolio.

The objective of GCR is to incubate intellectual integration across disciplines in a rapid manner by supporting new, potentially sustainable relationships among researchers. The aim is not only to provide solutions to the problem that engendered the collaboration, but also to develop novel ways of framing related research questions and to open new areas of research. The GCR paradigm is based upon the assumption that researchers and stakeholders jointly frame their research questions from inception. They must collectively develop effective ways of communicating across disciplines and sectors, adopt common frameworks for their solution, and, where appropriate, develop a new scientific vocabulary.

The current GCR solicitation supports research projects inspired by societal and scientific grand challenges that warrant sustained team effort which crosses NSF directorate and division boundaries and that are not currently supported by other NSF programs, initiatives or Big Ideas. Problems that require the involvement of the larger research community and that will likely extend beyond the project duration are of particular interest.

Future pathways for the researchers beyond the project duration may include the initiation of large centres, institutes, NSF programs or even new disciplines. It is expected that successful teams may spend protracted time at the beginning of a project to develop effective ways of communicating across disciplines, supporting and training teams and developing common scientific vocabulary.

National Institute of Health

The NIH is the primary federal agency that conducts and supports medical, health and behavioural research. »

» About 80% of the NIH budget funds extramural research through grants, contracts and other awards. A further 10% goes to intramural research being carried out at NIH operated facilities. Almost all of this funding comes from the Departments of Labor, Health and Human Services, Education, and Related Agencies (LHHS),

Accelerating COVID-19 Therapeutic Interventions and Vaccines

Through accelerating COVID-19 Therapeutic Interventions and Vaccines (ACTIV), the NIH brings together government agencies, non-profit organisations and numerous biopharmaceutical companies.

ACTIV is a public-private partnership created to develop a coordinated research strategy for prioritising and speeding the development of the most promising treatments and vaccines. This initiative is coordinated by the Foundation for the National Institutes of Health (FNIH), and works alongside:

- The Department of Health and Human Services (including the Biomedical Advanced Research and Development Authority),
- Centers for Disease Control and Prevention,
- The Food and Drug Administration,
- The Department of Defence,
- The Department of Veterans Affairs,
- The Operation (formerly known as Operation Warp Speed),
- The European Medicines Agency,
- Representatives from academia, philanthropic organizations, and numerous biopharmaceutical companies.

Through the ACTIV initiative, the NIH is pursuing the four fast-track focus areas that it deems most ripe for opportunity, each of which is led by a working group of senior scientists representing government, industry, non-profit, philanthropic, and academic organizations. It aims to:

1. Develop a collaborative, streamlined forum to identify preclinical treatments;
2. Accelerate clinical testing of the most promising vaccines and treatments;
3. Improve clinical trial capacity and effectiveness,
4. Accelerate the evaluation of vaccine candidates to enable rapid authorization or approval.

THE CONVERGENCE ACCELERATOR: AN NSF INITIATIVE

Launched in 2019, the NSF Convergence Accelerator initiative builds upon basic research and discovery to accelerate solutions toward societal impact. The program funds teams to solve societal challenges through convergence research and innovation. To enhance its impact, the initiative also places teams together in cohorts, allowing them to synergize their work through facilitated collaboration.

While the overarching goal of the program is to enable long-lasting societal impact, results for each solution and the ways in which solutions transition to societal impact will vary. Examples include the integration of a solution into existing systems; the production of open-source tools and knowledge products, the expansion of solutions into new markets, and follow-on funding and investment.

The Convergence Accelerator's programme structure offers researchers and innovators the opportunity to accelerate their research toward tangible solutions that really make a difference. Taking a hands-on approach, researchers gain new skills and experiences that they can carry into their future careers. The program is use-inspired and application-oriented, and is fed by basic research and discovery. It integrates teams from industry, academia, non-profits, governments and the practices of other communities and offers intensive hands-on education and mentorship to participants.

Accelerating Medicines Partnership

The Accelerating Medicines Partnership (AMP) was launched in 2014 and is a public-private partnership between NIH, the Food and Drug Administration, multiple biopharmaceutical and life science companies and many non-profit and other organisations. It aims to transform the current model for developing new diagnostics and treatments. Current AMP projects are focusing on diseases such as Alzheimer's, type 2 diabetes, Parkinson's disease and schizophrenia.

AMP partners share the common goals of creating new diagnostics and therapies for patients and reducing the time and cost of developing them. The program aims to improve understanding of therapeutically relevant biological pathways and to validate information that could be relevant for the development of multiple therapeutics. Through this cross-sector partnership that is managed through the Foundation for the NIH, partners share their expertise and resources. The partnership has received over $650 million to date—some of it having come from kind contributions—and has an integrated governance structure that enables the best-informed contributions to science from all participants.

Initiative: Proposed Aadvanced Research Projects Agency for Health

To improve the US government's capabilities of speeding up research to improve the health of all Americans, President Biden proposed the establishment of the Advanced Research Projects Agency for Health (ARPA-H). The project will be awarded $6.5B over the next three years, and will be tasked with building high-risk, high-reward capabilities (or platforms) that drive biomedical breakthroughs.

THE STATE GOVERNMENT OF MASSACHUSETTS

The Massachusetts Life Science Center
MLSC was established in 2006 as an independent quasi-governmental organisation with the ambition of developing a hub for the Massachusetts life sciences ecosystem. It encourages innovation and economic growth by investing in science and business concepts that promise to strengthen and protect Massachusetts' position as a global leader in the life sciences. It also seeks to accelerate the commercialization of promising treatments, therapies and cures to improve patient care, create jobs and drive economic and STEM workforce development.

MLSC offers programs that fund innovation-driven economic and workforce development initiatives in Massachusetts. Since its establishment, MLSC has strategically invested over $700 million in the state, through a combination of grants, loans, capital infrastructure investments, tax incentives and workforce programs. This funding has propelled the development of new therapies, devices and scientific advancements to improve patient health and wellbeing in Massachusetts and beyond.

MLSC understands that the life sciences are much more than a simple sector. Instead, it sees the Boston ecosystem as a culture that's comprised of government, academic, and industry stakeholders working together. Such cross-sectoral leadership will remain integral to the continuing scientific and economic development. This ecosystem cultivate a collaboration with the private members of Mass Bio, equivalent to Medicon Valley Alliance for Denmark / Sweden.

Supporting Acceleration: The Example of LabCentral
Since its launch in Massachusetts in 2013, LabCentral has successfully shown how a public-private partnership can create an economic and scientific engine to drive the biotech industry and economy.

LabCentral was started with a founding sponsorship from private pharmaceutical company, Astellas, an MLSC grant and key support from MIT Investment Management Company. Since then, Thermo Fisher Scientific and Waters Corporation have joined as sponsors, and this, alongside additional funding from the private sector has sustaned the model.

The next generation of accelerator, LabCentral 238 (named for its postal address on Main Street), is the first-of-its-kind shared laboratory space designed as a launchpad for highly potential life sciences biotech start-ups. It trains experts for the Bio Manufacturing challenges and spans a total of 100,000 square-feet in the heart of Kendall Square in Cambridge. It houses an authorised laboratory and has office space for 70 start-ups, involving approximately 500 scientists and entrepreneurs.

BECOMING A DIGITAL HEALTH LEADER: A STATE-LEVEL STRATEGY

Massachusetts is today a strong actor in the digital health economy thanks to the Massachusetts Digital Initiative launched by the government in 2016. This public-private partnership is comprised of more than 30 healthcare experts from Massachusetts who advise Governor Charlie Baker's administration on ways technology can help improve healthcare quality across the Commonwealth, reduce costs and increase job growth.

The council, an outgrowth of the Massachusetts Digital Health Initiative, draws on dozens of leaders from tech companies, providers, payers, medical device manufacturers, life sciences, academia and government to help Baker position the Bay State to capitalize on a digital health market estimated to reach $32 billion over the next decade.

Baker, a former CEO of Harvard Pilgrim Health Care, led the first meeting of the Digital Health Council at the Massachusetts General Hospital Museum of Medical History and Innovation in 2016. The meeting focused on envisioning strategies that could help Massachusetts grow its efforts in technologies as varied as electronic health records, consumer wearables, data analytics and telemedicine.

"For Massachusetts to become a national leader in digital health, we need to continue to build on the momentum our Digital Health Initiative has already produced. This council will collaborate to move past barriers in the healthcare industry and solve significant challenges to make advances in patient care, lower health care costs and address public health crises like the opioid epidemic."

Charlie Baker in 2016

ENTREPRENEURSHIP: A DISCIPLINE TO LEAD INNOVATION FROM THE BENCH TO PATIENTS' BEDS

Implementing a Culture for Entrepreneurship Institutions

Entrepreneurs are essential agents of innovation. They have the ability to foresee and identify unmet needs and come up with innovative ways of meeting market demands. The culture for entrepreneurship is full part of successful life sciences clusters. By definition, life sciences clusters provides a supportive environment for entrepreneurs. The clusters give access to knowledge and mentors, as well as easy access to relevant network from research, education, finance or business.

While we speak about Bioconvergence ecosystem, an important responsibility relay on entrepreneurs capabilities to leverage all the different ingredients into a success story: Perfoming convincing proof of concept, establishing the best got-to market strategy, attracting smart money, recruiting the right talents, developing the company toward new markets ect.

Training the Right Entrepreneurs to Develop Bioconvergence

Some say everyone is an entrepreneur while others says it is something that must be taught. Whatever the truth, entrepreneurship remain a high-risk, high-reward career choice for any individual who decides to embrace it. It certainly makes sense to be educated about both the market you address and entrepreneurship itself.

This is where the different ingredients of the ecosystem come together. As with any other disciplines, an entrepreneur can go to university for training. It is fascinating to see how much universities has multiplied new curriculum for entrepreneurs. With the pool of talents with scientific, engineering and technical background in Massachusetts Universities, it is easy to understand that supporting entrepreneurship would naturally lead to a large number of start-ups based on bioconvergence.

The Martin Trust, Center for Entrepreneurship at MIT

The MIT Entrepreneurship Center is one of the largest research and teaching centers at the MIT Sloan School of Management. It was founded in the early 1990s with the mission of developing MIT's entrepreneurial activities and interests in education and research, alliances, and the community. Managing director, Bill Aulet, is responsible for leading the development of entrepreneurship education. His first book, Disciplined Entrepreneurship, was released in August 2013 and has been translated into over 18 languages and has been the content for three online edX courses which have been taken by hundreds of thousands of people in 199 different countries. It has become a primary text for entrepreneurs interested in learning about de-risking their start-ups.

The book does not only provide a proven pathway to becoming an entrepreneur. It also empowers those with the will to innovate.

The Arthur Rock, Center for Entrepreneurship at Harvard Business School

The Harvard Business School has always been a landing place for would-be entrepreneurs. But it wasn't until 2003 when iconic venture capitalist, Arthur Rock, donated $25 million for the creation of a program in the field of entrepreneurial management, that the Rock Center became a destination and centrepiece for the school's entrepreneurial efforts. We recognize here the same model based on philanthropic donation as the American Research Institutes.

Harvard and MIT are two examples of universities that offer specific training on entrepreneurship. Both models have similar features that are part of their success:

- A strong recognition of alumni resources;
- The creation of communities to fuel collaboration;
- Education based on real-life scenarios (pitch sessions, competitions, application of theories on concrete start-up projects);
- A diverse and complete network of resources for selected fellows (investors, mentors, advisors).

Increasingly, new initiatives are increasing diversity within entrepreneurship. Until now, most entrepreneurs have been highly educated men from wealthy families. But new initiatives are supporting women and minorities in their entrepreneurship ventures.

In 2015, Boston's mayor, Martin J. Walsh, launched WE BOS in with the aim of bringing more equity to the city's thriving business ecosystem. WE BOS connects female business leaders and helps them foster skills, get technical assistance, and plug into existing business networks. Women account for over half of Boston's residents. However, according to Women Entrepreneurs Boston, only one of every $23 in commercial bank loans go to women-owned businesses, while women-led businesses make up just three percent of venture capital investments in the city.

TRAINING ENTREPRENEURS AT THE PATIENT'S BED

Within healthcare, it's the healthcare professionals and patients that need most support. With this in mind, hospitals now develop their own curriculum to train entrepreneurs in life sciences and healthcare.

Even though hospitals and medical centres never intended to be used to train in anything other than clinical practice, these days they can play an important role in developing the practice of their own healthcare practitioners.

The Mayo Clinic Mode; From the Bench to Patients' Beds

Mayo Clinic, one of the leading hospital groups in the US when it comes to innovation and quality of care, has launched the Office for Entrepreneurship as part of its Center for Clinical and Translational Science. The aim of the model is to encourage a culture of entrepreneurship through education.

Sitting at the intersection of education and clinical exposition, the model is described by its director, Maarten Rotman, as having some key advantages:

- Early validation of need;
- Development of more user-friendly solutions;
- Shortened pathway from the bench to patients' beds;
- Ability to pivot projects thanks to continuous feedbacks from healthcare professionals ;
- Early Access to real-world proof of concept.

HIGH-RISK FUNDS: GASOLINE FOR BIOCONVERGENCE INNOVATION

Different Options for Access to Required Financings

Because expensive technologies are needed to discover, develop and validate bioconvergence innovations, there is a need for high-risk funding. The market size and the absence of regulation within the life sciences has allowed the US to become a global market, and it is still an attractive place for high-risk investors seeking high rewards. Such players have played an important role in the development of bioconvergence, specifically Greater Boston.

Aside from public funds, there are four main ways that entrepreneurs can use to financially sustain their work:

Angel Investors

An angel investor (also known as a seed investor, private investor, or angel funder) is a high-net-worth individual that offers financial support to small start-ups or entrepreneurs, typically in exchange for ownership equity in the company. They can usually be found within the entrepreneur's entourage, and provide a one-time investment to help the business launch or get through a difficult stage.

Private Equity

Private equity is a source of investment capital that usually comes from specialised companies called private equity firms. These firms purchase stakes in private companies or buy out public companies' with a view of privatising them and making them more profitable.

Venture Capital

Life sciences companies often need significant amounts of capital to reach their scientific and operational milestones, particularly in the clinical growth stages. Venture capital investments can help as they bring resources outside of financial assistance. They help founders and managers to navigate pitfalls and capitalise on scientific and market opportunities. »

"Historically, the US remains a great spot for private investors but competition is fierce between us to accede to the best deals. From an investor vision, it is expected, that a company attract private investment and do not live only with public fundings, as it shows the team ability to get to the private market."

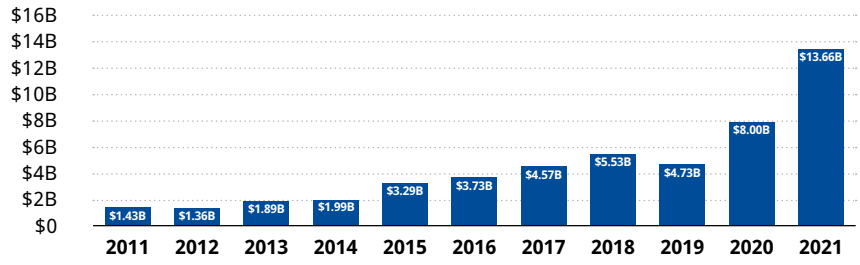
Anton Xavier
Director Silicon Valley Bank
Start-up Banking Life Sciences

» Initial Public Offering
An initial public offering is the process of issuing shares of a private corporation to the public for the first time. This allows a company to raise capital through public investors and offers share premiums to current private investors, rewarding them for their initial investment.

Debt Financing and Loans
Debt financing allows proprietors to maintain control of their companies. Lenders don't want a stake in the businesses they support, but business owners must make sure they can afford the cost of the monthly payments with interest. This can be the best option for those not prepared to give away a percentage of their companies.

All financing options are easier to accede in the US than anywhere else in the world due to the high concentration of financers, higher market volatility and the North American culture of risk investments. Competition between investors in the US has led to a valuation boom in companies and start-ups. This boom has taken the search for undervalued start-ups and science companies to other territories, and thanks to the quality of its science and light density of private investors, is a top choice for financers.

BOSTON: A STRONG FINANCIAL PLACE FOR BIOTECH INVESTMENT



VC investment in Massachusetts companies grew by just over **70%** from 2020.

36% of all US biopharma venture funding went to Massachusetts-based biopharma companies up from **29%** in 2020.

If Silicon Valley has been a paradise for tech companies to accede huge amount of risk capitals, its Biotech equivalent is Massachusetts. The Covid-19 pandemic and the scientific and financial success of Moderna Therapeutics have confirmed Boston as an Eldorado for the Biotech industry and those seeking to invest in breakthrough science.

Boston already held several records in term of funding per capita in the life sciences industry in 2020, but 2021 was an absolute record-breaking year for the city.

Following on the success of 2020, Boston's biopharmaceutical companies received $13.66 billion in venture capital funding in 2021—a 70% increase. This set a new record that eclipsed the combined venture capital funding from 2019 and 2020.

Thanks to the 25 Massachusetts headquartered biopharmaceutical companies that went public in 2021, the Massachusetts ecosystem will continue to drive significant growth within the biomanufacturing space across the Commonwealth. With lab space vacancies having hit 0% in Cambridge and Boston, much of that expansion will happen outside Massachusetts' traditional biopharmaceutical clusters.

Dedicated Financing Structures to Bioconvergence
Over time, the Bostonian ecosystem has become a leader in bioconvergence innovation and has continued to improve, de-risk, and accelerate the process of developing innovations in this highly regulated market segment. Innovative financing models born and raised in Boston are set to disrupt the ways in which successful companies are developed. Here are some examples of new financing structures:

Flagship Pioneering
Flagship Pioneering is a unique model that combines scientific creativity, technological ingenuity, systematic entrepreneurship, executive leadership, professional capital management and a vast network of experts in a single institution that produces first-of-their-kind businesses. Flagship Pioneering is the principal founder, funder and owner of many companies. It takes sole responsibility for the long-term success of these companies by providing them with all the resources they need.

Atlas Venture
Atlas Venture is a biotech venture capital firm that was founded in 1980 by Michiel de Haan as a subsidiary of NMB Bank in the Netherlands. The company spun out from NMB Bank in 1987, and in 1990, it diversified its venture capital funds to include life sciences and technology in its investment strategies. These two sectors that were very isolated at this time, so the move was an innovative one. Atlas Venture is committed to investing in promising pharma and biotech start-ups, focusing on finding and funding remarkable entrepreneurs with experience in research, business and clinical development––all necessary tenets for building a breakthrough biotech company.

INCUBATORS: NEST FOR BIOCONVERGENCE

INCUBATORS SUPPORT CROSS-DISCIPLINARY COLLABORATION AND BIOCONVERGENCE

Incubators are a key ingredient of the success of the bioconvergence industry. They are spaces where entrepreneurs from different horizons and sectors can meet, brainstorm, support each other and find synergies. They are essential structures that match the flexibility needs of fast scaling small- and medium-sized enterprises.

Incubators represent more than a simple real estate hosting solution for start-ups in the field of bioconvergence. They are company-specialised service providers, many of which focus on specific sectors or groups of entrepreneurs. Incubators may offer private, public or academic partnerships or they may invest in start-ups and receive equity in exchange.

There is space for many players and models as demand for support for early- and mid-stage companies grows.

In Greater Boston there are nearly

Boston Incubator and Accelerator Programs

50 start-up accelerators, incubators and similar support programmes. These programmes provide select early-stage ventures with office space, capital, mentorship, industry connections, investor introductions and other support. However, the spaces aren't just for founders. They also make great connection points for those who want to be involved with innovation in their industry, since they run events and offer partnership opportunities.

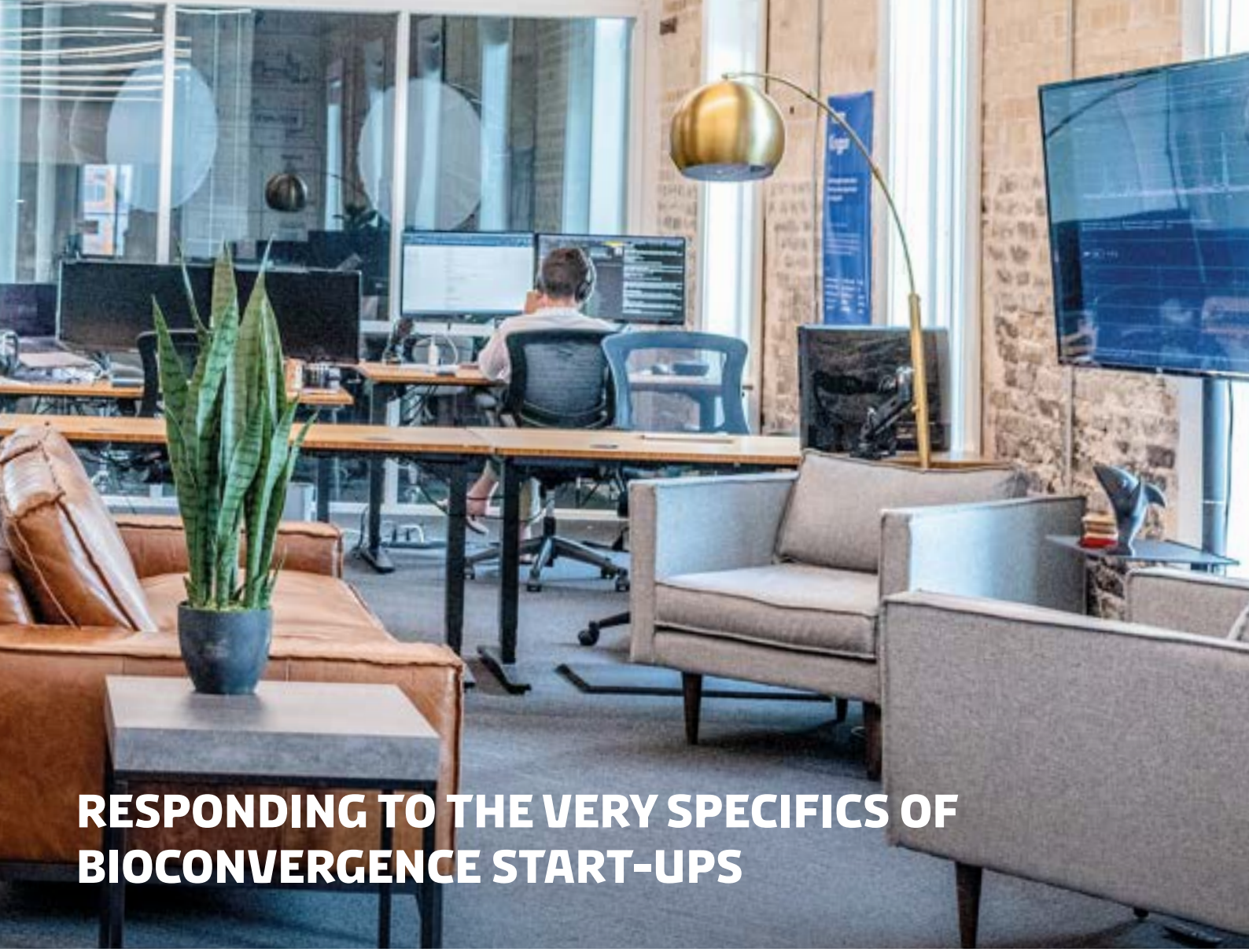
DIFFERENT TYPES OF INCUBATION: RESPOND TO DIFFERENT NEEDS

University-based Incubator
Typically, university-based incubators are sponsored by academic institutions and so give preference to faculty and student entrepreneurs from the same university or institute. These incubators use universities as a source of technology source and to help their sponsors leverage university research in their commercialisation efforts.

Region-specific Incubators
Region-specific incubators partner with area leaders in an effort to diversify a region's economy. They create a strong high-tech industry base and carry out technology transfer activities to build a strong entrepreneurial culture. Geographical focus is a natural competitive factor for regional business incubators since their mission is to support local businesses.

Industry-specific Incubators
Some incubators focus on a particular industry and create a network among entrepreneurs in the field. They may select their businesses by need, such as funding, office space, IT infrastructure or bench labs, or they may base it on staff training capacities.

For-profit and Not-for-profit Incubators
Incubators also differ in their strategic objectives. Some offer their products, technologies or services in exchange for profit while others operate on a not-for-profit basis.



RESPONDING TO THE VERY SPECIFICS OF BIOCONVERGENCE START-UPS

As we have established, growing a bioconvergence company requires major investment.

The state of Massachusetts has identified they key challenges faced by entrepreneurs in the field and has massively invested in facilitating the transition from scientific hypothesis to realisation. This public structure offers a bridge for bioconvergence students to become entrepreneurs in the bioconvergence ecosystem.

LabCentral is a Massachusetts non-profit company that was founded in 2013 as a launchpad for high-potential life sciences and biotech start-ups. Operating over 225,000 square feet in Cambridge and on the Harvard University campus, LabCentral offers a network of fully permitted laboratory and office spaces for as many as 125 start-ups comprising approximately 1,000 scientists and entrepreneurs. The company is committed to creating a more sustainable and inclusive biotech system supporting developments in STEM, workforce training, and next generation entrepreneurship through its LabCentral Ignite initiative.

LabCentral was funded in part by two $5 million grants from the Massachusetts Life Sciences Center. Founding sponsors include Eppendorf, Roche, Triumvirate Environmental and Johnson & Johnson Innovation.

To accommodate demand for its growing start-ups, LabCentral grew in size with support from Pfizer, Inc. in December 2017. The company went on to open an additional 100,000 sq. feet of shared laboratory and office space in 2021 at 238 Main Street, naming this sub-section LabCentral 238. Designed with a focus on process development and scale-up for bio-manufacturing, LabCentral 238's purpose is to facilitate company transitions from R&D bench-scale science into scalable production of pre-clinical material in anticipation of clinical and GMP manufacturing. LabCentral 238 will provide those within its network access to the scale-up, pilot plant facilities and technical support they need for their ongoing work

This collaborative model has proven very successful and has played an active role in Boston's success as an ecosystem. It remains a strong example of private/public collaboration, and this model has now spread across the US and beyond.

Although incubators do not directly execute bioconvergence science or projects, they clearly play a strong role in the success of ecosystems working within the field of bioconvergence innovation.

Tel Aviv – a Global Powerhouse for Bioconvergence

THE ISRAELI ECOSYSTEM: A DYNAMIC AND VIBRANT DRIVER OF RESEARCH AND TECHNOLOGY DEVELOPMENT

For Israel, bioconvergence is the new big venture. Led by the government, Israel is working strategically towards turning bioconvergence into the most important engine of growth within the nation's tech industry. This is not the first time that Israel has been a frontrunner in a brand new industry. It was also one of the first countries to identify cyber, fintech and AI as potential growth engines and is today a leader in these areas.

The Israeli ecosystem is well placed to take the leading role in bioconvergence, with its excellence in life science research, its strongholds in engineering disciplines and its position as the world's second-largest centralized electronic health records system. Israel boasts a vibrant start-up ecosystem with access to international venture funding and has a particularly strong ability to spin-out and commercialise research.

Israel has already established a strong bioconvergence industry comprising of over 80 start-ups. These companies have attracted multiple multinational corporations to establish bioconvergence-focused research and innovation activities in Israel, and a number of national and international venture funds have started investing heavily in the field of bioconvergence.

"Usually, one out of every ten meetings with start-up companies and researchers may be of relevance for Novo Nordisk. In Israel, maybe one out of every ten meetings was not relevant".

Jakob Steen Petersen
CVP of Global Research, Novo Nordisk

STRENGTHS OF ISRAELI INNOVATION ECOSYSTEM IN BIOCONVERGENCE

Israel is a leader in life sciences' research

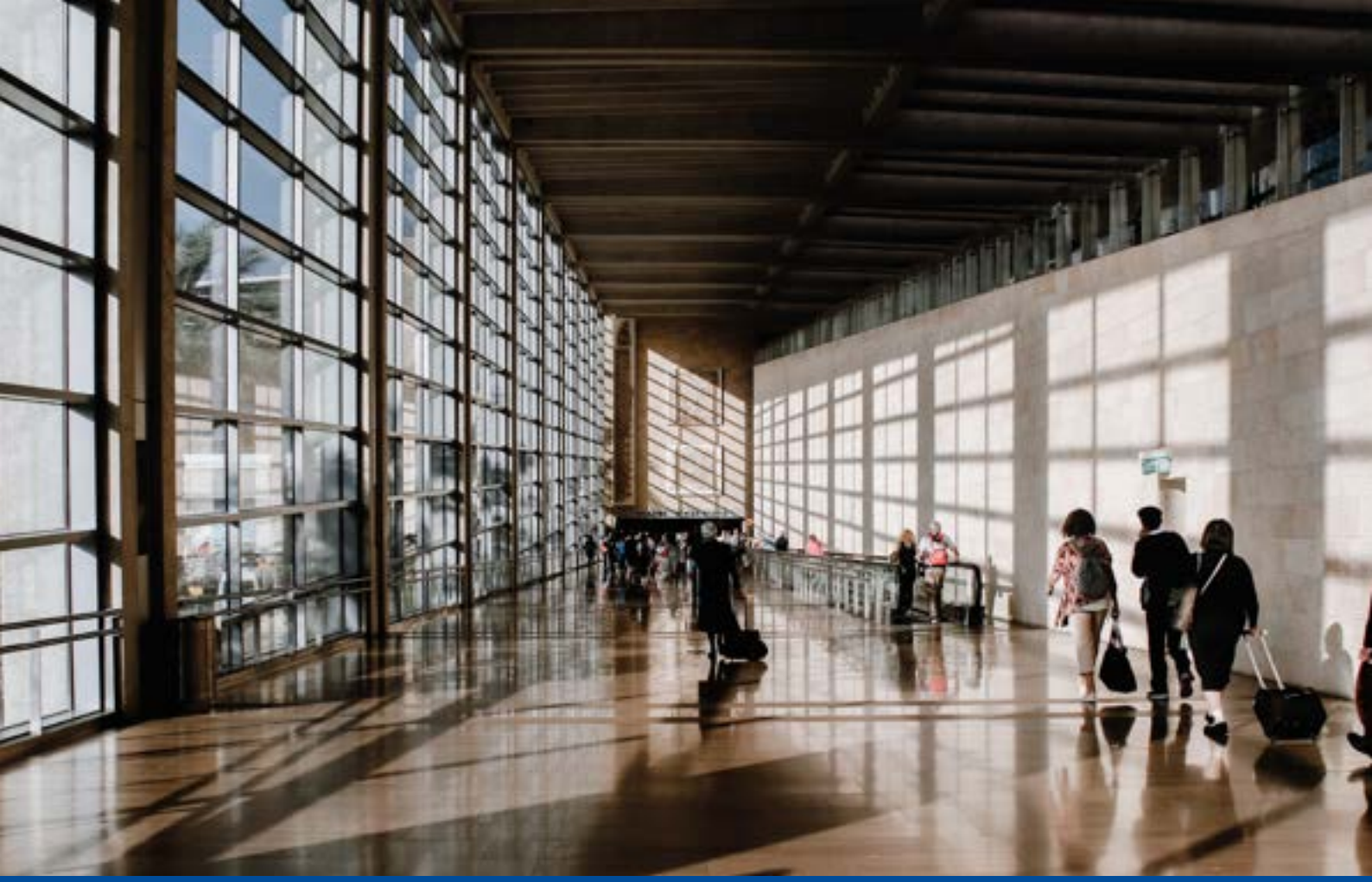
- Israel is ranked 4th. in the World Quotations Index for its multidisciplinary research
- Israel is 5th in the world in the number of patents per capita
- The Weizmann Institute for Science is ranked 2nd in the world by prestigious 100 Nature Index

Israel has a strong medical devices industry

- More than 600 active companies
- Exports of 1.6 billion dollars

Israel is a leader in AI

- More than 500 Israeli companies operate in the health industry and rely on AI technologies



EXAMPLES OF BIOCONVERGENCE PROJECTS AND INITIATIVES IN ISRAEL

Aposense
Aposense specialises in developing innovative drugs using the structural and electrical properties of biological membranes. Aposense has developed a way of energising molecular binding reactions for various medical applications, including imaging of cell death; formation of intramembrane drug depots for sustained release; and transmembrane delivery of macromolecules, such as DNA, siRNA and therapeutic proteins

Senseera
Senseera is an Israeli start-up that has formed a consortium with researchers in academia and hospitals as well as diagnostic companies. The consortium formulates body fluid tools for the early detection of diseases such as pancreatic cancer, fatty liver, hepatitis and Alzheimer's. The project is an example of the close multidisciplinary collaboration between different stakeholders of an ecosystem helping develop a new solution.

Precise-Bio
Precise-Bio has developed revolutionary technology in the field of tissue printing and engineering that enables the printing of individual cells.

MyBiotics
MyBiotics applies a bioconvergence methodology to harnessing the human microbiome for future health. MyBiotics has developed AI-based, culturing, fermentation and delivery technologies to generate a highly stable and diverse bacterial community that can be efficiently delivered to different sites across the human body to restore microbiome equilibrium.

MeMed
MeMed has developed a platform capable of making precise distinctions between bacterial and viral infections. The technology combines a smart algorithm with machine learning, systems engineering and molecular biology to decipher the reaction of the immune system.

Anima Biotech
Anima Biotech has developed a platform that finds selected small-molecule mRNA medicines and determines how they work. This unique technique blends AI mRNA image analysis with large-scale automated phenotypic screening in live biology. The platform's high-scale automation and integrated technologies have enabled the organisation to build a broad pipeline spanning 18 different discovery programmes.

ISRAEL: A STRONG ACADEMIC FORCE

In Israel, the fast-developing field of bioconvergence primarily springs out of multidisciplinary academic research. Both universities and hospitals are strong drivers of life science research and development, and both play a key role in advancing the potentials of bioconvergence. Israel is renowned for its excellence in academia, where technology and innovation go hand in hand, and where the commercialisation of research dominates. The country's strong academic foundation in bioconvergence serves as an important factor in attracting multinational companies and international investors to the region.

ISRAELI UNIVERSITIES: THE CORE OF BIOCONVERGENCE

Israel is home to seven world-leading research universities and one open university. These are:

- Bar-Ilan University,
- Ben-Gurion University of the Negev,
- The Hebrew University of Jerusalem,
- Technion Institute of Technology,
- Tel Aviv University,
- The University of Haifa ,
- The Weizmann Institute of Science,
- IDC Open University.

Hebrew University, Technion Institute and Weizmann Institute rank among the world's 100 best universities according to the 2021 Shanghai Ranking. Tel Aviv University was ranked as number 200 and Bar-Ilan University and Ben Gurion University of the Negev were ranked within the top 500. Israel spends over four percent of its GDP on R&D, the highest among OEDC countries.

Israel is also a leading nation in attracting grants from European framework programs, and Israeli institutions have produced five noble prize winners in the last ten years, all of them in natural sciences. Israel is a renowned research centre in the fields of biological sciences and precise sciences, ranking fourth in a global index that measures the average number of quotations per multidisciplinary research paper.

Israeli universities focus not only on the research and development of new solutions, but also place great emphasis on commercialisation for spinning out research. Israeli technology transfer companies are global leaders in establishing spinoffs and generating revenue and royalties from IP. Such revenues get reinvested in research and innovation. It's this ability to commercialise research that has resulted in the country ranking fifth in the world in patents per capita.

The Weizmann Institute has registered nearly 2,000 patents and around 73 spinoff companies, generating a cumulative income of around $28 million. The Hebrew University has registered 10,000 patents, 900 licenses and 125 spinoff companies, while Technion has established around 90 spinoff companies. These numbers clearly indicate Israeli universities' commitment and talent in commercialising research.

Within Israel's universities, bioconvergence collaborations tend to happen organically across different departments. Multidisciplinary research plays an integrated role in the nation's academic culture. For example, when Covid-19 hit and highlighted the need for better and faster solutions, the Technion Institute established the Human Health Initiative in collaboration with Rambam Hospital. The initiative is a research fund that aims to develop new therapies and create rapid diagnostics and technologies by pooling expertise from AI and mathematical modelling to immunology, chemical engineering and robotics.

ISRAELI HOSPITALS: CENTRAL DRIVERS OF BIOCONVERGENCE

In Israel, hospitals are also significant centres of research and innovation. They play an important role in driving bioconvergence. Ichilov hospital in Tel Aviv, for example, is leading the way in harnessing bioconvergence for hospital research and innovation, and it has plans to establish an on-campus bioconvergence research institute in collaboration with Tel Aviv University.

The large majority of Israeli hospitals have established innovation centres and technology transfer companies, and the nation boasts one of the highest numbers of hospital-sponsored innovation centres or healthcare accelerators per capita in the world. The country's hospitals work closely with industry in developing and spinning-out cutting-edge solutions, and provide crucial access to needs, solutions, experts, data and testing opportunities.

As an example, **Sheba Medical Center**, the largest hospital in the Middle East, has established an on-campus innovation centre called Accelerate Redesign Collaborate (ARC). ARC works closely with national and international start-ups and global companies such as J&J, Pfizer, Boston Scientific and Google in validating new solutions through access to data and clinical implementation. As a unique initiative, ARC has also joined forces with Triventures Venture Fund. Together the two partners have raised a seed fund of $45 million for investment in Sheba spinoffs.

As another example, **Rambam Hospital** has established the digital-health incubator, MindUP in joint venture with Medtronic, IBM, Pitango Ventures Capital and Impact First Investments. Together the partners accelerate the scaling of start-up companies and provide necessary access to validation and funding. Currently they have 13 start-ups in their portfolio, and these companies receive hands-on mentoring to build a solid foundation for a successful future. MindUP invests in six main categories:

- Bioconvergence and bioinformatics,
- Diagnostics and therapeutics,
- Chronic condition management,
- Sensors and remote monitoring,
- Clinical decision support systems,
- mHealth, Ehealth and LoT for healthcare.

Hadassah Medical Center is housing the world's first IBM accelerator on its Ein Kerem campus in Jerusalem. **IBM accelerator** provides start-ups with access to the hospital experts, data, testing and labs, while providing the companies with mentoring and guidance in developing, validating and commercialising new technologies.

These innovation centres are important vehicles for accelerating bio-onvergence research and development in collaboration with industry.

LEADING ACADEMIC INSTITUTIONS IN BIOCONVERGENCE IN ISRAEL

The Hebrew University of Jerusalem (HUJI)
Tissue Dynamics is a company founded by Professor Yaakov Nahmias from HUJI and Professor Doron Gerber from Bar-Ilan University (BIU). Nahmias is a bioengineer and the founding director of the Grass Center for Bioengineering at HUJI, while Gerber is a researcher at BIU's Institute of Nanotechnology. Tissue Dynamics is a biotechnology company developing the next generation organ on-chip (OOC) tools. Its unique microfluid platform imitates the physiology of real human tissues such as the liver and brain. This enables researchers to study the mechanisms behind new therapies and identify toxicity levels. It has the potential to transform the pharmaceutical, nutraceutical and cosmetic industries, since it can reduce research and development costs within the pharmaceutical industry by 30-80 percent. The company has received funding from the European Union's Horizon 2020 programme.

Weizmann Institute (WIS)
WIS graduates founded EmendoBio, a company that combines protein engineering, molecular biology and gene editing systems to achieve the best gene editing solutions. The technology addresses disorders and diseases that were previously considered incurable, and is currently focused on haematology, ophthalmology and immuno-oncology.

Another success story from WIS is Galvani Bioelectronics. Created by Professor Yael Yaniv and licensed to the pharma company GSK, this company forges miniaturized, implantable closed-loop systems that detect and deliver precision neuromodulation of specific nerve fibres to treat a wide variety of disorders.

Bar-Ilan University (BIU) and Sheba hospital
Professor Mira Barda-Saad and her research team at Bar-Ilan University have, in collaboration with Sheba hospital, discovered a new approach to treating leukaemia by combining biology, AI and machine learning. Using bioconvergence, researchers were able to identify small molecular compounds that damage cytoskeletal proteins in cancer cells in blood without damaging healthy cells. These compounds, called WASp proteins, control the activity and structure of actin to enable malignant functions in cancer cells.

Venture Capital
Life sciences companies often need significant amounts of capital to reach their scientific and operational milestones, particularly in the clinical growth stages. Venture capital investmeelopment in collaboration with industry.

THE ISRAELI BIOPHARMA INDUSTRY: A STRONG MAGNET FOR INTERNATIONAL COLLABORATION

The Israeli start-up ecosystem is in a good position to lead the bioconvergence revolution. Nicknamed the Start-up Nation, Israel is incubating some of the most promising developments in bioconvergence. With 1,600 active life sciences companies, and with unparalleled expertise in fields ranging from AI and digital health to nanotechnology, Israel is home to more than 600 active medical device companies, 500 AI-driven healthcare companies, and numerous research and development centres established by major multinational companies such as Medtronic, Philips and GE. If that weren't enough, the Israeli industry already comprises over 80 start-ups working in the field of bioconvergence.

Israeli bioconvergence developments are gaining international attention. Consider BiomX, which blends synthetic phages with a cutting-edge AI technology to find and develop novel microbiome-based therapies for cancer prevention and treatment. BiomX is a new, publicly traded firm that provides a complete end-to-end solution, from target identification to therapeutic drug development. Its method enables precise microbiome modulation and microbial balance restoration by adding or removing bacteria using native or synthetically altered phages.

Israel's achievements have been made possible by multi-stakeholder, multidisciplinary collaborations that brought together academic researchers, technologists and industry. The nation exemplifies the type of cross-pollination that lies at the heart of bioconvergence. But its Israel's world-renowned human that has led to the country's early success in bioconvergence. The Start-up Nation was born out of out-of-the-box thinking, and it is now in a good position to usher in a new era of healthcare.

Israel's bioconvergence capabilities and the enormous amounts of high quality research and innovation being generated within the field in the country are attracting multinational corporations to Israel. One such initiative is **AION Labs**.

AION Labs is a unique alliance of Pfizer, AstraZeneca, Merck, Teva, AWS and Israel Biotech Fund. It is an excellent example of bioconvergence collaboration that is spearheading the use of AI in drug discovery and development. The initiative is modelled after the German BioMed X Institute by inviting Israeli and international inventors, scientists, and technologists to solve R&D challenges of pharma with the support and guidance of years of accumulated know-how, data, and experience from their partners. Its team of experts hopes the technologies AION Labs is developing will pave the way to the future of pharma, removing the gap between technologies and markets.

A unique feature of AION Labs is that it attracts expertise from various disciplines, working across borders to form the best team to solve specific needs. This model breaks down silos, allowing for the truly multidisciplinary approach that bioconvergence requires. Not only that, AION Labs utilises global crowdsourcing with local incubation of the best research talents and ideas to solve the biggest challenges in biomedical research.

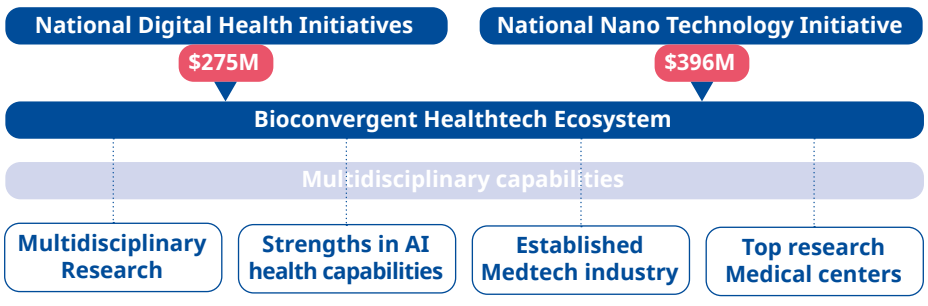
ISRAELI GOVERNMENT: A MOTOR FOR BIOCONVERGENCE ACCELERATION

The Israeli government plays an essential role in stimulating and advancing scientific fields with significant economic impact and the potential for developing into national strongholds and competitive edges. Israel's government is working proactively towards expanding and advancing bioconvergence nationwide and positioning its bioconvergence ecosystem as a global leader, with the assumption that the position will lead to global investments and attract the best players in the field.

The Israel Innovation Authority (IIA) is the primary governmental institution to be pushing the bioconvergence agenda in Israel. The IIA is responsible for planning and managing the government's growth strategies in industrial research and development, and it was established as an independent entity on 1st January 2016. Its structure was partly inspired by the Danish Innovation Fund.

The IIA aims to promote economic growth, contribute to national technological development, strengthen entrepreneurship, and improve R&D cooperation both nationally and internationally. The unit also plays an essential role in commercialising knowledge and technologies and in linking public-private partnerships between research institutions and industries. The IIA also helps showcase start-ups to foreign entities to help propel them forwards.

Despite the enormous potential of this field, the bioconvergence industry is still in its infancy and is characterised by high regulatory, clinical and financial risks. To overcome such barriers, the Israeli government encourages research and innovation through a variety of investment tools that provide initial and high-risk investments throughout the process from idea to raising round A funding, thereby de-risking science and technology for the ecosystem partners. »



Bio-convergence - Israel's Next Economic Growth Engine

National Funding Tools – Encouraging Bio-Convergence Across all Stages

The programs are based on the Israeli innovation paradigm, which emphasises open innovation, collaborations between academic research and industry as well as the translation of innovative technology to commercial application. Creating commercial relationships with large corporations, typically multinational corporations, is the main goal for many Israeli entrepreneurs. They thus have a considerable impact on the global ecosystem's structure.

The most significant tool for expanding the industry and creating a world-leading efficient ecosystem is the Incubator Program, Israel's strategic investment programme for early start-ups and spinoffs meant to attract private round A investments. The authority provides 85 percent of a start-up's total budget for the first two years, helping move new technologies through the first very risky stage of development, increasing the survival rate of start-ups without taking equity. It does this indirectly, providing funds via incubators, innovation labs and venture funds.

These incubators, innovation labs and venture funds provide the last 15 percent of the market and have the responsibility, as experts, in assisting start-ups and spinoffs scale to a level from which they can attract and raise round A financing. The tool is also available to international corporates and venture funds as a de-risked method for acquiring access to Israeli investment, and by this clever strategy, Israel has attracted international investors and corporates.

Key to its success is that Israel has invested public funds into companies and start-ups in order to attract private investments. In addition to providing funding, the programme creates a safe, regulated space for start-ups to play with their innovations before they move on to working with private investors. This approach naturally creates a significant number of exits, since companies and start-ups working within bioconvergence are routinely sold to corporations that are part of the incubator program, meaning their technologies and processes are absorbed into the multinational corporations.

To obtain its bioconvergence goals, the IIA is investing $10 million in new research and developments.

"Biology, mathematics, physics, they are all connected. The future is convergence. We cannot go ahead with silos and silos. Israel has great minds. We have a great culture of hi-tech and start-up companies, great minds that are reinventing everything, not only medicine, but technology and the internet. All of that can be and should be converged in a way that we reinvent the way that we understand things, confront challenges and progress with therapies. This is what medicine is going to look like in the future. Not only classic medicine, but a convergence of all sciences to rebuild the future."

Professor Ronni Gamzu
CEO of Ichilov Hospital, Israel

ISRAEL INVESTORS: A STRING AND LONG LASTING EXPERTISE IN FINANCING BIO-INNOVATION

In 2021, investments in the Israeli bioconvergence and related sectors crossed the $1 billion mark for the first time ever. Investments in the industry had nearly doubled between 2019 and 2020, and the previous years had seen average funding rounds relating to bioconvergence increasing significantly year on year.

Israel's investment environment consists mainly of venture capital, private equity funds and multinational corporations. Crucial to this is the presence of over 300 multinationals and cutting-edge research facilities. This ecosystem creates collaboration between big investors and multinationals, most often in the form of incubators and venture capital funds. There are over 25 incubators in Israel and the country has the highest venture capital volume per capita in the world.

The growing interest in bioconvergence has prompted more incubators and investment funds to focus on this sector. The Israeli ecosystem of incubators, resources, and facilities has created a low-risk model for investors that has attracted more international investment in the bioconvergence industry. Increasing investments from private equity funds and hedge funds, which usually invest in start-ups in the later stages and low-risk options, indicate this trend. Prominent examples include OrbiMed, Tige Global, Warburg Pincu and Viola Growth.

Some of the most noteworthy incubators and VCs in Israel are eHealth Ventures, AION Labs, and MindUp.

The Israeli healthcare provider Maccabi has partnered with global pharmaceutical firms Medison Ventures, Amgen Ventures, Shanghai Creation Investment, Mayo Clinic, and the Israel Innovation Authority to create eHealth Ventures. This partnership acts as a direct investor, incubator, and accelerator of start-ups in the field of bioconvergence and digital health and boasts a fund of over $30M.

Venture capital funds and investments in start-ups vary from a few million to over $100 million. Recent examples include the NGT Healthcare II fund $90M+ in capital and the start-up Viz.ai, which raised $100M as of April 2022, making it one of the newest unicorns in Israel.

ANALYSIS & NEXT STEPS

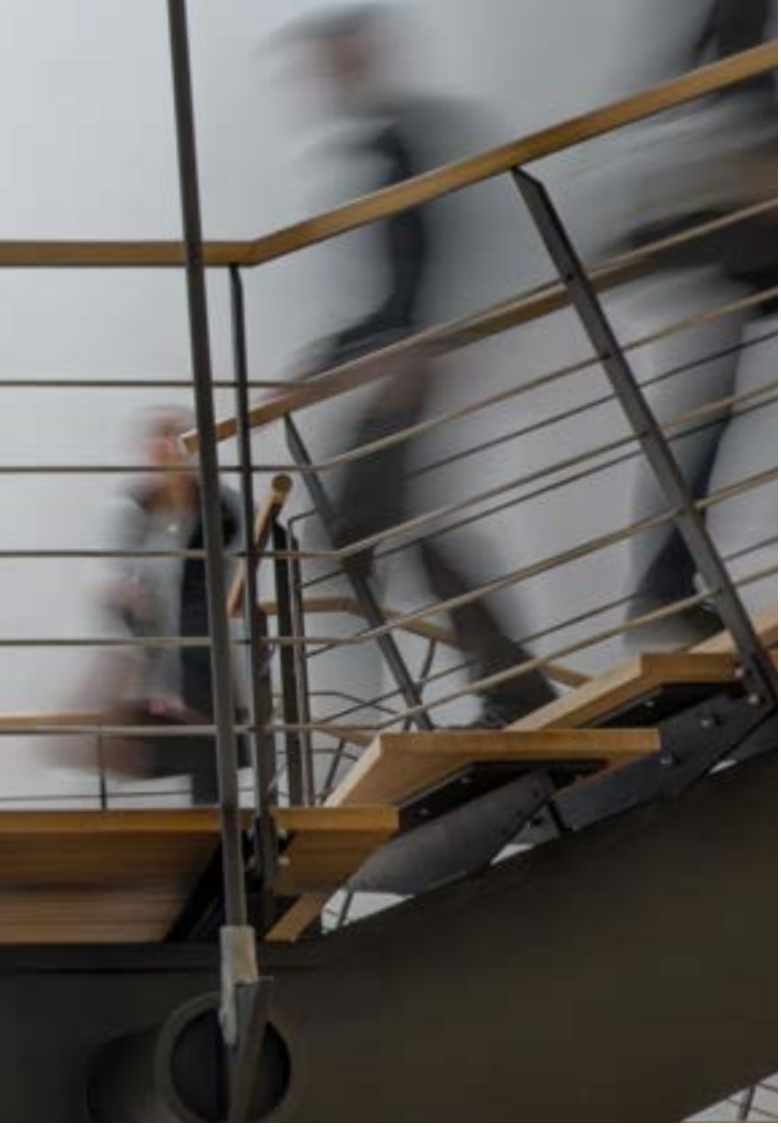
This report has led us to a better understanding of how bioconvergence as a strategy can support ecosystems and benefit the entire innovation community in value creation, economic development, and international influence. We will continue our focus in 2023.

Innovation Centre Denmark in Boston and Tel Aviv will discuss these conclusions and work together to identify the best ways to promote a mutual benefit relationship.

By taking part in workshops and exchanges with key experts from these two leading ecosystems, we have been able to define the main characteristics they share.

The Boston and Tel Aviv ecosystems both benefit from the presence of strong acdemic institutions and dense industrial networks spanning the biopharmaceutical and technology industries. They also share a common culture within which both private and public players participate in joint initiatives that support the growth and attractivity of the ecosystems.

All of this has led to the rise of multiple infrastructures that support knowledge sharing, entrepreneurship and innovation development in the sector of biology. Incubators, entrepreneurship education and accelerator programmes are just some of the many different ways of helping such ecosystems advance, and Boston and Tel Aviv have



both proven capable of meeting the needs of entrepreneurs.

However, although Boston and Tel-Aviv have a lot in common, they have not evolved based on the same strategy. While Boston's bioconvergence ecosystem was mostly born out of the academic sector combined with researchers' natural inclination to develop disruptive technology and solutions, Israel's strategy has been very much driven by the government. Israeli authorities enjoy a helicopter view of the local ecosystem and impulse the strategy to make it more collaborative toward this new field and to keep the ecosystem beyond the global leaders.

There are many explanations for this difference, including Israel's historic involvement of government in economic affairs, the different homeland market opportunities that exist between the two nations and differing structures and financing models of academic institutions and hospitals.

Boston Ecosystems: Key Takeaways

The Bostonian ecosystem is today considered one of the major US innovation hubs in both tech and life sciences. It even competes with Silicon Valley. Here are some of the main factors that have made this feat possible:

- Boston has a strong homeland market that accelerate the commercial success of local innovation,
- Its international reputation and public policy attract global companies and start-ups from all around the world,
- The ecosystem has both the will and investment possibilities to foresee the next challenges in life sciences and to develop next generation solutions,
- There is a strong culture of competition that thrives on breakthrough science in both industry and academia,
- The high-risk, high-reward culture exists in both the public and private sectors,
- Whatever comes out from the Bostonian ecosystem is broadly shared with the global community which supports its leadership position.

Tel-Aviv Ecosystems: Key Takeaways

Tel-Aviv's bioconvergence strategy is one of the most structured strategies in the world. This feeds local disruptive innovation and international collaboration in Israel;s tech capital. Here are some of the factors that make that possible:

- Tel-Aviv enjoys a small internal market of eight million inhabitants that led Israeli entrepreneurs, government and investors to build up a strong international network of partners,
- There is major public investment to finance and coordinate the ecosystem toward bioconvergence,
- Experienced investors and dedicated international R&D labs develop and finance biotechnologies,
- There is a strong pool of talents coming from all universities in Israel,
- Tel-Aviv boasts a strong landscape of industries capable of executing external innovation and supporting early-stage innovations.

INNOVATION CENTRE DENMARK BOSTON

INNOVATION CENTRE DENMARK TEL AVIV